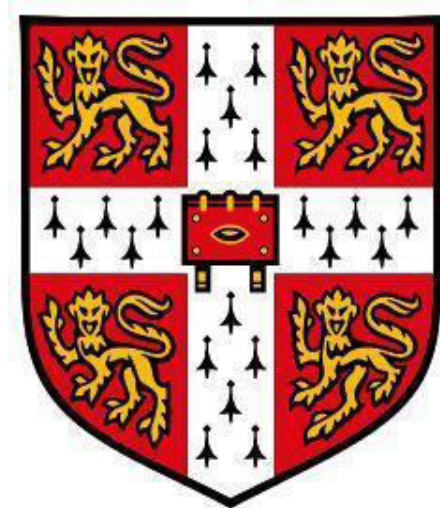


# **Small-Scale Biodiversity Improvements**

**University of Cambridge**

Olivia Rowe   Zosia Staniaszek   Ian Mak   Weijia Shi   Shishir Garg

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**Social Innovation Programme**

Environment and Energy Section

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## Table of Contents

<b>1. Acknowledgements</b>	<b>2</b>
<b>2. Executive Summary</b>	<b>2</b>
<b>3. Introduction</b>	<b>2</b>
<b>4. Recommendations</b>	<b>3</b>
<b>5. Methodology</b>	<b>4</b>
<b>6. Biodiversity and Wellbeing</b>	<b>5</b>
<b>7. Volunteering</b>	<b>6</b>
<b>8. Biodiversity Improvement-Strategies</b>	
<b>8.1 Animal-oriented approaches</b>	<b>7</b>
<b>8.2 Planting Approaches</b>	<b>15</b>
<b>8.3 Design Features</b>	<b>20</b>
<b>9. Case Studies</b>	
<b>9.1 Urban site example- effective biodiversity management</b>	
<b>9.1.1 Cambridge Centre for Mathematics</b>	<b>26</b>
<b>9.2 Urban site example- to improve biodiversity</b>	
<b>9.2.1 Cambridge Centre for Mathematics</b>	<b>31</b>
<b>9.2.2 Herchel Smith Building</b>	<b>35</b>
<b>9.2.3 Sociology Department</b>	<b>39</b>
<b>10. Conclusion</b>	<b>42</b>
<b>11. Bibliography</b>	<b>43</b>
<b>12. Appendix</b>	<b>45</b>

## 1. Acknowledgements

This report was written as part of a social innovation project with The Cambridge Hub in partnership with the University of Cambridge, Environment and Energy Section. We would like to thank Amy Munro-Faure from the Environment and Energy Section for her supervision and guidance throughout the project. We are also grateful to Michael Crowder and The Cambridge Hub for providing us the opportunity to be a part of this interesting project. Any errors remain our own.

## 2. Executive Summary

The aim of this report is to provide information about small-scale biodiversity improvements which can be made easily and cheaply in the University of Cambridge but with tangible and visible impacts. The data was collected using desk-based research and visits to different department sites of environmental deprivation in the University of Cambridge. The report illustrates the importance of biodiversity and the positive impact of the natural environment on human immune function, mental health, stress and subjective wellbeing. The benefits of environmental volunteering on both biodiversity and wellbeing are discussed as well as the importance of voluntary research on the effectiveness of biodiversity interventions to fill gaps in the literature. Advantages, considerations and estimated costs of animal-oriented, planting and design feature biodiversity interventions are detailed. The Centre for Mathematics is used as a case study to illustrate the positive impact of past interventions. The Centre for Mathematics is also used, along with the Herchel Smith building and the Sociology department as case studies for possible actions that could be taken on currently impoverished sites within the University's estate. Limitations of the study include the lack of specific research comparing different biodiversity interventions in urban environments, the publication bias towards positive intervention results and the concern that research in different areas may not be applicable to the local environment in Cambridge. We conclude that there is no 'one size fits all' biodiversity intervention but rather sites should be examined in context as to their suitability for different possible interventions.

## 3. Introduction

This report provides information about small-scale biodiversity improvements which can be made easily and cheaply but with tangible and visible impacts. After a section outlining our methodology, the limitations of our study and a summary of our recommendations, the report begins with a discussion of the effects of biodiversity and volunteering on psychological well-being. We then introduce different biodiversity improvement strategies separated into the categories of animal-oriented approaches, planting approaches and design features. We discuss the Centre for Mathematics as a case study for a site that has experienced effective biodiversity improvement. We then look at the Centre for Mathematics again along with the Herchel Smith Building and the Sociology Department and suggest recommendations for biodiversity improvement strategies.

Another specific aim of this report is to persuade the reader of the importance of increasing biodiversity in urban areas. Biodiversity can be defined as both the abundance of organisms present in an environment and the number of species of each organism present. This two-way definition creates much ambiguity in research because there is no standard measure to judge the effectiveness of different biodiversity interventions. However, it is clear that biodiversity loss has vast implications for life on earth. Biodiversity loss reduces the efficiency by which ecological communities capture biologically essential resources, produce biomass, decompose and recycle biologically essential nutrients (Cardinale et al., 2012). Furthermore, loss of biodiversity destabilizes ecosystems and reduces their ability to recover from a variety of disasters. A recent meta-analysis (Hooper et al., 2012) revealed that the impact of biodiversity loss on primary productivity (the synthesis of organic compounds from carbon dioxide) is comparable to that of drought, climate warming, elevated carbon dioxide and several other known processes. Increasing biodiversity helps to reduce dangerous levels of pollutant gases in the atmosphere and increases the ecological stability of the planet (Shah, 2014). Urban development can be detrimental for biodiversity (Hardman, 2011) because “vital habitat is destroyed or fragmented into patches not big enough to support ecological communities”. It is therefore extremely important to promote the increase of biodiversity in urban areas such as Cambridge.

## 4. Recommendations

When it comes to small-scale biodiversity improvements, this report acknowledges that there is no one size fits all approach. Space, time and resources often serve as important determinants of the type of measures to be put in place. Hence, we have created a range of options, categorised in animal and plant oriented approaches, as well as design features, to cater to a range of circumstances. Furthermore, we have highlighted how these options can be set up, alongside their benefits and considerations.

