Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Biodiversity Audit at Áras an Uachtaráin

Final Report

Prepared by

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October 2020

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HIGHLIGHTS

- 14 distinct habitat types were identified within Áras an Uachtaráin, with 80% of the 130-acre site classified as natural habitats, including
  - woodlands 29%
  - grasslands 31%
  - parkland 15%
- During the 12-month period (October 2019 to September 2020), 805 different species were identified within the boundary:
  - 297 species of plant: 176 flowering herbs, including the rare and protected Hairy St. John's Wort (*Hypericum hirsutum*), 67 trees and 32 grasses
  - 247 species of invertebrate, including
    - 73 moths including the Yellow Shell (*Camptogramma bilineata*)
    - 15 butterflies including the Comma (*Polygonia c-album*)
    - 32 beetles including the Rhinoceros beetle (*Sinodendron cylindricum*)
    - 24 spiders including the cave spider (*Meta menardi*)
    - 2 pseudoscorpions
  - 188 fungi, including 55 edible species
  - 51 bird species, from buzzards (*Buteo buteo*) to goldcrests (*Regulus regulus*), including the Amber-listed little grebe (*Sinodendron cylindricum*), which produced two clutches of chicks on the Áras pond in 2020, and the Great Spotted Woodpecker (*Dendrocopos major*), which was recorded in the Arboretum.
  - There were 18 mammal species observed, from foxes (*Vulpes vulpes*) and badgers (*Meles meles*), to bats (*Pipistrellus nathusii*) and pygmy shrews (*Sorex minutus*)
- The most diverse habitats were the woodlands, in which nearly 500 different species were recorded, followed by the semi-natural grasslands (including the parklands) in which 334 different species were recorded.
- The wet grasslands, which account for only 0.4% of the overall area of the Áras, contained 18.5% of all of the species recorded.
- The current management is already sensitive to, and promoting, biodiversity on site, but recommendations for enhancing biodiversity are provided, whilst still maintaining the historic landscape, aesthetic appeal and formal function of the grounds. These include improving the quality of the semi-natural grasslands and creating more wetland habitat, as well as providing homes and food for a range of species.

EXECUTIVE SUMMARY

Biodiversity is the variety of life on Earth: all of the different types of habitats and the species of microorganisms, fungi, plants and animals they contain. Biodiversity supports everything that we need to survive - food, clean air and water, raw materials, fertile soils and stable climates. However, we are in the midst of a biodiversity crisis, with worldwide degradation and loss of habitat, species extinctions, and declines in populations of wild species. Urbanisation, industrialisation and intensification of agriculture have transformed and fragmented wildlife habitats. We have tidied up our green spaces, treated wildflowers as weeds, paved over many of our lawns and filled in holes in buildings and trees. This loss of biodiversity matters to all of us, because of the crucial role that ecosystems play in supporting life on earth. We need to work together to make changes across our countryside, towns and cities to restore healthy environments that support both people and nature.

> "*Reversing biodiversity loss requires all of us to be leaders within our own spheres of influence – in our homes, our places of work…in our communities – to demonstrate the message that our biodiversity…is our right, but also our responsibility.*" -
> President Higgins, National Biodiversity Conference, 2019.

At the request of President Michael D. Higgins, the Office of Public Works commissioned Trinity College Dublin's School of Natural Science to conduct a 'biodiversity audit' of Áras an Uachtaráin and its grounds, and to make recommendations to improve and maintain the biodiversity of the grounds. Áras an Uachtaráin is located within the Phoenix Park, Dublin. The house is set amid 130 acres of parkland and gardens dating back to the construction of the house in 1751. The grounds contain features such as an arboretum, wilderness area, formal gardens, avenues, walks, ceremonial trees, an ornamental lake with a boat house and a walled kitchen garden, producing organic fruit, vegetables and flowers for the Áras. There are also several pastures where horses are, and until relatively recently, cattle have been grazed.

From October 2019 to September 2020, with the exception of the Covid-19 restriction period (March-May 2020), a team of ecologists from Trinity College Dublin regularly surveyed the habitats within Áras an Uachtaráin in order to quantify both habitat and species diversity, and update the habitat map, on the 130-acre site. Fourteen distinct habitat types were identified within the Áras, which means the site is extremely diverse given its size. In total, we identified 805 species from over 3500 records. These figures do not include the many horticultural varieties of plant grown in the kitchen and formal gardens. In total, we identified 297 species of plant, 247 invertebrates, 188 fungi, 51 bird species, 18 mammal species, and 2 fish. It is the first time a year-long biodiversity audit has been conducted by the OPW and TCD.

Certain species are particularly noteworthy. The threatened plant, Hairy St. John's Wort (*Hypericum hirsutum*) was recorded in two locations in the grounds of the Áras. Two species of cave spider *Meta menardi* and *Meta merianae* were recorded in the old Ice House tunnel. These species have very specific habitat requirements and consequently have a limited distribution. The Great Spotted Woodpecker (*Dendrocopos major*), a recent natural reintroduction to Ireland, was recorded in the Áras, and the Amber-listed Little Grebe (*Sinodendron cylindricum*) produced two clutches of chicks on the pond during this year's breeding season. The Áras is home to the majority of Irish bat species, who utilise its woodlands, pastures and pond, including the Nathusius bat (*Pipistrellus nathusii*), one of our rarer species.

Two invasive plant species, Japanese Knotweed (*Fallopia japonica*) and Giant Hogweed (*Heracleum mantegazzianum*), were recorded growing in the grounds of Áras an Uachtaráin, but are being actively managed by the OPW. Two invasive mammal species that were previously recorded in the Phoenix Park, the American mink (*Neovision vision*) and the bank vole (*Myodes glareolus*) were not recorded during this survey. However, the invasive grey squirrel (*Sciurus carolinensis*) is extremely abundant, as it is throughout the Phoenix Park. While the Áras grounds are of national significance from a historic landscape perspective, their biodiversity potential is fully compatible with this ethos as set out in the Florence Charter and reinforced within the Phoenix Park Conservation Management Plan.

The site and its management are already benefitting biodiversity. There is a mosaic of different habitat types in close proximity to one another, pollinator-friendly planting, organic horticultural practices, a promising wildflower stock, and wildlife-friendly management practices such as leaving dead wood to decay naturally. Over 80% of the Áras Demesne is made up of woodlands and grasslands, with the Formal Gardens and Kitchen Gardens accounting for a further 10% of the area.

There is potential to further enhance biodiversity, whilst still maintaining the historic landscape, aesthetic appeal and formal function of the grounds. The most significant actions would involve 1) improving the quality of the semi-natural grasslands, and 2) creating more wetland habitat. Specific actions to provide nesting and roosting opportunities for different species, and deliberately encouraging certain host plants for invertebrates are recommended. Ultimately, a mosaic of different habitats in close proximity to one another, each with its own diverse and robust population of plants, support a diversity of invertebrates, which in turn support the birds and mammals. Successful management for biodiversity relies on getting the foundations right, good habitat management thereafter and a long-term perspective. The long-term management and monitoring of biodiversity at Áras an Uachtaráin is important, along with continued scientific research. Opportunities for training and education on best-practice should be pursued along with a public outreach programme.

INTRODUCTION

What is biodiversity and why does it matter?

Biodiversity is the variety of life on Earth, all of the different types of habitats and the species of microorganisms, fungi, plants and animals they contain. These organisms have evolved together over millions of years to interact with one another in ways that produce healthy, balanced ecosystems. Everything that humanity needs to survive - the food we eat, the water we drink, the air we breathe, soils in which to grow crops, landscapes for health and recreation, and even regulation of our climate – relies on biodiversity. For example, plants provide oxygen, absorb carbon dioxide, regulate flooding and prevent soil erosion. Bees, hoverflies, butterflies and moths pollinate crops such as fruits, nuts and oils, as well as nearly all wild plant species. Insects and other wildlife break down fallen leaves and wood, animal dung and other detritus – creating rich soils for more plants to grow. Time spent in natural environments is hugely beneficial to our physical and mental health and well-being.

However, we are in the midst of a biodiversity crisis, with world-wide habitat degradation and destruction, species extinctions and declines in global populations of plants and animals. Urbanisation, industrialisation and intensification of agriculture have transformed and fragmented wildlife habitats. We have prioritised a small number of "desirable" species in our green spaces, treated many wildflowers as weeds, paved over our gardens, drained our wetlands, and filled in holes in buildings and trees. Furthermore, the threat of climate change only exacerbates the extinction risks for many species. However, there is room for people and nature, and it is not too late to make changes that benefit biodiversity and our enjoyment of it. Positive changes, like growing wildlife-friendly plants, letting lawns grow longer in places, adding ponds and nesting places, can help support biodiversity, and connect people with nature again. The more different types of green space, and the more people who get involved, the better!

Together we can all make changes across our countryside, our towns and our cities to restore healthy environments that support both people and nature.

"*Reversing biodiversity loss requires all of us to be leaders within our own spheres of influence – in our homes, our places of work…in our communities – to demonstrate the message that our biodiversity…is our right, but also our responsibility.*"

- President Higgins, National Biodiversity Conference, 2019.

The Audit

At the request of President Michael D. Higgins in August 2019, Trinity College Dublin, The University of Dublin, was awarded a contract to complete a biodiversity audit of Áras an Uachtaráin, Phoenix Park (Figure 2 and 2) by the Office of Public Works (OPW) over a 12-month period commencing in October 2019.

In summary, the project aimed to deliver:

1. Inventory of the formal, horticultural and natural habitats found in the Áras (including those of potential value to protected species), classified according to Fossitt (2000), and mapped using GIS, along with current management regimes for each habitat type;
2. Current species lists of the plants and animals in each habitat type, identifying those of conservation interest (protected, rare, notable at local/regional/national level);
3. Recommendations for both short- and long-term management actions to improve biodiversity, consistent with the Phoenix Park Conservation Management Plan 2011;
4. Biodiversity Audit Report for Áras an Uachtaráin.

The project was conducted by a team of biodiversity experts based in the School of Natural Sciences, at Trinity College Dublin, Ireland's premier research-led academic institution, led by Professor Jane Stout, and managed by Dr Aoibheann Gaughran. The team also involved several expert consultants and students who assisted with sampling (Figure 3).

This report builds on previous surveys that informed the Phoenix Park Conservation Management Plan, and subsequent surveys, carried out in the Phoenix Park. Here we present the results of the surveys for each habitat type present in Áras an Uachtaráin in turn, make recommendations for the enhancement of its biodiversity, and highlight opportunities for public engagement and education about the value of biodiversity.

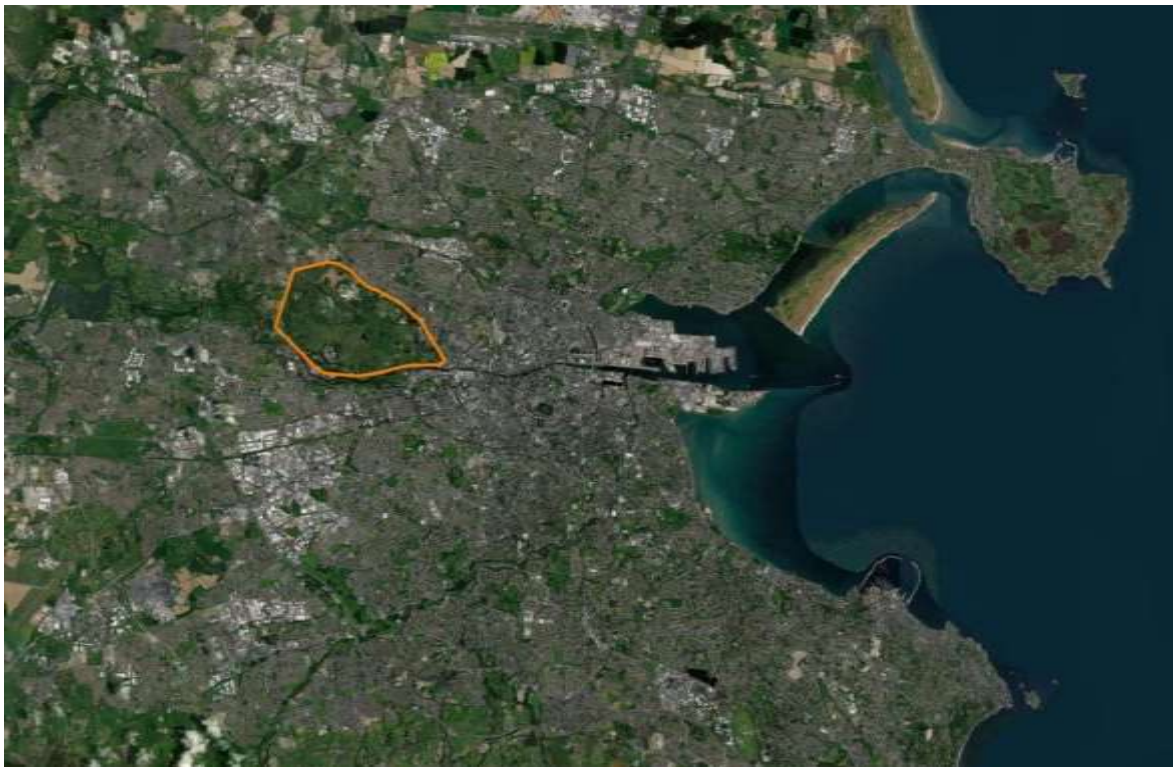

Figure 1 Location of the Phoenix Park in Dublin.

Figure 2 Location of Áras and Uachtaráin within the Phoenix Park, Dublin.

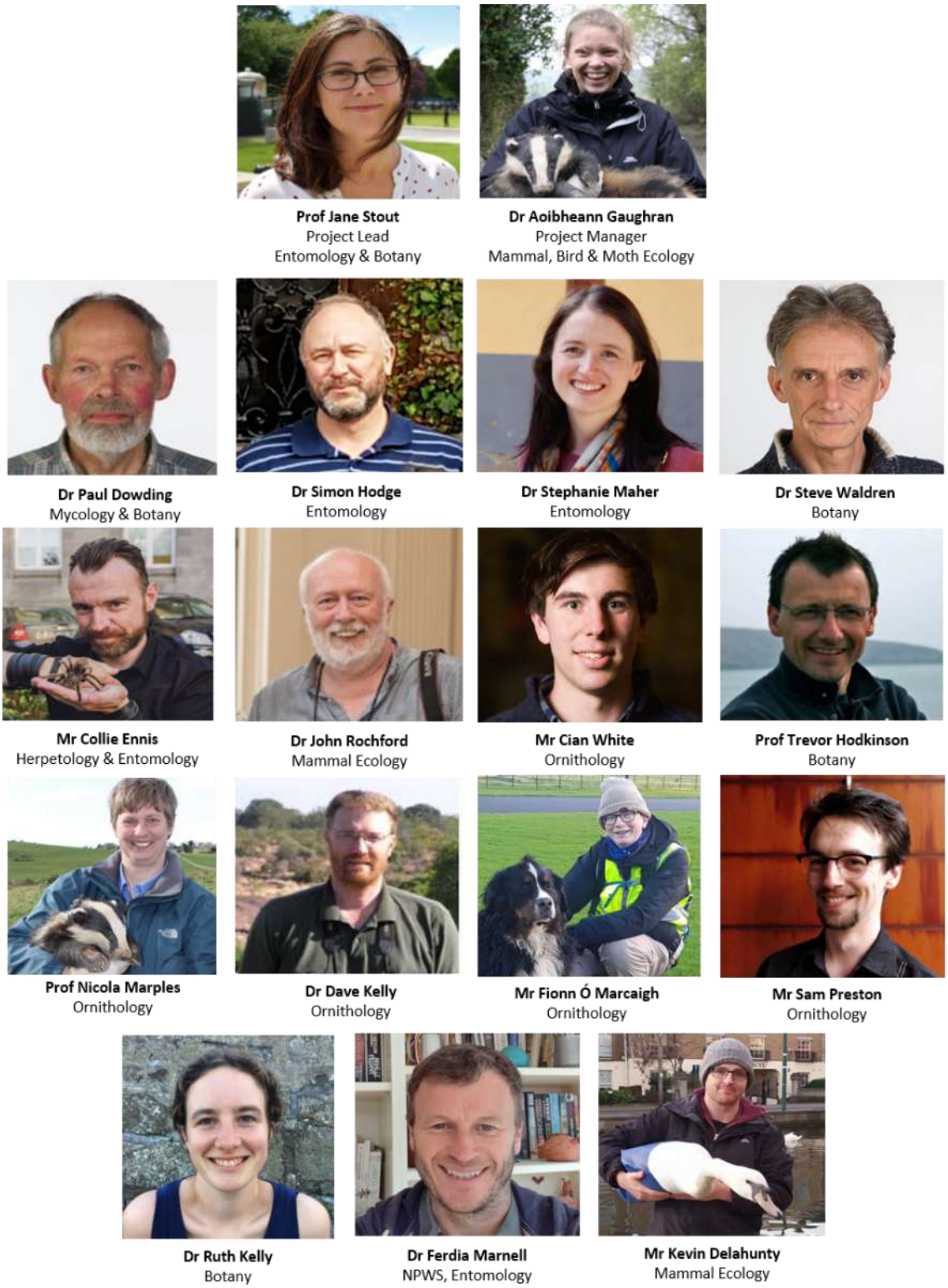

Figure 3 Members of Trinity College Dublin's Biodiversity Audit Team.

INVENTORY OF HABITATS

Within the grounds of Áras an Uachtaráin, 14 different habitat types have been classified according to Fossitt (2000) (Table 1). An updated habitat map (Figure 4) reflects changes to the extent of habitats in recent years, and the types of habitat present, based on the plant species identified by the TCD team during the course of the 2020 surveys. For example, the extent of areas originally classified as Scattered Trees and Parkland has increased, presumably as planting has matured. Changes in the management of grasslands also altered some of their classifications, although there is great variability in the quality of these grasslands, depending on how particular areas have been managed. Figure 5 highlights the location of specific areas that are mentioned throughout this report.

Table 1 List of Habitat Types Identified in Áras an Uachtaráin, 2020.

Habitat Type	Colour Code	Fossitt Code	Area/ Length	% of Total Area
Mixed Broadleaved Woodland		WD1	145905 m^2	29.1
Mixed Broadleaved/Conifer Woodland		WD2	12446 m^2	2.5
Conifer Woodland		WD3	4260 m^2	0.8
Scattered Trees and Parkland		WD5	73865 m^2	14.7
Ornamental/Non-Native Shrub		WS3	821 m	0.2
Dry Calcareous/Neutral Grassland		GS1	155874 m^2	31.1
Amenity Grassland		GA2	28247 m^2	5.6
Wet Grassland		GS4	1910 m^2	0.4
Artificial Lakes & Ponds		FL8	2910 m^2	0.6
Drainage Ditches		FW4	1425 m	0.3
Treelines		WL2	382 m	0.1
Horticultural Land (Kitchen Garden)		BC2	18196 m^2	3.6
Flowerbeds and Borders		BC4	6624 m^2	1.3
Buildings and Artificial Surfaces		BL3	48733 m^2	9.7

Figure 4 Habitat Map for Áras an Uachtaráin, 2020.

Figure 5 Names of areas within Áras an Uachtaráin referred to in the report.

INVENTORY OF SPECIES

Species Lists

In total, 3,511 records of plants, animals and fungi were made, which comprised 805 individual species (Figure 6). A list of species recorded in Áras an Uachtaráin during this project is available in Appendix 1 Species list for Áras an Uachtaráin 2019/2020. While this list is as comprehensive as possible, it is not exhaustive as certain groups were not surveyed systematically during this audit, *e.g.* bryophytes (mosses, liverworts and hornworts). Previous reports show records for 122 different species of mosses and liverworts and it is likely that they are still to be found on site. In addition, the Covid-19 related restrictions meant that we were unable to survey between 18th March and 17th May 2020, and also had limited access to laboratory equipment for identification purposes for the rest of the study period. This likely resulted in some species being unrecorded, *e.g.* early spring species of bee. Finally, our species list does not include the many varieties of flowers, fruit and vegetables growing in the Formal and Kitchen Gardens. These species/varieties are more likely to change year to year, and a list of same is available in Appendix 2 Planting list for the orchards, beds and borders of Áras an Uachtaráin.

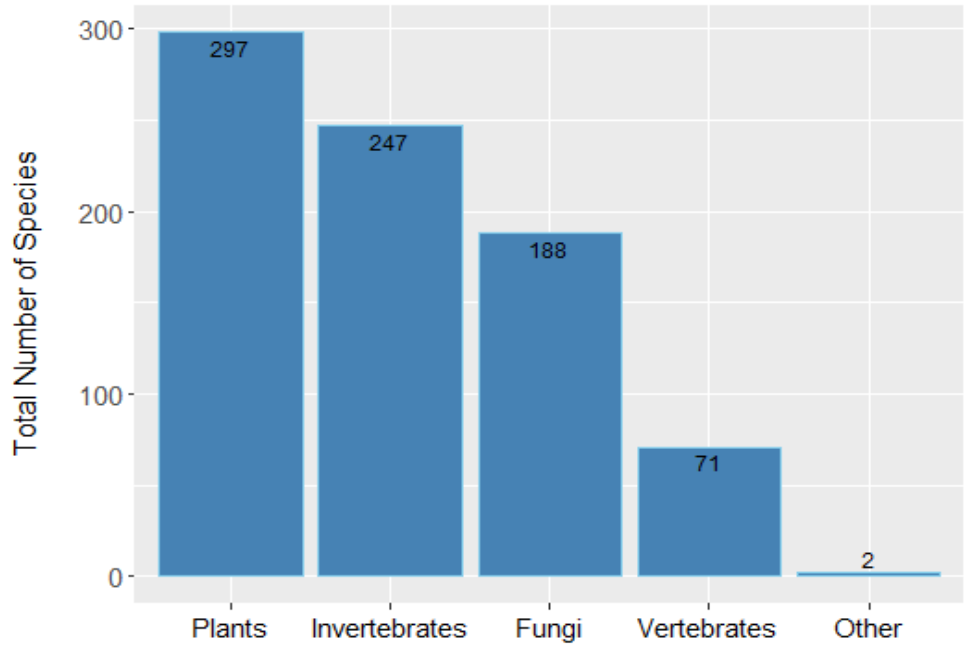

Figure 6 Number of species recorded in Áras an Uachtaráin for each major taxa - plants, invertebrates, fungi, vertebrates and other (algae & cyanobacteria).

The complete set of our records from the 2019-20 survey has been submitted to the OPW and the National Biodiversity Data Centre (NBDC). Sampling protocols used during this survey can be found in Appendix 3 Survey Protocols. A list of licences obtained can be found in Appendix 4 Ethical Approval and Licences.

Overview of Plant Taxa

Botanical surveys were carried out in each habitat type using walking transects, where surveyors recorded the presence of species encountered along each transect line. In addition, to maximise the species list, researchers also kept records of plant species encountered during other survey types, so that species that may not have occurred along transect lines could be included. In total, we recorded 297 plant species across all habitat types (Figure 7). We did not systematically sample for bryophytes (mosses, liverworts and hornworts) during this survey.

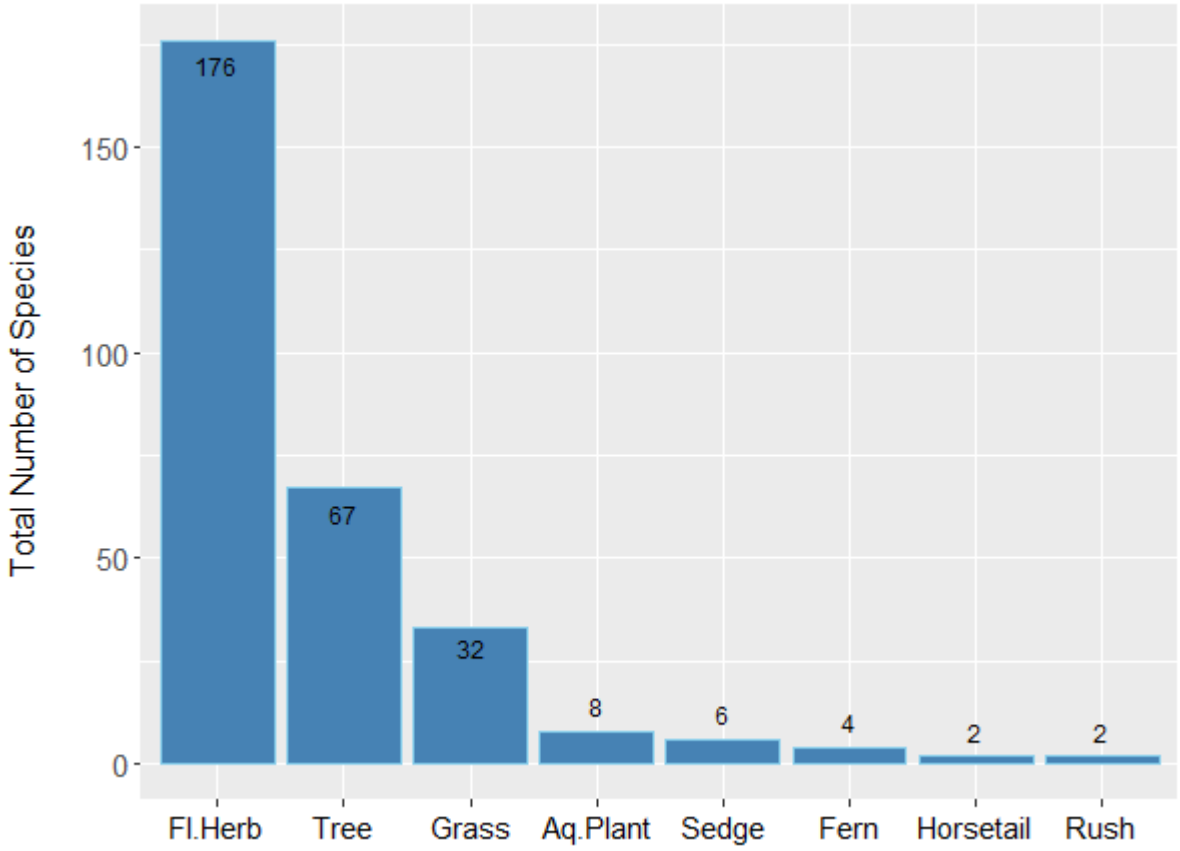

Figure 7 Number of plant species recorded in Áras an Uachtaráin, according to growth habits. Fl.Herb = Flowering Herb, Aq.Plant = Aquatic Plant.

Flowering Herbs

Figure 8 Wildflowers Hairy St. John's Wort (*Hypericum hirsutum*), Pyramidal Orchid (*Anacamptis pyramidalis)* and Broad-leaved Helleborine (*Epipactis helleborine*), growing in the grounds of Áras an Uachtaráin.

We recorded 176 species of flowering herb. Among the most notable species recorded was Hairy St. John's Wort (*Hypericum hirsutum*). This species has an extremely limited distribution in Ireland and is subject to a Flora Protection Order. Hairy St. John's Wort was recorded in two locations in 2020, Nut Island and the Wilderness Area. It was previously recorded (Tubridy, 2008) only in the Wilderness Area. Two species of orchid were recorded: pyramidal orchids (*Anacamptis pyramidalis)* and broad-leaved helleborine (*Epipactis helleborine*) were observed in grassland and along a woodland path respectively. Both are indicators of calcareous soil. Many species of flowering herb that are vital food plants for invertebrates and other species were record, *e.g.* common bird's-foot trefoil (*Lotus corniculatus*) which is the principal larval food plant of the common blue butterfly (*Polyommatus icarus*). Orange-tip butterfly (*Anthocharis cardamines*) eggs were observed on the Cuckoo flower (*Cardamine pratensis*). Six spot burnet moths (*Zygaena filipendulae*) were observed feeding on common knapweed (*Centaurea nigra*) and thistles (*Cirsium* spp.). Yellow rattle (*Rhinanthus minor*), "the meadow-maker", was recorded in the Arboretum parkland. This species is hemi-parasitic on grasses and is considered important in the restoration of semi-natural grasslands, reducing the dominance of grasses, thereby creating space for native wildflowers. Two invasive species of concern, Japanese Knotweed (*Fallopia japonica*) and Giant Hogweed (*Heracleum mantegazzianum*), were recorded within the perimeter of Áras an Uachtaráin, but are being activity managed by the OPW. Genetic studies are being conducted on the Japanese Knotweed by Trinity College Dublin to compare it with

other Irish populations. In addition, bindweed (*Calystegia silvatica*) and winter heliotrope (*Petasites pyrenaicus*) are extensive in several areas and require management.

Grasses, Sedges, Rushes and Ferns

A diverse range of grasses was recorded (N=32) from agricultural-staple perennial ryegrass (*Lolium perenne)*, to quaking grass (*Briza media*), both in the paddocks to the north of the house, and reed canary grass (*Phalaris arundinacea*) in the wet grassland around Nut Island. *Briza media* is considered an important indicator of semi-natural calcareous grasslands, and it was encouraging to record this particularly where cattle have been grazed in recent decades. Downy oat grass (*Helictotrichon pubescens*) was also recorded in the northern paddocks and is characteristic of calcareous grassland. One species of potential concern is prairie grass (*Bromus catharticus*), a South American species that has the potential to become invasive. This was recorded in several areas throughout the Áras, although it was not dominant in the sward. It should be monitored on an ongoing basis. Several species of sedge and rush were recorded as well as two horsetails and four ferns. The ferns included garden cultivar varieties of the soft shield fern (*Polystichum setiferum*) and Hart's tongue fern (*Asplenium scolopendrium*).

Trees

There are 67 species of tree in the Áras, found primarily in the woodlands and parkland, but also scattered throughout the pastures. These include native, naturalised and exotic species. The Arboretum, The Queen's Walk and Formal Gardens contain many examples of exotic tree species (*e.g.* Katsura, *Cercidiphyllum japonicum*), often as a result of the tree-planting tradition by visiting dignitaries and Heads of State. However, more recently only native oak trees (*Quercus robur,* Ireland's national tree) have been planted on such occasions. Oak trees support more wildlife than any other native tree species. They provide a habitat for invertebrates, mosses, lichens and liverworts, and food and nesting spaces for birds and mammals. Their fallen leaves form a rich leaf mould that supports beetles and fungi. Other native species found on site such as hawthorn (*Crataegus monogyna*), yew (*Taxus baccata*) and rowan (*Sorbus aucuparia*) provide food in the form of nectar and pollen for pollinators, and berries for birds and mammals. Yew trees can also be found growing in the Formal Gardens as well as in hedgerows along the perimeter fencing. Many Horse Chestnuts were infected with the leaf miner *Cameraria ohridella*, and there were some early signs of ash dieback disease (*Hymenoscyphus fraxineus*) in some trees.

Overview of Fungi

Sampling for macromycetes (toadstools and mushrooms) began at the end of October 2019 and ended at the beginning of September 2020, thus missing some important weeks in the year for fungi. Nevertheless, 188 species were collected with maxima per visit of 50 species on 28/10/19 and 52 species on 28/11/19. Just over one quarter of species found were only recorded on a single visit, probably due to the short life of most fruit bodies, and to the climatic variability in Ireland of the summer/autumn transition, coupled with the basic seasonality of most fungi. We found very low frequency of honey fungus (*Armillaria mellea*) which was known by OPW staff to be abundant, and Milk Caps (*Lactarius* spp.), especially those species symbiotic with oak.

Mycorrhizal species made up 13.3% of the list, parasites 2%, and saprophytes almost 85%. Four species were deadly poisonous - *Hebeloma crustuliniforme*; *Paxillus involutus*; *Clitocybe rivulosa* and *Inocybe patoulliardii*, with another 25 species considered to be poisonous. Among the latter was the yellow staining mushroom (*Agaricus xanthodermus*) which was widespread and common in the Áras in August and September, and is similar to the edible Horse Mushroom, which was also found in August, just outside the Horse Paddock. Fifteen species were too similar to poisonous species to risk eating. Sixteen species are good to eat and a further 39 species are considered to be edible. The remainder are not edible for a variety of reasons; small size, bitterness, and texture (toughness, slimy surface) are the most frequent.

Figure 9 Bird's-nest fungi (*Crucibulum laeve*). Photo: Paul Dowding

There were more species found in the woodlands and on their margins than anywhere else. The openness of the woodlands and the lack of a woody understorey allows the rank growth of grass which made fungi difficult to find, so the list is likely to be an underestimate. Fungi were easy to see in the mown grass at the woodland margins as well as in

patches of tree leaf litter. Nearly all the conifers, as well as at least a quarter of the broadleaves planted in the Áras have microscopic mycorrhizal symbionts which never form toadstools. The list of fungi (58) found on dead wood is not complete, but has been greatly enhanced by the fungi found on wood and bark chips as mulch. There were swarms of bird's nest in the mulch along the Queen's Walk in August and September (Figure 9).

The Horse Paddock and Large and Small paddocks were disappointing (4 species), compared with 21 found in lawns. For example, there were 6 species of waxcap in the lawn areas and none in the grazed paddocks and pastures. There are several possible reasons for this, linked to grazing regimes, including the use of anthelmintics, especially ivermectins, in both cattle and horses, and the annual application of fertiliser, especially nitrate, to the cattle pastures. Only one fungal species specific to dung was found, on one cattle dung pat. Four more species associated with old but disappeared dung were found in the lawn areas, where dog, fox and badger dung occasionally occurred.

Overview of Animal Taxa

Sampling focussed on several groups of vertebrates and invertebrates, using a variety of taxa-specific sampling methods. These included:

1. Invertebrates
    a. Bees
    b. Butterflies/Moths
    c. Flies
    d. Beetles
    e. Arachnids
    f. Other invertebrates

2. Vertebrates
    a. Birds
    b. Mammals
    c. Amphibians
    d. Reptiles
    e. Fish

Invertebrates

Ireland is home to more than 20,000 invertebrate species (12,000 insects), 247 of which were recorded during 2020 at the Áras. Given that many invertebrates are small and taxonomically challenging, and their populations vary from year to year, our sampling has likely not uncovered the full diversity of species present on the site. Nevertheless, we did identify representatives from ten insect orders (Lepidoptera - butterflies and moths; Diptera - True flies; Hymenoptera - bees, wasps and ants; Coleoptera - beetles; Hemiptera - true bugs; Orthoptera - grasshoppers and crickets; Odonata - dragonflies and damselflies; Neuroptera - lacewings; Trichoptera - caddisflies; and Dermaptera - earwigs), along with a range of other arthropods (spiders, harvestmen, pseudoscorpions, crustaceans), molluscs (slugs and snails) and annelids (worms) (Figure 10).

