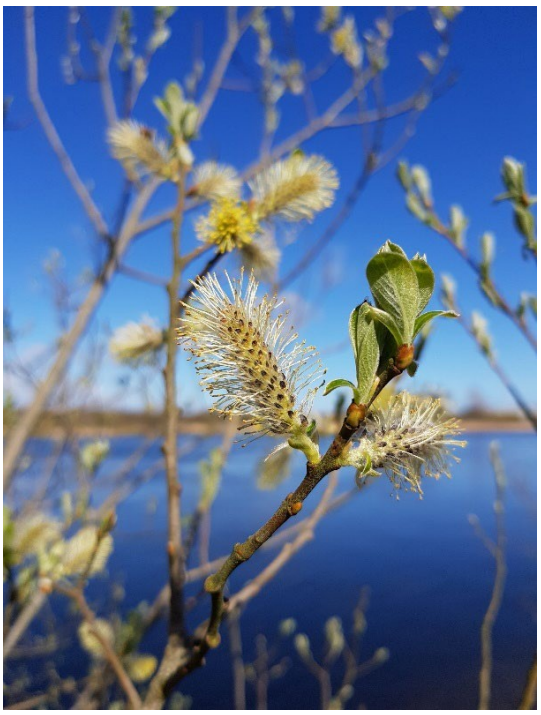
Biodiversity Action Plan 2021-2025







NUI GALWAY
SUSTAINABILITY
STRATEGY
learn live lead

OÉ Gaillimh
NUI Galway

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Cover photos (left to right, top to bottom):

Cuckoo flower (*Cardamine pratensis*). Gesche Kindermann.

White-tailed bumblebee (*Bombus lucorum*) and charlock (*Sinapis arvensis*). Michael Day.

Willow bud (*Salix* sp.). Gesche Kindermann.

Wren (*Troglodytes troglodytes*). Caitríona Carlin.

Large red damsel fly (*Pyrrhosoma nymphula*). Michael Day.

Velvet Shanks (*Flammulina velutipes*). Aidan Pawaroo.

Brown hairstreak butterfly (*Thecla betulae*). Caitríona Carlin.

Abbreviations:
CUSP Community and University Sustainability Partnership
SNS School of Natural Science
EV Environmental Science

1 Introduction

NUI Galway's main campus (Figure 1.1) is situated on the banks of the river Corrib, on the edge of Galway City. The boundary with the river forms part of a site designated for nature, Lough Corrib Special Area of Conservation (SAC). It is likely to be the most biodiverse campus in Ireland, having recorded most species within a 24 hour time period during the Intervarsity Bioblitz run by An Taisce GreenCampus and National Biodiversity Date Centre in 2014 and 2015.

The main campus covers an area of 105.5 ha, with the Carron, Carna and Finavarra Research Stations collectively adding another 4 ha. Including Acadamh premises at Carraroe and Gweedore, Mace Head, Shannon College, Medical Academies in Castlebar, Sligo and Letterkenny, NUI Galway is responsible for 1,330,330 m^2.

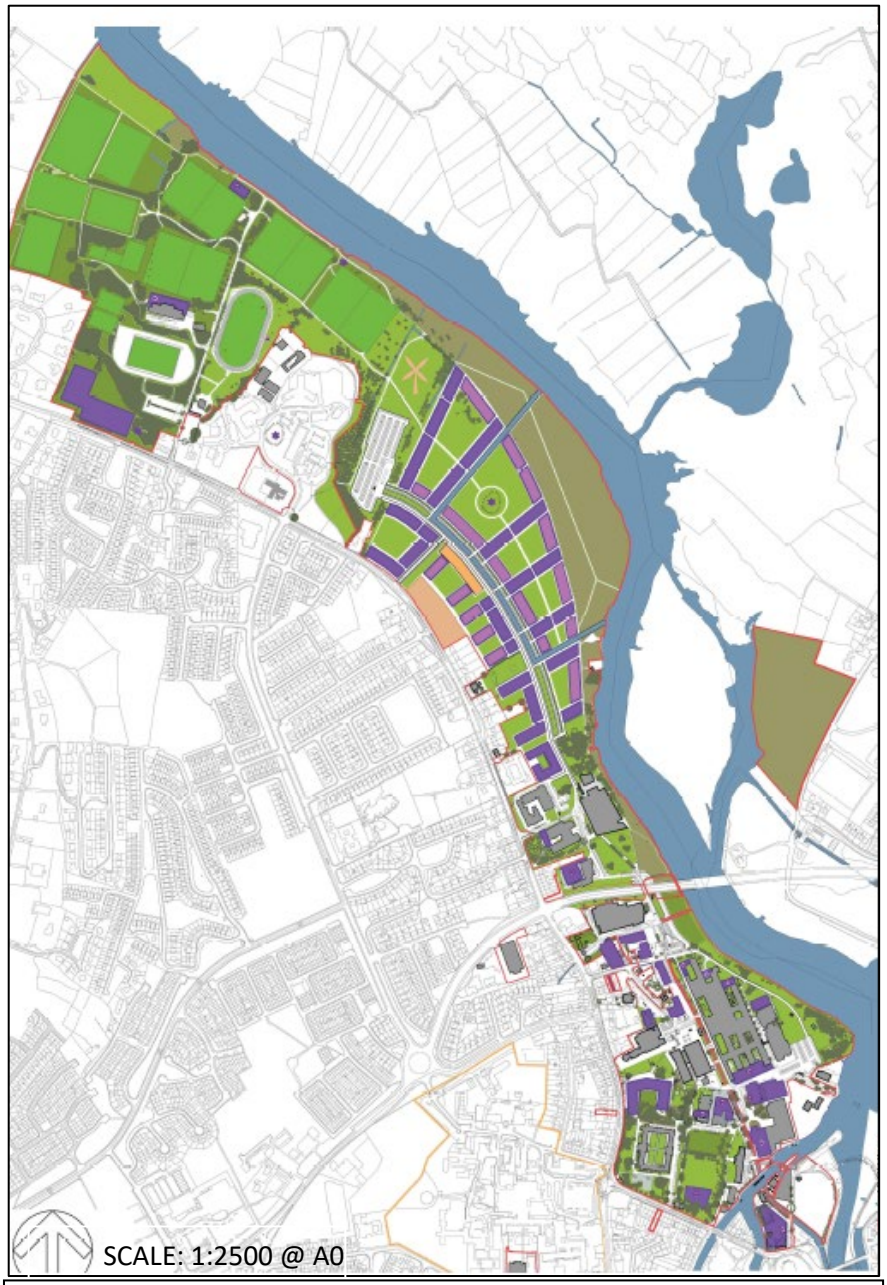

Figure 1.1 Outline of NUI Galway Main Campus (Source NUI Galway Masterplan 2015 Reddy Architecture + Urbanism 2017)