The strategies presented in this report are:

- Nest boxes
- Bird feeders
- Bug hotels
- Hedgehog houses
- Bat boxes
- Log piles
- Communal gardens
- Pollinator nest sites
- Planting wildflowers
- Creating ponds
- Living walls
- Rain gardens

## 5. Methodology

### *Biodiversity*

Initially desk-based research was conducted to examine the importance of biodiversity, the relationship between biodiversity and wellbeing, different biodiversity interventions and case studies of successful biodiversity interventions in urban and university spaces. Resources were collected from a mixture of academic journals, species conservation websites and university websites. Key search terms included ‘biodiversity’, ‘wellbeing’, ‘urban’, ‘university’, ‘biodiversity interventions’, ‘plants’, ‘insects’ and ‘animals’. From this initial research we were able to draw up a list of all the possible small-scale urban biodiversity interventions and the advantages and considerations of each. We also carried out basic google searches to estimate the expected costs of each intervention.

### *Case Studies*

In addition to desk-based research, we met with different university departments and their green impact teams. We obtained these contacts from Amy Munro-Faure, as she has been in touch with biodiversity initiatives across campus. We arranged suitable visit times through online scheduling platform (Doodle). We also informed the contacts that the purpose of our project and visit is to look at the kinds of biodiversity interventions carried out in the past and where there could be room for improvement. During the visit, we interviewed the department contacts about past initiatives, current situation, and any challenges they face. We also took notes and photographs of the space. We were particularly interested in environmentally deprived outdoor spaces. Our key case studies include the Maths Department, the Herschel Smith Building and the Sociology Department.

### *Limitations*

The difficulty with defining biodiversity means it is hard to examine the relative effectiveness of different biodiversity interventions. Furthermore, as most research is organised by or funded by conservation organisations, there is a significant publication bias towards research that supports the positive impact of different biodiversity interventions. There is also a general lack of attention to potential issues with these proposed interventions. This makes it impossible to objectively determine the “best” biodiversity intervention.

In addition to this, there is little research about biodiversity in Cambridge specifically. This means that a biodiversity intervention which was effective elsewhere in the country may not be effective in Cambridge. It is therefore incredibly important to learn which species are local to the area before attempting an intervention. We strongly suggest conducting research alongside any biodiversity intervention such as a bioblitz to be able to compare different interventions in the Cambridge area. Finally, most of our biodiversity interventions do assume a level of commitment from unpaid volunteers. However, the impact of biodiversity and environmental volunteering on wellbeing along with the importance of biodiversity in general would hopefully provide enough motivation for volunteers.

## 6. Biodiversity and Wellbeing

Little research has been conducted on the specific impacts different small-scale biodiversity improvements have on human wellbeing. However, there is plenty of evidence supporting the broader effects of the natural environment on wellbeing in terms of both physical health and subjective wellbeing. For example, a review regarding the effects of biodiversity on health (Rook, 2013) found that living close to the natural rural or coastal environment is associated with a reduction in overall mortality, cardiovascular disease and depressive symptoms and increases subjective feelings of wellbeing. Furthermore, looking at green spaces or walking in parkland or forests is associated with increased subjective wellbeing and physiological changes such as reduction in salivary cortisol (stress hormone) and blood pressure along with significant changes in neuroimaging scans. For example, one study (Hartig, Book, Garvill, & Olsson, 1996) involved showing photos of a natural environment to participants and this led to significantly more positive emotional self-reports compared to control participants who saw no photos. Participants in the experimental condition also demonstrated less attentional decay in subsequent tasks and the researchers hypothesized that this would be more significant the longer the task. Humans are believed to have evolved in wooded grassland (Sponheimer et al., 2013) and thus the positive effect of the natural environment on our psychology could be an evolved reward for approaching this ideal hunter-gatherer habitat (Rook, 2013).

Rook's review also detailed the association between green space and social interactions, exercise and sunlight which all have positive psychological benefits. For example, it has been found that people overwhelmingly prefer to be in sunlit areas (Aries, MBC; Aarts, MPJ; van Hoof, 2015). Moreover, another study (Brown & Jacobs, 2011) using data from the World Health Organization's Large Analysis and Review of European Housing and Health Survey (n=6,017) found participants who reported inadequate natural light in their homes were 1.4 times more likely to report depression. Mood disorders like depression are often characterized by biological rhythm disturbances and since our natural sleep/wakefulness cycle relies on sunlight (Aries, MBC; Aarts, MPJ; van Hoof, 2015), light therapy could be very promising for these types of mood disorders (Wirz-Justice, 2006).

However, what is perhaps most interesting from this review (Rook, 2013) is the finding that biodiversity has significant impacts on the human immune system. Rook notes that common illnesses in high-income countries are due to a failure of the immune system and this failure may be due to a lack of exposure to micro-organisms from our evolutionary past. It is argued that since these organisms needed to be tolerated, they evolved roles in driving immunoregulatory mechanisms. However, the loss of biodiversity in urban environments and monoculture farming has led to a loss of these micro-organisms and thus less microbial input for immunoregulation. Therefore, improving biodiversity, especially in urban environments, is crucially important.

It is clear that biodiverse landscapes and green space in general have positive effects on both subjective wellbeing and health. Given this, it is very important to improve biodiversity in urban and student environments in which mental health is generally worse. For example, a meta-analysis (Peen, Schoevers, Beekman, & Dekker, 2010) of high-quality studies performed in high-income countries since 1985 revealed that prevalence of depression in urban areas was 39% higher than in rural areas. In addition to this, the prevalence of anxiety

disorders was 21% higher in urban than in rural areas. Therefore, any intervention which objectively improves wellbeing in urban areas like increasing biodiversity is of great importance. Furthermore, student mental health is a commonly known issue and a study assessing a large random study of university students (Eisenberg, Gollust, Golberstein, & Hefner, 2010) found the estimated prevalence of any depressive or anxiety disorder was 15.6% for undergraduates and 13.0% for graduate students. Suicidal ideation was reported by 2% of students. University often provides a stressful atmosphere, especially at such a rigorous university as Cambridge, therefore, small-scale biodiversity improvements which have a known effect on wellbeing are extremely beneficial.