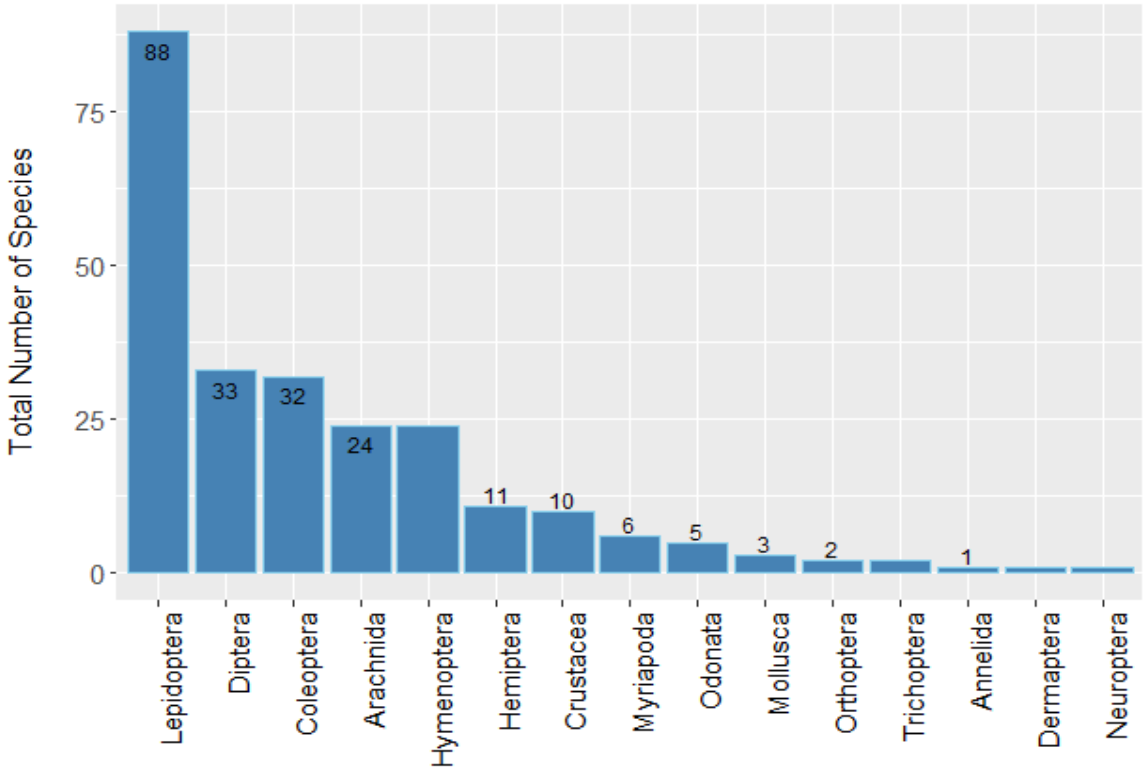

Figure 10 Number of unique invertebrate species recorded in Áras an Uachtaráin, by major taxonomic groupings.

Invertebrates were surveyed in all habitat types using a variety of appropriate sampling methods. Particular sampling methods were used to target specific lifestyles and taxonomic groups.

Specifically, we focussed on:

1. Pan trapping and walking transects for bees and other flower-visiting insects;
2. Light traps for nocturnal moths;
3. Nocturnal arachnid surveys;
4. Baited traps for insects associated with fruit and carrion;
5. Hand searches of specialist habitats, such as horse manure, rotting logs;
6. Tree-beating for phytophagous insects and spiders;
7. Vegetation sweeping for spiders, ladybirds and flies;
8. Pitfall trapping for ground beetles and millipedes; and
9. Litter sieving for woodlice, harvestmen and pseudoscorpions.

We did not systematically sample for Molluscs, Annelids or Odonata during this survey.

Bees

Figure 11 Bumble bees (*Bombus muscorum, Bombus lucorum agg., Bombus lapidarius)* feeding on ornamental and wild flowers in Áras an Uachtaráin. Photos: Jane Stout.

Twelve species of bee were recorded at the Áras, including the European honeybee (*Apis mellifera*), which is present on the site in multiple managed hives. Bees were most abundant and recorded most frequently foraging in the Wilderness Area, the Kitchen Garden, the President's Flower Garden and Nut Island. There are 99 species of wild bee present on the island of Ireland, just 11% of these are represented in the species list for the Áras. Furthermore, while one third of Irish bee species are considered threatened,

no bee species with this status was recorded during the surveys. The bee taxa in Ireland can be loosely separated into two groups: social bees and solitary bees. Social bees include honeybees (1 species in Ireland) and bumblebees (21 Irish species) and are characterised by living in colonies comprising a single reproductive queen, along with several generations of workers and, at certain times of year, males. Within solitary bee species (77 Irish species), all females are reproductive, and each establishes and maintains a nest. In contrast to social bees, solitary bees grow and develop in isolation, in individually provisioned cells.

At least seven of the 21 bumblebee species found in Ireland were recorded at the Áras. *Bombus lucorum agg.* comprises an aggregation of up to three morphologically indistinct species (*Bombus lucorum*, *B. magnus* and *B. cryptarum*) along with the similar *Bombus terrestris*, which can only be reliably distinguished to species level using DNA fingerprinting, which was not possible in this study. The *B. lucorum agg.* and *Bombus pascuorum* were the most prevalent and widely distributed species in our surveys. The overall representation of bumblebees (both in terms of species richness and abundance) at the Áras was relatively positive, given the site is in an urbanised area. Bumblebees can travel two to three km from their nest site to gather food and so can exploit resources in multiple areas. *Bombus muscorum* was the only bee species of note recorded in the Áras (Figure 11). While it is not considered threatened, *Bombus muscorum* is uncommon. In terms of solitary species, the Áras was found to be relatively depauperate with only 3 of the 77 solitary Irish species represented in our species list. The abundance of solitary species on the site was also extremely low with only 4 observations across the entire survey period. This poor representation is likely due to a lack of sampling during March-May (due to Covid-19 restrictions), and possibly because all the requisite resources (food and nest sites) are not within close enough proximity for population establishment and growth, and compounded by the urbanised landscape within which the Áras sits.

Moths & Butterflies

There are 1,504 species of moth recorded in Ireland, 577 macro-moths and 927 micro-moths (MothsIreland checklist, 2020), 73 of which were recorded in the Áras (*e.g.* Figure 12). Moths play a significant role as herbivores, as pollinators and as a prey item for birds and bats. The majority of moths feed on plant material as a larva. Adults feed mainly on plant nectar. Moths can be found in every terrestrial habitat in Ireland, with the greatest numbers of species in woodlands, but grassland also supports a significant number of species. Habitat requirements may vary between adults and larvae.

Figure 12 Moths. Buff Arches (*Habrosyne pyritoides*) on oak bark and Cocksfoot Moth (*Glyphipterix simpliciella*) on black medick, Six-spot burnet (*Zygaena filipendulae*) on knapweed.

Forty-three species (8%) of Irish macro-moth are assessed as threatened with another 24 (4%) assessed as Near Threatened or Data Deficient (Allen *et al*, 2016). Fourteen species of macro-moth are considered to have become Regionally Extinct. The remaining species are all assessed as being of Least Concern. Micro-moths have not been assessed. No moth species are legally protected in Ireland or Northern Ireland; however, a licence is required to operate a light trap under Section 35 of the Wildlife (Amendment) Act, 2000.

Figure 13 Yellow shell (*Camptogramma bilineata*) assessed as Near Threatened on the Irish Red List. Photo: Ferdia Marnell.

We recorded 73 species of moth in the Áras, but this is likely an underestimate. All of the macro-moths recorded were of Least Concern status, except for the Yellow Shell (Camptogramma bilineata) which is assessed as Near Threatened, having been lost from many inland sites due to habitat loss (Figure 13
). It favours rough unimproved grassland, where larvae feed on a number of herbaceous perennials. Moths were surveyed under NPWS licence on four different occasions across the summer, using 2 to 3 light traps in different habitats each time. Moths have limited flight periods and the timing of these varies for each species, therefore moths can be trapped in any month of the year. The number of species recorded in the Áras would likely increase if surveys were undertaken with greater sampling intensity, and over a longer time period.

Ireland has 32 resident and 3 common migrant butterfly species. While not quantitatively sampled, 15 butterfly species were recorded in the Áras on an ad hoc basis while performing other surveys (e.g. Figure 14).

Figure 14 Butterflies photographed in Áras an Uachtaráin. Top left to bottom right: common blue (*Polyommatus icarus*), silver washed fritillary (*Argynnis paphia*), holly blue (*Celastrina argiolus*), peacock (*Inachis io*), newly emerged white (*Pieris* sp.) and speckled wood (*Pararge aegeria*). Photo of SWF by Trevor Hodkinson.

Recorded butterfly species included meadow brown (*Maniola jurtina*), speckled wood (*Pararge aegeria*), red admiral (*Vanessa atalanta*), peacock (*Inachis io*), small

tortoiseshell (*Aglais urticae*), comma (*Polygonia c-album*), orange tip (*Anthocharis cardamines*), common blue (*Polyommatus icarus*), holly blue (*Celastrina argiolus*), ringlet (*Aphantopus hyperantus*) and silver washed fritillary (*Argynnis paphia*). All species are among the most commonly encountered species in Ireland, with the exception of the comma butterfly, a recent arrival in Ireland, first recorded in 2000, and now confirmed resident. Commas were observed on several occasions foraging on a thistle patch in the Wilderness Area close to the Visitor Carpark. The only species afforded legal protection in Ireland, the Marsh Fritillary (*Euphydryas aurinia*) was not recorded in the Áras, but neither was the larval food plant devil's bit scabious (*Succisa pratensis*).

The presence of so many different species of butterflies suggests a range of suitable floral resources and larval host plants were present in the grounds. Because they fly during the day, conspicuous and relatively easy to identify, the butterfly fauna represents an obvious indicator group for use in future surveys. One caveat is that clear seasonal trends in the appearance of the different butterfly species occurred throughout the study period (May to August), suggesting multiple visits to the site would be required, preferably during fine weather, in order to more completely catalogue this group.

True Flies

The flies present in the Áras were highly diverse both in terms of the species observed and the number of families they constituted. Unfortunately, many of these species could not be identified and so this order of insects remains very much underrepresented in the final species lists.

Hoverflies (Syrphidae, Figure 15) were a conspicuous group that could be readily collected by sweep-netting from flowers. Thirteen species of hoverfly were recorded, including the common 'marmalade fly' (*Episyrphus balteatus*) and the bumblebee mimic (*Volucella pellucans*). Apart from a few specimens collected from pan traps, we did not use any passive trapping techniques to survey hoverflies, as it was thought these methods would result in too much unnecessary bycatch. Hoverflies represent another insect group that could be developed as an indicator of conservation success in the Áras, and could be targeted in any future surveys.

Figure 15 Hoverflies *Volucella bombylans,* feeding on thistle flowers, and *Syrphus ribesii,* feeding on blackberry flowers.

The collecting of drosophilid 'fruit flies' was targeted, and this family proved fairly diverse, with at least seven species recorded over the survey period. The Áras provides good resources for this group for flies, from rotting fruit in the orchard to the high diversity of fungal fruiting bodies present later in the year. Even so, some common species of *Drosophila* were not recorded, *e.g. D. hydei*, *D. busckii*, and it is likely that additional species of this group await discovery. The emerging fruit pest, *Drosophila suzukii*, was recorded on three separate dates.

Beetles

A number of conspicuous beetle species were repeatedly observed, including ladybirds (at least four species, *e.g.* Figure 16), the malachite beetle (*Malachius bipustulatus*), the common soldier beetle (*Rhagonycha fulva*), and the common click beetle (*Athous haemorrhoidalis*).

Figure 16 Seven-spot ladybird (*Coccinella septempunctata*) life stages record at the Áras - larva, pupae, newly-emerged adult and mature adult.

Several ground beetles (Carabidae) and rove beetles (Staphylinidae) species were recorded, although additional species are likely to be present. Of note, was the presence of the longhorn beetle (*Grammoptera ruficornis*) and the rhinoceros beetle (*Sinodendron cylindricum*). Attempts to obtain members of the silphidae ('sexton beetles') using pitfall traps baited with meat and fish proved unsuccessful.

Arachnids

The arachnid fauna was diverse, and all the main groups (spiders; harvestmen; mites; pseudoscorpions) were recorded during the survey, although no mites were identified to species level (Figure 17). Spiders were common and 24 species were identified, although this certainly represents an underestimate of the species actually present. Most of the spiders recorded are considered common and widespread, but notable finds include the false widow spider (*Steatoda nobilis*) and two species of cave spider (*Meta menardi* and *Meta merianae*) which were observed in an old tunnel by the Icehouse. These cave spiders have very specific habitat requirements and consequently have a limited distribution. Two species of pseudoscorpion (*Chthonius ischnocheles* and *Neobisium carcinoides)* were recorded in leaf litter at the base of mature beech trees.

Figure 17 Pseudoscorpions (*Chthonius ischnocheles* and *Neobisium carcinoides*), flower crab spider (*Misumena vatia*) and the cave spider (*Meta menardi*).

Other invertebrates

All the expected species of woodlouse, millipedes and centipedes were recorded, including both the pill woodlouse (*Armadillidium vulgare*) and pill millipede (*Glomeris marginata*). Given the diversity of suitable habitats, *e.g.* woodland; grassland; formal gardens, there are likely more species belonging to all of these groups present in the grounds of Áras.

Vertebrates

There are 450 species of bird (many of which are migratory and rarely seen), 60 species of mammal (26 terrestrial), one native reptile species (common lizard, *Zootoca vivipara*), three native amphibian species, and 29 species of freshwater fish (15 of which are native) in Ireland. We recorded 51 species of bird, 18 species of mammal and two species of fish in the Áras (Figure 18). No reptiles or amphibians were found in the Áras, despite intensive and dedicated searches for them by herpetological experts.

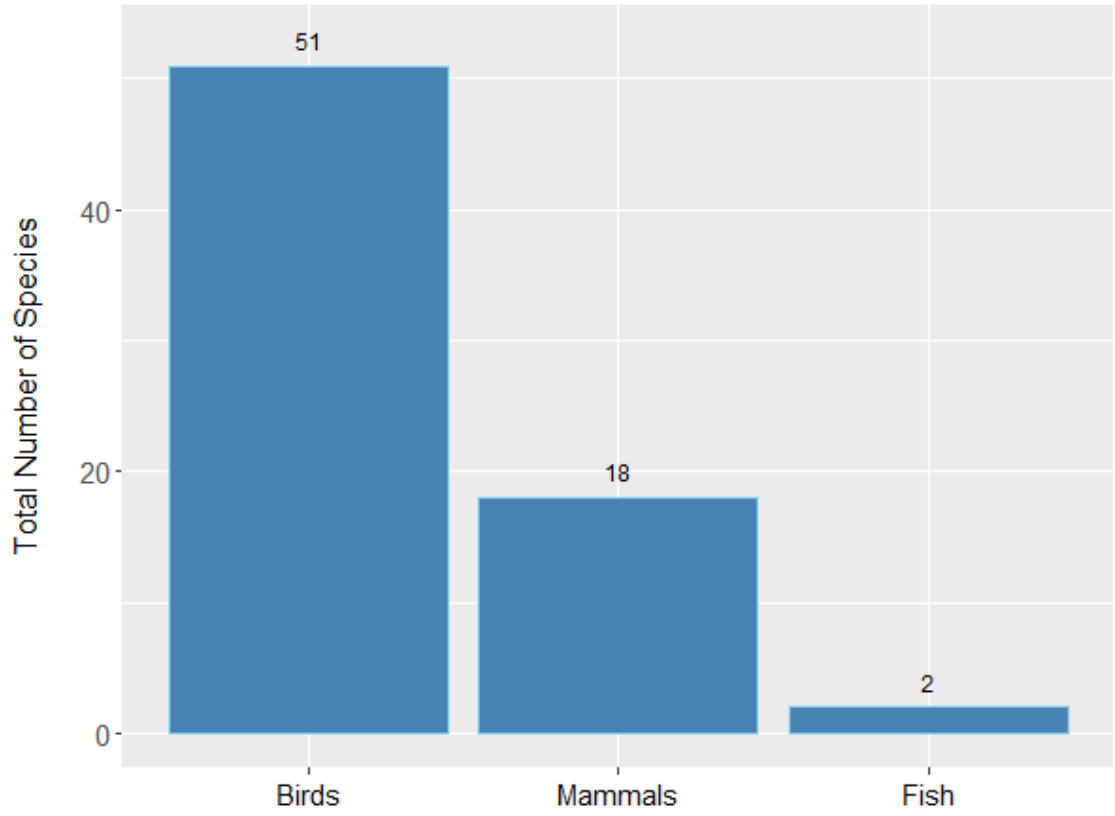

Figure 18 Number of species of vertebrates (birds, mammals and fish) recorded in the Áras.

Birds

In total, 51 species were recorded using a combination of walking transects, point counts and vantage point surveys. This included 36 residents, a further 10 resident species which have a winter migratory component, 4 summer migrants, and 1 winter migrant. All bird species are protected by law (under the EU Birds Directive and EU Habitats Directive). The Áras species list includes 21 species that are on the Birds of

Conservation Concern in Ireland lists (Colhoun and Cummins, 2013), including 3 (Tufted Duck, Black-headed Gull, Herring Gull) that are Red-listed and are of highest concern, and a further 18 species that are Amber-listed. Jackdaw was the most commonly observed bird species with over 500 observations during the combined winter and summer visits. Woodpigeon, Wren and Blue Tit were also abundant (>300 observations) and widespread. Magpie, Blackbird and Robin were also relatively abundant (>200 individuals) and widely distributed.

Of the 51 total species, 28 are confirmed as breeding species within the Áras, 2 are considered to be probable breeding birds, 16 are considered to be possible breeding birds, and 5 are non-breeding birds. The non-breeding birds are three gull species, Cormorant and Greylag Goose.

Figure 19 Swallows (*Hirundo rustica*) and coot (*Fulica atra*). Photos by Art O'Leary.

The species recorded during the breeding season can be described within the following 14 bird groups:

- Waterbirds – 10 species were recorded, including 3 gull species. The majority of these are resident species whose numbers are augmented by winter visitors. Coot were most often observed in this group, being observed 20 times in the summer visits. Coot (Figure 19), Moorhen and Little Grebe were confirmed breeding on the Áras pond.
- Birds of Prey – 3 species were recorded (Sparrowhawk, Buzzard and Kestrel) in small numbers with Sparrowhawk and Buzzard confirmed to be breeding.
- Gamebirds – Pheasant, one individual recorded during the summer.

- Pigeons & Doves – 3 species were recorded. Woodpigeon was the most numerous and widespread, and was present in all 11 habitats during the winter and summer visits. Feral Pigeon and Collared Dove were much less prevalent, present in relatively few habitats.
- Crows – A total of 5 species was recorded with Magpie, Jackdaw and Hooded Crow being the most prevalent among the group. Jackdaw was the most abundant species overall throughout the 2020 survey with over 500 observations in the Áras, and occurring in nearly all habitats in both winter and summer visits. Over 200 observations of Magpies and over 40 observations of Hooded Crows were recorded in the Áras, both species being relatively widespread. The reclusive Jay was recorded infrequently but is likely to be breeding in the wooded areas of the Áras. A family group was observed close to the visitor carpark.
- Kinglets – Goldcrest was widespread, present in 6 and 8 habitats during the winter and summer visits respectively.
- Tits – All 4 regularly occurring tit species in Ireland are resident, and were relatively widespread and abundant throughout the park during this survey. Blue Tit was most abundant with over 300 observations recorded across all visits.
- Larks – Skylark was observed once in the summer visits but was not recorded breeding. It is a possible breeder in the larger pastures but due to tree cover in these habitats, this species will likely choose to nest in the broader Phoenix Park.
- Warblers – Blackcap and Chiffchaff were recorded and are summer migrants. Blackcap was observed more frequently but Chiffchaff was observed in more habitats. Willow warbler, a similar summer migrant was not recorded in the Áras, although it breeds in the Phoenix Park (Lewis, Coombes & Crowe, 2015).
- Treecreepers – Treecreeper is a resident species, and breeding in the Áras in woodland habitats.
- Starling, Chats & Thrushes – 5 species of which Blackbird, followed by Robin, were the most often observed birds within this grouping. Song Thrush was more numerous and widespread than Mistle Thrush across the Áras. No chats (Stonechat or Whinchat) were recorded in the Áras and their absence is not considered unusual in the park or woodland habitats that dominate the Áras.
- Sparrows – House Sparrow was observed only once and is considered to be a rare but possible breeder.

- Pipits & Wagtails – Pied wagtail was recorded on a few occasions and is breeding around the buildings of the Áras. No Meadow Pipits were recorded in the Áras, only one breeding pair in the Phoenix Park in 2015 after the cold winters of 2009/ 10 and 2011/12.
- Finches – 6 species were recorded with Chaffinch being the most abundant and widespread. Greenfinch and Goldfinch were less widespread, and Siskin was most scarce, and 1 individual recorded in the winter visits.
- Swallows & Swifts – Swallows and Swifts were recorded during summer visits, and swallows were confirmed to be breeding in the Áras, with nests observed in outhouses (Figure 19). Swifts are probably breeding in the wider Phoenix Park (Lewis, Coombes & Crowe, 2015).

Bird ringing

A single bird-ringing session was carried out in August 2020 (Figure 20). Bird ringing generates information on the survival, productivity and movements of birds, helping researchers understand why populations are changing. Bird ringing has been carried out in Ireland and Britain for over 100 years, so in ringing birds in the Áras, we have contributed to a long-term dataset. The birds were netted, ringed and photographed under license from the NPWS and BTO. We had a moderate catch of four species - wren, great tit, robin and blackcap. We caught young birds (born in 2020) of each of these species, which indicates they had bred nearby.

Figure 20 Mist netting and ringing birds under licence (Photos: Maxwell Photography, Aoibheann Gaughran, Maxwell Photography).

We would expect wrens and great tits to disperse locally, over winter, but the robins and blackcaps are likely to move further afield. Robins born in Ireland have been known to winter in continental Europe (France, Spain or Portugal), although the majority stay in

Ireland throughout the year. Blackcaps, as a species, have a much more complex migration strategy; some populations are sedentary, some migrate over shorter distances and some over longer distances. Blackcaps which breed in Ireland are shorter distance migrants, and spend the winter in southern Europe or northern Africa. During autumn and winter, both robins and blackcaps (which bred in other European countries) may visit Ireland.

By ringing these species throughout the year, we can monitor their migration patterns. This also allows us to detect any changes in migration patterns over time (*e.g.* creeping trends like global warming, or exceptional weather events).

Mammals

All of Ireland's mammals are listed as Least Concern, with the exception of the black rat (*Rattus rattus*, Vulnerable) and the grey wolf (*Canis lupus*, Regionally Extinct) (Marnell *et al*, 2019). However, most terrestrial mammals enjoy some level of legal protection, with 13 listed on the EU Habitats Directive, 22 on national legislation in the Republic of Ireland, and 18 on national legislation in Northern Ireland.

Figure 21 Fox (*Vulpes vulpes*) photographed in Áras an Uachtaráin by Art O'Leary.

In this study, mammals were surveyed using a variety of methods including camera-trapping (Figure 22), live-trapping, audio recording, footprint tunnels and observations made during site visits. In total, 15* wild species of mammal were recorded during the survey period, as well as horses, dogs and cats (Table 2). The invasive grey squirrel (Sciurus carolinensis) is one of the most commonly observed wild mammal species in Áras an Uachtaráin. However, the site also supports a good population of native badgers (Meles meles) and foxes (Vulpes vulpes), both of which are breeding on site as evidenced by the presence of cubs and juveniles.

Figure 22 Mammals observed on trail-camera in the Áras. Top left to bottom right: adult fox, fox cub, fox and badger together, brown rat, rabbit, adult badger, pygmy shrew, woodmouse and juvenile badgers.

Foxes and badgers were the species most frequently captured on trail-camera. Badgers, as well as their setts, are protected under the Wildlife Acts (Wildlife Act, 1976; Wildlife Amendment Act, 2000). Several badger setts were recorded within the perimeter of the Áras. Nearly all of Ireland's bat species*, which are also protected under the Wildlife Acts (1976, 2000, were recorded, with the exception of the Lesser Horseshoe bat

(Rhinolophus hipposideros), which is only found in the west of Ireland. The woodlands and pond are important foraging areas for bats, and the woodlands also likely provide many tree-roosting opportunities. Hedgehogs (*Erinaceus europaeus*) were not recorded within the grounds of Áras an Uachtaráin, despite being present in the wider Phoenix Park (Haydon, 2007). This is surprising because there are frequent records received by the National Biodiversity Data Centre for this species, and it is thought to be common in suburban gardens and parks (Marnell et al., 2019).

The invasive American mink (*Neovision vision*), which occurs in the Phoenix Park, was not recorded during the course of the survey, but neither were the native stoat (*Mustela erminea hibernica*), otter (*Lutra lutra*) or pine marten (*Martes martes*). The pine marten has seen a recovery in numbers and distribution in recent years (Lawton *et al*. 2020), and it is possible that it will be recorded in the Phoenix Park in the not too distant future, since there are records for the species nearby (Lawton *et al*. 2020, NBDC, 2020). There is increasing evidence that the pine marten is facilitating the recovery of the native red squirrel (*Sciurus vulgaris*) in Ireland (Lawton *et al*. 2020, Twining *et al*. 2020). However, the limiting factor for the pine marten in urban areas are human disturbance (Twining *et al*. 2020) and appropriate denning sites, *e.g.* hollows in older trees, (Croose *et al*. 2016).

Neither the non-native bank vole (*Myodes glareolus*) nor the invasive greater white-toothed shrew (*Crocidura russula*) were recorded during our surveys. It is likely that the greater white-toothed shrew will encroach on the Phoenix Park more quickly than the bank vole, as its range is spreading at a rate of 5km/year (McDevitt *et al*. 2014), and there are recent records for it close to the M50 (NBDC). This would be to the detriment of the native pygmy shrew (*Sorex minutus*), which was recorded during this survey.

Table 2 Wild Mammals recorded in Áras an Uachtaráin

Species Name	Common Name	Methods
Meles meles	Badger	Direct Observation Camera Trap
Vulpes vulpes	Fox	Direct Observation Camera Trap
Sciurus carolinensis	Grey Squirrel	Direct Observation Camera Trap
Rattus norvegicus	Brown Rat	Camera Trap Mink Raft
Apodemus sylvaticus	Woodmouse	Longworth Trap Camera Trap
Sorex minutus	Pygmy Shrew	Mostela Box
Oryctolagus cuniculus	Rabbit	Direct Observation Camera Trap
Nyctalus leisleri	Leisler's bat	Bat Detector Direct Observation
Pipistrellus pipistrellus	Common pipistrelle bat	Bat Detector Direct Observation
Pipistrellus pygmaeus	Soprano pipistrelle bat	Bat Detector Direct Observation
Pipistrellus nathusii	Nathusius' pipistrelle bat	Bat Detector
Myotis daubentonii	Daubenton's bat	Bat Detector Direct Observation
**Myotis spp. (mystacinus/brandtii/ nattereri)*	*Whiskered/ Brandt's/ Natterer's bat	Bat Detector
Plecotus auritus	Brown long-eared bat	Bat Detector

* it is extremely difficult to differentiate between Whiskered, Brandt's and Natterer's bat using detectors alone. Trapping and hand examination are usually required.

Amphibians, Reptiles & Fish.

The ponds, ditches and areas of flooding in woodland were surveyed for amphibians during the breeding season. Amphibian surveys conducted by the Herpetological Society of Ireland took place in the wider Phoenix Park at the same time as surveys within the perimeter of the Áras. Surprisingly, common frogs (*Rana temporaria*) and smooth newts (*Lissotriton vulgaris*) were not recorded within the ground of Áras an Uachtaráin, despite the existence of suitable habitat, and the fact that the wider park supports healthy populations of both species. It is unclear why this is the case. Native amphibian species found within the park prefer to breed in temporary or fish free bodies of water. This may explain their absence from the grounds of the Áras.

Figure 23 Common lizard (*Zootoca vivipara*) basking on a felt mat and identification of an individual smooth newt (*Lissotriton vulgaris*) using ventral patterning. These species were not recorded in Áras an Uachtaráin. Photos: Collie Ennis under licence.

Surveys for common lizards *(Zootoca vivipara*) employed felt traps positioned adjacent to stone walls and in sunny areas in the Kitchen Garden. Lizards were not recorded within the Áras.

Two species of fish were recorded in the Pond: three-spined stickleback (*Gasterosteus aculeatus*) and rudd (*Scardinius erythrophthalmus*). These are likely relict populations from when the Áras pond was part of a larger pond, which is now part of Dublin Zoo.

REVIEW OF HABITATS

Grassland & Parkland Habitats

Figure 24 Location of grassland and parkland habitats in Áras an Uachtaráin

What is there and where is it?

Grasslands account for approximately 186,000m^2/46 acres on the Áras site. We classified the majority (84%) of grassland as dry calcareous and neutral grassland (GS1). The rest was classed as Amenity grassland (GA2) (15%), and wet grassland (GS4) (1%). More grassland is found within habitats that are classified as Scattered Trees and Parkland (~73,000m^2/18 acres), and this is a mixture of GS1 and GA2, bringing the total area of the Áras under grass to just over 50% (Figure 24). Together, the grasslands and parklands contained 41% of the species (N=334) recorded in Áras an Uachtaráin.

Dry calcareous and neutral grassland (GS1) is found in the Large and Small Paddocks to the north of the house, the Horse Paddock to the south of the house, the 1916 Meadow

and areas of the parklands that are not regularly mowed, *e.g.* in the Arboretum to the right hand side of the main avenue upon entry via the Phoenix Gate.

GS1 grasslands are defined as being typically unimproved or semi-improved dry grassland, calcareous or neutral, but not acid. They are usually associated with low intensity agriculture. Most old permanent pastures and less intensively managed lowland grasslands fit into this category. Extensive, *i.e.* low-intensity, grazing is a characteristic feature. Good quality semi-natural species-rich grasslands are characterised by low-nutrient input (nitrogen and phosphorus), meaning artificial fertiliser is not applied, there is limited input from livestock, and vegetation is not allowed to decay on-site. As a result, GS1 comprises a wide range of grasses and broadleaved herbs, and species richness varies but can be high (up to 45 species per m^2).

The quality of the GS1 grassland within the Áras is extremely variable, with the most species-rich areas to be found in the Arboretum, where grassland management has been reduced to one cut in late summer for the last number of years. However, the paddocks to the north of the house have - until 2020 - been used for cattle grazing by the Department of Agriculture, Food and Marine. The cattle have recently been replaced by 4-6 horses. The paddock to the rear of the house has been grazed by the Garda Mounted Unit horses. All three paddocks are considered species-poor, particularly in floral diversity. The 1916 Meadow is of intermediate quality, with greater floral diversity than the paddocks, but poorer than the Arboretum.

The Formal Gardens and much of the roadside/paddock-side verges and parkland are maintained as amenity grassland (GA2). GA2 is managed for purposes other than grass production/grazing and is regularly mown to maintain very short swards. It may contain a variety of grasses but is not particularly rich floristically. Typical broadleaved herbs found include daisy (*Bellis perennis*), dandelion (*Taraxacum spp*.), clovers (*Trifolium spp.)* and plantains (*Plantago spp*.).

An area of wet grassland (GS4) can be found surrounding Nut Island, a "ditch" that was, during the 1800's, water-filled. GS4 can be found on flat or sloping ground where soils are poorly drained or subjected to seasonal or periodic flooding. Species composition varies considerably, and it often contains abundant rushes (*Juncus spp*.) and/or small sedges (*Carex spp*.) The proportion of broadleaved herbs is often high. Yellow iris (*Iris pseudacorus*) and purple-loosestrife (*Lythrum salicaria*) can be found in damper areas.

The Context

All areas of GS1 contained a good variety of grass species (n = 27) such as sweet vernal grass (*Anthoxanthum odoratum*), common bent (*Agrostis capillaris*) and meadow fox-tail (*Alopecurus pratensis*). Grasses are important food plants for many species of butterfly and moth. Two grasses that are particularly good indicators of strongly calcareous soils were recorded – downy oat-grass (*Helictotrichon pubescens*) and quaking grass (*Briza media*) although these were not common in the sward. The areas within the Arboretum where mowing has been reduced is the best example of GA2 habitat in the Áras, with 75 species of flowering broadleaved herb recorded in this area alone (Figure 25). Present were many species that are excellent for invertebrate and birdlife such as common bird's-foot trefoil (*Lotus corniculatus*), bedstraws (*Galium spp.*), knapweed (*Centaurea nigra*), clovers (*Trifolium spp.*) thistles (*Cirsium spp.*) and nettles (*Urtica dioica*). This was the only location where yellow rattle (*Rhinanthus minor*) was recorded.

Figure 25 Lady's bedstraw (*Galium verum*) growing in the Arboretum parkland.

Figure 26 Orange-tip butterfly egg (*Anthocharis cardamines*) and "cuckoo spit" (froghopper excretions) on Cuckoo flower (*Cardamine pratensis*) in the 1916 Meadow.

The 1916 Meadow was relatively good quality GS1, having a good diversity of grasses, but a much more limited diversity of broadleaved herbs compared to the grassland in the adjacent Arboretum. It did contain common bird's-foot trefoil, Lady's bedstraw (*Galium verum*), clovers (*Trifolium* spp.), meadow vetchling (*Lathyrus pratensis*), primrose (*Primula vulgaris*) and self-heal (*Prunella vulgaris*). In early summer, there was an abundance of cuckoo flowers (*Cardamine pratensis*) on which orange-tip butterflies (*Anthocharis cardamines*) preferentially lay their eggs. Indeed, many orange-tip eggs were observed during our surveys ().