In 2015, NUI Galway set up CUSP (The Community and University Sustainability Partnership), which produced a 2017-2020 Sustainability Strategy to enable the university to promote environmental, social and economic sustainability. This contributed to NUI Galway being awarded a FEEE GreenCampus Flag by An Taisce in 2019, an internationally recognised symbol acknowledging NUI Galway's commitment to promote sustainable practices under the categories of energy, waste, travel, water and biodiversity. In 2020, NUI Galway was awarded a Green Flag Award for its campus by An Taisce. This endorses the University's strategic focus on Sustainability as a core value, by endeavouring to sustainably manage the campus and become a role model for positive impact on the environment. The Green Flag Award recognises international benchmarking standards for parks and green spaces that are managed in environmentally sustainable ways.

CUSP operates from a "Learn-Live-Lead" perspective, researching the best ways to live sustainably, putting these into action on campus and demonstrating leadership in Irish sustainability for 3rd level institutions. CUSP is sub-divided into six themes - Research and Learning, Energy and Greenhouse Gas Emissions, Nature and Ecosystems, Health and Wellbeing, Built Environment, and Governance and Leadership. This Biodiversity Action Plan contributes to the Nature and Ecosystems theme, outlining how the university can increase its commitment to biodiversity in the next five years.

1.1 What is Biodiversity?

Biodiversity, or "biological diversity", is defined by the United Nations Convention on Biological Diversity as the variety of life, from all ecosystems and the ecological complexes of which they are part, including diversity within and between species and of ecosystems (CBD, 2016). Nature provides us with indirect benefits, such as flood prevention from trees' roots mitigating soil erosion and simply being out in nature benefiting people's mental health (Abernethy and Rutherford, 2000; NEAR Health, 2020). In recent decades, land-use intensification and habitat fragmentation has resulted in biodiversity loss in Ireland (Fitzpatrick et al., 2007; Wyse et al., 2016; Marnell et al., 2009; Walsh et al., 2019) and abroad (Klejin et al., 2006; Sánchez-Bayo, and Wyckhuys, 2019). This directly impacts on humanity's day to day lives, with nature providing us with jobs, food and pharmaceuticals. Biodiversity loss results in fewer ecosystem services provided by the organisms around us, as well as a loss of species that took millions of years to develop (Rhodes, 2018). Given our biodiverse campus, NUI Galway has an important role in teaching about, researching, and taking action to safeguard the biodiversity our campus supports to help combat the global crisis.

1.2 What are our Commitments to Conserve Biodiversity?

As Ireland is a member of the EU and the UN, NUI Galway must implement relevant laws and agreements. The most far-reaching of these are the UN's Sustainable Development Goals, a list of 17 objectives to create a more sustainable world by 2030 (UN, 2018). Relevant goals for biodiversity include the ''Life on Land'' (Goal 15) and "Life Below Water" (Goal 14), whose targets include increasing the amount of protected area both on land and in water, preventing and reducing the spread of invasive species and increasing scientific knowledge of the marine environment. Goal 11, which aims to make cities and human settlements inclusive, safe, resilient and sustainable, and climate action (Goal 15) are also relevant.

The EU 2020/2050 Biodiversity Strategy lists six targets, linked to 20 actions, for example, increasing the assessment of habitat and species, and restoring at least 15% of degraded ecosystems by 2020 (EU, 2014). The EU Habitats Directive legally protects 200 European habitats, such as turloughs and alluvial woodland, as well as over 1000 species under threat- including the bottle nosed dolphin, freshwater pearl mussel and marsh fritillary butterfly (European Commission, 2007). This legislation safeguards these habitats and the species by designating these locations to be Special Areas of Conservation. The Wildlife Acts, 1976 and 2000 prohibit or regulate activities that may adversely affect wildlife in Ireland, such as hunting. This legislation protects all bird species, 22 other animal species and 86 species of flora. Ireland's Biodiversity Action Plan aims to increase conservation efforts and awareness of biodiversity while also implementing biodiversity into decision-making throughout Irish society (NPWS, 2017).

1.3 What is an Action Plan?

Biodiversity Action Plans (BAPs) are plans that aim to increase the biodiversity within a specified area from country to community level (NPWS, 2017; UCC, 2018; Ennis Tidy Towns, 2017). As most of Ireland's habitats are semi-natural (i.e. have in some way been modified by humans), they need maintenance, restoration and/or enhancement work to care for an area's biodiversity. NUI Galway's Biodiversity Action Plan is divided into sections; actions that can be done quickly and within 2 years, medium term (3-4 years) and long-term (5 years) actions which will take more time to plan, implement and monitor biodiversity enhancement action.

2 Short-term Actions

2.1 Organic Gardening Society

NUI Galway's Organic Gardening Society (Figure 2.1) is situated behind No. 12 Distillery Road, with the garden being open during term from 4-5pm on Tuesdays and 12-2pm on Saturdays. This society practises sustainable gardening. They grow a variety of crops, including tomatoes, apples, lettuce and potatoes, herbs, and borage for pollinators. It is open to all members of the college as well as the public. By raising awareness of this society, it will gain more support and develop the organic garden on campus to grow more produce, support pollinators, contribute to students' education and promote positive mental health.