## 7. Volunteering

Biodiversity improvement strategies should consider the positive impact of community volunteering on both biodiversity and wellbeing. For example, a study (Dennis & James, 2016) looking at ten different organised social–ecological initiatives in the inner-city area of Greater Manchester found the level of community participation to maintain and improve these green spaces was linearly associated with increases in biodiversity. Furthermore, another study looking at the experience of practical volunteering (O’Brien, Townsend, & Ebdon, 2010) in green spaces found a range of benefits to wellbeing. These included improved fitness, keeping alert, meeting other people and reduced stress levels. We therefore strongly recommend engaging the local community in any biodiversity improvement effort. Apart from involving volunteers in the creation of a biodiverse environment, we also recommend the organisation of “bioblitzes”. This refers to an intensive field study, usually around 24 hours, whereby volunteers and local scientists attempt to record all the living species within a designated area. Bioblitzes are really beneficial because they increase public interest in biodiversity and also provide useful data for other local biodiversity development projects. For example, we can analyse the effectiveness of different biodiversity interventions on a local scale and see which species are prominent and which species we can target in future interventions. The University of Manchester has a biodiversity garden in the Michael Smith University Building Quad and students take part in bioblitzes in this area which gives them training in identification and contributes to a data bank. See the following link for more information on the effectiveness of this garden<sup>1</sup>.

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<sup>1</sup> [http://www.sustainabilityexchange.ac.uk/the\\_michael\\_smith\\_building\\_quad\\_university\\_of\\_m](http://www.sustainabilityexchange.ac.uk/the_michael_smith_building_quad_university_of_m)

## 8. Biodiversity Improvement Strategies

### 8.1 Animal Oriented Approaches

This section will discuss the following animal-oriented approaches to improving biodiversity:

- Nest boxes
- Bird feeders
- Bug hotels
- Hedgehog houses
- Bat boxes
- Log piles

#### 8.1.1 Nest Boxes

Nest boxes provide a place for a bird to make its nest in. It is important to consider the location of the bird box, which species it is targeted at and the height and flight path of the bird. For example, information from the British Trust for Ornithology Website details the different birds that are likely to take up residence in different bird boxes<sup>2</sup>.

For example, Cambridge University Botanic Garden reports frequent sightings of great and blue tits so small boxes with holes would be useful in increasing the existing abundance of these species. However, biodiversity refers to both the number of species present and the abundance of individuals of each species so using different types of bird boxes to attract different kinds of species is also recommended. To see other birds commonly found in Cambridgeshire, look at the Cambridge Bird Club What's About website<sup>3</sup> and for specifically Cambridge centre, the University Botanic Garden website<sup>4</sup>.

#### *How they can be set up*

Nest boxes should be situated near trees, shrubs or other cover to offer protection. Although you can buy nest boxes commercially, if constructing one yourself it should be made out of wood. Metal and plastic are unsuitable materials as they may cause the contents of the nest to overheat or allow condensation to build up inside the box, wetting eggs and chicks. To see instructions on how to build a nest box, see the following website<sup>5</sup>.

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<sup>2</sup> <https://www.bto.org/about-birds/nnbw/nesting-birds>

<sup>3</sup> <http://cbcwhatsabout.blogspot.com>

<sup>4</sup> [http://www.botanic.cam.ac.uk/Botanic/Page.aspx?p=27&ix=2756&pid=2707&prcid=4&ppi\\_d=2707](http://www.botanic.cam.ac.uk/Botanic/Page.aspx?p=27&ix=2756&pid=2707&prcid=4&ppi_d=2707)

<sup>5</sup> <https://www.bto.org/about-birds/nnbw/make-a-nest-box>



### ***Benefits***

- Provide a safe habitat for nesting birds and their young.
- Easy to put up.
- Migratory birds may use the nest boxes as well.
- A review of nest box studies found nest boxes to be on average 67% effective (Williams, D.R., Child, M.F., Dicks, L.V., Ockendon, N., Pople, R.G., Showler, D.A., Walsh, J.C., zu Ermgassen, E.K.H.J., Sutherland, 2018)

### ***Considerations***

- They must be cleaned every winter with hot water.
- They are sometimes limited in terms of their impact because they may help just a small number of nesting birds.

### ***Estimated Costs***

- Can be bought for as little as £5.
- Raw materials are inexpensive.



*Greenwich House (left) and the Astronomy department (right), University of Cambridge<sup>6</sup>*

## **8.1.2 Bird Feeders**

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<sup>6</sup> Photos sourced from the University of Cambridge, Environment and Energy Section.

Bird feeders are placed outside and supply food for birds. Different species prefer different foods so it is important to choose your seed depending on which birds you wish to attract.

### *How they can be set up*

These online guides provide useful information for choosing the correct bird feeder for different birds<sup>7</sup>.

### *Benefits*

- Attracts birds and provides food for them.
- Different food types/positions will attract more species.

### *Considerations*

- Bird feeders are not useable everywhere because they need cover nearby, such as trees and shrubs.
- They need to be refilled regularly.
- May attract pests, such as rats and squirrels.
- Parasites and diseases spread easily when birds gather around a feeder. However, according to a recent surveillance study in Great Britain (Lawson et al., 2018), providing a variety of food sources and regularly cleaning the bird feeder can help to mitigate this risk.

### *Estimated Costs*

- As little as £10 for the feeder and £5 for every 1.5kg of seed.



*European goldfinches on a garden bird feeder in the United Kingdom<sup>8</sup>*

### **8.1.3 Bug Hotels**

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<sup>7</sup> <https://shopping.rspb.org.uk/page/birdfeeders>  
<https://www.thespruce.com/benefits-of-bird-feeding-386531>

<sup>8</sup> [https://commons.wikimedia.org/wiki/File:Carduelis\\_carduelis\\_-United\\_Kingdom\\_-two\\_at\\_garden\\_bird\\_feeder-8.jpg](https://commons.wikimedia.org/wiki/File:Carduelis_carduelis_-United_Kingdom_-two_at_garden_bird_feeder-8.jpg)

Bug hotels provide nesting areas for solitary bees, hibernation areas for a range of insects and food for insects that eat rotting vegetation such as woodlice. They also provide shelter for larger animals such as hedgehogs.

### *How they can be set up*

They can be made out of wood, dry leaves, moss, straw, sand, pine cones and a variety of other natural materials. The RSPB have a useful guide on how to construct bug hotels<sup>9</sup>.

If constructing a bug hotel for bees in particular, it must be positioned in full sun, facing south east or south, at least a metre off the ground and with no vegetation in front of it obscuring the entrances to the tunnels. It must also be fixed securely to prevent shaking and swaying from wind. For a detailed guide on how to construct an insect hotel for bees, see wild bee expert, Marc Carlton's easy online guide<sup>10</sup>.