The wet grassland (GS4) surrounding Nut Island, despite accounting for 1% of grassland habitats and 0.4% of the Áras grounds overall, was also extremely diverse, supporting a variety of grasses, sedges, ferns and horsetails, and 36 species of broadleaved herb. These included plants specifically adapted to damp conditions, *i.e.* reed canary-grass (*Phalaris arundinacea*), enchanter's nightshade (*Circaea lutetiana*), yellow flag (*Iris pseudacorus*) and purple-loosestrife (*Lythrum salicaria*). In total, 18.6% (n=150) of all of the species recorded in the Áras occurred in this small area.

In addition to typical GA2 species, the areas of amenity grassland also contained a variety of additional broadleaved herbs, such as self-heal (*Prunella vulgaris*), common bird's-foot trefoil (*Lotus corniculatus*), clovers (*Trifolium* spp.), speedwells (*Veronica* spp.) creeping cinquefoil (*Potentilla reptans*), tormentil (*Potentilla erecta*) and yarrow (*Achillea millefolium*).

Finally, grasslands act as a carbon sink, sequestering significant amounts of atmospheric carbon in the soil. Grassland accounts for the majority of habitat in the Áras.

The Challenges

The Large and Small Paddocks to the north of the house are in very poor condition from a biodiversity perspective, having been subject to intensive cattle grazing (30-35 head of cattle on approx. 28 acres) for many years. Management included regular application of fertilizer and weed-killer, topping of grass and some re-seeding, presumably with ryegrasses. As a result, these pastures are currently not much richer than improved agricultural grassland (GA1).

GA1 is intensively managed or highly modified agricultural grassland that has been re-seeded and/or regularly fertilised, and is now heavily grazed and/or used for silage making. It is species-poor, usually dominated by ryegrasses (*Lolium* spp.) and white clover (*Trifolium repens*). While the grasses species mix in the paddocks *are* more diverse than in typical GA1 pastures, ryegrasses were abundant and broadleaved herbs were dominated by a very limited number of species: buttercups (*Ranunculus* spp.), docks (*Rumex* spp.), creeping thistle (*Cirsium arvense*) and nettles. These last three are indicative of heavy grazing, compaction and high nutrient levels, particularly nitrogen. However, floral diversity did improve towards the edges of these pastures in areas adjacent to amenity grassland. In addition, some good indicators of calcareous grassland were recorded (downy oat-grass and quaking grass) in these pastures, suggesting potential for restoration. The Horse Paddock to the south of the house is of similarly poor quality, and is also subject to poaching (mechanical damage to grasses and soils) in some areas.

Non-paddock areas where the sward has been allowed to grow have not been optimised for biodiversity. In good quality species-rich grasslands where nutrient input is low, the sward is typically mowed just once a year, and is quickly removed thereafter, either by hand, mechanically or through after-grazing by live-stock at low-intensity. Alternatively, species-rich grasslands are subject to very low-intensity year-round grazing.

Figure 27 The Horse Paddock to the south of the Queen's Walk, dominated by a just a few flowering herbs, such as buttercups (*Ranunculus* spp.).

While the grass in the 1916 Meadow and much of the Arboretum had been allowed to grow, once mowed, toppings had not been removed, allowing nutrients to return to the soil. Increased soil nutrients favour the dominance of grasses in the species mix, which in turn crowd out broadleaved herbs reducing overall species diversity. The Arboretum also has areas where brambles and ivy are encroaching, and there are many tree seedlings and saplings.

Opportunities for Improvement

Returning GS1 grasslands to favourable condition is a long-term commitment that requires a light but consistent management touch. It will take several years for soil nutrient levels to decrease and for species-richness to increase, particularly in the paddocks. However, the Áras is starting from a good foundation. The soil in the area is a fine loamy texture over a limestone bedrock, a typical calcareous brown earth (http://gis.teagasc.ie/soils/map.php). The majority of grassland has been classified as semi-natural GS1, albeit of varying condition depending on previous management practices. The fact that the areas around the Arboretum in particular have good floral diversity means that there is a natural stock of wildflower seed providing tremendous potential for recovery and enhancement of biodiversity in adjacent areas. In fact, there may be a good seed bank in the soils of poorer-quality areas, such as the paddocks, waiting for appropriate management to facilitate their return. Improving the quality of

the grasslands would filter up to higher trophic levels. For example, if devil's bit scabious (*Succisa pratensis*) were to germinate in the grasslands, it may encourage the return of our only protected butterfly, the Marsh Fritillary (*Euphydryas aurinia*).

The following are management recommendations to improve the quality of the semi-natural grasslands in Áras an Uachtaráin:

Test soil nutrients to establish current levels of phosphorus (P), potassium (K) and magnesium (Mg), and to monitor ongoing reductions in nutrient levels on an annual basis. Undertaking soil nutrient tests is a good method to find out whether the land falls within the expected range for typical GS1 plants. If the environmental limits are exceeded, then seeds may not germinate, so it is important to research the conditions of the site and make sure they are appropriate. It is estimated that N content should be > 0.1-0.2%. However, there is no commercially available test for nitrogen (N) levels in soils and is usually deduced from past management history (Teagasc). However, at TCD we can measure the total N content using a Leco elemental analyser, or we can assess the available N in the soil in the form of nitrate and ammonium. Soil analysis is recommended for all GS1 areas, *i.e.* the Arboretum, the 1916 Meadow, the two paddocks to the north of the house, and the Horse Paddock to the South.

Table 3 Soil Index Nutrient Levels for P, K and Mg adapted from Teagasc.

		Soil test result range for each Index (mg/L)		
Index	Description	P	K	Mg
1	Very low	0-3.0	0-50	0-25
2	Low	3.1-5.0	21-100	26-50
3	Medium	5.1-8.0	101-150	51-100
4	High	≥8.1	≥151	≥

Reduce dominance of potential competitive species such as docks, thistles, nettles, ivy and brambles by non-chemical means, *e.g.* hand-weeding or local application of a citronella-based herbicide. These species are extremely valuable for biodiversity, and should be allowed to grow in other areas of the Áras grounds, and even in small areas within GS1 grasslands. Recommended for all GS1 areas on a prioritised and phased basis.

Mow grass once a year and remove all cuttings/toppings. This will reduce the nutrient levels in the soil, in time decreasing the dominance of grasses in the mix, allowing broadleaved herbs to recover. Where toppings cannot be removed mechanically, they may be removed manually. The location of paths mowed through the meadows to allow the public to enjoy these areas can change year-to-year. Recommended for the 1916 Meadow and the Arboretum. This management action has already been implemented as of September 2020.

Manage as a Hay Meadow: Cuttings could be harvested as a sustainable, local source of hay for the Garda Mounted Unit Horses. However, all ragwort (*Senecio jacobaea*) must be removed from hay meadows. While ragwort is an excellent resource for all types of pollinators, and is the larval food plant of the cinnabar moth (*Tyria jacobaeae*), it is toxic to livestock if ingested, and as such is a notifiable weed. Livestock avoid fresh ragwort as long as there is enough food available to them, but will ingest it in hay. Recommended for the 1916 Meadow.

Conservation Grazing: Allow livestock (cattle, ponies or sheep) to graze grasslands in a low-intensity manner. This reduces vegetation growth, reduces the return of nutrients from decaying vegetation to the soil, and helps to create areas of bare ground, without poaching, which many broadleaved herbs need to germinate. Bare ground may also be created through mechanical means, *e.g.* chain-harrowing. There are several options for grazing management:

- Low-intensity year-round grazing – Recommended as an option for the Large and Small Paddocks;
- Winterage - grazing only in winter months and removing livestock completely during the summer, allowing flowers to flourish unhindered. Recommended as an option for the Large and Small Paddocks.
- After-grazing. Mow once a year and allow livestock to graze afterwards. Recommended for the Arboretum;
- Grazing management should be implemented as soon as possible, once a grazing management plan has been agreed between relevant parties (see RESOURCES).
- The proposed grazing regime should have explicit input from an ecologist experienced in grassland and agricultural management who can inform grazer species/breed, stocking densities, rotation patterns and appropriate grazing locations.

Natural recolonisation. Allow a period of time (1-3 years) to pass to let wildflowers naturally recolonise the grasslands once the mowing/grazing regime has commenced. However, to speed up the process, wildflowers could be encouraged in other ways.

Harvest yellow rattle (*Rhinanthus minor*), aka "the meadow-maker", from the Arboretum, or purchase native stock from a reputable Irish supplier, and sow in other areas. Yellow rattle parasitises the roots of grasses and is excellent for reducing their dominance in meadows, clearing the ground for flowering herbs. Once the grass has been cut hard and clippings and thatch removed, the soil should be scarified to expose bare ground. Fresh seed should be sown by hand before November as seeds need about 4 months of low temperatures in order to germinate in spring. Alternatively, the seeds can be cultivated with host grasses and plugs sown directly into the meadow in Spring. As above, yellow rattle grows best once soil nutrients have been reduced. Seed should be sown before November, as yellow rattle needs a period of cold weather in advance of spring germination. Alternatively, plugs could be sown in spring. Recommended for the 1916 Meadow and Large and Small Paddocks

Green hay: hay from a species-rich donor site, *e.g.* the Arboretum is spread on a species-poor recipient site. Green hay is harvested just as wildflowers and grasses are shedding their seeds and are still 'green'. The hay is quickly transferred to the species-poor recipient site where it is spread allowing the seed to drop. It is then removed a few days later. This method is recommended once nutrient levels in the recipient site have declined to sufficiently low levels, appropriate for wildflowers. Recommended for the 1916 Meadow and Large and Small Paddocks depending on soil nutrient levels.

Sow native, locally sourced wildflower seeds. These can be harvested from the Arboretum or from nearby populations (see RESOURCES). If this is not possible, native provenance wildflower seeds can be sourced from local specialist suppliers. It is extremely important that native rather than non-native wildflower mixes are used for wildflower meadows, and that seeds are sourced from Irish populations rather than horticultural varieties. Many commercially available seed mixes can contain non-native species that could become invasive. They may not provide the right kind of food at the right time of year for native insects. Some commercially available wildflower mixes contain native species, but from genetically distinct populations, that are not adapted to the local conditions. Locally adapted populations of wildflower are better suited to the local environment and are able to cope with local

pressures. Some commercial wildflower mixes also contain horticultural varieties of native species, that are bred for their colour, hardiness, ease of growth rather than their nutritional value to native insects. Some of these varieties contain less nectar, pollen or essential nutrients that our native insects need. Finally, some commercial mixtures may not contain the full complement of species that, by flowering at different times, provide food right throughout the growing season. This method is recommended once nutrient levels in the recipient site have declined to sufficiently low levels, appropriate for wildflowers. Recommended for 1916 Acorn Meadow and the Large and Small Paddocks.

Grow and plug wildflowers (sourced as above) directly into meadows. Again, this method is recommended once nutrient levels in the site have declined to sufficiently low levels, appropriate for wildflowers. Recommended for 1916 Acorn Meadow and later the Large and Small Paddocks, as above.

If conservation grazing is a chosen management option to restore species-rich grassland, we recommend that a rare breed of Irish cattle, such as Droimeann, Dexter or Moiled Cattle, be used. These traditional breeds of cattle are hardy, adapted to local conditions, and can prosper on grassland which would be too poor in nutrients to support larger, modern breeds of beef and dairy cattle. Conservation grazing using rare breeds would contribute not only to the enhancement of biodiversity in the Áras, but to the conservation of our agricultural heritage. Winter-grazing Droimeann are currently used to maintain the biodiversity of the species-rich grasslands in Fernhill Park by Dun Laoghaire Rathdown County Council. Dexter Cattle are used for conservation grazing by Fingal County Council, and Dexter and Moiley in Oxford Island, Co. Armagh. Treating livestock with avermectins should be avoided as these can have a negative impact on biodiversity, *e.g.* fungi and other soil biota. Where grazing is not appropriate, other forms of management such as annual mowing and hay-making should be used.

While not currently a problem, the spread of prairie grass (*Bromus catharticus*) should be monitored in the grasslands. Seed is the main source of infestation, and as few seeds remain dormant, the most important aspect of prairie grass management is to reduce its seed bank.

We assume that the Horse Pasture will continue to be used to graze the Garda Mounted Unit Horses, and therefore suggest that efforts to improve the paddocks be confined to those areas to the north of the house.

We recommend that grassy areas of Scattered Trees and Parkland (WD5), *e.g.* to the north and east of the Kitchen Garden, where grass has been allowed to grow should be managed in the same way as the Arboretum, *i.e.* annual mow with cuttings removed. As nutrient levels decline native wildflower seeds could be sown and/or plugged to enhance these areas. Similarly, the area around the bench close to the south-eastern corner of the perimeter path, at the far side of the Horse Paddock, could be managed as a small wildflower meadow.

We do not recommend much change to the management of areas of amenity grassland, given the need for many areas of Áras an Uachtaráin to look neat, and there is already a good deal of diversity in these areas. In particular, the area of roadside verge on the approach to Cabra Gate may act as a natural seed source for the adjacent paddocks. In the Formal Gardens, strips around the edges that do not face the house directly could be mowed with less regularity to allow broadleaved herbs to flower.

Finally, we do not recommend any change to the management of the wet grassland, since it supports a great deal of diversity given its size (0.4% of the grounds), and is also directly adjacent to one of the two areas where Hairy St. John's Wort (*Hypericum hirsutum*) occurs.

Woodland Habitats

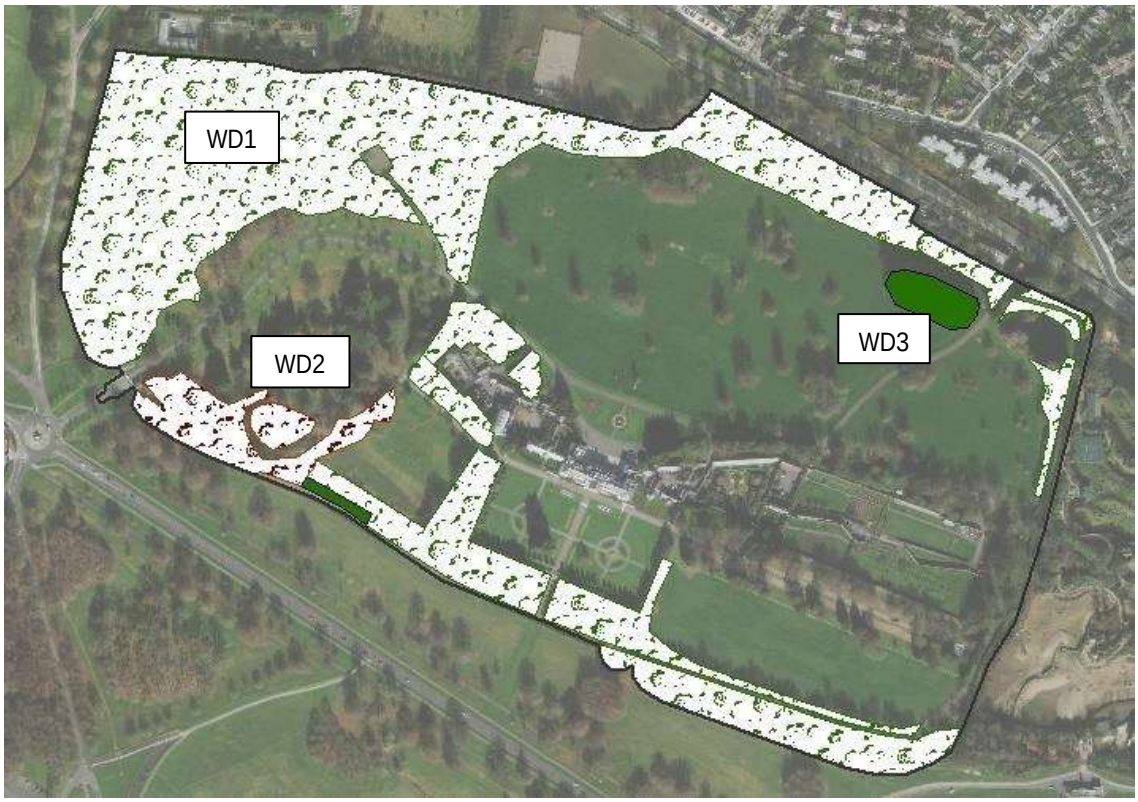

Figure 28 Location of woodland habitats in Áras an Uachtaráin.

What is there and where is it?

The woodland accounts for approximately 162,000m^2/40 acres, or just over 30% of the area of Áras an Uachtaráin. In woodland habitats, the main structural element is trees, rather than shrubs. The Áras woodlands are classified as highly modified/non-native, *i.e.* those that have been modified or managed to some extent by humans over centuries. The majority (90%) of woodland are mixed broadleaved woodland (WD1). WD1 is composed of 75-100% of a variety of broadleaved trees and 0-25% conifers, and may include native and non-native species. WD1 is found in the Wilderness Area, the woodlands along the northern and eastern perimeter paths and the areas surrounding the Formal Gardens to the south of the house. Together, the woodlands are the most biodiverse habitat in the Áras, with nearly 62% (N=497) of all species recorded occurring in these areas.

Mixed broadleaved conifer woodland (WD2) accounts for 7.5%. Woodland is classified as WD2 is composed of mixed stands of conifer and broadleaved trees, and where both types have either a maximum of 75% or a minimum of 25% cover. This type of woodland is found in the vicinity of Nut Island.

Conifer woodland (WD3) comprising 75-100% conifer species, accounts for 2.5% of woodland in the Áras. It is found in two areas, a stand in the Large Paddock close to the Cabra Gate, and a strip behind the more recently planted broadleaved trees, adjacent to the 1916 Meadow.

In addition to woodland habitat, there is, of course, parkland habitat (WD5, discussed in the section above) where scattered trees stand alone or in clusters. There are also some linear features such as ornamental/non-native shrubs (WS3) that run along the boundary with Dublin Zoo and are features of the Formal Garden, and a treeline (WL2) composed of lime (*Tilia europaea*) either side of the road to Buggy's Gate (Figure 4).

The Context

The woodlands are well established with a relatively open canopy in some areas. There are many native and naturalised species that provide good resources for other aspects of biodiversity. The majority of fungal species were found there. The understory is considerably more developed than in the wider Phoenix Park due to the exclusion of fallow deer in recent years (Figure 29).

There was a high level of botanical diversity in the ground layer and understory, with 108 species of flowering herb and 150 species of fungi identified in woodland. A considerable amount of this diversity is located along the woodland rides (perimeter paths). Hairy St. John's Wort (*Hypericum hirsutum*) was recorded in two areas, at the edge of Nut Island and in The Wilderness along the northern perimeter path. This species is protected under Section 21 of the Wildlife Act, 1976 and is listed in the Flora (Protection) Order, 2015. It is illegal to cut, uproot or damage it in any way, to offer it for sale, including seed. In addition, it is illegal to alter, damage or interfere in any way with its habitat. This protection applies wherever the plants are found and is not confined to sites designated for nature conservation. There are very few records of Hairy St. John's Wort on the NBDC database, only eight in total, one of which was from a previous survey of the Áras. There are 154 records on the BSBI database for Ireland, but only 36 of these were recorded since 2000. The species has an extremely limited distribution, and is largely confined to the Liffey Valley. To have a second record of this species in the Áras is fantastic.

Figure 29 Wild garlic (*Allium ursinum*) flowering in the Wilderness woodland.

The Wilderness Area provides good quality forage for bees and other pollinating insects, with the diversity of flowering herbs providing a succession of foraging opportunities throughout the season. Veteran trees and deadwood are allowed to stand where it is safe to do so, providing resources for invertebrates such as beetles, spiders, woodlice, millipedes and habitat for bats and 49 species of saprophytic fungi. The woodlands (northern perimeter pathway from the Wilderness Area to the Pond, eastern perimeter path near Kitchen Garden) provide excellent habitat for bats, with the highest levels of bat activity recorded in these areas on static detectors and during walking transects. A foraging bat was even captured on a trail-camera in The Wilderness Area (Figure 30).

Although the woodlands were not surveyed specifically for the presence of bat tree roosts, the abundance of mature trees provide many potential roost features in the

forms of cracks, crevices, lifting bark, wounds, knotholes, fluting, grey squirrel holes and ivy.

Figure 30 Bat caught foraging on trail-camera in the Wilderness Area.

Dead and diseased trees also provide good roosting opportunities in the form of, *e.g.* desiccation features and butt-rots, as do pruning cuts in healthy trees. The northern and eastern perimeter paths act as a commuting route between roosting and foraging areas, and also as foraging areas for bats.

Other mammals such as grey squirrels, foxes and badgers were observed or recorded on camera using the woodlands. Two badger setts were located in WD1 habitat, while a further two were located in parkland, albeit in close association with trees. The Wilderness and Nut Island, held reasonable numbers of woodmice, as did the area around the southern perimeter path adjacent to the horse pasture. Pygmy shrews were recorded on trail-camera in The Wilderness and on Nut Island.

The Mixed Broadleaf Woodland (WD1) held the highest species richness and diversity of birds of any of the habitats in the Áras. The presence of jay (*Garrulus glandarius*) and treecreeper (*Certhia familiaris,* Figure 31), both mature woodland specialists, indicates that the Mixed Broadleaf Woodland is of high habitat quality. Sparrowhawk (*Accipiter nisus*), raptors favouring woodland habitats, bred in the Conifer Woodland (WD2) adjacent to the pond and were observed hunting in the both the Mixed Broadleaf Woodland (WD1) and the Mixed Broadleaf Conifer Woodland (WD2) surrounding Nut Island, indicating that the Áras woodland habitats provide nesting and foraging resources to this species. Buzzard (*Buteo buteo*), while not a woodland specialist, nested in the mature trees of the Wilderness Area (Figure 31). A single Great Spotted Woodpecker (*Dendrocopos major*) was observed in the woodland around Nut Island. The Great Spotted Woodpecker is a recent addition to Ireland's avifauna having colonised Wicklow in the early 2010's and has subsequently spread into surrounding counties. The woodland habitat in the Áras would support the Great Spotted Woodpecker, who need

mature trees, typically Oak (*Quercus* sp.), to forage in, and should be viewed as a possible breeder.

Figure 31 Buzzard (*Buteo buteo*) and treecreeper (*Certhia familiaris*) in The Wilderness Area. Photos: Art O'Leary

The Challenges

Horse chestnut life miner infection and ash dieback are problems on a national level. While many horse chestnut trees in the Áras were infected with the leaf miner *Cameraria ohridella*, it does not significantly impair the trees' overall health, rather its effect is mostly aesthetic. There were some early signs of Ash dieback disease (caused by *Hymenoscyphus fraxineus*) in some trees. The interior of the woodlands ground layer is dominated by several invasive species such as bindweed and winter heliotrope, and there are several stands of Japanese Knotweed. The Japanese Knotweed forms very large stands in places and repeated treatment will be required for eradication. Giant Hogweed was also recorded close to Buggy's Gate. While the latter are being actively managed by the OPW, they will need ongoing treatment. Winter heliotrope and bindweed outcompete native species.

No stoats, pine marten, hedgehog or long-eared owl were recorded in the woodlands, or indeed anywhere else in the Áras. There is a large population of grey squirrel on site, and indeed in the wider Phoenix Park.

Finally, there is a significant amount of disposal of grass cuttings/horticultural/ arboricultural arisings in some of the woodlands which has resulted in excessive local fertilisation and an increase in nettles, problem and invasive species at ground level.

Opportunities for Improvement

While there is no cure for ash dieback or horse chestnut leaf miner, the OPW follows the guidance issued from the Department of Agriculture, Food and the Marine, with regard to the management and prevention of the spread of tree diseases within its sites. Likewise, the OPW Tree Management Policy & Biosecurity Statement sets out best practice guidance for its staff including the gardening team at Áras an Uachtaráin. Biosecurity measures should be employed, such as removing all plant debris such as leaves *etc.* from clothing and footwear, washing off all soil and plant debris from boots, tools and equipment, and then spraying them with disinfectant. Ash trees which become progressively defoliated over successive years should be felled and their stumps killed, as coppice shoots are particularly vulnerable to the disease.

The Hairy St. John's Wort is subject to a Flora Protection Order and must be protected. With immediate effect, all staff working in the grounds should be aware of its diagnostic features so that it can be identified, recorded and its habitat protected. *Hypericum hirsutum* grows in open or partially shaded habitats such as rough and ungrazed grassland, clearings and rides in woodland, on the banks of rivers and road verges. This is consistent with the two locations at the edge of Nut Island and in the Wilderness Woodland adjacent to the Northern Perimeter path. This second location is particularly vulnerable to "tidying-up" through mowing. It is possible that it occurs in other areas within the Áras.

A tailored approach will be required for invasive species. Very targeted, repeated applications of herbicide will be required for Japanese Knotweed, rather than widespread spraying, and this is the current management practice for this species. Giant hogweed is biennial. If flowering is prevented manually, the seed source will be decreased. It is difficult to manage bindweed and winter heliotrope, particularly over such large expanses, as they spread vegetatively, and even the smallest root fragments can regenerate. We do not recommend the spraying of glyphosate, which is non-

selective, to control bindweed and winter heliotrope. However, it is possible that planting more holly in the understorey will decrease their dominance by shading them out. However, care must be taken however not to shade areas where St. John' Wort is found, as it prefers partial share and more open areas.

Figure 32 Pine marten den box (Photo: Ruth Hannify) and pine marten kits in a den box (Photo: Johnny Birks).

While no pine marten were recorded during the course of this survey, there are several records of this species in close proximity to the Phoenix Park (NBCD). The limiting factor for pine marten in urban areas is lack of suitable woodland habitat and nesting sites, and general avoidance of people. However, the records suggest the potential for pine marten to colonise the Phoenix Park via the Liffey Valley corridor. The presence of mature trees in the Áras, and the wider park, may provide cover for pine marten and some opportunities for denning *e.g.* squirrel holes, cavities *etc*. To encourage colonisation, nest boxes specifically designed for pine marten (see pinemarten.ie) could be installed and monitored on an ongoing basis (Figure 32). Uptake of nest boxes has been successful in other locations (Croose *et al*. 2016). Guidelines for managing pine marten in woodlands are available at pinemarten.ie.

Despite pine marten recovery resulting in apparent wide-scale declines of the invasive grey squirrel, the latter will likely persist in urban areas due to the pine martens' reluctance to occupy such habitats (Twining *et al.*, 2020). It is possible that if a population of pine marten is established in the Phoenix Park, they would help to reduce grey squirrel numbers in the park, although eradication would be unlikely, given the

persistence of grey squirrels in the wider urban environment where pine marten will not go. However, this continued source of urban grey squirrels could promote the survival of pine marten in the park.

Many woodland songbirds nest in the cavities created when branches break off trees as the cavities provide high quality nesting sites. The number of cavities in a woodland can be limiting to songbird population numbers and so nest boxes should be provided to ensure an adequate supply of high-quality nesting sites. Nest boxes should be of a variety of designs as different birds have different requirements, *e.g.* different sized entrance holes for closed boxes, open designs for robins, baskets for long-eared owls. Nest boxes have the added advantage of being accessible to experienced bird ringers to allow monitoring of bird populations trends.

Building long-term log piles throughout the woodland is recommended. These provide habitat for mosses, lichens and fungi and attract invertebrates such as longhorn beetles, woodlice, centipedes, millipedes and molluscs. These in turn attract predators such as small birds, mice and hedgehogs. Log piles also provide denning opportunities for mammals such as stoat, pine marten and hibernating hedgehogs.

It is extremely likely that bats are roosting in the woodlands of Áras an Uachtaráin. Bat roosts are legally protected under Irish and European law. It is an offence to interfere with any structure or place used for breeding or resting by a bat or interfere with a bat while it is occupying a structure, even accidentally. Therefore, it is important that, prior to the felling of old trees and other such works in the woodland, bat surveys carried out by a licenced ecologist, or a trained and licenced arboriculturalist, are conducted.

Current low levels of lighting should be maintained in woodland areas to facilitate roosting, commuting and foraging bats, with perhaps a reduction in intensity along the section of eastern perimeter path (between the pond and the Kitchen Garden), that is currently well lit at night.

A single, dedicated composting area should be created for all gardening/horticultural/ arboricultural arisings.

Wetland Habitats

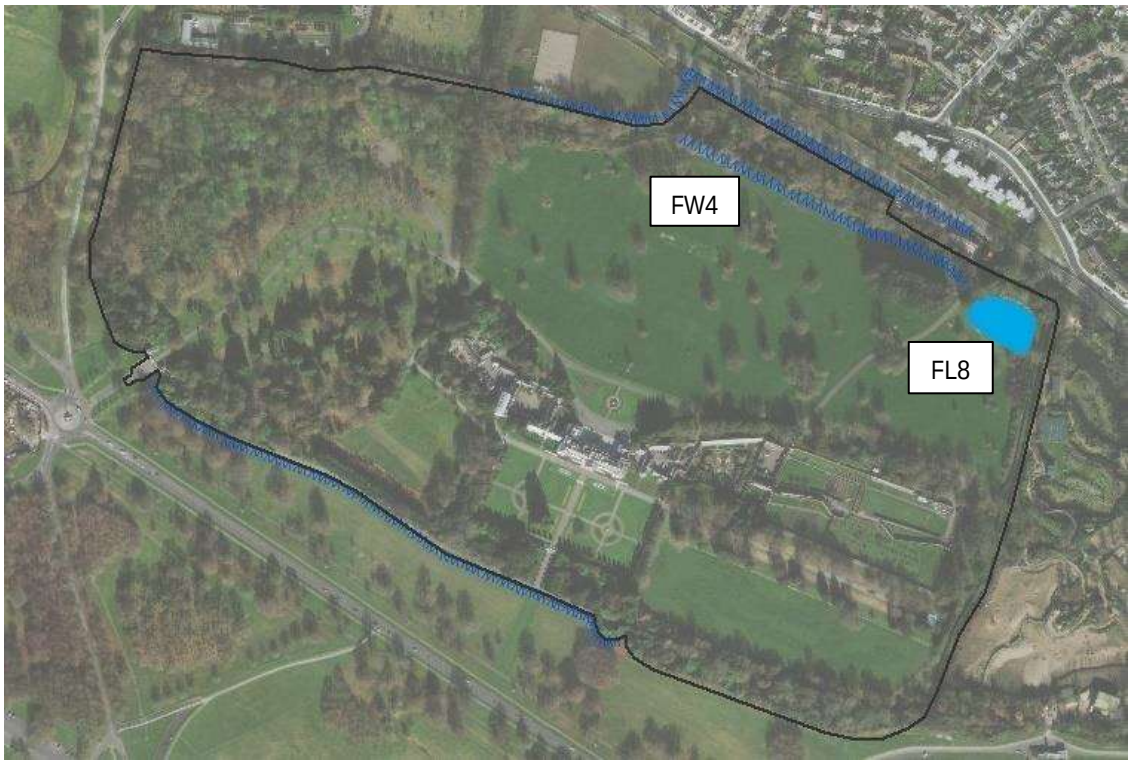

Figure 33 Location of aquatic habitats in Áras an Uachtaráin.

What is there and where is it?

A section (c. 330m) of a stream emerges from its underground culvert between the Large Paddock and the northern perimeter path. This is classified as a drainage ditch (FW4), *i.e.* a watercourse that has been excavated or modified to enhance drainage or control the flow of water. It drains into the pond at the north-eastern corner of Áras an Uachtaráin close to the Cabra Gate. The flow in the stream is negligible, but probably increases in rainy conditions. The Áras pond is an artificial pond (FL8), *i.e.* an artificial or ornamental waterbody typically found in parks, demesnes, gardens *etc* (Figure 34). The pond is approximately 2,910m2, and has a mean depth of 0.7m (max 1.4m) (Caffrey *et al*. 2008). The Áras pond is dammed at both its eastern and western inflow and outflow points. It drains to the Fish Pond in Dublin Zoo through underground pipes, and was in fact part of the Fish Pond until the boundary between the Áras and Dublin Zoo was altered in 2000. There are also two ha-has, *i.e.* sunken fences that create wet ditches, just outside the northern and southern perimeter fencing.

The Context

Figure 34 The Pond at Áras an Uachtaráin, looking towards the Large Paddock.

A previous survey (Caffrey *et al*. 2008) found that the Áras pond was a healthy watercourse expected to support healthy populations of flora and fauna. Our survey had confirmed this expectation. The marginal vegetation is well developed and provides good nesting habitat for waterbirds such as little grebe (*Tachybaptus ruficollis*), coot (*Fulica atra*) and moorhen (*Gallinula chloropus*), all of which bred on the pond in 2020 (Figure 35). The predatory heron (*Ardea cinerea*) was also observed regularly at the pond, indicating that the pond provides good food resources for animals at higher trophic levels. The pond supports a healthy invertebrate population both aquatic and terrestrial (Figure 34). For example, damselflies and dragonflies were observed over the marginal vegetation and water and small tortoiseshell caterpillars (*Aglais urticae*) were developing on nettles (*Urtica dioica*) growing at the edge. Ladybirds were observed

feeding on aphids that were infesting nettles. The boat house and vegetation surrounding the pond is a haven for arachnids such as black lace web (*Amaurobius ferox*), snake back (*Segestria senoculata*) and walnut orb weaver (*Nuctenea umbratica*) spiders, which thrive there feeding on woodlice and flying invertebrates. Rudd (*Scardinius erythrophthalmus*) continue to thrive in the pond, and three-spined stickle-back (Gasterosteus aculeatus) were also recorded during this survey.

Figure 35 Pond fauna. Small tortoiseshell caterpillars (*Aglais urticae*), coot (*Fulica atra*) with chick, moorhen (*Gallinula chloropus*), azure damselfly (*Coenagrion puella*), brown hawker dragonfly (*Aeshna grandis)*, and two-spot ladybird (*Adalia bipunctata*). Bird photos by Art O'Leary.