Figure 2.1 NUI Galway's organic garden

Table 2.1 Actions to enhance awareness of the Organic Gardening Society

Year	Action	Responsibility
Year 1	• Meet with Buildings and Estates Team. • Be added to Green Campus and the Nature and Ecosystems subgroup of CUSP. • Plant pollinator-friendly wildflowers in the garden, following All-Ireland Pollinator Plan recommendations.	Organic Gardening Society CUSP
Year 2	• Erect signs to raise awareness of the society. • Add seating to the organic garden. • Procure storage space for gardening equipment.	Organic Gardening Society Buildings and Estates

2.2 Pollinator Enhancement

Pollinators such as bumblebees, hoverflies, butterflies, moths and other insects help fertilise crops, fruits, and flowers (Figure 2.2). Due to declines in their numbers, an All-Ireland Pollinator Plan is working to increase pollinator numbers by bringing about a landscape where they can flourish. NUI Galway signed up to the All-Ireland Pollinator Plan in 2018 and has committed to providing sustainable habitats for pollinators on campus, by following the guidelines from the All-Ireland Pollinator Plan booklet. Student projects will be dedicated to monitoring and evaluating the effectiveness of these measures, for implementation in to the next BAP.

Figure 2.2 A white-tailed bumblebee (*Bombus lucorum* agg.) and charlock

Table 2.2 Actions for pollinator enhancement

Year	Action	Suggested Responsibility
Year 1	• Leave areas of the campus unmown to provide nectar and pollen sources for pollinators. • Integrate car parks with unmown areas to allow for biodiversity gradients. • Set aside grassland patches for wildflower research. • Obtain plants from local genetic stock, if possible. • Ensure any bare ground left for pollinator enhancement are not in the vicinity of invasive species. • Plant and enhance existing hedgerows.	Buildings and Estates, Applied Ecology Unit, Botany and Plant Science, Zoology
Year 2	• Survey vegetation in spring and summer on campus. • Determine which design(s) of insect hotel would be suitable to put up on campus. • Erect and monitor said insect hotel designs	Buildings and Estates, Applied Ecology Unit, Botany and Plant Science, Zoology

The campus is home to many pollinators (i.e. animals that feed on nectar and pollen of plants; as they move from flower to flower, they transport pollen between plants, and in doing so help them reproduce) such as bees, wasps, butterflies and hoverflies (Nicholls, 2013). The university subsequently produced its own pollinator plan for 2018-2020. Actions for pollinator enhancement already implemented on campus include leaving some areas unmown and reducing mowing frequency elsewhere (for example, the Engineering Lawn and Biodiversity Trail). More detail about future actions can be seen in Table 2.2.

Setting aside areas for wildflower strip research would allow for long-term multi-year projects. The results of this could help determine which wildflower strip mixtures are best for the west of Ireland, as while there has been much research done on this topic (Hat *et al.,* 2017; Haaland *et al.* 2011; Bowie *et al.,* 2014; Thomas and Marshall, 1999), not much is known in an Irish context. These results could then be used in NUI Galway's next BAP.

As over 62% of Ireland's bee species are solitary mining bees, creating south-facing soil mounds for them to nest in would provide many local bee species with suitable habitat (NBDC, 2015).

Native seeds should be used when planting wildflowers on campus, as native planting has been shown to attract significantly more diverse pollinator communities (Rollings and Goulson, 2019). Procuring local seeds would also decrease transport costs. This would also allow for local genetic diversity of these plants to be maintained.

Wildflower monitoring can be carried out by BotSoc, incorporated into botany/ecology modules or covered through outreach events such as GoWild in Galway. Hedgerow management should be carried out according to NBDC (2016g) guidelines.

Figure 2.3 Bee hotel on campus

Insect hotels are man-made structures that aim to attract insects and other invertebrates by providing them with suitable habitat. These hotels typically focus on attracting cavity-nesting solitary (non-stinging) bees. Ireland is home to 99 species of bees, divided into 77 solitary, 21 bumblebee and one honeybee species (NBDC, 2015; 2017). Solitary bees do not live in hives, instead doing the job of workers and being able to reproduce. Of the 77 solitary species in Ireland, 62 are ground-nesting and the remaining 15 are cavity-nesting- 10 of which use insect hotels (NBDC, 2015). Some of these hotels are already present on campus (Figure 2.3).

More insect hotels will be put up on pre-selected sites on campus, being at least 1.5 m off the ground, ensuring that they are well secured to the post/tree they are attached to prevent swaying and facing a southerly/easterly direction (NBDC, 2015). However, creating artificial habitats for wildlife can be complicated. The design of these structures should be carefully considered before erecting more insect hotels (Purrington, 2019). Some insect hotels have proven to be quite attractive to solitary wasps as well as bees (Gaston *et al.,* 2005b). Students will investigate their effectiveness, which will inform recommendations regarding future use.

3 Medium-term Actions

3.1 Wetlands

Due to being on the banks of the River Corrib, NUI Galway has extensive wetland habitats (Figure 3.1), including reedbeds, marshes and wet grasslands. However, there are no ponds on campus- habitats that provide shelter and breeding grounds for a range of invertebrates and amphibians (Wood *et al*., 2003; Gaston *et al.* 2005b). These actions will take a number of years to be implemented (Table 3.1).

Figure 3.1 Wetland along the Biodiversity Trail on campus

Table 3.1 Actions to enhance wetlands on campus

Year	Action	Responsibility
Year 2	• Determine the invertebrate and floral diversity of wetlands on campus. Design student projects on wetlands.	Applied Ecology Unit/Zoology/Botany and Plant Science
Year 3	• Update the Landscaping document to include wetland management based on the results from Year 1. • Implement student projects comparing the wetlands, temporary and permanent and their surrounding habitats etc.	Buildings and Estates Applied Ecology Unit/Zoology/Botany and Plant Science
Year 4	• Compile results of student projects to be implemented into the next NUIG BAP.	Applied Ecology Unit/Zoology/Botany and Plant Science

3.2 Composting

Waste on campus is currently being divided into recycling or general waste, with few composting options. This means that NUI Galway sends more waste for incineration both directly, through producing more general waste, and indirectly, through compostable material mistakenly being put into recycling bins and thereby contaminating waste that could be reused. By investigating opportunities to utilise organic waste on campus, the amount of waste - related environmental damage that NUI Galway is currently causing can be decreased (Table 3.2).

NUI Galway has innovative waste management research groups on campus who use bioreactors to turn organic waste into biofuel, a greener alternative to fossil fuels. By using a reactor to turn the compost NUI Galway generates into a usable, valuable product. Through this process NUI Galway will contribute to the United Nation's Sustainable Development Goals of Responsible Consumption and Production, Affordable and Clean Energy and Climate Action (UN, 2018). These will in turn inform other subgroups in CUSP and inform the next version of the Biodiversity Action Plan.