### *Benefits*

- Widely regarded as an urban solution to declining populations of beneficial insects.
- Will be especially useful during winter, when the insects hibernate.
- Can be a project for architecture/engineering students to build.
- Versatile - even hedgehogs can use bug hotels

### *Considerations*

- The design of the bug hotel must be good for it to be effective. In fact, environmental researcher Rosita Moenen, argues that increasing numbers of badly-designed artificial nesting sites have actually contributed to higher loss of (solitary) bees by parasitism (Moenen, 2012). Large bug hotels with oversized holes are more likely to attract parasites so often smaller is better.
- Maintenance is very important - bee hotels should be inspected at the end of summer and cleaned. This reduces the chance of parasitism.

### *Estimated Costs*

- Raw materials are inexpensive and can also buy ready-made bug hotels on the RSPB website for as little as £8.99<sup>11</sup>.

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<sup>9</sup><https://www.rspb.org.uk/get-involved/activities/give-nature-a-home-in-your-garden/garden-activities/build-a-bug-hotel/>

<sup>10</sup> <http://www.foxleas.com/make-a-bee-hotel.asp>

<sup>11</sup> [https://shopping.rspb.org.uk/bees-butterflies-bugs/?utm\\_source=GNAHmain&utm\\_medium=GNAHhome&utm\\_campaign=GNaH2016](https://shopping.rspb.org.uk/bees-butterflies-bugs/?utm_source=GNAHmain&utm_medium=GNAHhome&utm_campaign=GNaH2016)





*Left: Bug hotel built by architecture students at Oxford Brookes University<sup>12</sup>*

*Right: Bug hotel by the David Attenborough Building, University of Cambridge*

### 8.1.4 Hedgehog Houses

Hedgehog houses are waterproof, insulated boxes made out of natural materials which hedgehogs can use for hibernation in winter.

#### *How they can be set up*

They should be placed in a quiet part of a garden against a bank, wall or fence. The entrance should not face North or North East to avoid the cold winter winds. After use in late March/early April they should be cleaned out. However, it is important to make sure no hedgehog is using the house before cleaning.



*Hedgehog house in UK garden<sup>13</sup>*

For more information on how to build a hedgehog house, the British Hedgehog Preservation Society has some useful tips<sup>14</sup>. Another step-by-step guide can be found on the Royal Society for the Protection of Birds website<sup>15</sup>.

<sup>12</sup> [http://www.sustainabilityexchange.ac.uk/oxford\\_brookes\\_university\\_bug\\_hotels](http://www.sustainabilityexchange.ac.uk/oxford_brookes_university_bug_hotels)

<sup>13</sup> [https://www.flickr.com/photos/timo\\_w2s/14028122819](https://www.flickr.com/photos/timo_w2s/14028122819)

<sup>14</sup> <https://www.britishhedgehogs.org.uk/hedgehog-homes/>

<sup>15</sup> <https://www.rspb.org.uk/get-involved/activities/give-nature-a-home-in-your-garden/garden-activities/giveahogahome/>

### *Benefits*

- According to the RSPB, there are less than a million hedgehogs left in the UK compared to over 30 million in the 1950s. Furthermore, hedgehogs help gardeners by feeding on slugs so it is really important to encourage their protection.
- If a female takes up residence she may have her young in the spring.
- There are less resources and covered areas in urban spaces for hedgehogs to make their nests naturally so hedgehog houses can be vitally important for survival.

### *Considerations*

- If constructing yourself, this can take a lot of time as wood needs to be nailed together and treated with water-based preservatives.
- In urban areas, hedgehogs may find the houses hard to access. Using hedges or keeping holes in fences can help to avoid this. (See University of Cambridge example of a hedgehog tunnel).

### *Estimated Costs*

- Basic hedgehog houses can be bought from £20, however the more permanent and preferred timber structure can be nearer £50.



*Hedgehog tunnel to allow hedgehog access between gardens, University of Cambridge<sup>16</sup>*

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<sup>16</sup> Photo supplied by the University of Cambridge Environment and Energy Section

### 8.1.5 Bat boxes

Bat boxes provide a place for bats to roost, sleep during the day and raise their offspring. Bats are more likely to roost if there are several boxes up next to each other.

#### *How they can be set up*

Bat boxes can be built whenever but they are more needed in winter when it is colder and wetter. Boxes should be sheltered from strong winds and ideally situated at least 4m above the ground and close to hedges and tree lines where bats feed. If constructing a bat box yourself, the RSPB has a useful instruction guide<sup>17</sup>.

#### *Benefits*

- Will be especially useful in winter for hibernation.
- Useful in urban environments because there are fewer wild habitats for bats to roost.
- Over 500 plant species rely on bats for pollination, yet bat numbers have declined dramatically in the last century, so conservation of bats is a key part of improving biodiversity.

#### *Considerations*

- They are difficult to make as they need to require both woodwork skills and untreated roughly-sawn wood which is hard to find.
- Whether bought or handmade, bat boxes need to be securely installed in a high place which can be added effort.
- Bats may use boxes to hibernate and roost for long periods of time, so this is unsuitable for any site set to be demolished in the near future.

#### *Estimated Costs*

- Bat boxes can be bought for as little as £20



*Bat boxes in North Tyneside, Great Britain<sup>18</sup>*

<sup>17</sup><https://www.rspb.org.uk/get-involved/activities/give-nature-a-home-in-your-garden/garden-activities/buildabatbox/>

<sup>18</sup><https://www.geograph.org.uk/photo/2747402>



### 8.1.6 Log piles

A log pile is a pile of logs and dead branches, ideally left to rot and placed under trees or shrubs where it is shady. They attract amphibians, insects, mosses, lichens and fungi. The Norfolk Wildlife Trust provide a useful guide for creating a dead wood habitat for wildlife<sup>19</sup>.

#### *Benefits*

- Minimum effort and resources required.
- Still beneficial in small garden spaces since two or three logs can provide a habitat for many invertebrates.
- Log piles next to ponds increase the survival rate of amphibious species.

#### *Considerations*

- They can be unsightly.
- Requires outdoor garden space.

#### *Estimated Costs*

- Sourcing wood and other natural materials can be free or extremely cheap.