The pond is an excellent foraging site for bats, that feed on emergent invertebrates, midges *etc*. A high level of bat activity was recorded at the pond with static recorders, heterodyne recorders and visual observations. All three pipistrelle species (Soprano, Common and Nathusius') were recorded at the pond, as was the Daubenton's bat. Leisler's bats were also recorded in the vicinity of the pond, although were likely foraging high over the adjacent paddocks. The recently repaired lighting system around the pond does not seem to have diminished bat activity. The invasive mink was not recorded on the mink rafts, although rodent prints were observed on the mink rafts.

The Challenges

While an algal bloom occurred during the month of August, this was likely a normal response to weather conditions. The pond appears to support a healthy ecosystem and we have no reason to believe that the water quality has changed much in recent years (although water quality was not tested), given that the opportunity for inputs into the system is low. A stream enters the Park close to the Castleknock Gate and flows underground to feed the Áras Pond (Caffrey *et al*. 2008).

However, it was extremely surprising that there was no evidence of amphibians in the Áras pond, particularly when there are healthy populations in the wider park. It is possible that spawning occurred later in the Áras than in the wider park, and was missed due to the Covid-19 restrictions on fieldwork. However, there is no reason why the timing of this activity in the Áras should differ from the rest of the park. It is possible that the fish population in the pond is too high for survival of spawn. However, adult frogs and newts were not encountered in any other areas during our survey - these can often be encountered in grass, for example. Perhaps the steep-sided ha-has act as a barrier to frog and newt migration.

The non-native false widow spider (*Steatoda nobilis*) was recorded at the boat house and in conifer trees near the pond. This species has become widespread in Ireland but is usually associated with human habitation (Dugon *et al*, 2017). Its impact on native spider species is not yet known.

Some edge vegetation was cleared at the eastern side of the pond during the course of our survey season to allow views from the bench over the pond. However, we acknowledge that this was on a very limited scale. There is also some bindweed growing among the edge vegetation that should be managed.

Opportunities for Improvement

The pond accounts for approximately 0.5% of the area of Áras an Uachtaráin. To enhance the potential of the pond, a floating island could be installed (Figure 36). These are artificial ecosystems, planted with native species, provide habitat and resources both above and below the waterline for birds, invertebrates and fish while also improving water quality. This would have the effect of increasing the amount of edge habitat in the pond, and would increase safe nesting opportunities for waterbirds.

Figure 36 Floating Island in Blessington Basin, Dublin (Photo: rte.ie) and Brayford Pool, Lincoln (Photo: biomatrixwater.com).

Floating islands have been installed with great effect in Blessington Basin in Dublin City. It is unlikely that frogs and newts will re-establish in the existing pond if the fish population is too high, and we do not recommend a reduction in the fish stock, as the rudd and stickle-back are a vital part of this ecosystem.

One of the best ways to enhance biodiversity in the Áras would be to increase the proportion of wetland areas in Áras an Uachtaráin by creating new ponds, both ephemeral and permanent. A series of ponds, rather than a single pond, could be created in the Large Paddock adjacent to the existing stream, preferably working with the existing natural system. A map dated 1813 (Figure 37) illustrates that an extensive water course once passed through the area north of the paddocks, but by 1830 this had been reduced to a stream and large lake (now the current Áras pond and Fish Pond in Dublin Zoo). This area could be investigated as a source for an expanded wetland, subject to hydrology, engineering and funding availability.

Pond complexes should include both permanent and seasonal ponds of varying areas and depths. Edges should be undulating to create different microhabitats. Most pond slopes should be shallow. Ponds should be allowed to colonise naturally, and should not be stocked with fish, to promote colonisation by frogs and newts. However, if natural colonisation by frogs and newts does not occur, a licence to translocate frog and newt spawn from other ponds with the Phoenix Park could be sought. Exotic aquatic and semi-aquatic plants should not be planted. If the paddock is used for livestock grazing, a fenced-off buffer zone will be required around the pond to protect it from physical damage and pollution. This buffer area could be planted for pollinators.

Figure 37 A section of a map dated 1813 illustrating that an extensive water course once passed through the area north of the paddocks.

Although for some time in the past there was a moat around Nut Island (Figure 38), we do not recommend re-wetting the ditch, as this is the only area of wet grassland (GS4) in the Áras, which given its small size is incredibly biodiverse. It supports a unique mix of species, and its removal for the creation of wetland would decrease rather than enhance the overall biodiversity of Áras an Uachtaráin.

Figure 38 Historic map indicating the presence of a moat around Nut Island

Cultivated Habitats

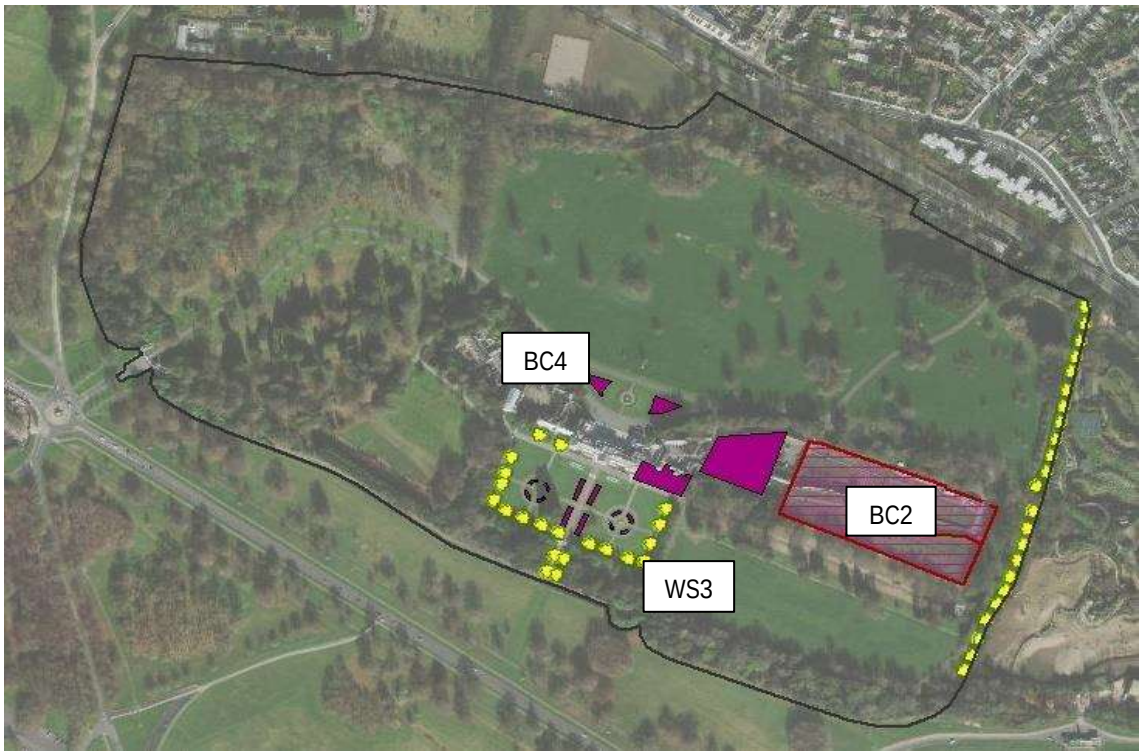

Figure 39 Location of flower beds and borders, ornamental shrubs and the walled Kitchen Garden.

What is there and where is it?

Cultivated land accounts for approximately 25,000m^2/6 acres, *i.e.* 5% of the total lands within the Áras (Figure 39). The majority (73%) is horticultural land (BC2), located in the walled organic Kitchen Garden. BC2 are defined as cultivated lands managed for the production of fruit, vegetables, culinary herbs, flowers and other ornamental plants, and includes orchards. Flowerbeds and borders (BC4) account for 27%. BC4 are defined as ornamental flowerbeds and borders where herbaceous plants and dwarf shrubs dominate. These generally originate from planting for the purposes of decoration and are regularly maintained or managed. Flowerbeds and borders are found primarily in the President's Walled Garden (Figure 40), and also in the Formal Gardens and in front of the main entrance to the house. In addition, there are approximately 820m of ornamental shrubs (WS3), mainly alongside the Zoo perimeter, while the rest are ornamental yew in the Formal Gardens.

The Context

Figure 40 The President's Flower Garden.

Both the Kitchen Garden and the President's Flower Garden are organic, and have officially been certified as such by the Organic Trust since 2010/11. In the Turner House (where peaches, kiwi, kumquat, grapes are grown) pesticide is not sprayed. Rather, biological pest control is used, *e.g. Encarsia formosa*, a parasitoid wasp of greenhouse whitefly, and lacewing larvae that are active predators of aphids, thrips, whitefly, leafhoppers, spider mites and mealybugs. Pyrethrum, an organically acceptable pesticide, is used on fruit. Prior to receiving organic status, the only chemicals sprays used were for potato blight. However, the variety of potatoes that are grown was changed from blight-vulnerable varieties such as Roosters to Orla, which is an early variety that can be cut back in the event there is a blight warning. Pellets are not used to control slugs.

The Formal Gardens are not organically certified. Nonetheless, the spraying of chemicals has been reduced, with pyrethrum used on the roses/flowers for insect pests, and Barrier H, a citronella-based herbicide to control weeds. Weeds are hand-weeded as much as possible along the paths. Organic fertilisers, such as Osmo Pro-2, are used in the beds. Grass clippings are left on the lawn areas so there is no need for artificial fertilisation.

There was much evidence of pollinator-friendly planting in both the Kitchen Garden and the President's Walled Garden. For example, in the Kitchen Garden two strips of

wildflower mix were sown along the path leading from the main entrance gate into the garden. An area adjacent to the central wall on the opposite side to the orchard that had been allowed to grow wild with wildflowers and escaped cultivars that supported a host of butterflies, bees and moths. Apple trees are a preferred food source for many Andrena species of bee (solitary, active in spring and early summer). Two specimens of *Andrena bicolor* were recorded in the pan traps at the orchard. These were the only records of solitary ground-nesting bees at the Áras.

The formal planting in the President's Flower Garden contained many varieties attractive to pollinators, such as salvias and scabious (Figure 41). In the Formal Gardens beds of lavender were alive with honeybees, bumble bees and hoverflies, as was the *Verbena bonariensis* which was planted in the beds directly in front of the house. The only observation of a leafcutter bee (*Megachile centuncularis*) was recorded on lavender in the Formal Garden beds. These beds are adjacent to many rose plants, which leafcutters use to line their nests and so it is beneficial that these plants occur in close proximity to one another.

Figure 41 Pollinator-friendly planting in the President's Flower Garden. Photo: Jane Stout.

Woodmice were trapped in the President's Walled Garden, and it also functioned as a foraging area for badgers. There was clear evidence that badgers had tunnelled under the large gate into this enclosed area on a regular basis, and even disturbed the

woodmice traps on one occasion to get at the peanut bait. The house mouse, *Mus musculus domesticus*, was not trapped in the small mammal traps set around the outbuildings and gardens. However, there was evidence of rodent control measures in place in the gardens and around many of the buildings. However, rodent prints were observed in hedgehog tunnels in the Kitchen Garden, but it is not possible to determine if these were woodmice or house mice prints. Foxes and cats were observed on trail-camera in the Kitchen Garden. Foxes were also observed accessing the Kitchen garden over the walls closest to the Zoo perimeter. Despite mink having attacked the chickens in the Kitchen Garden in the past, no mink were recorded on trail-camera adjacent to the secure coop, or anywhere else in the Áras.

The Challenges

There is a lot of bindweed growing in the Kitchen Garden due to the fact that glyphosate is not applied. However, efforts are being made to control it, *e.g.* manually removal in the area where soft fruits are usually grown.

Figure 42 Wildflower mix beds in the Kitchen Garden.

While it is really encouraging to see wildflower mixes being sown for pollinators, these were commercial mixes sourced from a French producer via a UK supplier (Figure 42).

While the risk of escape from a border is not as great as it would be if sowing commercially available mixes in meadows, it would be preferable if seed of Irish provenance sourced from local producers were sown, for the reasons outlined 0 above (Grasslands section).

Despite the fact that pyrethrum is certified as an organic pesticide - when it is not combined with piperonyl butoxide or other synthetic pesticides - there are still concerns regarding its use. Pyrethrum is non-specific and is therefore highly toxic to most insects. While it is highly effective against pest species, it is also deadly to the beneficial insects that pollinate vegetables, fruit trees and flowers, and themselves act as natural pest controllers. Pyrethrum is also toxic to fish and amphibians, and should be kept out of drains and waterways.

The wild patch adjacent to the central wall was flailed and rotovated in the middle of July, to prepare for the installation of a polytunnel. This removed a hotspot of floral and invertebrate diversity from the area at the height of the flowering season. Removal could have been postponed until after the flowering season.

Despite the fact that rehabilitated hedgehogs had previously been released by OPW staff in the Kitchen Garden there was no evidence of hedgehogs found, either with footprint tunnels or trail-cameras, here or anywhere in the Áras. To survey for lizards, basking mats were deployed in sunny locations adjacent to walls in the Kitchen Garden, but no lizards were detected. Neither did OPW staff report ever seeing lizards on site. The closest known population of lizards in Dublin is located on North Bull Island, so it is perhaps not surprising that none were recorded.

While all of the solitary bee species recorded during the surveys were recorded in cultivated areas, their abundance and diversity was incredibly low. One of the most obvious limiting factors for these species is the lack of nesting sites for them in proximity to forage. Solitary bee species either nest in sandy, well-draining soil or in pre-existing cavities above the ground (for example gaps in mortar, wood or artificially installed “bee hotels”). These types of structures were largely absent from the Kitchen Garden, The President’s Flower Garden and the Formal Gardens.

Opportunities for Improvement

The use of pyrethrum should be minimised where possible, and natural pest control encouraged. Pyrethrum daisies could be grown in the Kitchen Garden to repel pests, and

could even be harvested, with dried flowers ground into insecticidal powder. Pyrethrum should never be mixed with other chemicals to increase their effectiveness, and should be kept away from waterways.

We recommend that a wild area be set aside in the Kitchen garden from 2021 onwards, similar to that which was located on the polytunnel site in 2020.
The wildflower mix used in the Kitchen Garden should be replaced with one of local provenance in 2021

The grass in the orchard area could be allowed to grow until harvest time (August/September each year), to allow wildflowers to bloom.

Habitats should be created for pollinators other than honeybees. Specific habitat areas (Figure 43) could be developed for invertebrates, including bare/sandy soil areas or scrapes for ground-nesting bees. These nesting sites would have the greatest chance for success in or near the Kitchen Garden where a ground nesting species has been recorded. Bee hotels could be installed adjacent to the lavender and rose beds in the Formal Gardens and President's Walled Garden to help establish a larger and more diverse population of aerial nesting solitary bee species.

Figure 43 Bee hotel, close up of *Osmia bicornis* in an artificial nest and bare soil created for mining bees. Photos: Julie Kendall and John Fogarty on pollinators.ie

Each insect group has evolved different types of mouthparts to exploit floral resources. The mouthparts of each species can only exploit flowers of a certain size and shape. While some insects, such as honeybees, are generalists and can exploit a wide range of flowers, others are specialists and have quite particular needs. Butterflies and moths have a long, very thin proboscis with which they take nectar from small tubular flowers. The mouthparts of most bee species consist of a fairly rigid hollow proboscis, the length of which closely dictates the shape and size of flowers that each species of bee can utilise. Proboscis length varies between 1mm and 19mm according to species, so a variety of flowers should be planted to meet their needs. To support insect diversity, we need to plant a diversity of suitable flowers. Certain native wildflowers attractive to a variety of pollinators could also be incorporated into the formal borders, along with the ornamental cultivars, in line with existing planting themes. There is an impressive collection of dahlias in the President's Flower Garden. Single dahlias have been introduced by the OPW horticulturalists, and we would recommend adding even more singles to this collection, as pollinators cannot access the flower resources of more complex varieties such as pompoms or cacti dahlias.

There is currently no single composting site in the Áras. Grass and horticultural arisings are disposed of in a variety of areas throughout the Áras, *e.g.* in parts of the Wilderness Area, in treelines and woodlands out of sight just off paths and at the edge of the Nut Island wet grassland. This has the effect of enriching those areas, altering the natural plant communities found there, encouraging weedy species and spreading problem species. We recommend that a single, dedicated composing area be created, perhaps at the back of the Kitchen Garden, where all waste material is deposited. The resulting compost can be used in the Kitchen Garden and formal beds. All problem waste (invasive species, infected Ash leaves *etc*.) should be dealt with appropriately.

Buildings and Artificial Surfaces

Figure 44 Location of buildings and artificial surfaces (BL3) such as roads, paths, yards (grey) and Kitchen Garden walls (red).

What is there?

Buildings and artificial surfaces (BL3) account for approximately 48,700m2 (12 acres), >10% of the total area of Áras an Uachtaráin, and consist of the main house, offices, outhouses, stores, yards, gatehouses, the boat house, the kitchen garden walls and stores, and all of the roads and paths (Figure 44).

The Context

While buildings and artificial surfaces might not be expected to contain much biodiversity, there are many structures that provide habitat and other resources for plants and animals in the Áras (Figure 45). For example, the walls, particularly those surrounding the Kitchen Garden, accommodate ferns and herbs such as ivy-leaved toadflax (*Cymbalaria muralis*) and snapdragon (*Antirrhinum majus*). The outhouses and

stores provide nesting spaces for birds such as the swallow (*Hirundo rustica*) and wood pigeon (*Columba palumbus*). Blue tits (*Cyanistes caeruleus*) were reported by staff to be nesting in the wall of the Gardeners' house. A grey squirrel (*Sciurus carolinensis*) drey was recorded in the Kitchen Garden potato store. Hibernating wasps and butterflies were recorded in the onion store. Evidence of bats roosting in the onion store was also recorded in the form of feeding remains and a small number of droppings. Fungi, such as shaggy ink cap (*Coprinus comatus*), and the cyanobacteria *Nostoc commune* were recorded growing on gravel paths. The boathouse was a haven for spiders. The tunnel adjacent to the old ice house was used by a variety of species including hibernating herald moths (*Scoliopteryx libatrix*), the cave spiders (*Meta menardi* and *M. merianae*), brown rats and badgers. The badgers used it as an entrance to their sett and also as a latrine. A badger "daybed" or nest, a structure not often encountered as badgers usually sleep underground, was built at the entrance to the still-covered part of the entrance in April 2020.

Figure 45 Natural encounters in artificial environments. Top left to bottom right: herald moths (*Scoliopteryx libatrix*) hibernating in the Ice House tunnel, a grey squirrel drey (*Sciurus carolinensis*) in the potato store, a peacock butterfly (*Inachis io*) hibernating in the onion store, a badger nest in the Ice House tunnel, a badger (*Meles meles*) captured using the nest, and shaggy inkcap (*Coprinus comatus*) mushrooms growing on a gravel path.

The Challenges

There was little evidence of bats using the buildings around the Áras for winter or summer roosting. Access to many of the roof spaces around the yards was restricted where vents were blocked by zinc mesh. Many of the buildings were in constant use and bats would be subject to disturbance, *e.g.* the attic of the main house and outlying buildings, and areas surrounding these buildings were very well lit at night. However, there were plenty of opportunities for roosting available, and use of these spaces by other species. The absence of evidence for bats is likely due to preferred roosting options elsewhere, *e.g.* natural roost features in the woodlands, rather than the unsuitability of at least some of these structures as roosts.

There was also no evidence of the use of the walls in the Kitchen Garden by mason bees for nesting sites, despite these being good habitats. Mason bees will nest in gaps in mortar in old buildings or walls, particularly if these structures are south-facing (note this activity does not cause any structural damage). This lack of occupancy may be because mason bees lacked other primary resources, *e.g.* plentiful food and mud to line nest cells, in close enough proximity. Their absence may also be due to the lack of a source population of mason bees within dispersal distance of the Kitchen Garden.

Opportunities for Improvement

Swift (*Apus apus*) have declined in Ireland by 60% compared to 1998, mainly through a loss of available nesting sites. Swifts nest in crevices of buildings, having adapted to the urban environment, and the recent refurbishment of many old buildings in Ireland has led to a shortage of crevices for swift to nest in. Swift were observed hawking insects around the Áras grounds and so are potential nesters, given the right nesting sites. We recommend erecting swift nest boxes on the buildings of the Áras. These nest boxes should be placed on a side of a building that gets some shade during the day and, if possible, be installed under eaves to give protection from the weather. They should be sited as high as possible, preferably more than 5 meters above the ground, with clear airspace so that the swifts can access nest boxes in high-speed direct flight. Swifts are colonial birds, preferring to nest in the company of other swifts. Therefore, it is advisable to erect multiple nests boxes side by side or to use a nest box with multiple nest cavities. Additionally, as swifts search for nest sites at locations where colonies are already established, it is strongly advised that a swift calling system is used to encourage the birds to start nesting at the new site.

Access to roofs and nesting spaces should be maintained for all animals where possible. Any future works to roofs or roof spaces should be mindful of disturbing these species, especially bats, since bats and their roosts are protected under Irish law. While there is little evidence for bat roosts within the buildings of Áras an Uachtaráin, it can never be assumed that buildings are unused by bats, as they move roosts between winter and summer roosts, and some areas and features were inaccessible for inspection during this survey. If works are planned in any of the buildings, particularly roof spaces/roofing material, bat surveys should be carried out by licensed ecologists. Legally, if a roost or bat is affected accidentally by such works, it is not a defence in law. However, if bats are present, derogation licences can be obtained in certain circumstances, to disturb bats and their roosts during the works.

While the evidence for use of internal spaces was limited, we suggest that bat boxes could be erected on external walls of buildings, in areas that are not well lit. We would recommend the use of crevice-style boxes with a gap at the bottom for droppings to fall out. These have the added benefit of not getting filled up with bird nesting materials which can block entry/exit. It would be essential to monitor boxes for their acceptance of use by bats and those boxes that remain unused two years after the date of erection should be relocated, *e.g.* to woodland areas. Seasonal inspection of bat boxes should be undertaken outside of the breeding season (mid-June to mid-August) to monitor usage, and in wintertime for general wear and tear and to remove droppings following use the previous summer. These inspections should be undertaken by a licensed bat-handler.

Similarly, because badger setts are protected under Irish law - and also because it is a unique habitat within the Áras that fosters other specialised species - the Ice House tunnel should be preserved. Any work to the tunnel would require a derogation licence from the National Parks and Wildlife Service.

Although there have been no scientific studies that have tested methods of encouraging mason bees to use old buildings and walls as nesting sites, ensuring that there is plentiful forage within close proximity and small patches of mud (which usually naturally occur at the base of garden walls) for the bees to line their nests with, may be incentive enough. One of the most common species of mason bee in Ireland is the red mason bee (*Osmia bicornis)*, which is active in spring and early summer (April - June). Planting spring-flowering species would be important for encouraging this species. The installation of one or two bee hotels near any potentially favourable nesting sites may also help to draw new individuals into the area.

FURTHER RESEARCH, EDUCATION AND OUTREACH

Research

There is ample scope for further biodiversity research to be carried out in Áras an Uachtaráin. Of course, it was not possible to survey every aspect of biodiversity during this project, and we would recommend systematic surveys for taxa that were not included during the course of this audit *e.g.* bryophytes, Odonata, Annelids, molluscs *etc*. As we now have a baseline for much of the biodiversity that does occur in the Áras, a programme of quantitative surveys should be put in place, to monitor change in biodiversity over time. For example:

- The existing bird, invertebrate, amphibian and small mammal trapping surveys should be repeated annually to monitor population trends. This would be particularly important in grassland habitats and proposed wetland habitats where we might expect to see the greatest changes in biodiversity, but should be carried out in all habitats to ensure there is no reduction in biodiversity.
- Bird boxes should be monitored to track breeding bird population trends and breeding success. Data from the monitoring of bat boxes should be similarly analysed.
- Bat acoustic surveys should be repeated to monitor species presence/absence and activity levels.
- Harp-trapping of bats under license to confirm the presence of Myotis species is and to contribute to the Nathusius pipistrelle Ringing Project is recommended.
- A specific bat survey of potential tree roosts for bats should be commissioned.
- A network of trail-cameras could be deployed and the imagery quantitively analysed monitor mammal presence/absence and detect to date "missing" species, such as stoat, pine marten and hedgehog.
- Pine marten boxes should be monitored to monitor uptake and assess breeding success.
- GPS tracking collars could be applied to badgers and foxes to ascertain how many social groups occur within Áras an Uachtaráin, and whether or not these individuals also use areas outside of the Phoenix Park.
- Annual quantitative surveys of the grasslands using revelés to calculate species richness and percentage cover should be implemented to measure the change in species-richness over time as grasslands improved under the new management regimes.

- The changing nutrient content of grassland soils over time should be measured and analysed, including nitrogen. Measuring total nitrogen content using a Leco elemental analyser would also give total carbon content. As the management intensity reduces and species composition changes, it would be interesting to measure any changes in N:C ratios over a 5-year timeframe. In addition, the available N in the soil in the form of nitrate and ammonium could be assessed, again over a similar timeframe but with more regular sampling. This can help better understand the availability of nitrogen in the soil and the emissions of nitrous oxide (N_20) from the grasslands.
- Any bee hotels that are installed should be monitored to track occupancy. There is the opportunity for some small-scale research projects to test the success of different types of bee hotels (*e.g.* materials, tube size) and different locations on the grounds. Similar projects could be carried out for ground nesting bees *e.g.* creating bare patches of soil verses introducing a sandy mix, altering the slope and so on. If nesting populations become established there would be opportunities to carry out research on nest parasites, pollen loads, and tracking the growth/decline of nest sites year on year.
- Given there are honeybee sites on site, a study on the interaction between honeybees and wild bees could be carried out, for example to investigate potential competition for floral resources.
- Moths are potential pollinators, but little is known about their efficacy as such or even which species they might pollinate. In addition to continuing licensed moth trapping surveys, research into the types of pollen they carry, and their pollen loads could be conducted.

Education and Outreach

It is incredibly important that the people who work and live in Áras an Uachtaráin feel an affinity for the biodiversity that exists on site, and understand the need for its protection and enhancement. A programme for biodiversity upskilling and mentoring of existing and new ground staff should be developed in, e.g. beneficial plants and features for wildlife, best-practice planting, habitat creation and habitat management for pollinators, species-rich grassland management, protection of rare species, management of problematic species etc. The appreciation of biodiversity for all other staff should be fostered through, e.g. a short biodiversity induction tour of the grounds. Staff could be encouraged to participate in existing citizen-scientists schemes, but within the grounds of the Áras, e.g. the Garden Butterfly Monitoring Scheme, Flower-Interaction Timed (FIT) counts, the Irish hedgehog survey, Dragonfly Dash!, BirdWatch

Ireland's garden bird and late nester surveys or by taking part in an annual Áras BioBlitz events, and submitting photos of the plants and animals they see in the Áras to the NBDC using their Biodiversity app.

The fact that Áras an Uachtaráin is, in normal times, open to the pubic in the forms of guided tours, presents an excellent opportunity to engage people in taking action for biodiversity, and to showcase the management actions for biodiversity that have already been undertaken by the OPW, as well as future management actions and best-practice. The already successful tours of the house and gardens could be extended to include a Biodiversity Trail, with interpretive signs and enthusiastic guides (following the successful model employed in the TCD Zoology Museum; final year or recently graduated students of TCD Botany, Zoology and Environmental Science are likely to be willing to take part in such a scheme). An annual schedule of biodiversity events could be developed such as a Schools' Outreach Programme based on the curriculum, *e.g.* designing and making bird/bat/pine marten boxes and bee hotels as part of the DCG subject, or demonstrating different vegetation, invertebrate & vertebrate survey techniques for ecology subjects. A seasonal calendar of public events could be designed *e.g.* nest-box building as above, dawn chorus walks in spring, bat walks April-September, bug safaris and pond dipping, wildflower tours/talks over the summer, traditional hay-saving demonstration in late summer, collecting and sowing wildflower demonstrations and collection of the Autumn apple harvest. It would of course be important to manage these activities in a way that was minimally disruptive for nature. Finally, the system of trail cameras and nest boxes could be used to engage the public in the online environment with streaming of footage from hot spot areas, *e.g.* badger sett (under license), fox den, bird nests (under license), squirrel drey cam, hedgehog feeding station, for example.

The richness of the biodiversity found in the habitats of Áras an Uachtaráin can showcase how we each can be leaders within our own spheres of influence when it comes to reversing biodiversity loss, and to demonstrate the message that our biodiversity is not only our right, but also our responsibility.

SUMMARY OF RECOMMENDATIONS

Management actions highlighted in green in Table 4 can be implemented immediately, or in late 2020/early 2021. Orange management actions should commence in 2021 and red management actions are longer term in nature, which require a planning phase before implementation. The '+' sign denotes the need for ongoing or annual management.

Table 4 Proposed management actions to enhance biodiversity and suggested timings.

Management Action	Timing
Grassland Habitats	
Soil nutrient testing of grassland habitats	Immediate and annual
Annual mowing and removal of toppings in Arboretum and 1916 Meadow	Late Aug/Sept 2020 and annually
Create areas of bare ground and sow yellow rattle	Autumn 2020
Plug propagated yellow rattle	Spring 2021
Protect (*i.e.* maintain) Nut Island wet grassland	2020 +
Reduce dominance of competitive species – docks, thistles, nettles brambles and ivy	Commence 2021 +
Manage grassy verges for wildflowers (annual mow & removal of toppings)	2021 +
Develop conservation grazing management plan for paddocks and arboretum	2020-2021
Implement conservation grazing regime in paddocks and arboretum	2021 +
Manage 1916 Meadow as a hay meadow	2021 +
Harvest wildflower seed/green hay from Arboretum and 1916 Meadow	2021 +
Consider reducing mowing regime in strips of amenity grassland in Formal Gardens	2021 +
Monitor prairie grass (*Bromus catharticus*) & control if necessary	2021 +
Woodland Habitats	
Train existing and new ground staff in identification of Hairy St. John's Wort & Legal Requirements for its protection	2020 +
Cease disposal of horticultural arisings in woodlands	2020 +

Management Action	Timing
Survey any trees marked for felling for bats	2020 +
Maintain low lighting levels and consider lowering light intensity where high intensity lights exist long perimeter paths	2020 +
Build long-term wood piles	2020 +
Continue to manage invasive species	2020 +
Install pine marten den boxes & monitor	Late 2020 +
Install a variety of birdboxes & monitor	Early 2021 +
Improve understory though holly planting	2021 +
Wetland Habitats	
Install floating island in the pond	2021
Maintain edge vegetation as much as possible	2021 +
Management plan for wetland creation in the Large Paddock	2020/2021
Wetland creation in the Large Paddock	2021/22
Potential translocation of amphibians under license if natural colonisation of wetlands does not occur after 2-3 years	2024/5
Formal and Kitchen Gardens	
Plant spring-flowering floral resources and create mud patches near Kitchen Garden walls to encourage mason bees	Late 2020/Early 2021
Create nesting habitat for solitary bees close to floral resources – bee hotels, bare soil/scrapes - monitor	Late 2020/Early 2021
Continue formal planting for pollinators, including butterflies and moths	2021
Consider inclusion of some native Irish wildflower species in ornamental planting regimes	2021 +
Use locally sourced seeds in Kitchen Garden wildflower beds	2021 +
Set aside a “wild” area in the Kitchen Garden	2021 +
Allow grass in Orchard area to grow until harvesting time	2021 +
Build hedgehog feeding stations	2021
Release rehabilitated rescue hedgehogs into Kitchen Garden	2021 & 2022

Management Action	Timing
Plan and construct single composting area in the Kitchen Garden	2021/22
Buildings and Artificial Surfaces	
Protect Ice House Tunnel	2020 +
Maintain access to roof spaces for wildlife	2020 +
Erect swift nest boxes on buildings & monitor	Spring 2021 +
Erect bat boxes on buildings in unlit areas & monitor	Spring 2021 +
Carry out bat roost surveys if works are planned for any buildings, particularly roof spaces	2021 +
General Recommendations	
Ongoing monitoring of changes in biodiversity over time	Annual surveys
Allow "weeds" to grow in less formal areas, and where appropriate	2020 +
Develop education and outreach programme of events	2020/2021 +
Develop Staff Biodiversity Upskilling & Induction Programmes	2020/2021 +
Develop Staff-Scientist Surveys *e.g.* FIT counts, BWI garden bird surveys, Áras BioBlitz, submit observations to NBDC *etc*.	2020/2021 +
Conduct formal survey for taxa not specifically targeted in this survey *e.g.* bryophytes, molluscs, annelids, odonata *etc*.	2020/2021 +

RESOURCES TO AID BIODIVERSITY MANAGEMENT

- Species-Rich Grassland Restoration Guides: Natural Regeneration, Green Hay, Seed Mixes, Brush-Harvesting, Yellow Rattle, Plug Planting, Seed Enhancement, Wildflower Succession, Grazing Animals, Conservation Grazing, Conservation Grazing for Semi-Natural Habitats, Irish Native Wildflower Seed Suppliers
- Rare Cattle Breeds: Moiley Cattle, Dexter Cattle, Droimeann Cattle
- Soil Index System
- Wetland Creation – pond design principles for biodiversity, pond creation toolkit pdf, pond creation guidance, creation/enhancement, floating ecosystems
- All-Ireland Pollinator Plan Resources: collecting and using wildflower seeds; creating and managing wildflower meadows, professional planting recommendations, carrying out FIT Counts, creating nesting habitats for pollinators,
- Habitat Creation and Management for Pollinators, MiniBeast Hotels, Bee Hotels
- Planting for Moths and Butterflies
- Bats and Lighting BCI Guidance, UK Guidelines, BCI Bat Box Guidance, BCI Bat Box Designs, RSPB Bat Boxes Designs, BCT Info Pack
- Pine Marten Nest Boxes and Forest Management Guidelines from pinemarten.ie
- BWI Bird Nest Box factsheet, BWI Saving Swifts Guidelines, RSPB Swift Box Design, Bird Boxes, BTO Nest Box Plans
- Hedgehog Home How-To
- Mink Raft Construction Guidelines
- Mostela Box Construction Guidelines

ACKNOWLEDGEMENT AND THANKS

We would like to sincerely thank the President Higgins for requesting that a biodiversity audit of Áras an Uachtaráin be conducted, and the OPW for commissioning Trinity College Dublin's School of Natural Sciences to carry out the project. We would like to thank the President and Mrs Higgins for access to Áras an Uachtaráin and its grounds, and Margaret Gormley, Chief Parks Superintendent, OPW and Conor Ó Raghallaigh, Deputy Secretary General to The President, for their assistance in facilitating this project. There were many OPW and Áras staff who helped us during the course of the survey, including Hans Zomer, Head of Communications and Information, Áras an Uachtaráin; Paul McDonnell, Park Superintendent, OPW; Declan Bermingham, Landscape Foreman, OPW; Robbie Norris, Head Gardener and all of the gardening team at Áras an Uachtaráin; the President's Sergeant and members of An Garda Síochána stationed at Áras an Uachtaráin, and the President's Aide de Camp. We would also like to thank Terry Flanagan of RTE's Mooney Goes Wild and Tony Maxwell, Maxwell Photography, for documenting the progress of the project.