Table 3.2 Actions for waste management on campus

Year	Action	Responsibility
Year 1	• Depending on survey results, do 1/2 of the most popular options to increase proper waste separation • Lab-scale proof of concept- using bioreactors to digest paper cup and food waste. • Student projects tied to the bioreactor trials • Optimise bioreactor trials • Test whether the digestate from the reactors can be used as fertiliser	Tuohy Lab O'Flaherty Lab
Year 2	• Optimise bioreactor trials • Scale up the bioreactor trials • Apply for funding for internal biodegradable waste bins	Tuohy Lab O'Flaherty Lab Buildings and Estates
Year 3	• Data collection and optimisation of the bioreactor trials • Investigate composting opportunities for staff and students that meet health and safety requirements • If funding successful, install internal biodegradable waste bins as a pilot, and monitor pilot.	Tuohy Lab O'Flaherty Lab CUSP (N&E)
Year 4	• Data collection and optimisation of the bioreactor trials • Trial composting opportunities for staff and students that meet health and safety requirements • Based on funding success and feedback from pilot, install more biodegradable waste bins.	Tuohy Lab O'Flaherty Lab CUSP (N&E)
Year 5	• Data analysis and outcomes of the bioreactor trials presented. • Present composting analysis and recommendations.	Tuohy Lab O'Flaherty Lab CUSP (N&E)

4 Long-term Actions

4.1 Brown Hairstreak

In January 2019, Caitríona Carlin, Applied Ecology Unit discovered brown hairstreak butterfly (*Thecla betulae*) eggs on young blackthorn on campus (Figure 4.1). As this butterfly (Figure 4.2) has a restricted range in Ireland, only recorded in Clare, parts of Galway, north Tipperary (Harding, 2008) and Mayo (Gammell and Carlin in press), habitat enhancement measures for this species are to be undertaken to mitigate development impacts in the vicinity of one of the sites in question (Figure 4.3). MKO Ltd, a local environmental consultancy involved in surveying the area prior to its development, developed the actions seen in Table 4.1, in collaboration with NUI Galway.

Left: Fig. 4.1 Brown hairstreak egg on blackthorn.

Right: Fig. 4.2 Brown hairstreak adult female

Not only do females brown hairstreak butterflies lay their eggs on young blackthorn but the brown hairstreak caterpillars feed on the leaves of young blackthorn (*Prunus spinosa*). This means that management must be in rotation to ensure that there is always some young blackthorn, and that stands don't get too old. As this is their larval foodplant, the age cohorts of blackthorn present on campus was determined, as well as the amount of bramble (Rubus fruticosus agg) in the areas where blackthorn occurs. Blackthorn is not only a valuable food plant for brown hairstreak caterpillars, but also for 383 other species (Rodwell, 1998).

Bramble is an excellent source of pollen and nectar for many pollinators. Brown hairstreak butterflies are elusive as they spend most of the day up in the tops of tall trees, often ash, but in the evening, they may be seen nectaring on bramble. The challenge is to maintain sufficient bramble for many insects, but also to ensure the dense areas do not encroach on young blackthorn or on the calcareous grassland, as these habitats are also important. The grassland is important botanically and for the invertebrate species it supports. This means that selected dense areas of bramble will be identified and cut back to create sheltered bays and allow for more potential blackthorn growth. An estimated growth of 40-60 cm/year was assumed to divide the blackthorn into cohorts (Ferry and Lodge, 1996) (Figure 4.3, 4.4).

Table 4.1 Actions to enhance brown hairstreak habitat. Source: MKO Natura Impact Statement NUIG Student Accommodation Phase II at NUIG Northern Campus, Dangan, Upper Newcastle, Galway (edited).

Year	Action	Responsibility
Year 1	• Egg count and map of distribution within Biodiversity Enhancement Area throughout various stages of management. • Identify key areas for habitat management and enhancement. • Remove old blackthorn thickets that are unsuitable for egg-laying. • Manage blackthorn in a 3-year rotation by trimming sections in rotation so that there are always uncut sections available for egg-laying. • Increase the availability of young blackthorn shoots that are suitable for egg-laying.	MKO Applied Ecology Unit Buildings and Estates
Year 2	• Manage blackthorn in a 3-year rotation by trimming sections in rotation so that there are always uncut sections available for egg-laying.	Buildings and Estates
Year 3	• Manage blackthorn in a 3-year rotation by trimming sections in rotation so that there are always uncut sections available for egg-laying. • Egg count and map of distribution within Biodiversity Enhancement Area throughout various stages of management.	MKO Applied Ecology Unit Buildings and Estates
Year 4	• Manage blackthorn in a 3-year rotation by trimming sections in rotation so that there are always uncut sections available for egg-laying.	Buildings and Estates
Year 5	• Manage blackthorn in a 3-year rotation by trimming sections in rotation so that there are always uncut sections available for egg-laying. • Egg count and map of distribution within Biodiversity Enhancement Area throughout various stages of management.	MKO Applied Ecology Unit Buildings and Estates