*Log pile in Epping Forest, Essex<sup>20</sup>*

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<sup>19</sup><https://www.norfolkwildlifetrust.org.uk/documents/a-living-landscape/wildlife-advice/garden/nwt-reptiles-in-your-garden>

<sup>20</sup><http://www.geograph.org.uk/photo/1213160>

## 8.2 Planting Approaches

This section will detail the following planting approaches to improving biodiversity:

- Communal gardens
- Pollinator nest sites
- Planting wildflowers

### *The role of plants in the ecosystem*

- Produce oxygen and remove carbon dioxide.
- Source of food and metabolic energy for nearly all animals.
- Provide habitats for animals, birds and especially small organisms which can hide among food or leaves.

### 8.2.1 Communal gardens

Communal gardens are shared by a number of local residents, typically in an urban setting. Historically, they have even been a key source of food, such as during World War II (Millar, 2003).

#### *How they can be set up*

Communal gardens can come in a variety of sizes - 'can be tiny plots, gardens on roofs, school gardens, private or open to the public.'<sup>21</sup> Given the idea is for communal access, it ideally should be located in a convenient location for members.

Within Cambridge University, good locations would include:

- Colleges – for members
- Department buildings – for staff and possibly students



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<sup>21</sup> Caroline Fernandez, Local Food Project Coordinator of the Women's Environmental Network (WEN) [http://www.bbc.co.uk/gardening/today\\_in\\_your\\_garden/community\\_about.shtml](http://www.bbc.co.uk/gardening/today_in_your_garden/community_about.shtml)



*Greenwich House, University of Cambridge*<sup>22</sup>

It is useful to form partnerships with environmental/socially-minded organisations to leverage off their expertise, as well as possibly diffuse manpower requirements, i.e. more people to help maintain the garden. Choices of what and where to plant can be made by the members of the communal garden, giving them a sense of ownership in the project. A rota (watering/ weeding/ general maintenance) should be clearly developed, with skilled and experienced members playing an active mentoring role in ensuring the project starts smoothly.

### ***Benefits***

- Pollinating insects and spill-over effects on the food chain: Mark Goddard<sup>23</sup> of the University of Leeds suggests that in Britain, community gardens make a major difference in pollinating insects. This is probably because they tend to feature fruit trees and bushes, unlike private gardens. Moreover, the ‘weedy corners tend to be a little more insect-friendly than private gardens.’ The growth of insects in communal gardens is likely to have a positive effect on the rest of the ecosystem. For example, bird populations who feed on insects are likely to grow.
- Cultivate sense of communal spirit and care for the environment: Maintaining a communal garden requires committed members who are willing to invest time and energy. The community of such individuals is likely to encourage each one’s commitment to environmentalism, while building a sense of community and belonging.
- Members of the communal gardens will be able to use some herbs or vegetables for their cooking. This is something that can be developed into a communal activity, which reinforces communal spirit.

### ***Considerations***

- Need for long-term coordination: Managing communal gardens in the long term requires sustained commitments from members throughout the year. For groups where there are regular breaks or turnovers, such as the termly holidays, this may pose a challenge.
- Need for expertise: Skilled or experienced members with knowledge of what/when/how to plant is likely to be required.

### ***Estimated costs***

- Depends on the scope/ size of the garden – could range from <£100 (small plot with few plants) to >£1000 (large with many plants).

<sup>22</sup> Photo supplied by the University of Cambridge Environment and Energy Section

<sup>23</sup> [https://e360.yale.edu/features/urban\\_nature\\_how\\_to\\_foster\\_biodiversity\\_in\\_worlds\\_cities](https://e360.yale.edu/features/urban_nature_how_to_foster_biodiversity_in_worlds_cities)

### *Evidence for success*

- Communal Garden at Murray Edwards College – been in operation since 2013. It is a collaboration between Murray Edwards, Cambridge Growing Spaces, Cambridge Hub and the University Environment and Energy Section. Members often use the vegetables for cooking, while volunteers organise events.
- A trial of 25 native flowering herb species planted in Cambridge University Botanic Gardens identified 16 species frequently visited by wild bees (Comba, Corbet, Hunt, & Warren, 1999). Ten species (seven of which were frequently visited by wild bees) was shown to provide abundant nectar in the garden environment.
- A trial of six native plant species recommended for pollinator-friendly gardens in Cambridge University Botanic Gardens, found all six were nectar-rich and frequently visited by wild bees.

### **8.2.2 Pollinator nest sites/planting pollinators**



*Greenwich House, University of Cambridge<sup>24</sup>*

### *How they can be set up*

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<sup>24</sup> Photos supplied by the University of Cambridge, Environment and Energy Section

Pollinator nest sites can be set up in communal gardens or green spaces in general. They should be regularly maintained for watering and weeding and pesticides should be strictly avoided, especially on open flowers<sup>25</sup>. Flowers should be packed in whenever they thrive, usually best in sun or part shade. The following website contains a list of pollinating plants for all year round<sup>26</sup>.

### ***Benefits***

- There has been growing evidence of the decline of pollinators in the UK<sup>27</sup>.
- Relatively easy and straightforward to set up.
- Beautify the environment with range and vibrancy of plants and flowers.
- Can identify which flowers/ plants will attract the ‘right’ kinds of pollinators the local ecosystem require.

### ***Considerations***

- Will require fairly regular maintenance, and likely the presence of a gardener.
- The seasons should be considered, especially when there is less in flower for insects to forage.

### ***Estimated costs***

- According to research by Sciencedirect.com, mixes selected to maximise crop-pollinating bee richness (6 species) cost 80USD.

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<sup>25</sup> <https://www.rhs.org.uk/science/conservation-biodiversity/wildlife/encourage-wildlife-to-your-garden/a-helping-hand-for-pollinators>

<sup>26</sup> <https://www.rhs.org.uk/science/pdf/conservation-and-biodiversity/wildlife/plants-for-pollinators-garden-plants.pdf>

<sup>27</sup> <https://www.rhs.org.uk/advice/profile?pid=528>

### 8.2.3 Planting wildflowers



*Coastal East Lothian : Wildflower Meadow at Winterfield Park, Dunbar<sup>28</sup>*

Wildflower meadows are alternatives to lawns and borders, and can provide a display for many months.

#### *How they can be set up*

It is first important to decide on what type of meadows will be most successful on the site. Perennial meadows thrive on poor soils because the grasses compete less with wildflowers. Annual meadows, usually of cornfield annuals, need rich soils however. Seeds chosen should be suitable to the various soil types and situation. Where possible, obtain seed of British origin. Full information is provided by the RHS<sup>29</sup>.