This project would not have been possible without the TCD field team: Dr Paul Dowding, Dr Simon Hodge, Dr Stephanie Maher, Dr Steve Waldren, Mr Collie Ennis, Dr John Rochford, Mr Cian White, Prof Trevor Hodkinson, Prof Nicola Marples , Dr Dave Kelly, Mr Fionn Ó Marcaigh, Mr Sam Preston, Dr Ruth Kelly, Dr Ferdia Marnell and Mr Kevin Delahunty. We are grateful to them for generously sharing their expertise, and for giving their time (at all times of the day and night!) to participate in this project.

We would like to thank the following people: Michael O'Donnell, Ken Bond, Eamonn O'Donnell, Karl Woods, Cathal McNaughton (moths), Brian Nelson, Stuart Dunlop, Roy Anderson, Dr Pepijn Luijckx and Sarah Gabel (other invertebrates) for confirmation of, or help with, species identification; and Dr Maria Long (Grassland Ecologist, NPWS) for discussions regarding grassland habitat management.

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APPENDICES

Appendix 1 Species list for Áras an Uachtaráin 2019/2020

Species Name	Common Name	Type
Agaricus arvensis	Horse mushroom	Fungi
Agaricus campestris	Field mushroom	Fungi
Agaricus semotus	Agaricus semotus	Fungi
Agaricus xanthoderma	Yellow-stainer	Fungi
Agrocybe dura	Spring fieldcap	Fungi
Agrocybe erebia	Agrocybe erebia	Fungi
Agrocybe praecox	Agrocybe praecox	Fungi
Amanita citrina	False death cap	Fungi
Amanita inaurata	Amanita inaurata	Fungi
Amanita pantherina	Panther cap	Fungi
Amanitopsis fulva	Tawny grisette	Fungi
Armillaria mellea	Honey fungus	Fungi
Auricula auricula-judae	Jew's ear	Fungi
Bjerkandera adusta	Bjerkandera adusta	Fungi
Bolbitius vitellinus	Bolbitius vitellinus	Fungi
Boletus albidus	Boletus albidus	Fungi
Boletus calopus	Boletus calopus	Fungi
Boletus chrysenteron	Boletus chrysenteron	Fungi
Boletus edulis	Cep/Penny bun	Fungi
Boletus porosporus	Boletus porosporus	Fungi
Bovista plumbea	Bovista plumbea	Fungi
Calvatia excipuliformis	Pestle puffball	Fungi
Calvatia utriformis	Puffball	Fungi
Clavaria cinerea	Clavaria cinerea	Fungi
Clavulinopsis cineroides	Beige coral	Fungi
Clavulinopsis corniculata	Clavulinopsis corniculata	Fungi
Clitocybe clavipes	Club foot	Fungi
Clitocybe flaccida	Tawny funnelcap	Fungi
Clitocybe geotropa	Clitocybe geotropa	Fungi
Clitocybe hydrogramma	Clitocybe hydrogramma	Fungi
Clitocybe nebularis	Clouded agaric	Fungi
Clitocybe rivulosa	Clitocybe rivulosa	Fungi
Clitopilus prunulus	The Miller	Fungi
Collybia butyracea	Buttercap	Fungi

Species Name	Common Name	Type
Collybia confluens	Clustered toughshank	Fungi
Collybia dryophila	Collybia dryophila	Fungi
Collybia fusipes	Spindle shank	Fungi
Collybia obscura	Collybia obscura	Fungi
Collybia peronata	Wood woolly-foot	Fungi
Conocybe lactea	Conocybe lactea	Fungi
Coprinus atramentarius	Common inkcap	Fungi
Coprinus comatus	Shaggy inkcap	Fungi
Coprinus congregatus	Ink cap	Fungi
Coprinus domesticus	Ink cap	Fungi
Coprinus impatiens	Ink cap	Fungi
Coprinus lagopus	Ink cap	Fungi
Coprinus micaceus	Ink cap	Fungi
Coprinus plicatilis	Pleated ink cap	Fungi
Coprobia sp.	Coprobia sp.	Fungi
Coriolus versicolor	Many-zoned polypore	Fungi
Cortinarius armillatus	Cortinarius armillatus	Fungi
Cortinarius betuletorum	Cortinarius betuletorum	Fungi
Cortinarius bulliardii	Cortinarius bulliardii	Fungi
Cortinarius crocolitus	Cortinarius crocolitus	Fungi
Cortinarius evernius	Cortinarius evernius	Fungi
Cortinarius lepidopus	Cortinarius lepidopus	Fungi
Cortinarius nemorensis	Cortinarius nemorensis	Fungi
Cortinarius purpurascens	Cortinarius purpurascens	Fungi
Cortinarius sanguineus	Cortinarius sanguineus	Fungi
Cortinarius semisanguineus	Cortinarius semisanguineus	Fungi
Crepidotus applanatus	Crepidotus applanatus	Fungi
Crucibulum laeve	Common birdsnest fungus	Fungi
Cylindrobasidium evolvens	Cylindrobasidium evolvens	Fungi
Diatrype disciformis	Diatrype disciformis	Fungi
Entoloma porphyrophaeum	Entoloma porphyrophaeum	Fungi
Entoloma rhodopolium	Entoloma rhodopolium	Fungi
Entoloma sinuatum	Entoloma sinuatum	Fungi
Exidia glandulosa	Witches butter	Fungi
Flocculina granulosa	Flocculina granulosa	Fungi
Ganoderma adspersum	Ganoderma adspersum	Fungi
Ganoderma applanatum	Bracket fungus	Fungi
Ganoderma applanatum	Artist's fungus	Fungi
Gymnopilus penetrans	Gymnopilus penetrans	Fungi

Species Name	Common Name	Type
Hebeloma crustuliniforme	Poison pie	Fungi
Hebeloma sinapizans	Hebeloma sinapizans	Fungi
Helvella crispa	Helvella crispa	Fungi
Helvella lacunosa	Black helvella	Fungi
Hygrocybe conica	Witche's hat	Fungi
Hygrocybe nigrescens	Blackening waxcap	Fungi
Hygrocybe nivea	Snowy waxcap	Fungi
Hygrocybe pratensis	Meadow waxcap	Fungi
Hygrocybe psittacina	Parrot waxcap	Fungi
Hygrophorus cossus	Goatmoth waxcap	Fungi
Hygrophorus eburneus	Ivory waxcap	Fungi
Hypholoma sublateritum	Brick caps	Fungi
Hypoxylon fragiforme	Hypoxylon fragiforme	Fungi
Hypoxylon nummularium	Hypoxylon nummularium	Fungi
Inocybe eutheles	Beige fibrecap	Fungi
Inocybe fastigiata	Torn fibrecap	Fungi
Inocybe fastigiata	Inocybe fastigiata	Fungi
Inocybe flocculosa	Inocybe flocculosa	Fungi
Inocybe geophylla	Inocybe geophylla	Fungi
Inocybe hystrix	Inocybe hystrix	Fungi
Inocybe patouillardii	Inocybe patouillardii	Fungi
Inocybe praetervisa	Inocybe praetervisa	Fungi
Inocybe pyriodora	Pear fibrecap	Fungi
Laccaria amethystina	Purple deceiver	Fungi
Laccaria laccata	Deceiver	Fungi
Lachrymaria pyrotricha	Lachrymaria pyrotricha	Fungi
Lachrymaria velutina	Weeping widow	Fungi
Lactarius rufus	Rufous milkcap	Fungi
Langermannia gigantea	Giant puffball	Fungi
Lepiota cristata	Lepiota cristata	Fungi
Lepiota brunneoincarnata	Lepiota brunneoincarnata	Fungi
Lepiota cristata	Stinking dapperling	Fungi
Lepiota friesii	Lepiota friesii	Fungi
Lepiota procera	Parasol mushroom	Fungi
Lepista nuda	Blewit	Fungi
Lepista saeva	Field blewit	Fungi
Leptonia serrulata	Leptonia serrulata	Fungi
Leucopaxillus giganteus	Giant funnelcap	Fungi
Lycoperdon perlatum	Puffball	Fungi

Species Name	Common Name	Type
Lycoperdon pyriforme	Stump puffball	Fungi
Lyophyllum connatum	Lyophyllum connatum	Fungi
Lyophyllum decastes	Clustered domecap	Fungi
Marasmius androsaceus	Horsehair fungus	Fungi
Marasmius oreades	Fairy ring champignon	Fungi
Marasmius rotula	Marasmius rotula	Fungi
Mycena acicula	Mycena acicula	Fungi
Mycena aetites	Mycena aetites	Fungi
Mycena candida	Mycena candida	Fungi
Mycena clavularis	Mycena clavularis	Fungi
Mycena fibula	Mycena fibula	Fungi
Mycena filopes	Mycena filopes	Fungi
Mycena galopus	Mycena galopus	Fungi
Mycena inclinata	Mycena inclinata	Fungi
Mycena lactea	Mycena lactea	Fungi
Mycena leptocephala	Mycena leptocephala	Fungi
Mycena leucogala	Mycena leucogala	Fungi
Mycena polygramma	Mycena polygramma	Fungi
Mycena pura	Mycena pura	Fungi
Mycena speirea	Mycena speirea	Fungi
Nectria cinnabarina	Coralspot	Fungi
Neobulgaria pura	Neobulgaria pura	Fungi
Otidea alutacea	Otidea alutacea	Fungi
Otidea cochleata	Otidea cochleata	Fungi
Oudemansiella mucida	Porcelain fungus	Fungi
Oudemansiella radicata	Rooting toughshank	Fungi
Panaeolus ater	Mottle-gill	Fungi
Panaeolus campanulatus	Bell-shaped mottlegill	Fungi
Panaeolus foenisecii	Panaeolus foenisecii	Fungi
Panaeolus rickenii	Mottle-gill	Fungi
Panaeolus semiovatus	Panaeolus semiovatus	Fungi
Panaeolus speciosus	Panaeolus speciosus	Fungi
Paxillus involutus	Brown rollrim	Fungi
Peniophora lycii	Peniophora lycii	Fungi
Peniophora quercina	Peniophora quercina	Fungi
Phaeolus schweinitzii	Phaeolus schweinitzii	Fungi
Phellodon confluens	Phellodon confluens	Fungi
Phlebia merismoides	Crust	Fungi
Pleurotus acerosus	Pleurotus acerosus	Fungi

Species Name	Common Name	Type
Pleurotus cornucopiae	Horn of plenty	Fungi
Pluteus cervinus	Pluteus cervinus	Fungi
Polyporus ciliatus	Fringed polypore	Fungi
Polyporus squamosus	Dryad's saddle	Fungi
Psathyrella hydrophila	Psathyrella hydrophila	Fungi
Psathyrella marescibilis	Psathyrella marescibilis	Fungi
Psathyrella microrhiza	Psathyrella microrhiza	Fungi
Psathyrella obtusata	Psathyrella obtusata	Fungi
Rhodophyllus rhodopolium	Rhodophyllus rhodopolium	Fungi
Russula atropurpurea	Russula atropurpurea	Fungi
Russula pulchella	Russula pulchella	Fungi
Russula vesca	Russula vesca	Fungi
Russula xerampelina	Russula xerampelina	Fungi
Schizophyllum commune	Splitgill	Fungi
Scleroderma verrucosum	Earthball	Fungi
Sebacina incrustans	Sebacina incrustans	Fungi
Stereum hirsutum	Yellow bracket	Fungi
Stropharia aeruginosa	Verdigris agaric	Fungi
Trcholoma orirubens	Trcholoma orirubens	Fungi
Tremella mesenterica	Tremella mesenterica	Fungi
Trichoderma columbetta	Trichoderma columbetta	Fungi
Tricholoma argyracium	Tricholoma argyracium	Fungi
Tricholoma atrosquamosum	Tricholoma atrosquamosum	Fungi
Tricholoma columbetta	Tricholoma columbetta	Fungi
Tricholoma lascivum	Tricholoma lascivum	Fungi
Tricholoma saponaceum	Soap-scented mushroom	Fungi
Tricholoma saponaceum var. squamosum	Soapy knight	Fungi
Tricholoma virgatum	Ashen knight	Fungi
Tricholomopsis platyphylla	Tricholomopsis platyphylla	Fungi
Tyromyces stipticus	White bracket	Fungi
Ustulina deusta	Ustulina deusta	Fungi
Vascellum pratense	Puffball	Fungi
Volvariella bombycina	Silky rosegill	Fungi
Volvariella speciosa	Volvariella speciosa	Fungi
Vuillemenia comedens	Vuillemenia comedens	Fungi
Xylaria hypoxylon	Candle snuff/stag's horn	Fungi
Xylaria polymorpha	Deadman's fingers	Fungi
Lasius niger	Black garden ant	Invertebrate

Species Name	Common Name	Type
Myrmica ruginodes	Myrmica ruginodes	Invertebrate
Aphis fabae	Black bean aphid	Invertebrate
Drepanosiphum platanoidis	Sycamore aphid	Invertebrate
Eucallipterus tiliae	Lime aphid	Invertebrate
Uroleucon jaceae	Large knapweed aphid	Invertebrate
Andrena bicolor	Gwynne's mining bee	Invertebrate
Andrena sp.	Mining bee	Invertebrate
Apis mellifera	Honeybee	Invertebrate
Bombus hortorum	Garden bumblebee	Invertebrate
Bombus lapidarius	Red-tailed bumblebee	Invertebrate
Bombus lucorum agg	White/buff-tailed bumblebee	Invertebrate
Bombus muscorum	Moss carder bee	Invertebrate
Bombus pascuorum	Common carder bee	Invertebrate
Bombus pratorum	Early bumblebee	Invertebrate
Bombus terrestris	Buff-tailed bumblebee	Invertebrate
Bombus vestalis	Vestal cuckoo bumblebee	Invertebrate
Megachile centuncularis	Patchwork leafcutter bee	Invertebrate
Abax parallelepipedus	Abax parallelepipedus	Invertebrate
Acilius sulcatus	Lesser diving beetle	Invertebrate
Adalia bipunctata	Two-spot ladybird	Invertebrate
Adalia decempunctata	Ten-spot ladybird	Invertebrate
Amara communis	Amara communis	Invertebrate
Aphodius rufipes	Night-flying dung beetle	Invertebrate
Athous haemorrhoidalis	Athous haemorrhoidalis	Invertebrate
Bembidion obtusum	Bembidion obtusum	Invertebrate
Brachypterus glaber	Brachypterus glaber	Invertebrate
Brachypterus urticae	Brachypterus urticae	Invertebrate
Coccinella septempunctata	Seven-spot ladybird	Invertebrate
Dascillus cervinus	Orchid beetle	Invertebrate
Dimetrota atramentaria	Dimetrota atramentaria	Invertebrate
Dytiscus marginalis	Great diving beetle	Invertebrate
Grammoptera ruficornis	Common grammoptera longhorn	Invertebrate
Hydrovatus clypelis	Hydrovatus clypelis	Invertebrate
Malachius bipustulatus	Malachite beetle	Invertebrate
Mecinus pascuorum	Mecinus pascuorum	Invertebrate
Melolontha melolontha	Common cockchafer	Invertebrate
Nebria brevicollis	Nebria brevicollis	Invertebrate
Othius punctulatus	Othius punctulatus	Invertebrate

Species Name	Common Name	Type
Propylea quatuordecimpunctata	Fourteen-spot ladybird	Invertebrate
Psilothrix viridicaeruleus	Psilothrix viridicaeruleus	Invertebrate
Pterostichus madidus	Pterostichus madidus	Invertebrate
Pterostichus niger	Pterostichus niger	Invertebrate
Pterostichus strenuus	Pterostichus strenuus	Invertebrate
Quedius curtipennis	Quedius curtipennis	Invertebrate
Quedius scintillans	Quedius scintillans	Invertebrate
Rhagonycha fulva	Red soldier beetle	Invertebrate
Sinodendron cylindricum	Rhinoceros stag beetle	Invertebrate
Stenus cicindeloides	Stenus cicindeloides	Invertebrate
Tachyporus obtusus	Tachyporus obtusus	Invertebrate
Aglais urticae	Small tortoiseshell butterfly	Invertebrate
Anthocharis cardamines	Orange tip butterfly	Invertebrate
Aphantopus hyperantus	Ringlet butterfly	Invertebrate
Argynnis paphia	Silver-washed fritillary	Invertebrate
Celastrina argiolus	Holly blue butterfly	Invertebrate
Inachis io	Peacock butterfly	Invertebrate
Maniola jurtina	Meadow brown butterfly	Invertebrate
Pararge aegeria	Speckled wood butterfly	Invertebrate
Pieris brassicae	Large white butterfly	Invertebrate
Pieris napi	Green-veined white butterfly	Invertebrate
Pieris rapae	Small white butterfly	Invertebrate
Polygonia c-album	Comma butterfly	Invertebrate
Polyommatus icarus	Common blue butterfly	Invertebrate
Vanessa atalanta	Red admiral butterfly	Invertebrate
Hydrospyche sp.	Netspinning caddisfly sp.	Invertebrate
Sericostoma personatum	Bushtailed caddisfly	Invertebrate
Geophilus flavus	Yellow centipede	Invertebrate
Lithobius forficatus	Common centipede	Invertebrate
Gryllus bimaculatus	Black field cricket	Invertebrate
Argulus foliaceus	Common fish louse	Invertebrate
Cyclops sp.	Cyclops copepod	Invertebrate
Daphnia pulex	Daphnia pulex	Invertebrate
Diaptomus sp.	Diaptomus copepod	Invertebrate
Forficula auricularia	Common earwig	Invertebrate
Calliphora vicina	Bluebottle	Invertebrate
Calliphora vomitoria	Bluebottle	Invertebrate
Chironomus sp.	Bloodworm	Invertebrate

Species Name	Common Name	Type
Conops quadrifasciatus	Yellow-banded conops	Invertebrate
Lucilia sericata	Common green bottle fly	Invertebrate
Meromyza sp.	Grass fly	Invertebrate
Phytomyza ilicis	Holly leafminer	Invertebrate
Sarcophaga carnaria group	Flesh fly	Invertebrate
Sarcophaga sp.	Flesh fly	Invertebrate
Tachina fera	Tachinid Fly	Invertebrate
Tipulidae sp.	Craneflies	Invertebrate
Drosophila funebris	Drosophila funebris	Invertebrate
Drosophila immigrans	Drosophila immigrans	Invertebrate
Drosophila kuntzei	Drosophila kuntzei	Invertebrate
Drosophila obscura	Drosophila obscura	Invertebrate
Drosophila subobscura	Drosophila subobscura	Invertebrate
Drosophila suzukii	Spotted wing drosophila	Invertebrate
Drosophila transversa	Drosophila transversa	Invertebrate
Omocestus viridulus	Common green grasshopper	Invertebrate
Nemastomella bacillifera	Black harvestman	Invertebrate
Phalangium opilio	Harvestman	Invertebrate
Baccha elongata	Hoverfly	Invertebrate
Episyrphus balteatus	Marmalade hoverfly	Invertebrate
Eristalis intricarius	Furry dronefly	Invertebrate
Eristalis pertinax	Eristalis pertinax	Invertebrate
Eupeodes bucculatus	Thistle-field syrph	Invertebrate
Eupeodes luniger	Common spotted field syrph	Invertebrate
Ferdinandea cuprea	Bronze sap hoverfly	Invertebrate
Helophilus pendulus	Dangling marsh lover	Invertebrate
Lucozona lucorum	Blotch-winged hoverfly	Invertebrate
Meliscaeva auricollis	Meliscaeva auricollis	Invertebrate
Myathropa florea	Batman hoverfly	Invertebrate
Platycherus albimanus	White-footed hoverfly	Invertebrate
Sphaerophoria scripta	Long hoverfly	Invertebrate
Syrphus ribesii	Humming syrphus	Invertebrate
Volucella pellucens	Pellucid fly	Invertebrate
Armadillidium vulgare	Pill woodlouse	Invertebrate
Asellus aquaticus	Water louse	Invertebrate
Oniscus asellus	Shiney woodlouse	Invertebrate
Philoscia muscorum	Striped woodlouse	Invertebrate
Porcellio scaber	Rough woodlouse	Invertebrate
Chrysoperla carnea	Green lacewing	Invertebrate

Species Name	Common Name	Type
Cylindroiulus punctatus	Spotted millipede	Invertebrate
Glomeris marginata	Pill millipede	Invertebrate
Polydesmus angustus	Flat-backed millipede	Invertebrate
Tachypodoiulus niger	Black snake millipede	Invertebrate
Lymnaea stagnalis	Great pondsnail	Invertebrate
Pisidium sp.	Pea mussel	Invertebrate
Planobarius corneus	Great ramshorn snail	Invertebrate
Abraxas grossulariata	Magpie moth	Invertebrate
Acrocercops brongniardella	Leaf blotch miner moth	Invertebrate
Acronicta alni	Alder moth	Invertebrate
Agriphilia tristella	Common grass-veneer	Invertebrate
Agrotis exclamationis	Heart and dart	Invertebrate
Alcis repandata repandata	Mottled beauty	Invertebrate
Apamea epomidion	Clouded brindle	Invertebrate
Apamea lithoxylaea	Light arches	Invertebrate
Apamea monoglypha	Dark arches	Invertebrate
Aphomia sociella	Bee moth	Invertebrate
Archips xylosteana	Variegated golden tortrix	Invertebrate
Cameraria ohridella	Horse chestnut leaf miner	Invertebrate
Campaea margaritaria	Light emerald	Invertebrate
Camptogramma bilineata bilineata	Yellow shell	Invertebrate
Cataclysta lemnata	Small China-mark	Invertebrate
Celypha lacunana	Dark strawberry tortrix	Invertebrate
Cerapteryx graminis	Antler moth	Invertebrate
Chloroclysta truncata truncata	Common marbled carpet	Invertebrate
Chrysoteuchia culmella	Garden grass-veneer	Invertebrate
Cleorodes lichenaria	Brussels lace	Invertebrate
Cnephasis sp.	Cnephasis sp.	Invertebrate
Colostygia pectinataria	Green carpet moth	Invertebrate
Cosmia trapezina	Dun-bar	Invertebrate
Cyclophora linearia	Clay triple-lines	Invertebrate
Cydia splendana	Chestnut tortrix	Invertebrate
Depressaria radiella	Parsnip moth	Invertebrate
Diarsia rubi	Small square spot	Invertebrate
Elachista atricomella	Black-headed dwarf	Invertebrate
Epiphyas postvittana	Light brown apple	Invertebrate
Eucosma cana	Eucosma cana	Invertebrate
Eudinoa angustea	Narrow-winged grey	Invertebrate

Species Name	Common Name	Type
Eudonia lacustrata	Eudonia lacustrata	Invertebrate
Eudonia mercurella	Eudonia mercurella	Invertebrate
Eupithecia vulgata	Common pug	Invertebrate
Glyphipterix simpliciella	Cocksfoot moth	Invertebrate
Habrosyne pyritoides	Buff arches	Invertebrate
Herminia tarsipennalis	Small fan-foot	Invertebrate
Hoplodrina sp.	Rustic/uncertain	Invertebrate
Hydriomena sp.	Highflyer (ruddy or may)	Invertebrate
Hypena proboscidalis	Snout	Invertebrate
Idaea aversata	Riband wave	Invertebrate
Idaea biselata	Small fan-foot wave	Invertebrate
Korscheltellus fusconebulosa	Map-winged swift	Invertebrate
Korscheltellus lupulina	Common swift	Invertebrate
Litoligia literosa	Rosy minor	Invertebrate
Lobesia abscisana	Smoky-barred marble	Invertebrate
Mythimna impura	Smoky wainscot	Invertebrate
Noctua janthe	Lesser broad bordered yellow underwing	Invertebrate
Noctua pronuba	Large yellow underwing	Invertebrate
Notocelia cynosbatella	Notocelia cynosbatella	Invertebrate
Notocelia uddmanniana	Bramble shoot moth	Invertebrate
Oligia fasciuncula	Middle-barred minor	Invertebrate
Opisthograptis luteolata	Brimstone	Invertebrate
Pandemis corylana	Chequered fruit tree tortrix	Invertebrate
Parapoynx stratiotata	Ringed China-mark	Invertebrate
Pasiphila rectangulata	Green pug moth	Invertebrate
Peribatodes rhomboidaria	Willow beauty moth	Invertebrate
Pleuroptya ruralis	Mother of pearl moth	Invertebrate
Plutella xylostella	Diamond back moth	Invertebrate
Scoliopteryx libatrix	The Herald	Invertebrate
Scoparia ambigualis	Common grey moth	Invertebrate
Scotopteryx chenopodiata	Shaded broad-bar	Invertebrate
Spilosoma lubricipeda	White ermine	Invertebrate
Thyatira batis	Peach blossom moth	Invertebrate
Tinea semifulvella	Fulvous clothes moth	Invertebrate
Udea lutealis	Pale straw pearl	Invertebrate
Udea olivalis	Udea olivalis	Invertebrate
Xanthorhoe designata	Flame carpet moth	Invertebrate

Species Name	Common Name	Type
Xanthorhoe montanata montanata	Silver-ground carpet	Invertebrate
Xestia zanthographa	Square-spot rustic	Invertebrate
Yponomeuta circumvoluta	Thistle ermine	Invertebrate
Zygaena filipendulae	Six-spot burnet	Invertebrate
Aeshna grandis	Brown hawker dragonfly	Invertebrate
Aeshna juncea	Common hawker	Invertebrate
Coenagrion puella	Azure damselfly	Invertebrate
Ischnura elegans	Blue-tailed damselfly	Invertebrate
Lestes disjunctus	Damselfly nymp	Invertebrate
Chthonius ischnocheles	Common chthonid	Invertebrate
Neobisium carcinoides	Common neobisid	Invertebrate
Dolycoris baccarum	Hairy/Sloe sheildbug	Invertebrate
Pentatoma rufipes	Forest bug	Invertebrate
Amaurobius ferox	Black lace web spider	Invertebrate
Anelosimus vittatus	Anelosimus vittatus	Invertebrate
Araneus diadematus	European garden spider	Invertebrate
Araniella cucurbitina	Cucumber spider	Invertebrate
Clubiona sp.	Sac spider sp.	Invertebrate
Enoplognatha ovata	Candy-striped spider	Invertebrate
Eratigena atrica	Giant house spider	Invertebrate
Meta menardi	Cave spider	Invertebrate
Meta merianae	Half-light/Cave orb weaver	Invertebrate
Misumena vatia	Flower crab spider	Invertebrate
Nuctenea umbratica	Walnut orb-weaver spider	Invertebrate
Pardosa amentata	Wolf spider	Invertebrate
Philodromus aureolus	Wandering crab spider	Invertebrate
Philodromus dispar	Running crab spider	Invertebrate
Pirata piraticus	Pirate wolf spider	Invertebrate
Pisaura mirabilis	Nursery web spider	Invertebrate
Salticus scenicus	Zebra jumping spider	Invertebrate
Segestria senoculata	Snake back spider	Invertebrate
Steatoda nobilis	False widow spider	Invertebrate
Tetragnatha sp.	Long jawed orb-weaver	Invertebrate
Theridion sisyphum	Mothercare spider	Invertebrate
Trochosa terricola	Ground wolf spider	Invertebrate
Xysticus sp. (lanio?)	(Red?) crab spider	Invertebrate
Zygiella x-notata	Missing sector orb-weaver	Invertebrate
Gerris lacustris	Common pond skaters	Invertebrate

Species Name	Common Name	Type
Gerris paludum	Water strider/pond skater	Invertebrate
Grypocoris stysi	Mirid bug	Invertebrate
Notonecta glauca	Common backswimmer	Invertebrate
Philaenus spumarius	Spittle bug	Invertebrate
Amblyteles armatorius	Amblyteles armatorius	Invertebrate
Amblyteles sp.	Inchneumon wasp	Invertebrate
Andricus quercuscalicis	Knopper gall wasps	Invertebrate
Dolichovespula norwegica	Norwegian tree wasp	Invertebrate
Dolichovespula sylvestris	Tree wasp	Invertebrate
Ectemnius sp.	Predatory wasp	Invertebrate
Netelia sp.	Ichneumon wasp	Invertebrate
Neuroterus quercusbaccarum	Common spangle gall wasp	Invertebrate
Vespula vulgaris	Common wasp	Invertebrate
Haemopsis sanguisuga	Horse leach	Invertebrate
Nostoc commune	Nostoc	Cyanobacteria
Eleodea canadensis	Canadian waterweed	Plant
Lemna triscula	Ivy-leaved duckweed	Plant
Mentha aquatica	Water mint	Plant
Nymphaea alba	Water lily	Plant
Persicaria amphibia	Amphibious bistort	Plant
Potamogeton pectinatus	Fennel pondweed	Plant
Sparganium erectum	Branched bur-reed	Plant
Veronica beccabunga	Brooklime	Plant
Asplenium scolopendrium	Hart's tongue fern	Plant
Athyrium filix-femina	Lady fern	Plant
Dryopteris affinis	Scaly male fern	Plant
Polystitchum setiferum	Soft shield fern	Plant
Achillea millefolium	Yarrow	Plant
Aegopodium podagraria	Ground elder	Plant
Ajuga reptans	Bugle	Plant
Alchemilla vulgaris	Lady's mantle	Plant
Alisma plantago-aquatica	Water plantain	Plant
Alliaria petiolata	Garlic mustard	Plant
Allium ursinum	Ramsons/wild garlic	Plant
Allium vineale	Crow garlic/wild onion	Plant
Anacamptis pyramidalis	Pyramidal orchid	Plant
Anagallis arvensis	Scarlet pimpernel	Plant
Anemone blanda	Blue anemone	Plant
Angelica sylvestris	Wild angelica	Plant

Species Name	Common Name	Type
Anthriscus cerefolium/ caucalis	Chervil/bur-chervil	Plant
Anthriscus sylvestris	Cow parsley	Plant
Anthyllis vulneraria	Kidney vetch	Plant
Antirrhinum majus	Snapdragon	Plant
Arctium sp.	Burdock	Plant
Arum maculatum	Lords-and-ladies	Plant
Aruncus dioicus	Goat's beard	Plant
Astilbe sp.	Astilbe	Plant
Bellis perennis	Daisy	Plant
Brassica napus	Rapeseed	Plant
Calystegia sepium	Hedge bindweed	Plant
Calystegia silvatica	Large bindweed	Plant
Capsella bursa-pastoris	Shepherd's purse	Plant
Cardamine hirsuta	Hairy bitter-cress	Plant
Cardamine pratensis	Cuckooflower	Plant
Carduus tenuiflorus	Slender thistle	Plant
Centaurea nigra	Black knapweed	Plant
Centranthus ruber	Red valarian	Plant
Cerastium fontanum	Common mouse-ear	Plant
Chamerion angustifolium	Rose-bay willowherb	Plant
Chenopodium album	Fat-hen	Plant
Circaea lutetiana	Enchanter's-nightshade	Plant
Cirsium arvense	Creeping thistle	Plant
Cirsium vulgare	Spear thistle	Plant
Clematis sp.	Clematis sp.	Plant
Conopodium majus	Pignut	Plant
Convolvulus arvensis	Field bindweed	Plant
Cotoneaster	Cotoneaster	Plant
Crepis biennis	Rough hawks-beard	Plant
Crepis capillaris	Smooth hawksbeard	Plant
Crepis vesicaria	Beaked hawk's-beard	Plant
Crocus vernus	Crocus	Plant
Cyclamen hederifolium	Cyclamen	Plant
Cymbalaria muralis	Ivy-leaved toadflax	Plant
Daucus carota	Wild carrot	Plant
Digitalis purpurea	Foxglove	Plant
Diplotaxis muralis	Annual wall rocket	Plant
Epilobium hirsutum	Great willowherb	Plant

Species Name	Common Name	Type
Epilobium montanum	Broad-leaved willowherb	Plant
Epilobium obscurum	Short-fruited willowherb	Plant
Epilobium parviflorum	Hoary willowherb	Plant
Epilobium roseum	Pale willowherb	Plant
Epilobium tetragonum	Square-stalked willowherb	Plant
Epipactis helleborine	Broad-leaved helleborine	Plant
Erysimum cheiri	Wallflower	Plant
Euphorbia amygdaloides	Wood spurge	Plant
Euphorbia helioscopia	Sun spurge	Plant
Euphorbia peplus	Petty spurge	Plant
Euphrasia sp.	Eyebright	Plant
Fallopia japonica	Japanese knotweed	Plant
Ficaria verna	Lesser celandine	Plant
Filipendula ulmaria	Meadowsweet	Plant
Fragaria vesca	Wild strawberry	Plant
Fumaria officinalis	Common fumitory	Plant
Galanthus nivalis	Snowdrop	Plant
Galium aparine	Cleavers	Plant
Galium palustre	Marsh bedstraw	Plant
Galium verum	Lady's bedstraw	Plant
Geranium macrorrhizum	Geranium cultivar	Plant
Geranium molle	Dove's-foot crane's-bill	Plant
Geranium pratense	Meadow crane's-bill	Plant
Geranium robertianum	Herb-robert	Plant
Geum urbanum	Wood avens	Plant
Glechoma hederacea	Ground-ivy	Plant
Hedera helix	Common ivy	Plant
Heracleum mantegazzianum	Giant hogweed - invasive	Plant
Heracleum sphondylium	Hogweed	Plant
Hieracium agg.	Hawkweed	Plant
Hieracium exotericum	Hawkweed sp.	Plant
Hyacinthoides (non-scripta x hispanica)	Bluebells (hybrids)	Plant
Hypericum androsaemum	St. John's wort tutsan	Plant
Hypericum hirsutum	Hairy St. John's wort	Plant
Hypericum perforatum	Perforate St. John's wort	Plant
Hypochaeris radicata	Cat's-ear	Plant
Iris pseudacorus	Yellow flag	Plant
Jacobaea vulgaris	Ragwort	Plant