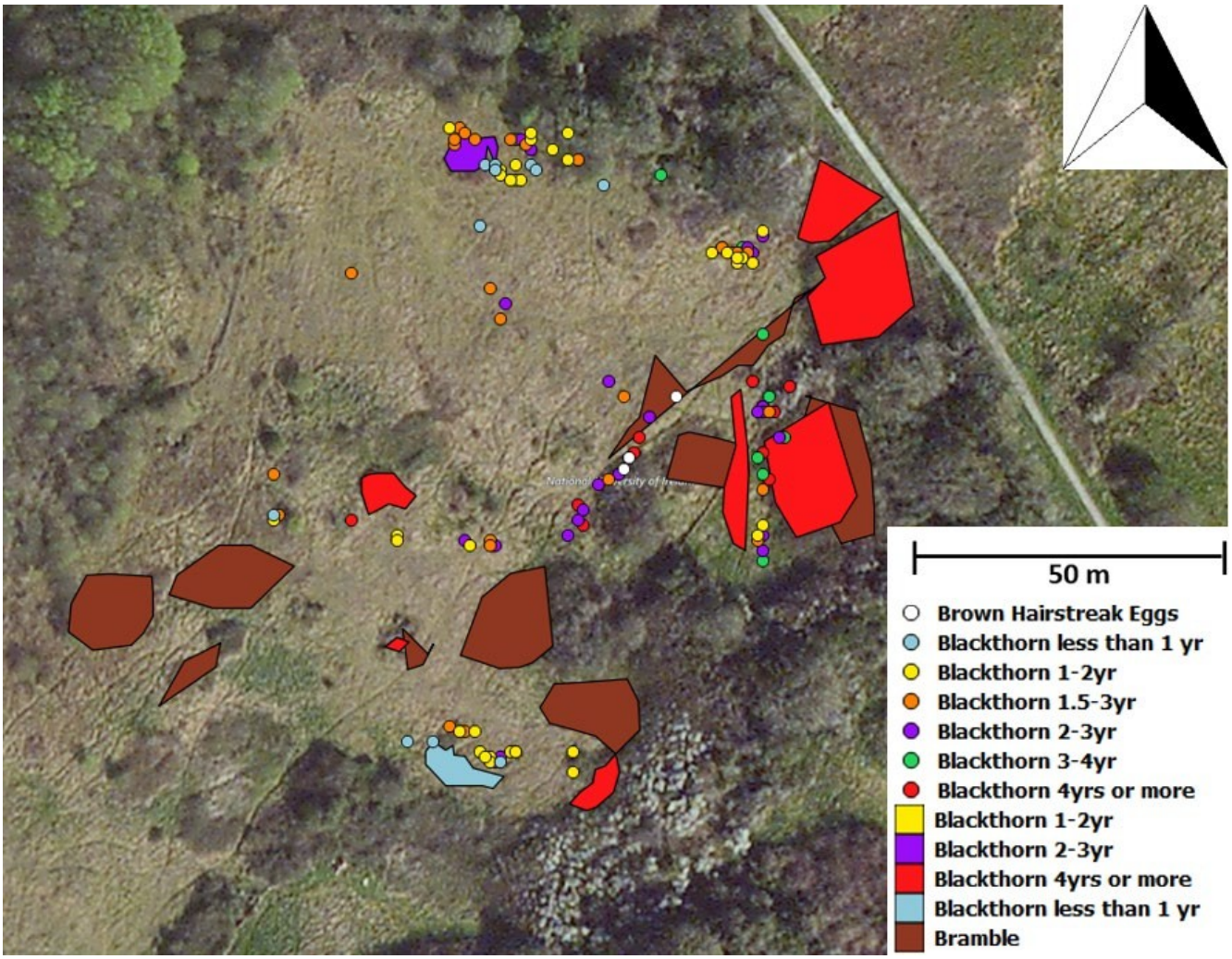

Figure 4.3 Map of blackthorn cohorts, bramble and brown hairstreak eggs on the development site

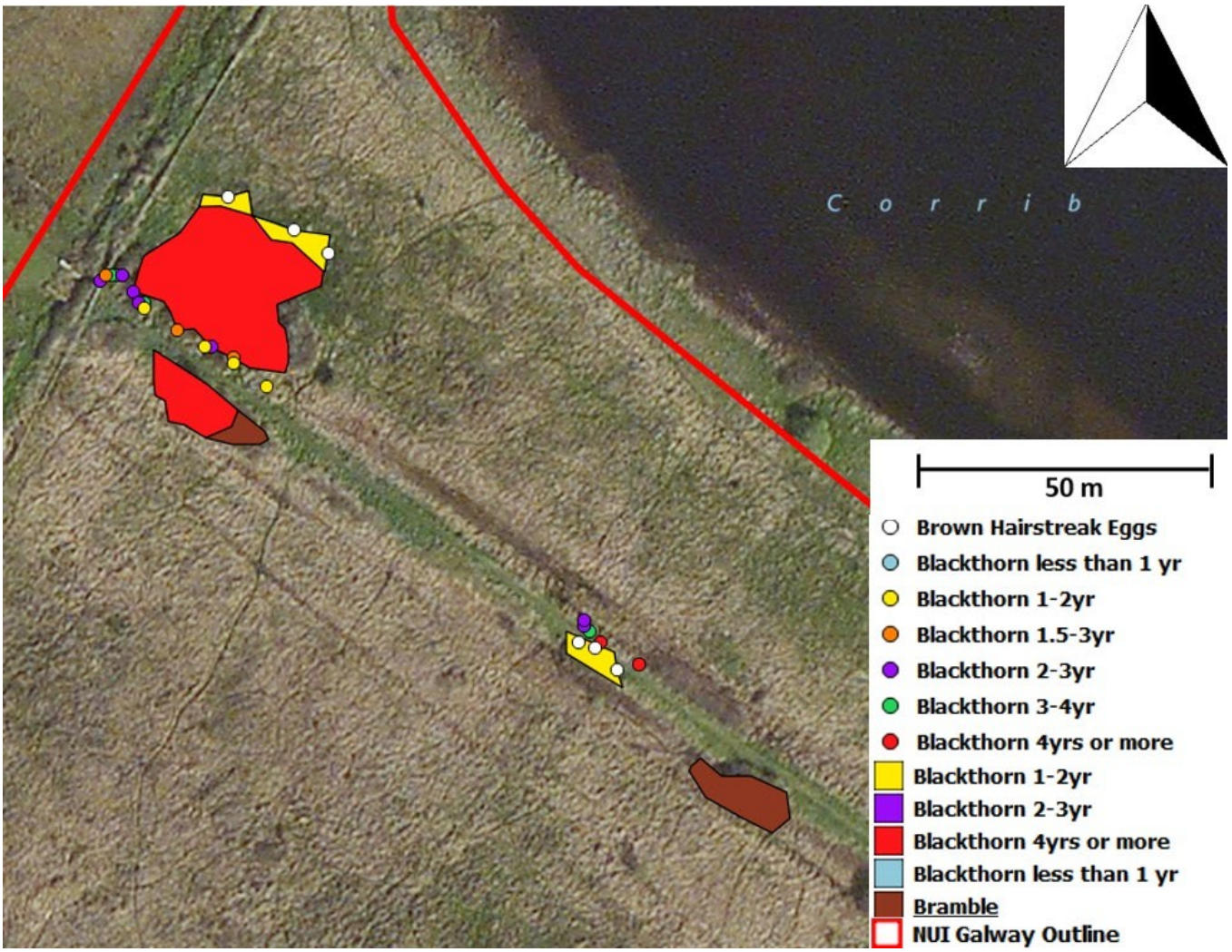

Figure 4.4 Map of blackthorn cohorts, bramble and brown hairstreak eggs on the dismantled railway/proposed Greenway route