#### *Benefits*

- Provide habitat for insects, which can attract birds and also provides shelter for small animals such as hedgehogs.
- Native wildflower seeds are relatively easy to find and inexpensive.
- Evidence for benefits of wildflowers<sup>30</sup>.

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<sup>28</sup> Richard West - [geograph.org.uk/p/3101749](http://geograph.org.uk/p/3101749)

<sup>29</sup> <https://www.rhs.org.uk/advice/profile?pid=436>

<sup>30</sup> <https://www.conservationevidence.com/data/index?terms=wildflower&yt1=>

### *Considerations*

- May require work for initial setup, such as preparing the soil and weeding, but will eventually require less maintenance.
- Grasses can be vigorous and out compete flowers – to combat this, introduce semi-parasitic plants.

### *Estimated costs*

- At the Holland wildflower farm, their cheapest range of mixes cost 231USD per acre for seed.

### *Evidence of success*

- How the Norway government has encouraged urban farmers to plant wildflowers<sup>31</sup>.

## **8.3 Design Features**

This section summarises the following design features for increasing biodiversity:

- Creating Ponds
- Living Wall or Green Façade
- Rain Gardens

These are improvements which require a significant amount of effort and planning, as well as needing a suitable area, but lead to creation of new habitats and have a significant impact on the area.

### **8.3.1 Creating ponds**

By introducing a new aquatic environment, you can provide a habitat for a wide range of new species including frogs, newts and dragonflies. Since this is a larger scale project, there are many more things to consider, but the end result can make a big impact. This could be integrated as part of a biodiversity garden.

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<sup>31</sup><https://www.theguardian.com/environment/2017/aug/26/oslo-meadows-biodiversity-bees-urban-gardeners>





*Pond in Selwyn College gardens<sup>32</sup>*

### *How they can be set up*

Depending on the type and size of area, pond designs will vary to suit the environment. An in depth guide to creating a pond can be found here<sup>33</sup>.

### *Benefits*

- Provides new habitat for amphibians and insects. This is one of the only biodiversity improvement methods which targets amphibians. Ponds provide a stop off point for species moving through the landscape, and an increased density of ponds forming a network helps to facilitate this movement.
- Noticeable visual effect. A water feature is a focal point in an environment and gives a change of landscape. This is eye-catching and people are more likely to notice it. Seeing species such as dragonflies and frogs shows a tangible increase in biodiversity.
- Pond colonisation happens naturally. Once the pond is formed, it is not necessary to plant and introduce many species as this should occur naturally. The shape and depth of the pond determine which species it will attract and how successful it is likely to be. Shallow banks are often best for wildlife and so the design of the pond is crucial.

### *Considerations*

- Location: One of the most important considerations is location. Ponds act as ‘stepping stones’ for movement of species through the landscape. Therefore, the pond needs to be in an area where there are plants and green spaces nearby, not completely isolated

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<sup>32</sup> Photo taken by authors

<sup>33</sup> <https://freshwaterhabitats.org.uk/wp-content/uploads/2013/09/pond-design-principles-for-diversity.pdf>

in an urban environment. Having a clean water source is the best way of supplying a pond.

- Budget and time: Making a pond requires a larger budget than some other biodiversity improvement methods. This is likely to be proportional to the size of the pond and the construction method. Planning is essential and external contractors may be required. Some minimal maintenance may be required to keep the pond habitable.

### *Estimated costs*

- The cost will vary according to the size of the pond and the area.
- A team of volunteers may be able to construct it or in other cases an external contractor will be required, with the costs associated with that.

### *Evidence for success*

- The University of Manchester included a pond in their biodiversity garden<sup>34</sup>, and it is home to many dragonflies and frogs. This is as part of a larger area with flower beds and a hay meadow. This is an example of a project which could be implemented with larger area and budget.
- Ponds can ‘support a huge diversity of life, including dragonflies, aquatic beetles, mayflies, caddisflies and other endangered amphibians such as the great crested newt’, according to Ian Thornhill, doctoral researcher in Urban Ecology at the University of Birmingham<sup>35</sup>. Pond numbers in the UK are declining and so more are needed to form a larger network which is more resilient to pollution incidences.
- There is a collection of evidence in literature for ponds increasing numbers of amphibians. The majority of studies show that creating a pond is beneficial, and not likely to be harmful<sup>36</sup>.

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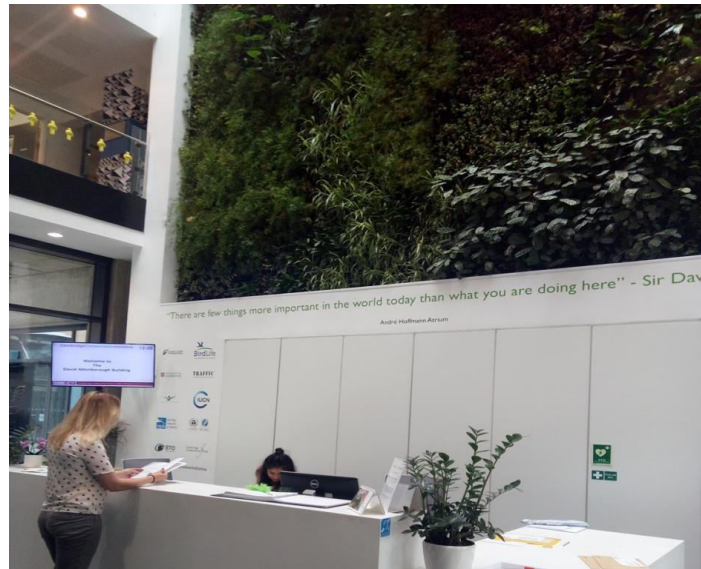
<sup>34</sup> [http://www.sustainabilityexchange.ac.uk/the\\_michael\\_smith\\_building\\_quad\\_university\\_of\\_m](http://www.sustainabilityexchange.ac.uk/the_michael_smith_building_quad_university_of_m)

<sup>35</sup> <https://www.birmingham.ac.uk/accessibility/transcripts/Ian-Thornhill-urban-ponds-biodiversity.aspx>

<sup>36</sup> <https://www.conservationevidence.com/data/index?terms=ponds&yt1=>

### 8.3.2 Living wall or green facade

Living walls may be set up on an existing wall or incorporated into the design of a new building. This is where plants are rooted in the wall or into a substrate attached to the wall. Green facades are where plants are rooted in a bed at the base of the wall and then trained to grow up the wall. These are very attractive displays which can be indoor or outdoor.