Species Name	Common Name	Type
Lamium hybridum	Cut-leaved dead-nettle	Plant
Lamium purpureum	Red dead-nettle	Plant
Lapsana communis	Nipplewort	Plant
Lathyrus pratensis	Meadow vetchling	Plant
Lavatera arborea	Tree mallow	Plant
Leontodon saxatilis	Lesser hawkbit	Plant
Leucanthemum vulgare	Ox-eye daisy	Plant
Leycesteria formosa	Himalyanan honeysuckle	Plant
Linaria purpurea	Purple toadflax	Plant
Lonicera periclymenum	Honeysuckle	Plant
Lotus corniculatus	Common bird's-foot-trefoil	Plant
Lycopus europeaus	Gypsywort	Plant
Lysimachia vulgaris	Yellow loosestrife	Plant
Lythrum salicaria	Purple loosestrife	Plant
Matricaria chamomilla	Mayweed	Plant
Medicago lupulina	Black medick	Plant
Mentha arvensis	Corn mint	Plant
Mycelis muralis	Wall lettuce	Plant
Myosotis arvensis	Field forget-me-not	Plant
Myosotis famosissima	Early forget-me-not	Plant
Narcissus sp.	Daffodil	Plant
Oxalis acetosella	Wood sorrel	Plant
Papaver cambrica	Welsh poppy	Plant
Papaver rhoeas	Poppy	Plant
Papaver somniferum	Opium poppy	Plant
Persicaria maculosa	Redshank	Plant
Petasites pyrenaicus	Winter heliotrope	Plant
Plantago lanceolata	Ribwort plantain	Plant
Plantago major	Greater plantain	Plant
Polygonum arenastrum	Equal-leaved knotgrass	Plant
Polygonum aviculare	Knotgrass	Plant
Potentilla anserina	Silverweed	Plant
Potentilla erecta	Tormentil	Plant
Potentilla reptans	Creeping cinquefoil	Plant
Potentilla sterilis	Barren strawberry	Plant
Primula veris	Cowslip	Plant
Primula vulgaris	Primrose	Plant
Prunella vulgaris	Self-heal	Plant
Ranunculus acris	Meadow buttercup	Plant

Species Name	Common Name	Type
Ranunculus bulbosus	Bulbous buttercup	Plant
Ranunculus repens	Creeping buttercup	Plant
Rhinanthus minor	Yellow rattle	Plant
Rosa canina	Dog rose	Plant
Rubus fruticosus agg.	Brambles	Plant
Rumex acetosa	Common sorrel	Plant
Rumex conglomeratus	Clustered dock	Plant
Rumex crispus	Curled dock	Plant
Rumex obtusifolius	Broad dock	Plant
Rumex sanguineus	Bloody dock	Plant
Sanicula europaea	Sanicle	Plant
Scrophularia nodosa	Common figwort	Plant
Senecio jacobaea	Ragwort	Plant
Senecio vulgaris	Groundsel	Plant
Silene dioica	Red campion	Plant
Sinapsis arvensis	Charlock	Plant
Sisymbrium officinale	Hedge mustard	Plant
Solanum dulcamara	Bittersweet	Plant
Sonchus asper	Prickly sow-thistle	Plant
Sonchus oleraceus	Smooth sow-thistle	Plant
Stachys sylvatica	Hedge woundwort	Plant
Stellaria graminea	Lesser stitchwort	Plant
Stellaria media	Common chickweed	Plant
Symphoricarpos albus	Snowberry	Plant
Tanacetum parthenium	Feverfew	Plant
Taraxacum officinale agg.	Dandelion	Plant
Teucrium scorodonia	Wood sage	Plant
Torilis japonica	Upright hedge-parsley	Plant
Trifolium dubium	Lesser trefoil	Plant
Trifolium incarnatum	Crimson clover	Plant
Trifolium pratense	Red clover	Plant
Trifolium repens	White clover	Plant
Tulipa	Tulip	Plant
Tussilago farfara	Coltsfoot	Plant
Urtica dioica	Common nettle	Plant
Verbascum thapsus	Great mullein	Plant
Veronica arvensis	Wall speedwell	Plant
Veronica chamaedrys	Germander speedwell	Plant
Veronica filiformis	Slender speedwell	Plant

Species Name	Common Name	Type
Veronica hederifolia	Ivy-leaved speedwell	Plant
Veronica officinalis	Heath speedwell	Plant
Veronica persica	Common field-speedwell	Plant
Veronica serpyllifolia	Thyme-leaved speedwell	Plant
Viburnum sp.	Viburnum sp.	Plant
Vicia cracca	Tufted vetch	Plant
Vicia sativa ssp. segetalis	Common vetch	Plant
Vicia sepium	Bush vetch	Plant
Viola reichenbachiana	Early dog-violet	Plant
Viola riviniana	Common dog-violet	Plant
Agrostis capillaris	Common bent grass	Plant
Agrostis stolonoifera	Creeping bent grass	Plant
Alopecurus pratensis	Meadow foxtail grass	Plant
Anthoxanthum odoratum	Sweet vernal grass	Plant
Arrhenatherum elatius	False oat-grass	Plant
Avenula pubescens	Downy oat-grass	Plant
Brachypodium sylvaticum	False-brome grass	Plant
Briza media	Quaking grass	Plant
Bromus catharticus	Prairie grass	Plant
Bromus hordaceus	Soft brome grass	Plant
Bromus ramosus	Hairy brome grass	Plant
Bromus sterilis	Barren brome grass	Plant
Catapodium rigidum	Fern-grass	Plant
Cynosurus cristatus	Crested dogstail grass	Plant
Dactylis glomerata	Cock's foot grass	Plant
Deschampsia caespitosa	Tufted hairgrass	Plant
Elymus repens	Couch grass	Plant
Festuca arundinacea	Tall fescue grass	Plant
Festuca gigantea	Giant fescue grass	Plant
Festuca ovina	Sheep's fescue grass	Plant
Festuca pratensis	Meadow fescue grass	Plant
Festuca rubra	Red fescue grass	Plant
Holcus lanatus	Yorkshire fog grass	Plant
Hordeum murinum	Wall barley	Plant
Hordeum vulgare	Barley	Plant
Lolium multiflorum	Italian ryegrass	Plant
Lolium perenne	Perennial ryegrass	Plant
Phalaris arundinacea	Reed canary-grass	Plant
Phleum pratense	Timothy grass	Plant

Species Name	Common Name	Type
Poa annua	Annual meadow-grass	Plant
Poa pratensis	Smooth meadow-grass	Plant
Poa trivialis	Rough meadow-grass	Plant
Equisetum arvense	Field horsetail	Plant
Equisetum palustre	Marsh horsetail	Plant
Juncus inflexus	Hard rush	Plant
Luzula campestris	Field wood-rush	Plant
Carex divulsa	Grey sedge	Plant
Carex hirta	Hairy sedge	Plant
Carex nigra	Common sedge	Plant
Carex pendula	Pendulus sedge	Plant
Carex remota	Remote sedge	Plant
Carex sylvatica	Wood sedge	Plant
Acer campestre	Field maple tree	Plant
Acer platanoides	Norway maple	Plant
Acer pseudoplatanus	Sycamore	Plant
Aesculus hippocastanum	Horse chestnut	Plant
Alnus glutinosa	Alder	Plant
Alnus incana	Grey alder	Plant
Betula pendula	Silver birch	Plant
Betula pubescens	Downy birch	Plant
Buddleja davidii	Butterfly-bush	Plant
Castanea sativa	Sweet chestnut	Plant
Cercidiphyllum japonicum	Katsura	Plant
Corylus avellana	Hazel	Plant
Crataegus monogyna	Hawthorn	Plant
Fagus sylvatica	European beech	Plant
Fraxinus excelsior	Ash	Plant
Fraxinus excelsior 'Pendula'	Weeping ash	Plant
Juglans regia	English walnut	Plant
Laburnum	Golden chain	Plant
Larix decidua	European larch	Plant
Laurus nobilis	Bay laurel	Plant
Liriodendron tulipifera	Tulip tree	Plant
Philadelphus coronarius	English dogwood	Plant
Platanus × acerifolia	London plane	Plant
Populus alba	White poplar	Plant
Populus spp.	Poplar	Plant
Populus x canadensis	Hybrid black poplar	Plant

Species Name	Common Name	Type
Prunus laurocerasus	Cherry laurel	Plant
Prunus lusitanica	Portuguese laurel	Plant
Prunus spinosa	Blackthorn	Plant
Prunus spp.	Flowering cherry	Plant
Quercus cerris	Turkey oak	Plant
Quercus ilex	Holm oak	Plant
Quercus petraea	Sessile oak	Plant
Quercus robur	Pedunculate oak	Plant
Robinia pseudoacacia	Golden robinia	Plant
Rosa arvensis	Field-rose	Plant
Salix alba	White willow	Plant
Salix fragilis	Crack willow	Plant
Salix viminalis	Common osier	Plant
Sambucus nigra	Elder	Plant
Sorbus aria	Common whitebeam	Plant
Sorbus aucuparia	Rowan	Plant
Sorbus intermedia	Swedish whitebeam	Plant
Tilia cordata	Small-leaved lime	Plant
Tilia cordata x platyphyllos	Lime hybrid	Plant
Tilia europaea	Common lime	Plant
Ulmus glabra	Wych elm	Plant
Cedrus atlantica Glauca	Blue atlas cedar	Plant
Cedrus deodara	Deodar cedar	Plant
Cedrus libani	Lebanon cedar	Plant
Chamaecyparis lawsoniana	Lawson cypress	Plant
Cupressus macrocarpa	Monterey cypress	Plant
Cupressus spp.	Cypress sp.	Plant
Cupressus×leylandii	Leylandii	Plant
Daphne laureola	Spurge laurel	Plant
Ginkgo biloba	Gingko/maindenhair	Plant
Ilex aquifolium	Holly	Plant
Magnolia grandiflora	Southern magnolia	Plant
Picea spp.	Spruce	Plant
Pinus nigra	Corsican pine	Plant
Pinus pinea	Stone pine	Plant
Pinus radiata	Monterey pine	Plant
Pinus sylvestris	Scots pine	Plant
Sequoiadendron giganteum	Giant redwood	Plant
Taxus baccata	Yew	Plant

Species Name	Common Name	Type
Thuja plicata atrovirens	Western red cedar	Plant
Ligustrum vulgare	Wild privet	Plant
Accipiter nisus	Sparrowhawk	Vertebrate
Aegithalos caudatus	Long Tailed Tit	Vertebrate
Alauda arvensis	Skylark	Vertebrate
Anas platyrhynchos	Mallard	Vertebrate
Anser anser	Greylag Goose	Vertebrate
Apus apus	Swift	Vertebrate
Ardea cinerea	Grey Heron	Vertebrate
Aythya fuligula	Tufted Duck	Vertebrate
Buteo buteo	Buzzard	Vertebrate
Carduelis carduelis	Goldfinch	Vertebrate
Certhia familiaris	Treecreeper	Vertebrate
Chloris chloris	Greenfinch	Vertebrate
Chroicocephalus ridibundus	Black Headed Gull	Vertebrate
Coloeus monedula	Jackdaw	Vertebrate
Columba livia f. domestica	Feral Pigeon	Vertebrate
Columba palumbus	Woodpigeon	Vertebrate
Corvus cornix	Hooded Crow	Vertebrate
Corvus frugilegus	Rook	Vertebrate
Cyanistes caeruleus	Blue Tit	Vertebrate
Delichon urbicum	House Martin	Vertebrate
Dendrocopos major	Great Spotted Woodpecker	Vertebrate
Erithacus rubecula	Robin	Vertebrate
Falco tinnunculus	Kestrel	Vertebrate
Fringilla coelebs	Chaffinch	Vertebrate
Fulica atra	Coot	Vertebrate
Gallinula chloropus	Moorhen	Vertebrate
Garrulus glandarius	Jay	Vertebrate
Hirundo rustica	Swallow	Vertebrate
Larus argentatus	Herring Gull	Vertebrate
Larus marinus	Greater Black Backed Gull	Vertebrate
Linaria cannabina	Linnet	Vertebrate
Motacilla alba	Pied Wagtail	Vertebrate
Parus major	Great Tit	Vertebrate
Passer domesticus	House Sparrow	Vertebrate
Periparus ater	Coal Tit	Vertebrate
Phalacrocorax carbo	Cormorant	Vertebrate
Phasianus colchicus	Pheasant	Vertebrate

Species Name	Common Name	Type
Phylloscopus collybita	Chiffchaff	Vertebrate
Pica pica	Magpie	Vertebrate
Prunella modularis	Dunnock	Vertebrate
Pyrrhula pyrrhula	Bullfinch	Vertebrate
Regulus regulus	Goldcrest	Vertebrate
Spinus spinus	Siskin	Vertebrate
Streptopelia decaocto	Collared Dove	Vertebrate
Sturnus vulgaris	Starling	Vertebrate
Sylvia atricapilla	Blackcap	Vertebrate
Tachybaptus ruficollis	Little Grebe	Vertebrate
Troglodytes troglodytes	Wren	Vertebrate
Turdus merula	Blackbird	Vertebrate
Turdus philomelos	Song Thrush	Vertebrate
Turdus viscivorus	Mistle Thrush	Vertebrate
Scardinius erythrophthalmus	Rudd	Vertebrate
Gasterosteus aculeatus	Three-spined stickleback	Vertebrate
Apodemus sylvaticus	Woodmouse	Vertebrate
Canis lupis familiaris	Dog	Vertebrate
Equus ferus caballus	Horse	Vertebrate
Felis catus	Cat	Vertebrate
Meles meles	Badger	Vertebrate
Myotis daubentonii	Daubenton's bat	Vertebrate
*Myotis mystacinus/brandtii**	Whiskered/Brandt's bat	Vertebrate
*Myotis nattereri**	Natterer's bat	Vertebrate
Nyctalus leisleri	Leisler's bat	Vertebrate
Oryctolagus cuniculus	Rabbit	Vertebrate
Pipistrellus nathusii	Nathusius' pipistrelle	Vertebrate
Pipistrellus pipestrellus	Common pipistrelle	Vertebrate
Pipistrellus pygmaeus	Soprano pipistrelle	Vertebrate
Plecotus auritus	Brown long-eared bat	Vertebrate
Rattus norvegicus	Brown rat	Vertebrate
Sciurus carolinensis	Grey squirrel	Vertebrate
Sorex minutus	Pygmy shrew	Vertebrate
Vulpes vulpes	Fox	Vertebrate

Appendix 2 Planting list for the orchards, beds and borders of Áras an Uachtaráin

Name	Name
Acanthus 'Morning Candle'	Apple Frank's Seedling
Achillea 'Cloth of Gold'	Apple Gibbons Russet
Achillea 'The Beacon'	Apple Gibbys Apple
Achillea 'Yellow Orange	Apple Golden Delicious
Actinidia kolomikta	Apple Golden Royal
Agapanthus	Apple Green Chisel
Alpine strawberry	Apple Honey Ball
Alstromeria	Apple Irish Molly
Alstromeria 'Andez Rose'	Apple James Greave
Alstromeria 'Mars'	Apple Jonathan / Worchester Pearmain
Alstromeria Verona	Apple Keegan Crab
Anemone	Apple Keegans
Anemone 'Honorine Jubert'	Apple Kerry Pippin
Anemone 'Lorelei'	Apple Kerry Pippin / Lanes Prince Albert
Anemone x Hybrida 'Lady Gilmore'	Apple Kilkenny Permain
Anthemis 'Sauce Hollandaise'	Apple King of the Pippin
Apple Allington	Apple Laxton Early Crimson
Apple April Queen	Apple Laxton Superb
Apple Ard Cairn Russet	Apple Leixlip
Apple Ballyfatten	Apple Lord Lambourn
Apple Barnhill Pippin	Apple Lough Tree
Apple Beauty of Ballintaylor	Apple Lough Tree of Wexford
Apple Brown Crofton	Apple Mrs Perry
Apple Cavan Wine	Apple Peach Melba
Apple Charles Ross	Apple Pippin
Apple Councillor	Apple Rawley Seedling
Apple Cox's Orange Pippin	Apple Red Brandy
Apple Davy Apple	Apple Reid Seedling
Apple Discovery	Apple Ross Nonpariel
Apple Dockney	Apple Rowley's Seedling / Laxton Superb
Apple Ecklinville Seedling	Apple Sam Young
Apple Eight Square	Apple Scarlet Crofton
Apple Ellisons Orange	Apple Strippy
Apple Farrell	Apple Thompson's Apple

Name	Name
Apple Turkey Willouby	Corylus avellana 'Red Majestic'
Apple Valentine	Cotinus cogg. 'Royal Purple'
Apple Victoria (Old)	Cotinus cogg. 'Royal Purple'
Apple White Crofton	Cranbe
Apple White Moss /Ballyvaughen	Crocosmia 'Emily McKenzie'
Appletown Wonder	Crocosmia 'George Davidson'
Artemisia abrotanum	Crocosmia 'John Boots'
Aster Frikarti Monch	Crocosmia Rowallone orange
Aster 'Little Carlow'	Cyclamen
Aster Pink Star	Cytisus battandieri
Astilbe chinensis 'Purple Candle'	Delphinium 'Faust' Deep blue
Astrantia Major 'Roma'	Delphinium 'Mighty Atom'
Astrantia Major 'Ruby Wedding'	Delphinium 'Strawberry Fair'
Astrantia 'Roma'	Diascia Personata
Brachyglottis 'Silver dormouse'	Echinacea Rubenstern
Buddleia 'Silver Anniversary'	Echinops 'Taplow Blue'
Buxus Sempervirens	Erysumum 'Bowles Mauve'
Calocephalus brownii	Eucalyptus sunii
Camelia	Euonymus alatus
Campanula 'Blue Bloomers'	Euonymus 'Emerald Gold'
Campanula 'Blue Planet'	Eupatorium Purp' Atropurpureum
Campanula glomerata 'Caroline'	Euphorbia 'Dixter'
Canna Lily	Fatsia japonica
Ceanothus d. gloire de versailles	Fig
Cercis siliquastrum 'Bodnant'	Forsythia
Chaenomeles x superba 'Pink Lady'	Forsythia intermedia spectabilis
Chimonanthus praecox luteus	Fremontodendron 'California Glory'
Chimonanthus praecox	Fuschia
Clematis armandii	Garrya elliptica
Clematis 'General Sikorski'	Gaura Lindlteimeri 'Siskijou Pink'
Clematis montana rubens	Genista 'Lydia'
Clematis 'Niobe'	Geranium Himalayense 'Irish Blue'
Clematis tangutica	Geranium Johnson's Blue
Cornus alba 'Aurea'	Geranium Maverick Red
Cornus sangiunem 'Magic Flame'	Geranium 'Silver Shadow'
Corylopsis	Geum 'Blazing Sonnet'

Name	Name
Geum 'Lady Stratheden'	Monarda 'Croftway Pink'
Geum 'Princess Juliana'	Monarda 'Praerienacht'
Helanium 'Golden Youth'	Nepeta
Helenium 'Indian Summer'	Nepeta 'Six Hills'
Helenium 'Moerheim Beauty'	Nepeta 'Subsessilis'
Hemerocallis 'Black Emmanuella'	Oenothera macrocarpa
Hemerocallis 'Lilioasphodelus'	Ophiopogon
Heuchera Pruhonica 'Raspberry Regal'	Origanum
Hookeria	Ornamental Cabbage
Hydrangea	Osmanthus delavayi
Iris siberica 'Shaker's prayer'	Pear
Irish Peach	Persicaria Microphala 'Red Dragon'
Jasminum officinale	Philadelphus 'Frosty Morn'
Knautia 'Melton Pastels'	Phlomis tuberosa 'Amazone'
Kniffofia	Polyanthus
Laurus nobilis	Potentilla 'Volcan'
Lavandula Hidcote	Rosa banksiae 'Lutea'
Lavender	Rose Raspberry Royale
Leonotis leonurus	Rosmarinus
Leucanthemum x superbum 'Broadway Lights'	Rosmarinus officinalis prostratus
Lippia	Rudbeckia 'Chim Chiminee' Hieta
Lippia citriodora (Aloysia triphylla)	Rudbeckia 'Dublin'
LitItrium Salicaria 'Swirl'	Rudbeckia Fulgida 'Pot of Gold'
Lobelia	Rudbeckia Fulgida var. 'Dreamii'
Lobelia 'Gerardii'	Rudbeckia Nitida 'Herbstonne'
Lobelia 'Sparkling Ruby'	Rudbeckia var. 'Dreamii'
Lobelia spec. 'Scarlet'	Salvia nemorosa
Lobelia Tupa	Salvia Nemorosa 'Cardonna'
Lonicera periclymenum 'Serotina'	Salvia Nemorosa 'SchwellenBurg'
Lythrum Salicaria 'Blush'	Salvia Nemorosa 'Violet Klose'
Lythrum Salicaria 'Swirl'	Salvia Ostfriesland
Magnolia x thompsoniana 'Olemhof'	Salvia 'SchwellenBurg'
Malus 'Red Cats'	Salvia stampede cherry
Monarda Austromontana Bees favourite	Santolina
Monarda 'Cambridge Scarlet'	Sarcococca humilis

Name	Name
Sariococca 'Humilis'	Taxus baccata
Scabiosa Atropurpurem 'Beaujolais Bonnet'	Thalictrum 'Elin'
Schizostylis 'Princess'	Thalictrum 'Hewitts double'
Schizostylus coccinea 'Major'	Thompson's Apple
Sedum spectable 'Brilliant'	Trachelospermum jasminoides 'White Wings'
Sophora microphylla 'Hillsop'	Verbena bonariensis
Spider Plants	Veronica longifolia 'Pacific Ocean'
Stachys	Viburnum 'Hilleri Winton
Stachys lanata	Viburnum rhytidophyllum
Symphoricarpos	Vinca Minor
Syringa v 'Sensation'	

Appendix 3 Survey Protocols

Bird Survey Methodology

Figure A 1 Location of point count sites, vantage point sites and walking transects for bird surveys.

Winter Bird and Summer Breeding Bird Survey Protocols

Bird surveys were undertaken on six occasions 2020, 3 winter surveys in January, February and March to observe any winter visiting species and 3 spring/summer surveys in May, June and July to observe spring breeding birds and summer migrants (Figure A 1). Each survey would begin at sunrise as this is when birds are most active, and each survey consisted of a repeated two rounds of the survey methodology to increase sample size.

The initial January survey method consisted solely of point counts. A point count consisted of going to a predefined point in the study area, waiting 1 minute for birds to settle after arrival of the surveyors, followed by a 5-minute period where birds were recorded inside or outside a defined radius of the point (Sutherland, Newton & Green, 2004). Distance bands of within 30 meters of the point and outside 30 meters of the point are used to class observations as in or outside of the point area. Any birds that flew over the point during the 5-minute interval were recorded as flyovers.

A stratified sampling approach was taken to distributing point sample locations in the Áras. A 100m by 100m grid was placed over a map of the Áras and where the north-south grid lines crossed the east west-grid lines a point count was located. Point count sites could not be located within 200m of another site in the same habitat to ensure independence of samples. Every habitat that occurred in the Áras had to be sampled at least once. These constraints resulted in a sampling design that sampled every habitat in the Áras and sampled habitats according to how abundant the habitat is (Figure A 1). For example, woodlands (the largest habitat type) areas received more point surveys than the pond (the smallest habitat type).

Upon completion of the January survey, a revised methodology was used to increase the habitat area surveyed. Line transects through forested areas and vantage point surveys looking out over fields replaced the point surveys in the respective habitat types (Figure A 1). This increased the habitat surveyed of the two most abundant habitat types in the Áras ensuring that these common habitat types were robustly sampled.

Data Analysis

Species Richness was calculated for Áras an Uachtaráin as a whole. The frequency that each species was observed, and the number of different habitat types a species was observed in was calculated.

Shannon diversity, which considers the abundance of each species when calculating a diversity score, was separately calculated for each habitat type. Data were aggregated by season, with January, February and March coded as winter and May, June and July coded as summer.

The uniqueness of the community each habitat was assessed by conducting a principal component analysis to create a species-habitat association graph.

Results

Species Richness

In total, 51 species were recorded during this survey (Table A 1). This included 35 residents, a further 10 resident species which have a winter migratory component, 4 summer migrants, and 1 winter migrant. The species list includes 21 species that are on the Birds of Conservation Concern in Ireland lists (Colhoun and Cummins, 2013), including 3 (Tufted Duck, Black-headed Gull, Herring Gull) that are Red-listed and are of highest concern, and a further 18 species that are Amber-listed.

Jackdaw was the most commonly observed bird species with over 500 observations during the combined winter and summer visits. Woodpigeon, Wren are Blue Tit and were also abundant (>300 observations) and widespread across the park (Table 1). Magpie, Blackbird and Robin were also relatively abundant (>200 individuals) and widely distributed.

Of the 51 total species, 28 are confirmed as breeding species within the Áras, 2 are considered to be probable breeding birds, 16 are considered to be possible breeding birds, and 5 are non-breeding birds (Table 1). The non-breeding birds are three gull species, Cormorant and Greylag Goose.

Species Diversity

Use of the Shannon index to calculate the bird diversity of Áras an Uachtaráin considers the abundance of each species, leading to a score lower than the species richness of 51. Figure A 2 is a rarefaction curve indicating both the species richness and Shannon diversity score when a given amount of individual birds have been surveyed. The round dot is the actual number of individual birds observed in the Áras over the sampling period, 3528 birds, from which a Shannon diversity score of 17.341 and a species richness of 48 (ignoring flyovers) is obtained.

By looking at the type of rarefaction curve generated is possible to assess how complete the sampling has been at the Áras. In this case we have obtained a curve which is approaching an asymptote, meaning that if we were to double the sampling effort and sample 7056 birds we would likely only increase the Shannon diversity score to 17.435 or increase the species richness to 55, meaning we have sampled intensely enough to reach a point of diminishing returns on effort and we can be confident the Áras has been sufficiently sampled.

Table A 1 Summary of species recorded in Áras an Uachtaráin in 2020. The number of times each species was recorded in winter and summer (Abundance) and the number of habitats in which the species was recorded in winter and summer is provided. Species observed flying over the survey area were recorded as 0 abundance (Cormorant, Greater Black-backed Gull, Swift).

Species	Common Name	Abundance		No. Habitats	
		Winter	Summer	Winter	Summer
Chroicocephalus ridibundus	Black headed gull	7	0	4	0
Turdus merula	Blackbird	111	190	10	11
Sylvia atricapilla	Blackcap	0	30	0	4
Cyanistes caeruleus	Blue tit	221	146	10	11
Pyrrhula pyrrhula	Bullfinch	0	11	0	4
Buteo buteo	Buzzard	5	2	3	1
Fringilla coelebs	Chaffinch	68	62	10	8
Phylloscopus collybita	Chiffchaff	0	26	0	7
Periparus ater	Coal tit	64	51	9	9
Streptopelia decaocto	Collared dove	0	3	0	3
Fulica atra	Coot	10	20	1	2
Phalacrocorax carbo	Cormorant	0	0	0	0
Prunella modularis	Dunnock	3	4	3	4
Columba livia f. domestica	Feral pigeon	0	2	0	1
Regulus regulus	Goldcrest	23	42	6	8
Carduelis carduelis	Goldfinch	32	23	8	8
Dendrocopos major	Great spotted woodpecker	0	1	0	1
Parus major	Great tit	35	18	6	6
Larus marinus	Greater black backed gull	0	0	0	0
Chloris chloris	Greenfinch	8	13	4	4
Ardea cinerea	Grey heron	5	2	2	1
Anser anser	Greylag goose	2	0	1	0
Larus argentatus	Herring gull	15	15	6	6
Corvus cornix	Hooded crow	35	27	10	8
Delichon urbicum	House martin	0	1	0	1

Species	Common Name	Abundance		No. Habitiats	
		Winter	Summer	Winter	Summer
Passer domesticus	House sparrow	1	0	1	0
Coloeus monedula	Jackdaw	283	300	10	11
Garrulus glandarius	Jay	10	4	3	1
Falco tinnunculus	Kestrel	1	0	1	0
Linaria cannabina	Linnet	1	0	1	0
Tachybaptus ruficollis	Little grebe	3	12	1	2
Aegithalos caudatus	Long tailed tit	48	2	7	2
Pica pica	Magpie	143	109	11	11
Anas platyrhynchos	Mallard	18	2	2	1
Turdus viscivorus	Mistle thrush	15	22	7	7
Gallinula chloropus	Moorhen	13	7	1	2
Phasianus colchicus	Pheasant	0	1	0	1
Motacilla alba	Pied wagtail	2	2	1	2
Erithacus rubecula	Robin	115	111	11	10
Corvus frugilegus	Rook	12	7	6	3
Spinus spinus	Siskin	1	0	1	0
Alauda arvensis	Skylark	0	1	0	1
Turdus philomelos	Song thrush	35	79	6	10
Accipiter nisus	Sparrowhawk	9	6	5	3
Sturnus vulgaris	Starling	3	27	3	5
Hirundo rustica	Swallow	0	21	0	6
Apus apus	Swift	0	0	0	0
Certhia familiaris	Treecreeper	7	4	2	2
Aythya fuligula	Tufted duck	0	1	0	1
Columba palumbus	Woodpigeon	139	277	11	11
Troglodytes troglodytes	Wren	98	243	10	11

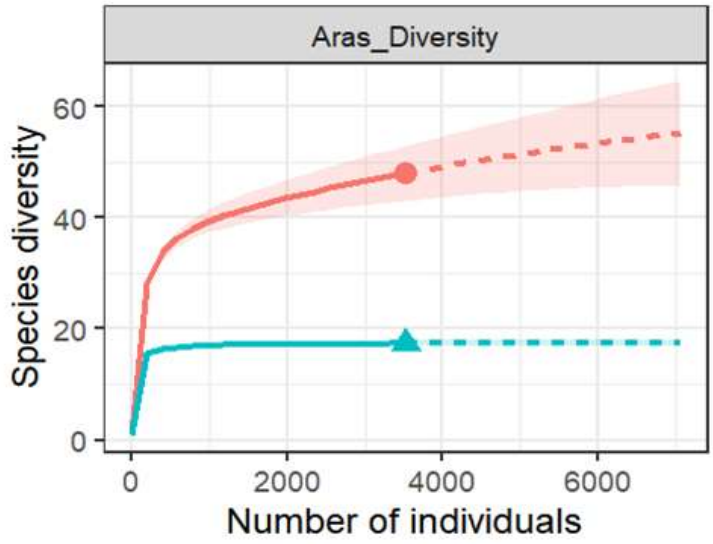


Figure A 2 Species Diversity of Áras an Uachtaráin. Red line and dot indicate the species richness rarefaction curve and observed score while the blue line and dot indicate the Shannon diversity rarefaction curve and observed score.

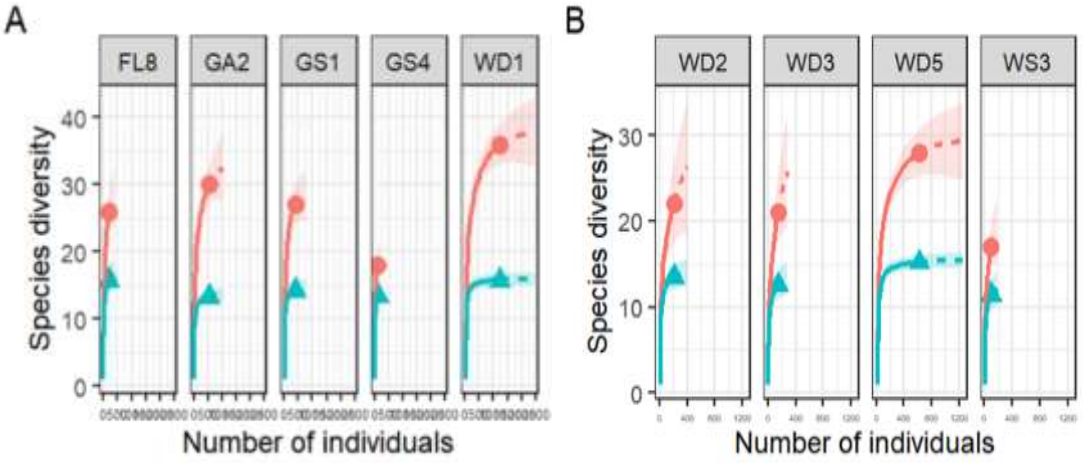


Figure A 3 Species Richness and Shannon Diversity by Habitat Type. Red line and dot indicate the species richness rarefaction curve and observed score while the blue line and dot indicate the Shannon diversity rarefaction curve and observed score.

Habitat Richness and Diversity

The species richness and Shannon diversity of each habitat was calculated (Figure A 3). The habitat codes follow the Fossitt (2000). Mixed Broadleaved Woodland (WD1) was the

habitat with the highest species richness followed by Amenity Grasslands (GA1), expected given the extent of each habitat at the Áras. The Mixed Broadleaved Woodland, pond (FL8) and Scattered Trees and Parkland (WD5) habitats all share a high Shannon diversity score of greater than 15.

Species-Habitat Associations

It is important to consider how unique a community is and not just compare Shannon diversity scores to determine what habitats are important. Taking species identity into account using a principal component analysis demonstrates how unique each community is in a given habitat.

Habitats that cluster together on Figure A 4 have similar species compositions, while habitats that are far apart have dissimilar compositions. Any habitat that is not clustered with other habitats has a unique community. As expected, the pond (FL8) habitat occupies a position distant from other habitats, indicating that the bird community found at the pond is unique and not found anywhere else at the Áras *e.g.* Coot, Moorhen, Mallard, Little Grebe, Tufted Duck. The Conifer Woodland (WD3) and Wet Grassland (GS4) also have unique communities, with Sparrowhawk nesting in the Conifer Woodland and many smaller passerine birds being recorded in the Wet Grassland (Blackcap, Long-tailed Tit, Robin).