4.2 Green Roofs, Living Walls and Sustainable Management

Green roofs (Figures 4.5, 4.6) and living walls (Figure 4.7) are components of green infrastructure. They form part of a multifunctional network throughout the campus including pollinator verges, meadows, herb beds, hedgerows and woodland. Green roofs provide some habitat for wildlife, absorb carbon dioxide from the atmosphere, decrease noise pollution and reduce heating costs (Lõhmus, and Balbus, 2015; Santamouris et al., 2007). More diverse vegetation on green roofs lead to a more complex community structure (Madre et al., 2013); with green roofs capable of supporting diverse assemblages of birds, insects and spiders- (Brennisen, 2003; Coffman and Waite, 2011). Living walls are similar to green roofs, covering façades of buildings while providing similar benefits to wildlife (Ottelé et al., 2010).

Figure 4.5 The Engineering Building's green roof

Table 4.2 Outline of actions for green infrastructure

Year	Action	Responsibility
Year 2	• Fill in the edges of the green roof with soil to allow sedum to spread and stop ragwort from colonising. • Explore options to implement green infrastructure on new builds. • Switch to sustainably sourced timber and compost. • Source alternatives to leaf blowers to reduce noise disturbance, air pollution, impact on wildlife, and air pollution, to sustain energy use. • Consult with Built Environment group about sustainable lighting.	Buildings and Estates CUSP
Year 3	• Add green building requirements to future tenders • If appropriate, implement green infrastructure on any new builds. • Identify areas to pilot lower levels of lighting • Trial alternative leaf management options	Buildings and Estates Procurement CUSP (N&E)
Year 4	• Explore options to install green infrastructure on any new builds. • Recommendations re leaf blowing reduction/alternative options	Buildings and Estates CUSP (N&E)
Year 5	• Review progress on these actions, lessons learned from trials or pilots • Recommendations re leaf blowing reduction/alternative options	SNS, CUSP (N&E)

NUI Galway is committed to Green Infrastructure and exploring the installation of green roofs and living walls on new buildings, with appropriate maintenance and monitoring. This information will inform subsequent good practice.

Left: Figure 4.6 Green roof composition. Source: Vijayaraghavan (2016)
Right: Figure 4.7 UCC's living wall. Source: UCC

In addition to these actions (Table 4.2), NUI Galway will strive to lessen its reliance on peat-based compost and unsustainable timber use, gradually transitioning to peat-free and sustainable alternatives. NUI Galway will endeavour to build environmentally friendly where possible use of local building materials to decrease transport costs, as well as decreasing intrusive lighting to lessen the built environment's impact on nocturnal wildlife.

As research funding increasingly requires research to be environmentally ethical, and researchers are required to demonstrate all efforts undertaken to minimize the impact of the research in terms of climate and environment, we must do more in terms of procurement of materials for data sampling and laboratory supplies. Every effort should also be made to cease using single-use materials when collecting biological data in favour of re-usable ones (rechargeable rather than single-use batteries, washable cups for pitfall trap collection rather than single-use cups etc.). Where possible, battery-powered equipment should be of the solar powered variety.

These changes will allow more NUI Galway labs to move towards Green Lab Certification, awarded to laboratories that achieve a high standard of sustainability. This will further NUI Galway's role as a trend-setter, with the CÚRAM lab on campus recently becoming the first Green Lab Certified laboratory in the EU.

4.3 Swift Nest Boxes

The common swift (*Apus apus*) is a cavity-nesting bird that has experienced population declines in Ireland of 27% in the last 25 years, leading it to be of medium conservation concern (Colhoun and Cummins, 2013; Whelan et al., 2018). This decline is due to various factors, including habitat loss, modern building methods not providing cavities to nest, agricultural intensification and climate change (Whelan et al., 2018). Swifts are a migratory bird, breeding in Europe during the summer and wintering in Central Africa (Åkesson et al., 2012). Swifts live in colonies, nesting in close proximity to each other, meaning that the loss of individual buildings can potentially wipe out an entire colony (Huxley, 2016; Whelan et al., 2018). To help reverse this downward trend, NUI Galway is committed to putting swift nest boxes on appropriate new builds (Table 4.3). NUI Galway will consult with BirdWatch Ireland and Swift Conservation Ireland to determine the best nest boxes for the proposed buildings. Swift attraction calls will be played near the nest sites to attract swifts when they arrive in Ireland in mid-April to when they leave in August, following the guidelines in Huxley (2018). This method has produced excellent nest box uptake by swifts in the past (Huxley, 2016). Due to swifts being very clean birds, maintenance of the nest boxes or nest bricks installed would be kept to a minimum (Huxley, 2019).

Table 4.3 Outline of actions for swift conservation

Year	Action	Responsibility
Year 1	• Determine whether swift boxes can be added to any buildings already constructed on campus. • Consult with BirdWatch Ireland and Swift Conservation Ireland to determine the best nest box model(s) to be put up on campus.	Engineering Buildings and Estates
Year 2	• Erect nest boxes/bricks on any new builds. • Erect speakers and attraction call materials to be played from mid-April-August (various times provided).	Buildings and Estates
Year 3	• Erect nest boxes/bricks on any new builds. • Erect speakers and attraction call materials to be played from mid-April-August (various times provided).	Buildings and Estates
Year 4	• Erect nest boxes/bricks on any new builds. • Erect speakers and attraction call materials to be played from mid-April-August (various times provided).	Buildings and Estates
Year 5	• Erect nest boxes/bricks on any new builds. • Erect speakers and attraction call materials to be played from mid-April-August (various times provided).	Buildings and Estates

4.4 Bat Boxes

Ireland is home to nine bat species, all of which occur on campus (CUSP, 2017). NUI Galway has 2 bat boxes already installed on campus, with 60 more to be erected in the near future to assess which model of boxes bats prefer to occupy, expanding on the research by McAney and Hanniffy (2015) and reinforcing CUSP's Learn, Live, Lead ethos. Bat boxes on campus will be monitored in conjunction with the Applied Ecology Unit and Galway Bat Group in both day- and night-time inspections to check for bat activity in the boxes' vicinity. As bats can take years to occupy boxes once they are set up (McAney and Hanniffy, 2015), monitoring will continue for the 5 years of this action plan (Table 4.4).