The woodland habitats (WD5, WD2, WD1) form a cluster, and similarly the grassland habitats (GA2, GS1) and the Ornamental Non-Native Shrub (WS3) cluster together, meaning that the bird communities in each cluster have a similar composition.

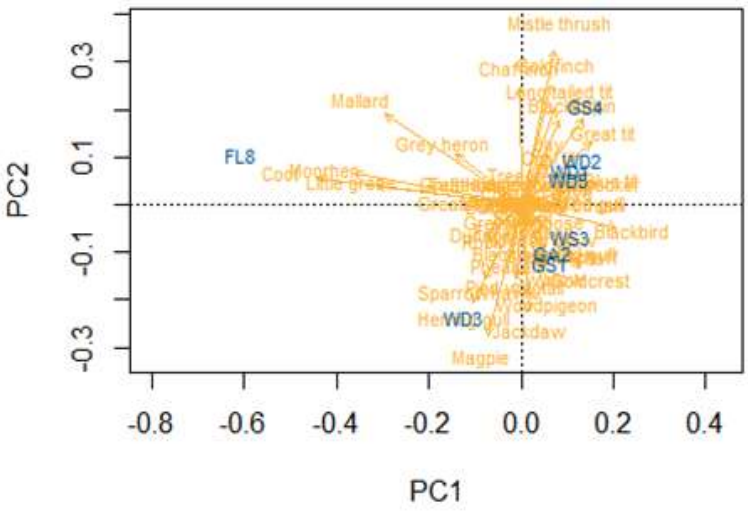


Figure A 4 Habitat-Species Associations

Species Richness and Diversity by Season

Figure A 5 compares species richness and diversity by season, with January, February and March comprising the winter season and May, June and July the summer season. The species richness increases in the summer season due to summer migrants like the Swallow, Chiffchaff, House Martin and Blackcap. We only recorded one winter migrant, the Greylag Goose, accounting the rise in species richness in summer. The Shannon diversity of the two seasons is very similar, indicating that there isn't a big population of summer migrants relative to the resident bird species.

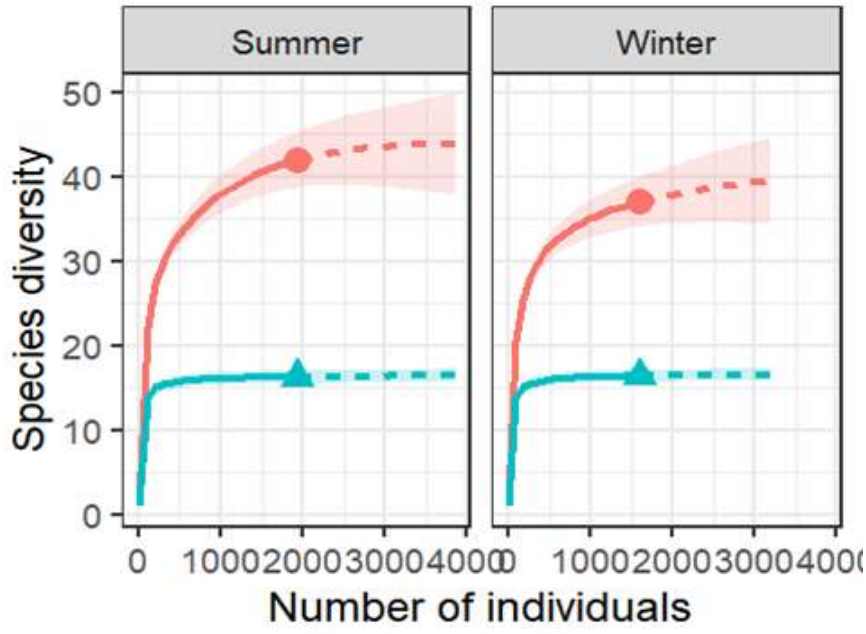


Figure A 5 Species Richness and Shannon Diversity by Season of Survey. Red line and dot indicate the species richness rarefaction curve and observed score while the blue line and dot indicate the Shannon diversity rarefaction curve and observed score.

Cian White, September 2020.

Bird Ringing

On the morning of the 11th of August 2020, we used mist nets (NR60, 18m, sourced from BTO, Thetford, UK) to trap birds in the Wilderness Area. Nets were set early in the morning of trapping, and ran until no birds were caught on successive net rounds. We did not use feeders or recordings of bird songs to boost the catch. We made regular visits to the nets and removed any birds caught in them. Birds were transported between the nets and the ringing station in soft cloth bags, to reduce stress to the birds and minimise their handling time. At the ringing station, birds were processed quickly by licensed ringers. We recorded the age and sex of the birds, as well as their wing length and weight. Some birds were photographed prior to release.

We had a moderate catch of four species:

- Wren x1
- Great Tit x3
- Robin x1
- Blackcap x2

We caught young birds (born in 2020) of each of these species, which indicates they had bred nearby.

We would expect Wrens and Great Tits to disperse locally, over winter, but the Robins and Blackcaps are likely to move further afield. Robins born in Ireland have been known to winter in continental Europe (France, Spain or Portugal), although the majority stay in Ireland throughout the year.

Blackcaps, as a species, have a much more complex migration strategy; some populations are sedentary, some migrate over shorter distances and some over longer distances. Blackcaps which breed in Ireland are shorter distance migrants, and spend the winter in southern Europe or northern Africa.

During autumn and winter, both Robins and Blackcaps (which bred in other European countries) may visit Ireland. By ringing these species throughout the year, we can monitor their migration patterns. This also allows us to detect any changes in migration patterns over time (*e.g.* creeping trends like global warming, or exceptional weather events).

David J. Kelly, September 2020.

Mammal Surveys

Figure A 6 Location of trapping points and transects for mammal surveys

Camera Traps

Motion sensitive trail-cameras were placed at a variety of locations around Áras an Uachtaráin (Figure A 6) from 18 May 2020 until 16 August 2020. The grounds were walked on several occasions to identify mammal tracks and signs. Locations were chosen based on the presence of footprints and foraging signs, well used paths/runs through vegetation, sett entrances/holes, and where OPW staff had reported seeing mammal activity. At most locations, the cameras were programmed to take video between 7pm and 7am in order to avoid being triggering by people, dogs, horses *etc*., unless situated in areas with little predicted human-related activity, *e.g.* the Wilderness Woodlands, behind the Pieta Statue, and the badger sett by the Ice House tunnel, where they were set to record 24 hours a day. The cameras recorded using infrared light during darkness. Cameras were left *in situ* for at least one week before being moved to another location. However, if moving vegetation caused excessive triggering, cameras were moved on to alternative locations. Footage was downloaded from memory cards (32GB) regularly and screened. Video footage of people/horses/dogs *etc.*, was deleted, except where it pertained to management practices, *e.g.* disposal of gardening waste, spraying *etc*.

Badgers, foxes, grey squirrels, rabbits, wood mice, rats and cats were all captured on trail-camera. The most numerous records were for badgers and foxes, which were recorded at most locations. There were multiple instances of more than one badger, or more than one fox, being recorded at the same time indicating the presence of family

groups. Juveniles of both species were recorded, illustrating that they were successfully breeding on site. There were occasions where badgers and foxes were recorded foraging in close proximity to one another. A rat was regularly captured on camera at the Ice House/Tunnel badger sett. A wood mouse was recorded on camera at Nut Island. A rabbit was recorded at the Pieta Statue.

While these last three species were recorded as individuals, it is not known if it was the same individual or multiple individuals that were recorded at different times. However, many woodmice were successfully trapped throughout the Áras using Longworth traps (see below), and rat holes were observed in several locations throughout the grounds. Rabbits were never observed on camera or in person in numbers greater than one, suggesting the population size in the Áras is quite low. Entrances to warrens were only found at the far end of the Horse Paddock, and there were limited areas where droppings were present (rear Kitchen Garden/Pieta Statue areas). An unidentified species of bat, and a buzzard, were also captured on camera in the Wilderness Area.

Aoibheann Gaughran, September 2020

Small Mammal Trapping

Trapping for small mammals was carried out in the grounds of Áras an Uachtaráin during the months of June and July 2020. The timing of this study was not ideal, given that woodland rodents typically display a seasonal cycle of abundance/activity, with a peak in late autumn/early winter, declining to a minimum in mid-summer. However, due to the restrictions on fieldwork caused by Covid-19 in the early part of the year, and the need to conclude the study before September, this was the only time-slot available.

Eight separate locations were selected and investigated (Figure A 7), spread over the entire grounds and representing as wide a range of woodland/woodland-edge habitats as possible. Two of the locations (A and G) were within blocks of mature woodland ('The Wilderness' and 'Nut Island' respectively), while four others were along treelines, in most cases abutting more extensive areas of woodland, sometimes outside of the boundary security fence. One set of traps (H) was located in the yards and gardens of the Áras, with a view to attracting any commensal rodents.

The trapping protocol employed was a modification of that developed by the Mammal Society (Mini Mammal Monitoring: Low Density Live Trapping) for detecting the presence/relative abundance of small mammals. Given the season, and in an attempt to increase trap-success, the number of traps used at each location was doubled, and the trapping period was extended over four days.

Figure A 7 Location of Small Mammal Traps

At each location, 20 Longworth Small Mammal Traps were set, in pairs, at c.10m intervals along a marked transect (Figure A 8). Trap nest-boxes were filled with dry hay as bedding material, and baited with nibbed peanuts. Several pieces of soaked carrot were also provided, as a source of water. Traps were placed under vegetation, at the base or trees or alongside other natural features, and some bait was scattered in the vicinity as an attractant. Traps were first set in late-afternoon/early-evening of Day 1 (no pre-baiting was carried out), and checked/reset at c.12h intervals over the next two days, with a final check and trap removal on the morning of Day 4. This allowed for some 100 'trapping events' over the four-day period. Locations A, C, G and H were trapped from 15-18 June, with Locations B, D, E and F being trapped some five weeks later, from 20-23 July.

Figure A 8 Longworth Trap for Small Mammal Trapping at the base of a tree

Woodmouse, *Apodemus sylvaticus*, was the only species recorded, and individuals were trapped at all eight locations. No direct attempt was made to catch pygmy shrew, *Sorex minutus*, and none were trapped (approximately one third of the traps were fitted with 'shrew escape holes'). As pygmy shrews can enter Longworth traps, live trapping was carried out under licence from NPWS, as pygmy shrews are protected under the Wildlife Acts (1976, 2000). The only records of a pygmy shrew during the study period were of two recorded on a trail-camera, visiting a 'Mostela' Box in the Wilderness Area in June and Nut Island in August. It had been hoped that the traps set at Location H, around the outbuildings and gardens of the main house, including the Garda stables, would have picked up House Mouse, *Mus musculus domesticus*, if present, but no evidence was found. Brown Rat, *Rattus norvegicus*, is known to be present (evidence from trail-camera and mink raft) but none were trapped. There was evidence of rodent control measures in place in the gardens and around many of the buildings.

Out of the total of 800 potential 'trapping events', there were 11 incidents where traps had been broken open and their contents scattered by Badgers, *Meles meles*. Six of these (a row of six consecutive traps alongside a wall) occurred on one night in June, within the walled flower garden (Location H). There was clear evidence that a badger had tunnelled under a gate into this enclosed area on a regular basis. The other incidents occurred at Location C (one trap, adjacent to a well-established Badger trail), Location F (a pair of traps near where there was a badger 'entrance' in the perimeter fence) and Location E. As well as two traps being opened at this location, a further seven were disturbed, probably also by badgers, evidence of whose foraging was abundant in the nearby grassland.

With the removal of these 11 potential 'trapping-events' and a further 23 'false alarms', where the traps were found closed but empty (with the possible exception of a large slug!), this left 766 occasions when a trap could possibly have caught an animal. There were 79 captures, representing a trap-success rate of 10.3%, involving a minimum of 53 animals. There was, however, great variation in these numbers, between the various Locations (Table A 2).

Table A 2 Trap Success and Minimum Number of mice (MNA) at each of eight Trapping Locations at Áras an Uachtaráin, summer 2020.

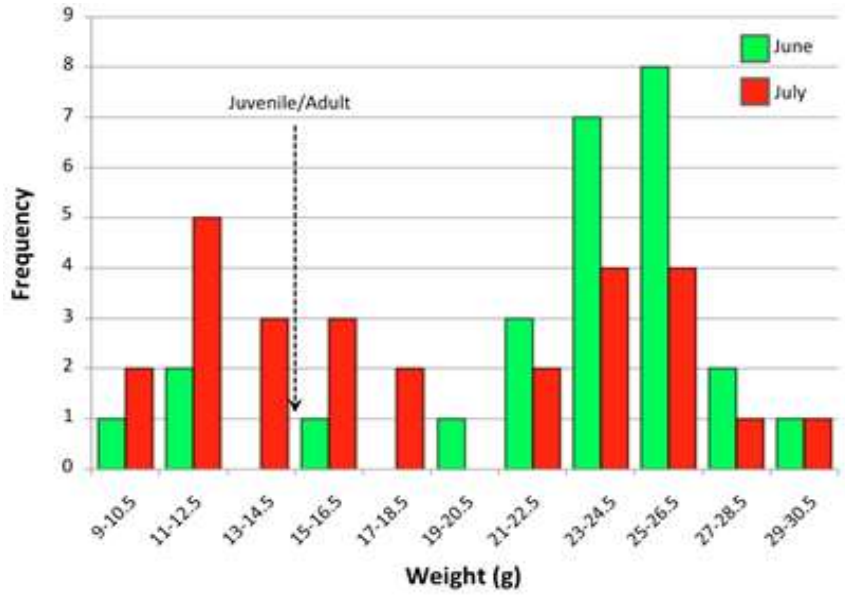
Location Code & Name	Potential Trapping - events	Events Disrupted or False-Alarms	Available Trapping-events	Captures	Trap Success (as % of Available)	'New' Animals (MNA)
A 'The Wilderness'	100	3	97	13	13.4	8
B Car-park	100	1	99	5	5.1	4
C Northern Perimeter	100	5	95	3	3.2	2
D Lake	100	0	100	1	1.0	1
E Eastern Perimeter	100	10	90	6	6.7	3
F Southern Perimeter	100	7	93	30	32.3	19
G 'Nut Island'	100	2	98	13	13.3	11
H Buildings and Gardens	100	6	94	8	8.5	5
Total	800	34	766	79	10.3	53

Both of the mature woodlands (A – the Wilderness Area and G – Nut Island), not surprisingly given the availability of food and cover, held reasonable numbers of mice, whereas the traps along paths, despite the presence of adjacent woodland, were perhaps too open and disturbed and therefore produced few animals. The woodlands around the edge of the lake and nearby pasture appeared to be particularly poor, although this may have been exacerbated by disturbance from on-going maintenance works in the area.

What was surprising, however, was the relative abundance of mice at Location F, within the trees between the southern perimeter track and the Horse Paddock. This was undoubtedly influenced by the area of dense and undisturbed woodland immediately beyond, and to the south of, the boundary fence, which was not investigated further.

Half of all males, and just over a third of the females caught were in breeding condition. One female, caught on three successive occasions at Location A (the Wilderness Area) in June, was observed to be lactating and gaining weight. Body weights of all 'new' mice caught ranged from 9.5g (female caught at Location F in July) to 30g (male caught 10m away on the same day), with a mean of 20.5 ± 6g. Males were on average very slightly heavier than females (24 males 22.2 ± 6g; 27 females 18.8 ± 5.6g; p=0.0368). Juveniles (animals ≤14.5g) made up almost 25% of total animals caught, with a greater number being trapped in July (10 individuals; 37% of total), the majority of these occurring at Location F (Figure A 9).

Figure A 9 Weights of all new mice caught at Áras an Uachtaráin, summer 2020.



Overall, the assessment is that woodmice are widespread and relatively abundant throughout the grounds of Áras an Uachtaráin. Pygmy shrews occur, at least in the Wilderness Area and Nut Island, and are probably more widespread, but no evidence could be found for the presence of the house mouse in the area, which is surprising. Brown rats were not caught but were recorded from trail-cameras. No other species were expected to occur.

John Rochford, September 2020

Hedgehog Footprint Tunnels

The hedgehog is a medium-sized insectivore and is probably one of our most recognisable mammals due to its characteristic spines. They are protected under the Wildlife Act, 1976 and the Wildlife (Amendment) Act, 2000. In the UK, hedgehog numbers are thought to be in decline, although urban populations are faring better than rural populations (PTES, 2020). While hedgehogs are perceived to be common and widespread in Ireland, there has been very little research on them to date. On the one hand, there are frequent records received by the National Biodiversity Data Centre (NBDC) for this species, commonly in suburban gardens and parks (Marnell *et al*., 2019). However, there is much anecdotal evidence that they are also in decline in Ireland. To resolve this uncertainty, an ongoing citizen science project by researchers in the National University of Ireland, Galway with the NBCD is aiming to get an accurate picture of hedgehog abundance and distribution in Ireland. Data Áras an Uachtaráin will contribute to this project.

To ascertain if hedgehogs were present in the Áras, footprint tunnels were deployed in two tracking sessions in June and July. In each tracking session, 6 tunnels were placed in various locations throughout the grounds of Áras an Uachtaráin (Figure A 6, Figure A 10). Hedgehogs tend to follow linear landscape features while foraging within their territories at night. Accordingly, footprint tunnels were placed along boundary fencing close to gates, close to wildlife passes under the fencing, along walls in the Kitchen Garden, by hedging along perimeter paths and in grassland where paths had been mown through long grass. The first trapping session occurred over 5 consecutive nights, and the second trapping session occurred over 4 consecutive nights resulting in 54 trap-nights.

The tunnels were prepared as follows. A single 22cm wide strip was cut from a 100x100cm piece of corrugated plastic to form a base board. On the remainder of the sheet 3 x 23cm wide panels were measured out and scored to allow them to fold. The sheet was then folded into a triangular prism and secured by sticking down the overlap with duct tape (Figure A 11). To prepare the base board, an upturned petri-dish lid was secured using double-sided sticky tape to the centre point of the base board. Masking tape (2-3 strips) was attached across the board on either side of the dish to make the ink pads. Ink was made by mixing non-toxic charcoal power (sourced from NHBS) with a small amount of vegetable oil, and a generous coating was then painted onto the masking tape. A4 paper was attached to either end of the baseboard and secured with

sticky tape. Finally, the petri-dish was filled with bait (cat food) and placed in the upturned petri-dish lid (Figure A 10). The base board was then slid inside the tunnel.

The tunnels were set up before dusk on the first evening and were checked shortly after dawn each morning. If the tunnel had been visited, photographs were taken of the footprints/trails, the used paper removed for reference, and fresh paper and paint applied to the base-board. Fresh bait was provided. The tunnels were removed between the two trapping sessions.

Figure A 10 Hedgehog footprint tunnel and base board alongside yew hedging at perimeter fencing.

No evidence of hedgehogs was detected in any of the footprint tunnels. Mice, cat and bird prints, and mollusc trails (slugs and snails) were detected. Some tunnels were disturbed by badgers trying to access the bait. Molluscs, mostly slugs, were detected at all sites, the small rodents in the Kitchen Garden, cats close to the Main and Cabra Gates, and badgers close to the pond and along the southern perimeter path. It is possible that hedgehogs were present in the grounds of the Áras but simply did not enter the footprint tunnels. However, hedgehogs were never recorded on any of the trail-cameras during the course of the study period. Neither were they sighted by researchers during night-time surveys of bats and moths. OPW staff reported that they have not seen a hedgehog since several rehabilitated hedgehogs were leased a few years ago.

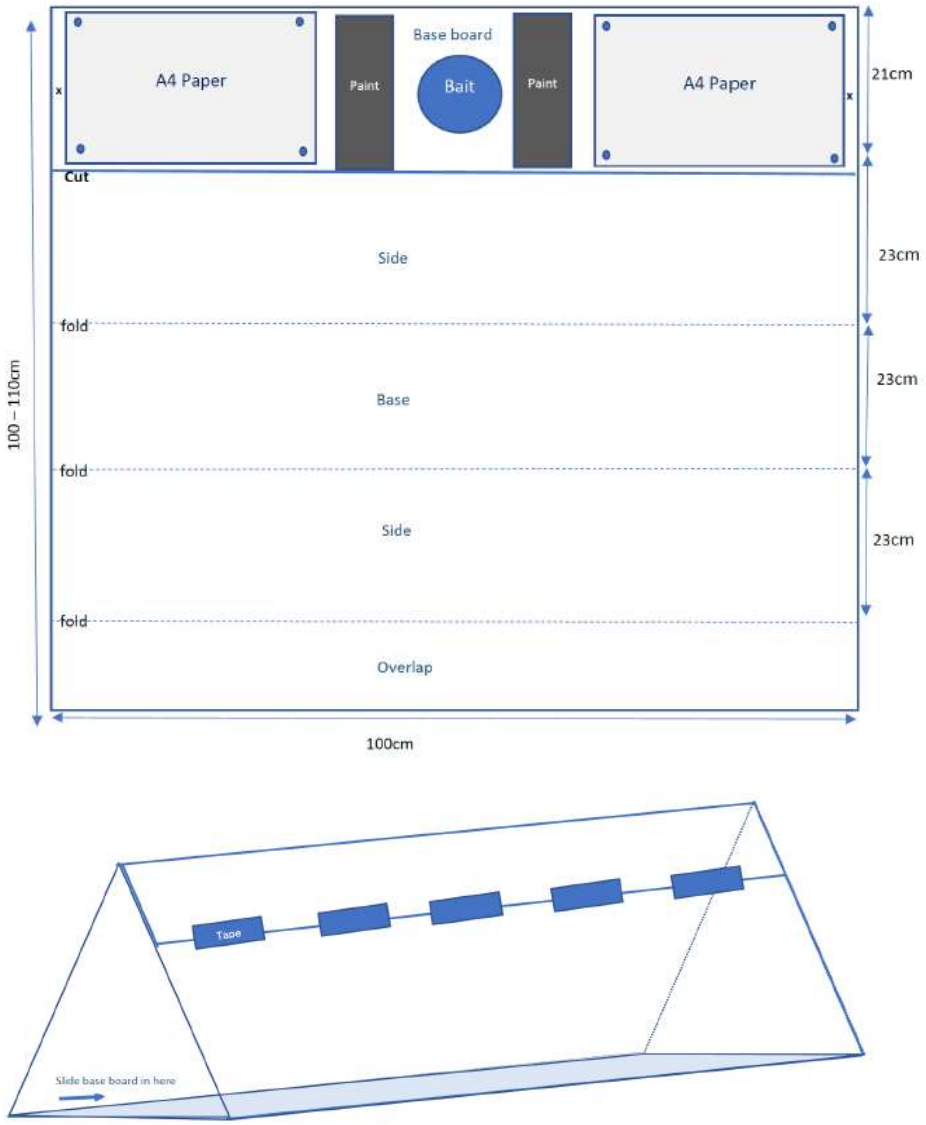


Figure A 11 Diagram for construction of Hedgehog Tunnels, from Irish Hedgehog Survey Guidelines (2020)

Aoibheann Gaughran and John Rochford, September 2020

Stoat Surveys

The stoat (*Mustela erminea hibernica*) is our smallest mustelid. It is a near endemic sub-species, *i.e.* it also occurs in Isle of Man, but greater than 90% of global population is estimated to occur in Ireland. Although it has widespread distribution in Ireland in a broad range of habitats, it is of added conservation value because of this near-endemic status. It is legally protected under the Wildlife Act, 1976 and the Wildlife (Amendment) Act, 2000. It would appear to have been underrepresented in Irish mammal research to date and more research on their ecology and conservation status would be valuable (Marnell *et al*. 2019). It is primarily carnivorous, feeding on small mammals, including rabbits, and birds. It can be found in grasslands and woodlands, among other habitat types. It tends to avoid open areas, travelling along hedgerows and stone walls.

Footprint Tunnels

To detect the presence of stoats, footprint tunnels were deployed in a single tracking session in July over 4 nights (Figure A 6). In the tracking session, 9 tunnels were placed in various locations throughout the grounds of Áras an Uachtaráin. Footprint tunnels were situated at intervals along the boundary fencing and in wooded areas (Figure A 12). Each of the 2 trapping sessions occurred over 4 consecutive nights, or 36 trap-nights. However, tunnel #2, located behind the Pieta Statue, went missing on the second night. This resulted in a total of 33 trap-nights.

Figure A 12 Stoat tunnel with baited foot plate placed on top for display purposes, and stoat tunnel *in situ* along boundary fence with the baited foot plate inside.

The tunnels were prepared as follows (Figure A 13). The tunnels were made from 50cm sections of 68mm square downpipe, with two holes drilled on the bottom, in the centre

5mm in from either edge. The base, 500mm x 60mm, was made from a sheet of metal. Two holes were drilled into the base board, at the centre point 5mm in from either short edge, so that once the base plate was inserted into the tunnel, the holes lined up. This allowed the plate to be secured to the tunnel with cable-ties once in-situ. To secure bait to the base plate, two holes were drilled into it at 25cm, approx. 15mm in from the edges. Masking tape (2-3 strips) was attached across the board 20mm. from these holes to make the ink pads. Ink was made by mixing non-toxic charcoal power (NHBS) with a small amount of vegetable oil, and a generous coating was then painted onto the masking tape. Strips of paper were cut to size and attached to either end of the base board with sticky tape. Finally, a small piece of chicken on the bone was secured to the centre of the plate with a cable tie. The base board was then slid inside the tunnel and secured to the tunnel with cable-ties. Excess ends were trimmed from all cable-ties.

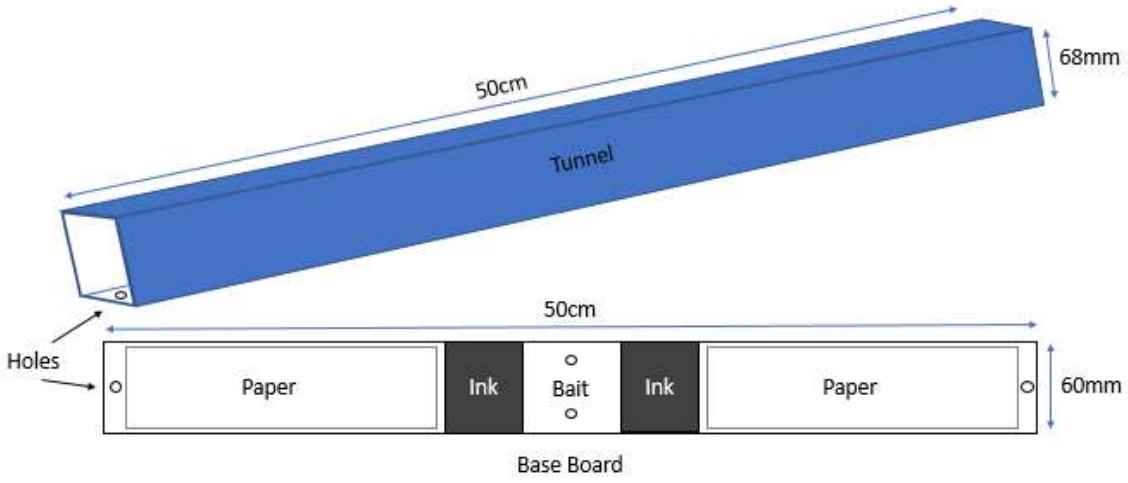


Figure A 13 Diagram of Stoat Footprint Tunnels

The tunnels were set up before dusk on the first evening and were checked shortly after dawn the following mornings. If the tunnel had been visited photographs were taken of the footprints/trails, the used paper removed for reference, and fresh paper and paint applied to the base board. The tunnels were removed after the final night.

No mammal prints were detected with the stoat footprint tunnels, except for a single set of mice prints in one tunnel. All tunnels attracted flies, beetles and slugs. One tunnel was disturbed by a fox or badger (moved), and two were disturbed by cats (paper ripped out). The hedgehog tunnel located close to one of these stoat tunnels was used by a cat on the same night. It is possible that stoats were present but did not enter the footprint

tunnels, however stoats were never recorded on any of the trail-cameras during the course of the study period, nor were they recorded with the Mostela box.

Mostela Box

In addition to stoat footprint tunnels, we used a Mostela box based on a design by the Dutch Small Mustelid Foundation (Figure A 14; Croose and Carter, 2019, Mos and Hofmeester, 2020). The Mostela has been used successfully in the Netherlands to detect weasels, stoats and polecats, and by the Vincent Wildlife Trust in Ireland to detect Irish stoats and pine marten. It comprises a wooden box with a plastic tunnel running through it and a camera inside, trained on the tunnel. We used 68mm square downpipe rather than 80mm circular piping. When an animal enters the tunnel, the camera is triggered and records a video or photo. We placed the Mostela box in two different locations, in woodlands by the perimeter fence and on Nut Island. To attract the mustelids, the box was baited internally with rabbit scent (National Scent Company Inc.) and chicken legs. The scent lure was applied to cotton wool which was placed in a perforated plastic tube. In addition, a second camera was placed outside the box to film any external animal activity around the Mostela. Scent lure was topped up at regular intervals. The boxes were left *in situ* at each location for approximately 3-4 weeks. SD cards were checked at regular intervals and any footage downloaded.

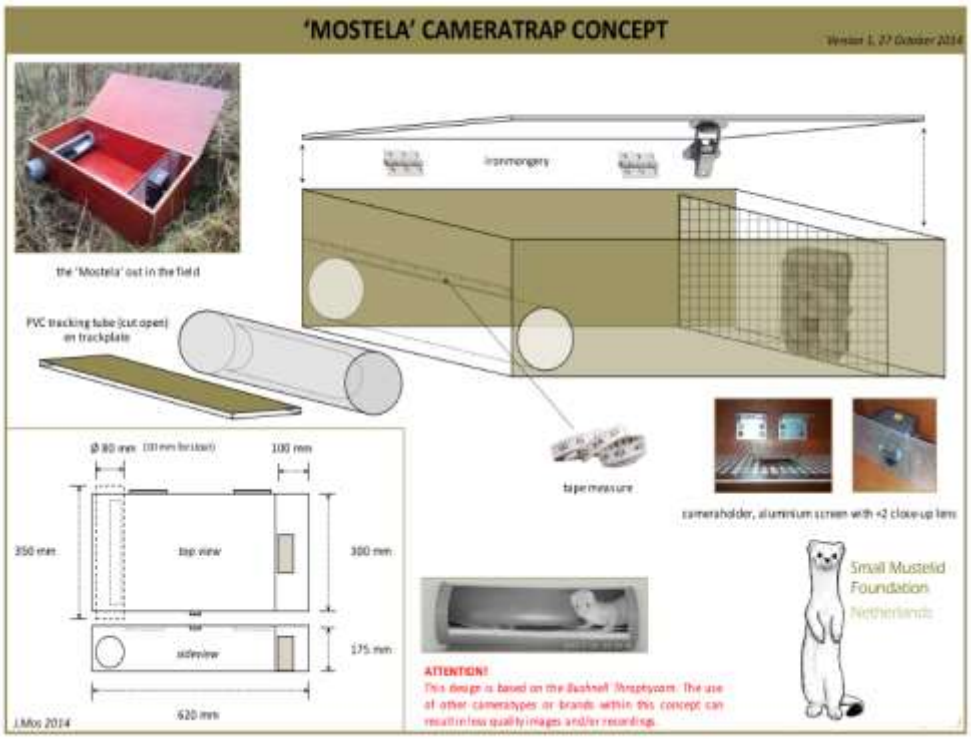


Figure A 14 Design of the Mostela box available at stichtingkleinemarters.nl

Figure A 15 A fox (*Vulpes vulpes*) caught on trail-camera investigating the Mostela box.

Neither stoat nor pine marten were detected with the Mostela box, on either internal or external cameras. Two pygmy shrews were recorded inside the Mostela in the Wilderness Area in June and at Nut Island in August. A woodmouse was recorded inside the Mostela box at Nut Island in August. Badgers and foxes were detected by the external camera trained on the Mostela box in both locations (Figure A 15). Some appeared interested in the box, while others appeared wary. Squirrels were regularly detected using the wood pile on top of the Mostela box on Nut Island as a grooming station. Blackbirds and wood pigeons were frequently recorded on the external camera foraging on the ground.

Aoibheann Gaughran and John Rochford, September 2020

Mink Rafts

The American mink (*Neovision vision*) is listed as one of the world's worst 100 invasive non-native species by the IUCN's Invasive Species Specialist Group. American mink (*Neovison vison*) populations are well established in Ireland as a result of escapes, both deliberate and accidental, from fur farms. They are important predators of ground-nesting birds (Roy *et al*. 2009; Marnell *et al*.2020). Are known to be present in the Phoenix Park (Haydon, 2007), and indeed killed chickens in the Kitchen Garden in the Áras a few years ago.

To detect the presence of mink, 2 mink rafts were constructed by John Rochford, based on the design by The Game and Wildlife Conservation Trust and were deployed at the Pond in Áras an Uachtaráin (Figure A 16). A mink raft comprised a buoyant base, a removable tracking cartridge (a porous basket containing a large oasis block topped with a pottery clay and sand mixture), and a wooden tunnel. It is designed to take footprint impressions of the mink; it will also detect the presence of otters (*Lutra lutra*) should they investigate the raft.