Table 4.4 Outline of actions for bat conservation

Year	Action	Responsibility
Year 1	Identify suitable trees to support bat boxes.	Applied Ecology Unit
Year 2	Install bat boxes.	Applied Ecology Unit
Year 3	Monitor bat boxes.	Applied Ecology Unit
Year 4	Monitor and review effectiveness of bat boxes.	Applied Ecology Unit
Year 5	Collate monitoring and make recommendations regarding bat boxes.	Applied Ecology Unit

4.5 Stone Sit Spots and Sustainable Seating

Seating and sit spots provide space for people to pause, reflect and be mindful in nature. This is based on research funded jointly by the EPA and HSE, in collaboration with communities, and based at NUI Galway. This research, the Nature and Environment to Attain and Restore (NEAR) Health project investigated how connecting to nature could benefit people's health and wellbeing, and, in so doing, deepen their commitment to carry out pro-conservation actions. The NEAR Health team published their findings in a toolkit. This highlighted the value of and need for 'passive' as well as 'active' ways of engaging with nature. Moments of solitude enable people to employ all their senses to connect with nature, while sitting outside, by themselves. This can be self-led, moments of mindfulness that allow people space to take a break, and feel restored. In their toolkit, the NEAR Health outlined some practical tips to incorporate this into daily or routine such as finding a place nearby, where people can go readily and be by themselves, to immerse themselves in this space, develop seasonal understanding of patterns and changes and create a meaningful awareness of nature at a place based level. A sit spot such as a fallen tree trunk, or a stable boulder is an ideal way to facilitate this relationship, and at the same time, showing sensitivity for the landscape (Table 4.5).

Drystone walls are a quintessential part of the west of Ireland and provide habitat for mosses and lichens (Fossitt, 2000). By introducing stone seating on campus, it will provide more spaces where people can enjoy NUI Galway's vibrant campus as well as increase suitable habitat for wildlife.

Seating made of recycled plastic will be long-lasting and will remove some plastic waste from the recycling process.

Table 4.5 Outline of actions for sustainable seating

Year	Action	Responsibility
Year 1	• Determine where to put the new seating. • Apply for funding for new seating	Buildings and Estates Nature and Ecosystems (CUSP)
Year 2	• Install at least 3 recycled plastic benches on campus. • Identify stone 'sit spots' on campus • Monitor use, condition and biodiversity value	Buildings and Estates Nature and Ecosystems (CUSP)
Year 3	• Seek sponsorship from NUIG Alumni • Install 2 additional recycled plastic benches on campus. • Build 2 additional stone benches on campus. • Monitor use, condition and biodiversity value	Buildings and Estates Nature and Ecosystems (CUSP)
Year 4	• Install 2 additional recycled plastic benches on campus. • Build 2 additional stone benches on campus. • Monitor biodiversity value, use, condition, and maintenance to inform recommendations for next BAP	Buildings and Estates Nature and Ecosystems (CUSP)
Year 5	• Install 2 additional recycled plastic benches on campus. • Build 2 additional stone benches on campus. • Review monitoring recommendations to inform next action plan.	Buildings and Estates Nature and Ecosystems (CUSP)

5 Ongoing Actions

5.1 Invasive Species Management

Species are classed as invasive when they are introduced to an environment outside of their native range, where they adversely affect native biodiversity, human infrastructure, economy or health (IUCN, 2000). As these invasive alien species are less susceptible to local predators and diseases, many are known to out-compete native plants and animals (Figure 5.1), typically forming monocultures (Figure 5.2). It is therefore important to remove these organisms before they spread and become a recurring problem (Table 5.1).

Figure 5.1 Invasive species on campus (from top, left to right): snowberry, buddleja, Japanese knotweed, Himalayan balsam

NUI Galway currently manages Japanese knotweed (*Fallopia japonica) (*Figure 5.1*),* winter heliotrope (*Petasites fragrans*) (Figure 5.2) and Himalayan balsam (*Impatiens glandulifera*) on campus, through mechanical and/or chemical means. However, there are other invasive ornamental species on campus, that have been planted for decoration as well as those which have escaped (Figure 5.1).

Maps of the invasive species on campus are available and will be updated regularly. As invasive species surveying took place from June-July 2019, it was not possible to determine the locations or abundance of Spanish or garden bluebells (*Hyacinthoides hispanica, H. x massartiana*) or three- cornered leek (*Allium triquetrum*), although these species have been seen on campus. A list of possible alternative plants that could be planted on campus in preference to these invasive species can be found in Table 5.2.

Figure 5.2 Monoculture of winter heliotrope

Actions (Table 5.1) including a literature search should be done annually to ensure the most up to date management practices for removal of invasive species on campus are adhered to. In addition, the campus should be used as a living lab for research into invasive species management techniques to determine whether the management regimes are working and to discover any new introductions. Planting of invasive species on campus should stop immediately in favour of native and non-invasive non-native species that promote an increase in biodiversity. Suggestions for alternative planting (Table 5.2) are supported by the National Biodiversity Data Centre's All Ireland Pollinator Project (NBDC, 2016g; 2016i) and other pollinator research (Balfour et al., 2013), with the invasive species' replacements fulfilling a similar aesthetic role. It should be noted that this is by no means an exhaustive list. This ties in with the NUI Galway Pollinator Plan 2018-2020.