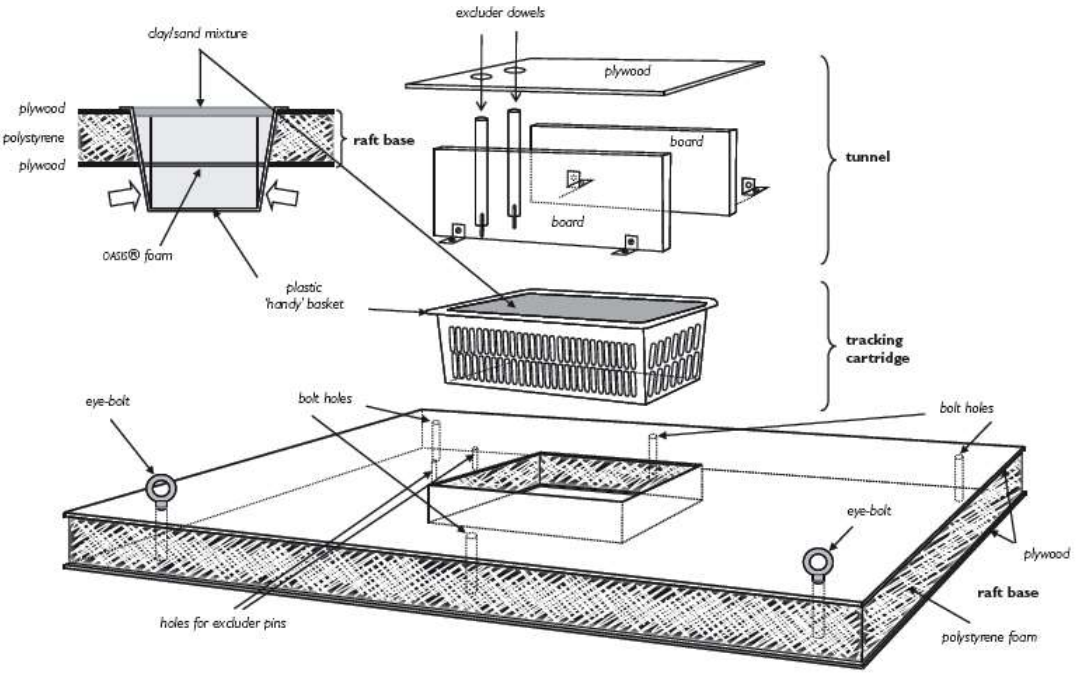


Figure A 16 Mink Raft design (Game and Wildlife Conservation Trust Guidelines, 2015)

One raft was deployed adjacent to the boathouse, and the second at the opposite corner of the pond (Figure A 17). They were secured with ropes to trees at the pond edge, which

also facilitated hauling-in for checking. The mink rafts were initially un-baited, but after a few weeks of complete inactivity, chicken legs were suspended over the tracking cartridge inside the tunnel. The rafts were deployed for 8 weeks in total and were checked at regular intervals. Debris such as leaves, and twigs were removed. If footprints were present, they were photographed, and the clay was smoothed out using a squeegee so that fresh prints could be captured.

Figure A 17 Mink rafts on the Áras pond and checking a raft for fresh footprints.

Results

The only tracks captured on the mink rafts were from rats at the boathouse, and bird impressions at the opposite corner. No evidence for mink was detected. The rat prints were only observed after the chicken bait had been deployed. The chicken was consumed to the bone. Bird prints were likely incidental, as a moorhen was observed walking around one of the rafts.

Although not specifically targeted, there was no evidence for otters (*Lutra lutra*) at the pond, either in the form of footprints on the raft, spraints, prey remains or slides at the pond edge. Although otters are present on the Liffey directly south of the Phoenix Park (Macklin *et al*. 2019), the Áras pond is connected to the Liffey via underground culverts that link the ponds in the Zoo and the People's Garden pond, making it an unlikely travel route.

Aoibheann Gaughran and John Rochford, September 2020

Bat Surveys

Bats are the only mammals that can undertake true powered flight. In Ireland, they are nocturnal and insectivorous, feeding on midges, mosquitos, moths and beetles, many of which are considered pest species.

Nine bat species have been confirmed resident in Ireland. These are:

- Common pipistrelle (*Pipistrellus pipistrellus*)
- Soprano pipistrelle (*Pipistrellus pygmaeus*)
- Nathusius' pipistrelle (*Pipistrellus nathusii*)
- Leisler's bat (*Nyctalus leisleri*)
- Brown long-eared bat (*Plecotus auritus*)
- Daubenton's bat (*Myotis daubentonii*)
- Whiskered bat (*Myotis mystacinus*)
- Natterer's bat (*Myotis nattereri*)
- Lesser horseshoe bat (*Rhinolophus hipposideros*)

Of these, the lesser horseshoe bat is unlikely to occur in Áras an Uachtaráin as it is limited to small populations in Cos. Kerry, Limerick, Cork, Clare, Galway and Mayo. Two other species have been recorded in Ireland. An individual Brandt's bat (*Myotis brandtii*) was discovered in Co. Wicklow in 2003. This bat is very similar to the whiskered bat (*Myotis mystacinus*), and identity can only be confirmed in the hand. An individual greater horseshoe bat (*Rhinolophus ferrumequinum*) was found in Co. Wexford in the winter of 2012-13. A second record for this species was made in Co. Wicklow over the summer of 2020. Although these species are considered vagrants, most likely from the UK, there is potential for them to reoccur/establish in Ireland.

All bat species are protected under the Wildlife Acts (1976, 2000). It is an offence to:

- Intentionally kill, injure or take a bat;
- Possess or control any live or dead specimen or anything derived from a bat;
- Wilfully interfere with any structure or place used for breeding or resting by a bat;
- Wilfully interfere with a bat while it is occupying a structure or place which it uses for that purpose.

The objectives of this study were to:

1. Confirm which bat species are present in Áras an Uachtaráin and
2. Identify the existence of significant bats roosts in buildings.

It takes into account a previous survey carried out in the Phoenix Park (Scott Cawley, 2007). The bat surveys undertaken in this study were carried out under a derogation licence issued by the National Parks and Wildlife Service, following the methods outlined in Aughney *et al*. (2008) and Collins (2016).

Audio Recordings

To determine which species were present, and which habitats they used for commuting and foraging, we carried out walking transects and deployed static bat detectors (Figure A 6). Walking transects occurred on four occasions (02/06/2020, 08/06/2020, 21/07/2020 and 11/08/2020). Surveys commenced 15 minutes after sunset and lasted approximately 1.5-2 hrs. Transects were walked at a slow, steady pace, approx. 3km p/hr. Calls were detected using a Magenta Bat5 heterodyne detector and EchoMeter Touch2 for iOS (Wildlife Acoustics) (Figure A 18). Species were identified based on their call frequency and call pattern (Russ, 2012). Although the EchoMeter Touch2 has an autoID function built-in, calls were recorded, and IDs verified using call analysis software (Kaleidoscope Version 5.2.1 and BatClassify).

Because walking transects only provide a snapshot of bat activity there is potential for species to be missed. To counteract this, two static bat detectors (Song Meter SM4 Bat FS, Wildlife Acoustics) were deployed (Figure A 18) between 21/05/2020 and 04/08/2020. These recorders were programmed to run from sunset to sunrise each night. They were left in a given location for 2-3 weeks before being moved to a different location. Calls recorded on the statics and EchoMeter were analysed using the Kaleidoscope and BatClassify. Locations for transects and statics were focussed on habitats where bats are most likely to be active, *i.e.* woodland rides, treelines and the pond, but the grasslands, parkland and formal gardens were also surveyed.

Figure A 18 Bat detectors - SM4 static recorder and microphone, Echometer handheld detector

Results

All species (except the Lesser Horseshoe bat) were detected on either the hand-held bat detectors or static recorders. However, it is extremely difficult to differentiate between the Myotis bats using heterodyne detectors alone. Analysis of the spectrogram and call statistics on Kaleidoscope can help to differentiate between them, but trapping and hand examination are usually required to confirm identification, particularly of Brandt's and Whiskered bats whose calls structures are almost identical. Daubenton's bats are easily identified by sight due to their unique flight pattern - they fly directly over slow-moving water in circles or in figures-of-eight, gleaning insects directly from the surface. Natterer's bats have previously been trapped in the Phoenix Park (Paul Scott, pers. comm.).

Soprano and Common pipistrelles, Leisler's bats and Myotis bats were frequently encountered during bat transects. Brown long-eared bats were also recorded during transects, but only occasionally. While it is impossible to differentiate between Myotis species during a transect, Daubenton's' bats were observed foraging over the pond on several occasions. Soprano and Common pipistrelles were also observed foraging over the pond, and Soprano pipistrelles and Leisler's were observed foraging over the Large Paddock to the North of the house.

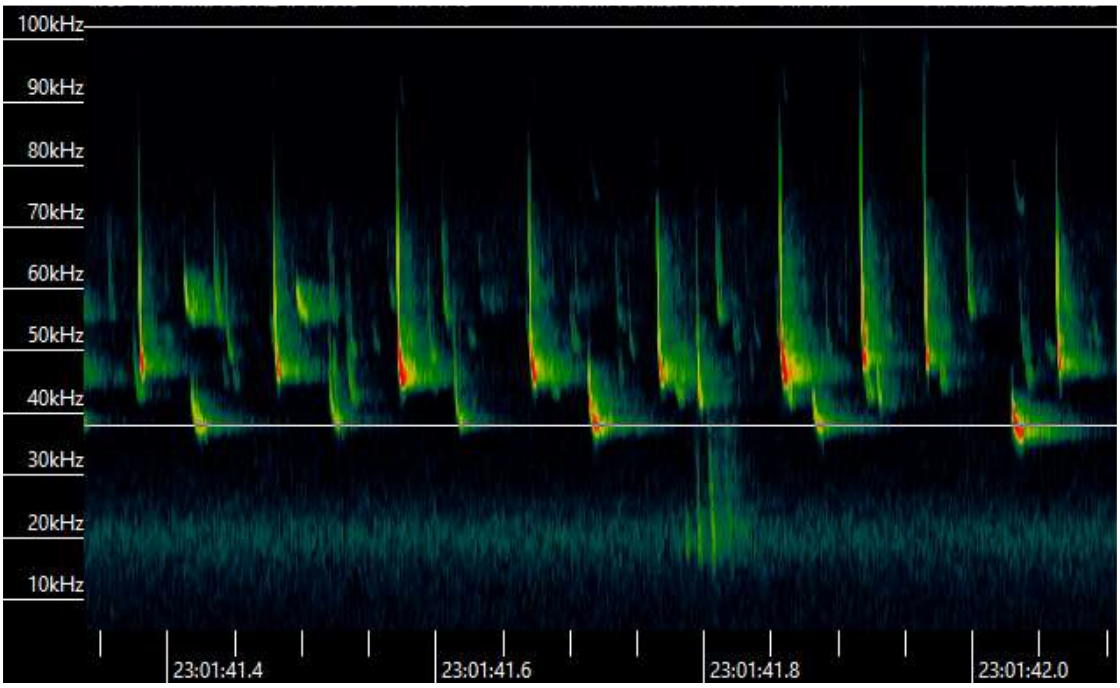


Figure A 19 Spectrogram showing three species of pipistrelle – pygmy (c. 55kHz), common (c. 45kHz) and Nathusius (c. 37kHz) – recorded foraging over the Áras pond at the same time.

Over 50,000 ultrasonic recordings were made on the static detectors. Each recording was maximum 15 seconds long, and it is important to state that a single bat can be responsible for a great many recordings, particularly if it was foraging in the vicinity of the static rather than passing by. The recordings were analysed using Kaleidoscope (*e.g.* Figure A 19) and BatClassify software. Kaleidoscope will only automatically identify one species per recording, and tends to identify files with multiple species as "noise" or "no ID". It also can erroneously identify "noise" as brown-long eared bats. However, BLE's can be confirmed and multiple species can be identified, if present, by visually inspecting the spectrograms. In contrast, BatClassify will identify multiple species on an individual recording, if present, but does not screen for Nathusius' pipistrelles.

Soprano pipistrelles accounted for the majority of recordings in the Áras, between 65-70% (Table X). The second most recorded bat was Leisler's bat (9-13.5%) followed by Common pipistrelles (5-12.5%) and Daubenton's bat (4.5-5.5%). All other species accounted for approximately 1% of calls respectively, except for Nathusius' pipistrelle and Natterer's bat which accounted for 0.1% each. These results are unsurprising, as the Soprano and Common pipistrelles are the most common species of bat in Ireland, followed by the Leisler's bat, whereas the Natterer's and Nathusius' bats are our rarest bat species.

Table A 3 Bat species identified using Static Reorders. The percentage of calls attributed to each species by Kaleidoscope and BatClassify.

Species	Common Name	Kaleidoscope (% of recordings)	BatClassify (% of recordings, at 80% confidence level)
Nyctalus leisleri	Leisler's bat	9.2	13.5
Pipistrellus pipistrellus	Common pipistrelle	4.8	12.475
Pipistrellus pygmaeus	Soprano pipistrelle	65.4	70.5
Pipistrellus nathusii	Nathusius' pipistrelle	0.09	NA
Plecotus auritus	Brown long-eared bat	0.8	0.3
Myotis daubentonii	Daubenton's bat	4.6	5.4
*Myotis nattereri**	Natterer's bat	0.1	0.08
*Myotis mystacinus/ M. brandtii**	*Whiskered bat/ Brandt's bat	1.75	0.8

* It is extremely difficult to differentiate between Whiskered, Brandt's and Natterer's bat using detectors alone. Trapping and hand examination are usually required to confirm ID.

The areas with the highest rates of and most diverse bat activity were the Eastern perimeter path between the Kitchen Garden and the Zoo (static and transects) and the Northern Perimeter path (transects and statics) from the Wilderness Woodland to the Cabra Gate, which are well-wooded areas with linear features (Table A 4). Static recorders located in the Wilderness Area did not record a high rate of activity compared to the woodland path areas, however a bat was recorded foraging in this area on trail-camera. The woodland in the Áras is of excellent quality with many potential tree roost features. It is likely that bats roost in the woodland, but use the paths (linear features) to commute and forage. The pond also had a high rate of activity, with Soprano, Common and Nathusius' pipistrelles, Leisler's bats, Myotis spp. and Daubenton's bats recorded there. However, as this is a foraging rather than commuting area, it is likely that the number of individuals was lower than in woodland areas where there was both commuting and foraging activity.

Table A 4 Present/absence of bat species in static detectors locations and activity levels.

Location	Whk /Bdt*	Natt*	Daub	Leis	NPip	CPip	SPip	BLE	No. recs	No. nights	Recs/ night
Perimeter path E	√		√	√	√	√	√	√	12181	15	812
The Pond	√		√	√	√	√	√	√	10702	17	630
Perimeter path N	√	√	√	√	√	√	√	√	22919	46	498
Wilderness Area	√	√	√	√	√	√	√	√	4474	31	144
Formal Gardens				√		√	√		491	14	35

* it is extremely difficult to differentiate between Whiskered, Brandt's and Natterer's bat using detectors alone. Trapping and hand examination are usually required.

There was much less bat activity recorded during walking transects in the paddocks to the north of the house. It was notable that the eastern perimeter path had low levels of activity between the pond and the Kitchen Garden, likely because this section of perimeter path is very lit at night. Very little activity was recorded to the south of the house in general, during transects through the Formal Gardens, the Acorn Meadow and the Arboretum, which are more open and less suitable for bats. Only Soprano pipistrelles and Leisler's were recorded in these areas, and very infrequently. It is likely that many of the Leisler's were in fact foraging outside the perimeter in the Phoenix Park. A static located in the Formal Gardens recorded the lowest rates of activity of all static locations (c. 1% of recordings), and the fewest number of species (mainly Leisler's and Sopranos pipistrelles, but also some Common pipistrelles). Certain areas in close proximity to the main building complex, *e.g.* between the Garda Mounted Unit Stables and the courtyard, are also very well-lit at night, and are avoided by bats.

Roost Surveys – 2nd March 2020

All bats in Ireland may use buildings for a variety of purposes throughout the year and throughout the life cycle. Therefore, it can never be presumed that buildings are unused by bats. Bats will roost in crevices in stonework, under tiles and slates, in crevices in brickwork and in cavity walls in brick buildings. Brown long-eared bats prefer to roost in large open roof spaces with stable temperatures, and can be observed in the open along ridge beam. Gaps under lead flashing and under soffit boards can provide access for bats.

Figure A 20 Kevin Delahunty surveying for bat roosts in attic of Áras an Uachtaráin

Surveys for winter roosts and potential summer roosts were carried out on the 2nd of March 2020 by Kevin Delahunty, John Rochford and Aoibheann Gaughran. The following buildings were surveyed for the presence of hibernating bats, potential for summer roosts and evidence of bat activity such as droppings, staining and remains of prey items:

- The Main House - roof, attic, basement and exterior;
- The exterior of the courtyard and interior of old stables beside private residence;
- The Garda Mounted Unit Stables;
- The Tunnel associated with the Ice House behind the Garda Mounted Unit Stables;
- The OPW Yard and associated buildings;
- The Gardener's Yard and associated buildings;
- The Kitchen Garden Stores;
- The Boat House and Garda Hut at the Cabra Gate.

Main House: The attic had many access points, *e.g.* drain exit and entrance points, gaps around doors, windows, gaps between bricks and wooden beams *etc*. However, there was little sign of bat activity with a single dropping located in the area above the portico. The attic is used daily to raise/lower the flag, and is often accessed by other workmen. A

single switch illuminates nearly all areas, some areas have windows or skylights. A single dropping was found in a dark space above the porch and there were masses of spiders and cobwebs, indicating a lack of use by bats. The basement is completely developed for use as exhibition space, offices *etc* and is unsuitable for bats. The exterior roof tiles and flashing were in good condition and there was no evidence of staining on the exterior walls. The south of the house is floodlit at night, but the north of the house is not.

Courtyard/Old Stables: No evidence externally or internally of bats but the old stables have potential as a summer roost. There are many access points around the windows and in the eaves. The roof and walls are in a state of disrepair with lots of crevices, and there is space between the lower ceiling and upper floorboards that would be ideal for roosting. However, no bats, droppings, staining or prey remains were observed.

The older part of the Garda Mounted Unit Stables has good potential as a summer roost with lots of access points around windows, under eaves and gaps in the walls. The roof is in a state of disrepair with lots of crevices and space between the false ceiling and roof. However, the lighting in this area is quite bright. The opposite side has undergone renovations and is unlikely to be suitable for bats.

Old Tunnel Entrance to Ice House: This exposed section of brick-work tunnel currently extends approx. 5m underground in a westerly direction, where it is blocked by soil but is connected to a badger sett. It is used as a sett entrance and badger latrine. The tunnel is perhaps not deep enough for a winter roost but may be suitable in summer as there are some crevices in between bricks. However, no evidence of bat activity was recorded during the survey, or at other times during 2020 when the tunnel was visited.

Gardeners' Yard: The building containing kitchen/offices appears to have access to roof spaces via soffit boards and under the eaves. The walls have many holes and crevices which would be appropriate for summer roosting. However, we were unable to access the roof spaces for further inspection. There are reports of old roosts in the toilet block, but it doesn't currently look suitable, due to modernisation.

Figure A 21 Feeding remains (Peacock butterfly) and bat droppings in the Onion Store

Kitchen Garden Stores: These buildings have many access points, as evidenced by swallows' nests (*Hirundo rustica*), a squirrel drey (*Sciurus carolinensis*), hibernating wasps (*Vespula vulgaris*) and butterflies (*Inachis io*). The internal roofing material in the Onion Store looked relatively recently renovated, but there is good potential for roosting between felt and slate roof tiles, although we were unable to access these areas. However, there was very little evidence of bat activity (one observation of bat droppings alongside butterfly wings on the floor adjacent to a section of internal wall panelling in the Onion store Figure A 21). No other evidence of bat activity was found.

OPW Yard: In most of the buildings surrounding the OPW yard the roof vents were blocked with zinc mesh. Some buildings had gaps in between the top of the wall and roof. There was staining at an access point on the two-storey building located behind the curved wall, to the upper left of the doors to the loft area where water tanks are located. However, this is likely due to squirrels, as there is a lot of squirrel activity in this area and OPW staff reported seeing squirrels climbing this wall. We were unable to access the upper floor and roof space. The ground floor and other buildings were occupied by OPW staff and heavily used. In addition, much of the roofing in these buildings looked relatively new. No other evidence of bat activity was found.

Boat House and Cabra Gate Garda: Both of these structures have good potential as summer roosts, under the roof tiles and behind the soffit boards respectively. However, there was an accumulation of cobwebs, particularly on the boathouse indicating lack of use. Works around these structures during the course of the study did not reveal the presence of bats, and new lighting does not appear to have affected foraging activity on the pond.

This survey was carried out in winter, while bats were hibernating. The fact that bats were not located does not mean that bats were not present, as it is very difficult to confirm presence with an acceptable level of confidence as bats often hibernate in deep

crevices. Ideally, a second survey of these structures would have been carried out later in the season when summer roosts were active. However, the Covid-19 restrictions meant that we were unable to do so before the lactation season (mid-June to mid-August), when roost disturbance is not recommended because it can be detrimental to survival of young.

Nonetheless, little evidence was found of bat activity - dropping accumulations, stains, feeding remains *etc*. There is potential for various buildings around the Áras to act as summer roosts, *e.g.* the old stable in the courtyard, the Garda Mounted Unit stables, the buildings near the pond and the Kitchen Garden Stores, but again the lack of activity signs suggest that It is likely that bats are preferentially roosting in natural features in the Áras woodlands or in the wider park, and indeed buildings in the Park (there are known roosts in Deerkeeper's Lodge and Magazine Fort, Scott Cawley, 2007).

Conclusions and Recommendations

This study recorded all expected species of bat in the Áras, bearing in mind that it is difficult to separate the *Myotis* species using non-invasive survey techniques. However, the analysis of acoustic signatures and the fact that the Natterer's bat has been trapped elsewhere in the Phoenix Park, are suggestive that these species do occur in the Áras. There was variability in bat activity across the site. Many of the areas adjacent to buildings were well lit at night, and the majority of recorded bat activity was confined to the wooded areas to the North and east of the grounds. Our findings are consistent with the Scott Cawley report (2007), which summarized that "floodlighting of buildings and recent renovation of roof space in the main house prevents bat access. Other outbuildings and lodges recently re-roofed and are not accessible for bats. Some availability of crevices and slate roost sites. Excellent roosting opportunities in trees."

While there was very little evidence for bat roosts within the buildings of Áras an Uachtaráin, it can never be assumed that buildings are unused by bats, as they move between winter and summer roosts, and some areas and features were inaccessible for inspection during this survey. If works are planned in any of the buildings, particularly to roof spaces/roofing material, further bat surveys should be carried out. Legally, if a roost or bat is affected accidentally, it is not a defence in law. However, if bats are present, derogation licences can be obtained in certain circumstances, to disturb bats and their roosts during such works. We refer to section 5.2 of Scott Cawley's 2007 report on recommendations to protect roosts in the event of proposed works.

While the evidence for use of internal spaces was limited, bat boxes could be erected on external walls of buildings in areas that are not well lit. The use of crevice-style bat boxes is recommended, with a gap at the bottom for droppings to fall out. These have the added benefit of not getting filled up with bird nesting materials which can block entry/exit. It would be essential to monitor boxes for their acceptance of use by bats. Boxes that remain unused 2 years after the date of erection should be relocated. Seasonal inspection of boxes should be undertaken outside of the lactation season (mid-June to mid-August) to monitor usage, and in wintertime for general wear and tear and to remove droppings following use the previous summer. These inspections should be undertaken by a licensed bat-handler.

The woodland in the Áras provides excellent resources for bats, particularly the presence of so many mature trees with potential roost features. The current management policy is to allow old/damaged trees to stand for as long as is safe. However, it will be necessary to carry out works in the woodlands at some point to remove trees that pose a risk to health or are diseased. In these instances, roost surveys should be carried out in advance by a licenced ecologists, or trained and licensed arborist, to ascertain their use by bats, recommendation of appropriate mitigation measures and facilitation of obtaining a derogation licence to fell these trees if bats are present. Again, we refer to section 5.2 of Scott Cawley's 2007 report on recommendations to protect roosts in the event of proposed works.

Bats are nocturnal and lighting can have negative effects on bats through avoidance behaviour, although different species vary in their response to light. Lighting can result in habitat fragmentation, disruption of commuting routes and foraging areas and even roost abandonment. Lighting can also have negative direct and indirect effects on their insect prey. Lighting in the grounds of the Áras should be kept to a minimum (Stone, 2013), taking security into account, particularly in those areas where high levels of bat activity have been recorded. Reducing light intensity in currently well-lit areas would reduce the overall amount and spread of illumination. For some bat and insect species this may be sufficient to minimise disturbance or the magnitude of any negative impacts. The intensity of lighting between the pond and the Kitchen Garden, which is currently very bright, could be reduced, security allowing, to facilitate connectivity between the northern and eastern perimeter paths.

Aoibheann Gaughran, September 2020

Figure A 22 Location of botanic walking transects

To develop a botanical and fungal species list for Áras an Uachtaráin observational surveys were carried out. Walking transects were employed rather quantitative surveys using quadrats, as the objective was to maximise the overall species count in each habitat and for the Áras overall, rather than estimating relative densities. However, botanical species assemblages for the various habitat types/areas were used to confirm Fossitt habitat types (Fossitt, 2000).

Transects were walked in woodland, parkland and grassland habitats as well as the formal and kitchen gardens, and the verges on the roads approaching the Buggy and Cabra Gates. Some of the transects that followed the perimeter path incorporated several different habitat types or mosaics of habitat types. In addition to walking transects, records were kept of species that may not have been encountered during formal surveys or that may have been missed due to the timing of such surveys. The aim was to survey from early spring until late summer, however, implementation of Covid-19 restrictions did not allow for surveying between 18th March and 17th May 2020, and some species that are present in Áras an Uachtaráin may have been missed. In addition, sampling for macromycetes (toadstools and mushrooms) began at the end of October 2019 and ended at the beginning of September 2020, thus missing the most important 8 weeks for these fungi.

Figure A 23 Aoibheann Gaughran and Jane Stout identifying herbs in the 1916 Meadow.

Figure A 24 Trevor Hodkinson identifying grasses around Nut Island.

Species were identified either in the field or in the lab using a variety of resources, *e.g.* . Rose & O'Reilly, 2006, Parnell & Curtis, 2012, Fitzpatrick *et al*. 2016 and Poland and Clement (2020).

Aoibheann Gaughran, September 2020.

Invertebrate Surveys

Figure A 25 Location of invertebrate sampling sites and transects

Pollinator Protocols

Two principal methods of sampling were used to evaluate the bee species present at Áras an Uachtaráin: Pan trapping and observational surveys. In total, four rounds of pan trapping and four observational surveys were carried out at the Áras between 18/05/20 and 15/07/20.

Observational Surveys

All observational surveys for bees were carried out by Dr Stephanie Maher. Surveys were performed in dry conditions when the temperature was >13°C. Surveys were carried out using the variable transect walk method (see Westphal *et al,* 2008) and all observed bee specimens (excluding *Apis mellifera*) were recorded. Variable transect walks of the entire site lasted approximately 2.5 hours. Observational surveys were carried out on the following dates in 2020: 20th May, 24th June, 2nd July, 15th July.

Due to Covid-19 restrictions, surveys for early spring species of bee could not be carried out and these species may be present on site, despite not appearing in this report.

Pan Trapping

Traps consisted of three bowls (one painted with blue, one white and one yellow UV paint), set in a metal clamp, attached to a 1.5m wooden stake and adjusted to the height of the surrounding vegetation. Bowls were approximately half filled with soapy water and put out for 48 hours during each round of sampling. In the first sampling period, three traps were set in each of the walled gardens, the acorn meadow and the paddock at the back of the main house, for a total of nine traps on the site. For the three remaining sampling rounds, the traps were moved from the paddock to the mixed woodland area (coordinates of trap locations are included with species records). Traps were only set when the weather was expected to be dry for the period of sampling.

Figure A 26 Jane Stout identifying species at plan traps located in the Large Paddock

Moth Trapping Protocols

There are 1,504 species of moth recorded in Ireland, 577 macro-moths and 927 micro-moths (MothsIreland checklist, 2020). Moths play a significant role as herbivores, as pollinators and as a prey item for birds and bats. The majority of moths feed on plant material as a larva. Many are pest species, mainly micro-moths, that feed on animal fibres (fur and feathers), stored food products and crop species. Adults, if they feed at all, feed mainly on plant nectar. Moths can be found in every terrestrial habitat in Ireland, with the greatest numbers of species in woodlands, but grassland also supports a significant number of species. Habitat requirements may vary between adults and larvae. Moth species are not legally protected in Ireland or Northern Ireland; however, a

licence is required to operate a light trap under Section 35 of the Wildlife (Amendment) Act, 2000.

Figure A 27 Heath moth trap located in the parkland behind the Kitchen Garden

Moth surveys were carried out using battery powered 15W Heath Traps (Anglican Lepidoptera Supplies) under license from the NPWS. Three moth traps were deployed in various different habitats on 4 different trapping occasions in May, June, July and August 2020. Traps were filled with egg cartons and placed on a light-coloured sheet to facilitate location of moths that were attracted to the light but didn't enter the trap itself. A light sensor switched the bulbs on at dusk and off at dawn. Traps, sheets and the immediate surrounding areas (tree trunks, walls *etc*.) were checked two hours after sunset and again shortly after sunrise the following morning. The egg cartons and the interior surfaces of the trap were checked only in the morning. Moths were identified on site and released where possible. Otherwise moths were placed in sampling pots for later identification in the lab and released back on site. Moths were identified using Waring, Townsend and Lewington (2017) and Sterling, Parsons and Lewington (2012), and these were confirmed by experts at MothsIreland using photographs supplied by the recorders.

Other Invertebrate Surveys

Several methods were used to collect and record invertebrates. On all visits, sweep nets were used to collect insects from vegetation in the meadow areas, thistles, nettles, and around the pond. The sweep net was also used to collect drosophilid flies from fungal fruiting bodies and rotting apples in the orchard. Insects and spiders were collected into a beating tray from the low branches of several trees, especially those in the vicinity of

the visitor car park. Leaf litter and the upper layers of soil were sieved onto a white tray to obtain millipedes, centipedes, woodlice, harvestmen and pseudoscorpions. Dung beetles were obtained from horse manure by flotation. Aquatic invertebrate surveys were conducted using a dip net in the margins of the pond during daylight and under torch light at night.

To collect ground spiders and carabid beetles, pitfall traps, consisting of plastic cups (100 mm x 75 mm diameter) were employed on five occasions. The traps were placed in wooded areas, the edge of meadow areas, the Horse Paddock, alongside some of the paths, and in the Kitchen Garden. On each collecting event, two traps were placed out at six locations and left in position for 4-5 days, using water with detergent added as a killing agent. Although many of these traps were pulled out of the ground by foraging animals, some contents could be retrieved. Further observational arachnid surveys were performed, sometimes using an electronic vibration device that simulates captured prey to lure spider species into the open.

Fly traps were employed on seven occasions between 15th June and 20th July, primarily to collect species associated with carrion, fungi and rotting fruit. The traps consisted of a net cylinder 30 cm tall x 23 cm diameter) with an inverted net funnel in the bottom through which the flies climbed into the main body of the net and were then unable to escape. Six different baits were used throughout the study, which were placed into a small tray suspended from the trap: banana, apple cider vinegar, sardines, smoked mackerel, pig's liver, and rotting mackerel.

Figure A 28 Baited fly trap suspended from a tree branch. Photo: Simon Hodge

Specimens that could not be identified in the field were later identified under microscope using appropriate keys. Casual observations of butterflies, bumblebees and other invertebrates which could be named in the field, were recorded when encountered during site visits.

Stephanie Maher, Aoibheann Gaughran, Simon Hodge and Collie Ennis, September 2020

Amphibians and Fish

Amphibian surveys were conducted during the breeding season and over the summer months under licence from the NPWS. Researchers searched for spawn clumps in water bodies and used dipping nets around the edges of the pond. Submerged fish traps were used to draw in any breeding smooth newts (*Lissotriton vulgaris*) and/or common frog tadpoles (*Rana temporaria*). Traps were constructed from mesh netting and were baited with trout pellets. Torches were used to search for frogs and newts at night when they are most active. No amphibians were recorded during this survey.

Figure A 29 Fish trap, out of water and submerged, used in smooth newt and common frog surveys. Photos: Collie Ennis.

Reptile surveys for the common lizard (*Zootoca vivipara*) were conducted both by observation and with the use of black felt mats to draw the reptiles in as basking areas. These were placed on the ground in sunny locations, adjacent to walls in the Kitchen Garden. No other locations were deemed suitable for lizards in the site. No lizards were recorded during this survey.

Fish surveys were conducted by netting and fishing in the pond, and two species were recorded: three-spined stickleback (*Gasterosteus aculeatus*) and rudd (*Scardinius erythrophthalmus*).

Collie Ennis, September 2020

Appendix 4 Ethical Approval and Licences

This project was approved by the School of Natural Sciences Research Ethics Committee, Trinity College Dublin.

Licences were sought from the NPWS and granted as follows:

- Sections 9 and 23 Licence No. 02/2019 – to photograph/film wild animals (badger, hedgehog, otter, pine marten, red squirrel, pygmy shrew), Dr Aoibheann Gaughran;
- Sections 23 and 34 Licence No. C250/2019 – to capture pygmy shrew, Dr Aoibheann Gaughran;
- Sections 22 and 22 Licence No. 04/2019 – to photograph/film all bird species, Dr Aoibheann Gaughran;
- Sections 9 and 23 Licence No. 03/2019 – to photograph/film all bat species, Dr Aoibheann Gaughran;
- Derogation licence from the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) to disturb and capture bats as part of scientific and research procedure (roost surveys), Kevin Delahunty and Dr Aoibheann Gaughran;
- Sections 23 and 34 Licence No. C31/2019 – to capture smooth newt, Colm Ennis;
- Sections 23 and 34 Licence No. C30/2019 – to capture common lizard, Colm Ennis;
- Sections 23 and 34 Licence No. C32/2019 – to capture common frog, Colm Ennis;
- Sections 23 and 34 Licence No. C19/2020 – to capture smooth newt, common frog and common lizard, Colm Ennis;
- Section 32 and Licence No. 29/2020 – to mist net birds for the purposes of ringing, Dr David J. Kelly;
- Section 32 and Licence No. 44/2020– to mist net birds for the purposes of ringing, Dr Nicola M. Marples;
- BTO Permit S/4354 – to ring birds, Dr David J. Kelly;
- BTO Permit C/4601– to ring birds Dr Nicola M. Marples;
- Sections 23 and 34 Licence No. C251/2019 – to capture moths using light traps, Dr Aoibheann Gaughran;
- Section 21 (5)(a) Licence No. FL16/2019 - to take Hairy St. John's Wort, Dr Aoibheann Gaughran.