Table 5.1 Outline of actions for invasive species management

Year	Action	Responsibility
Year 1	• Map Spanish/Garden Bluebells and Three-cornered Leek. • Cease invasive planting on campus. • Erect signage in areas with invasive species showing how to identify invasives, report sightings and be biosecure. • Treat invasive species via mechanical and/or chemical means according to best practice. • Ensure all waste generated is disposed of according to biosecurity protocols. • Carry out a literature search for any updated management practices of the invasive species on campus. • Recheck the campus for invasive species to check if coverage has in/decreased and check for new introductions.	Buildings and Estates Applied Ecology Unit/ Botany and plant science
Year 2	• Treat invasive species via mechanical and/or chemical means according to best practice. • Ensure all waste generated is disposed of according to biosecurity protocols. • Carry out a literature search for any updated management practices of the invasive species on campus. • Recheck the campus for invasive species to check if coverage has in/decreased and check for new introductions.	Buildings and Estates Applied Ecology Unit/ Botany and plant science
Year 3	• Treat invasive species via mechanical and/or chemical means according to best practice. • Ensure all waste generated is disposed of according to biosecurity protocols. • Carry out a literature search for any updated management practices of the invasive species on campus. • Recheck the campus for invasive species to check if coverage has in/decreased and check for new introductions.	Buildings and Estates Applied Ecology Unit/ Botany and plant science
Year 4	• Treat invasive species via mechanical and/or chemical means according to best practice. • Ensure all waste generated is disposed of according to biosecurity protocols. • Carry out a literature search for any updated management practices of the invasive species on campus. • Recheck the campus for invasive species to check if coverage has in/decreased and check for new introductions.	Buildings and Estates Applied Ecology Unit/ Botany and plant science
Year 5	• Treat invasive species via mechanical and/or chemical means according to best practice. • Ensure all waste generated is disposed of according to biosecurity protocols. • Revise the literature review to include any updated management practices of the invasive species on campus.	Buildings and Estates Applied Ecology Unit/ Botany and plant science

Table 5.2 Invasive species list and alternative planting

Species	Latin Name	Management Source	Alternative Planting	Latin Names
Japanese Knotweed	*Fallopia japonica*		Accidental Introduction	N/A
Winter Heliotrope	*Petasites fragrans*		Accidental Introduction	N/A
Himalayan Balsam	*Impatiens glandulifera*	Guidelines on The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (Transport Infrastructure Ireland, 2010)	Accidental Introduction	N/A
Buddleja, Butterfly Bush	*Buddleja davidii*		Comfrey, Borage	*Symphytum officinale, Borago officinalis*
Montbretia	*Crocosmia x crocosmiiflora*		Oilseed Rape, Herb Robert, Lady's Bedstraw, Purple Loosestrife, Bugle, Phacelia	*Brassica napus, Geranium robertianum, Galium verum, Lythrum salicaria, Ajuga reptans, Phacelia tanacetifolia*
Snowberry	*Symphoricarpos albus*	https://www.invasiveweedsolutions.co.uk/ Note that cotoneaster can be spread by birds, NUIG will not plant new sources of this species.	Heather, Lavender, Rosemary	*Erica sp., Calluna vulgaris, Lavandula × intermedia, Rosmarinus officinalis*
Laurel	*Prunus laurocerasu*		Native Hedgerow Species	Various
Spanish Bluebell	*Hyacinthoides hispanica*		Common Bluebell	*Hyacinthoides non-scripta*
Garden Bluebell	*Hyacinthoides x massartiana*		Common Bluebell	*Hyacinthoides non-scripta*
Cotoneaster	*Cotoneaster horizontalis*		Heather, Lavender, Rosemary	*Erica sp., Calluna vulgaris, Lavendula sp., Rosmarinus officinalis*
Three-cornered Leek	*Allium triquetrum*		Accidental Introduction	N/A
Lesser New Zealand Flax	*Phormium colensoi*	https://www.cabi.org/	Common Reed, Rushes, Grasses	*Phragmites australis, Carex* sp., Poaceae

5.2 Fungal Diversity

While fungi (Figures 5.3, 5.4) are often overlooked outside of their role as a food source, without them, society and the world's ecosystems would be unrecognisable. Two of the most obvious ways that fungi have influenced human society is through the discovery of fungi in the genus *Penicillium*, which produces penicillin and has saved countless lives, as well as the use of yeast in making bread and alcohol (Willis, 2018).

Left: Figure 5.3 Honey Fungus (*Armillaria* sp.)

Right: Figure 5.4 Common Puffball (*Lycoperdon perlatum*)

However, this underestimates this kingdom's impact on the world, with white rot fungi capable of decomposing wood, due to the lignin that wood is comprised of having an extremely variable structure. As a result of this, white rot fungi not only recycle the wood's nutrients back into the ecosystem but also help humans clean up pollution through bioremediation (Stella et al., 2017). In addition, fungi can also help convert waste products into useful biofuels, which lessens humanity's reliance on less sustainable alternatives (Seiboth et al., 2011).

Another of fungi's roles in the global ecosystem is through their close association with many plant species- with over 90% of extant plant species having associated mycorrhizal fungi (Willis, 2018). These plant-fungal interactions create mutualisms that benefit both parties, aiding in both fungal and plant conservation. Due to fungal species' stringent habitat requirements they can as useful biological indicators when selecting sites for the conservation of flora (Heilmann-Clausen et al., 2014).

Table 5.2 sets out the actions we can take to conserve fungi on our campus.

Table 5.2 Actions to increase fungal diversity on campus

Year	Action	Responsibility
Year 1	• Complete an initial campus fungal diversity map • Preform high-level analysis on fungal samples collected	Tuohy Lab
Year 2	• Molecular bar-coding of fungal samples • Monitor change in fungal diversity on selected sites on campus	Tuohy Lab
Year 3	• Monitor change in fungal diversity on selected sites on campus • Transplant species-rich fungal samples into fungal-poor areas on campus	Tuohy Lab Buildings and Estates
Year 4	• Monitor change in fungal diversity on selected sites on campus • Transplant species-rich fungal samples into fungal-poor areas on campus	Tuohy Lab Buildings and Estates
Year 5	• Monitor change in fungal diversity on selected sites on campus • Transplant species-rich fungal samples into fungal-poor areas on campus	Tuohy Lab Buildings and Estates

6 Further Surveys and Actions

All additional actions will be monitored and recommendations made for subsequent versions of this Biodiversity Action Plan.

Survey	Location	Responsibility	Year of Completion
Habitat Mapping	NUIG Research Stations	Applied Ecology Unit	2022
Habitat Mapping	Main Campus	Applied Ecology Unit	2024
Mammal Surveys e.g. hedgehog project	Main Campus	Zoology and Applied Ecology Unit	2024 2023
Bird Survey	Main Campus	Zoology and Applied Ecology Unit	2023
Bryophyte Survey	Main Campus	Botany Plant Science	2024
Open-Access Repository of Biological Data on Campus	Main Campus NUIG Research Stations	School of Natural Sciences	2025
NUIG Biorecorder App partnered with NBDC trial	Main Campus NUIG Research Stations	School of Natural Sciences in partnership with Informatics	2025

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