*Green Wall, David Attenborough Building<sup>37</sup>*

#### *How they can be set up*

Green facades can be set up relatively easily by planting climbing plants at the base of a wall. Living walls need more planning and the design is a lot more involved. There are several different types and a variety of species can be planted in them. There are different techniques which can be used to construct a living wall (Lepp, 2008).

#### *Benefits*

- Air quality improvement. Whether indoors or outside, the plants growing on the wall will remove carbon dioxide from the air and emit oxygen, reducing air pollution.
- Insulation and water conservation. Living walls and green facades help to insulate and cool a building, improving energy efficiency. Water runoff can also be reduced, diverting rainwater which may otherwise run directly into drains.
- Provides bird nesting sites. Once established, the plants on outdoor walls can provide nesting and sheltering sites for birds and generally attract more birds to the area, compared to a bare wall (Angold et al., 2006). This can help to increase bird biodiversity in the area. Efforts can also be directed at one particular flagship species of bird to conserve.

<sup>37</sup> Photo sourced by the University of Cambridge, Environment and Energy Section



- Visual effect. Provides contrast in creating a large green area within an urban landscape. Noticeable for everyone who works and studies in/around the building.

### *Considerations*

- Species chosen to plant. For a green facade, the direction the wall faces and which species are suitable for this habitat should be considered. Importantly, the species should not have a negative impact on the building. Flowering species will have the most visual impact so these may be preferred.
- Planning and expense. A living wall takes large amount of planning and consultation with building management to incorporate one, so it is a much larger project. The substrate for the plants needs to be attached to the wall, with some form of watering mechanism, but also separated from the construction materials by a waterproof membrane.
- Green facades with plants rooted at the base are much simpler to set up and so would be more suited to a small scale project.

### *Estimated costs*

- For a green facade, climbing plants can be planted at the base of the wall and encouraged to grow up with some sort of framework for <£50.
- For implementing a green wall, the costs are highly dependent on the size and design. It requires special materials and consultation about the effects on the building.

### *Evidence for success*

- Above is a picture of the living wall currently situated in the David Attenborough building.
- Outdoor living walls and green facades improve the biodiversity of colonising species in the area. They also support a range of insects and provide nesting and foraging sites for birds (Francis & Lorimer, 2011).

## **8.3.3 Rain gardens**

In urban environments there is often a large amount of runoff due to the vast tarmac and concrete surfaces, so that rainwater flows straight into drains and is not used. The idea of a rain garden is to utilise the water and mimic the natural water retention of undeveloped land.

### *How they can be set up*

Rain gardens can be set up in any area with a water runoff source, such as near buildings. For example, the water from a roof can be channeled directly into a rain garden instead of into a drain. The area should be shallow or have a dip so that the water does not just run off. There should be some form of drainage in case of flooding but will already be in place in most

areas. Species planted in a rain garden should be deep rooted, and preferably native to the local area. A range of plants can be grown including bushes, flowers and trees, or even fruit or vegetables. An extensive guide to building a rain garden, including list of suggested species can be found here<sup>38</sup>.

### ***Benefits***

- Preserves clean water. Water running off from buildings may have low level pollutants in it, and passing it through a rain garden can help to purify it. Having more absorbent ground surfaces in urban areas can also help to reduce flooding.
- Creates habitat. Planting flowers, bushes and shrubs and a range of species provides a habitat for insects and other species. Providing ground cover may be beneficial for small animals such as hedgehogs.
- Low maintenance. The inclusion of deep rooted plants means that even in dry periods the plants can still access water and don't require watering. The benefits of natural drainage occur even if the garden has areas with weeds etc.

### ***Considerations***

- Location. The rain garden should be near a water runoff source, such as a building or a pavement. The ground should drain relatively quickly and should not be too high in clay - this can be checked by doing some simple tests.
- Overflow drainage. There should be some method for draining in case the water level gets too high - this will usually be the method of draining already in place and so should not cause any problems.

### ***Estimated costs***

- The cost of implementing a rain garden will depend on the type of site. If the site has soil and natural drainage already, water will need to be diverted and plants will need to be introduced, which may incur a small cost.
- If the area already has paving or another sealed surface, then the costs of removing this are likely to be a significant factor.

### ***Evidence for success***

- A rain garden was installed as part of a pavement in Hackney, managed by Groundwork London. The planting was done by local residents. It improved the appearance of the area and included a natural draining site instead of a normal pavement, diverting water runoff from drains.

## **9. Case Studies**

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<sup>38</sup> <https://raingardens.info/wp-content/uploads/2012/07/UKRainGarden-Guide.pdf>

## **9.1 Urban Site Example - Effective Biodiversity Management**

### **9.1.1 The Centre for Mathematical Sciences**

Cambridge centre for mathematical sciences has done an exemplary amount of work in the last 18-24 months to significantly enhance biodiversity at The Centre for Mathematical Sciences and surrounding areas. The most unique thing about the work undertaken is that the department has implemented measures in tandem with the residential community which in turn, has galvanised people from the community to undertake more efforts to improve biodiversity in the area.

Some of the initiatives which had an effect in improving Biodiversity in the campus are listed as follows:

- Last year, the Green Impact team organised a community Daffodil bulb planting session in the surrounding areas of the department. Nine people living in nearby residential areas turned up on a Sunday morning to plant more than 1000 bulbs. A similar planting day was organized this year and seven neighbours helped plant a further 1100 bulbs which included English Daffodils and Bluebells in the immediate neighbourhood.
- The other major initiative that the department took was to put 13 bird boxes all over the site to provide a habitat for birds. This initiative was started by somebody in the department who donated a birdbox, which inspired the Green Impact team to purchase 12 more birdboxes. This initiative was implemented at a time when the birds had already started to build their nests, so the effectiveness of this measure is yet to be determined, but previous studies on birdboxes have unequivocally shown their effectiveness. For instance, Schwartz et al. (2010) found that birdboxes lead to an additional 3.2 new species per garden on average representing a 26% increase in a study of gardens in Paris. Similarly, Five studies from across the world found higher population densities or population growth rates in areas with nest boxes. The green impact team is undertaking a survey next spring to estimate the quantifiable impact of birdboxes in the department.
- At the same time, some bird feeders have also been put up in the department to provide foods for birds, especially during winters when it is extremely difficult for them to find food. These measures have been effective in attracting new species and helping support the local bird population.
- The Green Impact team is planning to buy hedgehog homes this year to provide a safe habitat for hedgehogs. Since there are a lot of wooden areas in the vicinity of the department, hedgehog homes will be a perfect addition. This initiative is being implemented in conjunction with two people who volunteer at a local wildlife sanctuary, and who have a considerable experience in helping hedgehogs survive winters.
- Moreover, with the help of some neighbours the department have created a wildflower corridor where they have planted a variety of indigenous species such as English

bluebells, daffodils, etc. The increase in species has not only provided more natural habitat for wildlife, but also benefits the local community by providing aesthetically pleasing spaces that helps improve the wellbeing people as 50-60% of the people who come to the center of Mathematical science pass through the corridor daily. The University gardening team have also planted lavender flower beds in some areas to attract bees. Although no continuous monitoring was in place at the CMS, existing literature and campus biodiversity guides suggest that plant diversity contributes positively to species diversity, attracting insects and invertebrates and providing habitat for birds and mammals. A similar case is the Braidburn Valley Park in Edinburgh; after establishing a wildflower meadow in the park, the area now attracts a variety of birds, butterflies, and insects. It may furthermore facilitate colonization of other wildflowers and grasses, as seen in the case of Braidburn Valley Park<sup>39</sup>.

- The site had from initial design terraced gardens to make the space more visually appealing while enhancing biodiversity by planting a wide range of species. Especially when taking into account the fact that 1/3rd of the site is built on the lower ground level areas.
- Similarly, a recent raised bed herb garden, consisting of plant. has been constructed and planted with species like curry, chilli, mint, lemon balm etc., funded by a Green Impact micro-grant to improve biodiversity and people's wellbeing, especially those that may tend and harvest it.

Even though the department does not have a quantifiable impact of these initiatives due to the amount of resources needed to undertake such kind of surveys, in recent years, several different kinds of species have been spotted ranging from urban foxes, muntjac deers to peacocks and green woodpecker, which serves as a microcosm about the effectiveness of these measures. The most fascinating point about the initiatives undertaken by the department is that they have been implemented using a very meagre budget of a few hundred pounds while significantly enhancing biodiversity not only in the department but in the vicinity areas as well.

To summarize, the key takeaways from this case study are twofold. Primarily, the measures should be compatible with existing natural and built environment. Meanwhile, since these interventions are open to the general public, project teams should involve local community throughout, to elicit support and encourage participation.

### **Different Initiatives that have been implemented<sup>40</sup>**

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<sup>39</sup> Refer to link: <https://www2.gov.scot/resource/0042/00424844.pdf>

<sup>40</sup> Photos taken by authors



*Terraced gardens from initial design and build stage*



*Bird-Boxes*



*Bird-Feeders*



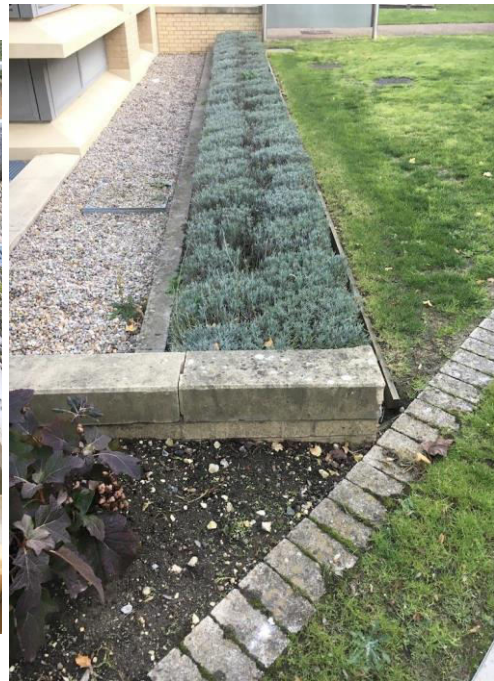


*Wildlife Corridor*





*Herb Garden and Lavender Beds*



*English Daffodils - Spring this year*



**9.2 Urban Site Example – To Improve Biodiversity**

## 9.2.1 The Centre of Mathematical Sciences

### *Objective*

The Centre for Mathematical Sciences (CMS) is located on Wilberforce Road (CB3 0WA), off Madingley Road and houses the faculty of mathematics. The department has made huge strides in terms of improving biodiversity in the last two years as noted earlier as well. But certainly, the Green Impact team is now looking for ways to further improve biodiversity on the campus. The objective of this case study is to explore potential interventions and make recommendations based on different factors.

### *Context and Constraints*

Existing initiatives at the Centre for Mathematical Sciences have ranged from putting up bird boxes to planting daffodil bulbs and a wildflower corridor<sup>41</sup>. The department is also currently undertaking some new initiatives related to building hedgehog homes etc.

In terms of geographic constraints, there are hardly any given the vast amounts of open and green areas on the campus. The main constraint is that the Cambridge Energy & Environment team and the Maths Green Impact team, seek a low-cost and easy maintenance solution given their limited budget.

### *Methodology*

The above project constraints were collected from site visit and discussions with Mick Young, Environment and Energy Coordinator - Maths. Solutions were produced from desk-based research and through lengthy discussions with Mick.

Reviewed resources include literature on urban biodiversity, past case studies of similar initiatives, and various web sources on biodiversity initiatives.

### *Recommended Solution*

Given the variety of species already found in the department in terms of flora and fauna, we recommend that a small wildlife pond can be constructed on the site. This was recommended taking into consideration the fact that the mathematics department already has large swathes of green space. We feel that a new aquatic environment will add a new dimension to the site as well as lead to creation of a new habitat. This project will help create a natural and complete ecosystem in the grounds and thus, significantly improve biodiversity in the area.

The benefits<sup>42</sup> of creating a wildlife pond in the area is that wildlife is instantly attracted to the newly constructed pond. Wildlife ponds attract a variety of species including amphibians

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<sup>41</sup> For full list of initiatives, please refer to the earlier section.

<sup>42</sup> For full list of benefits, refer to the pond section of the report.



such as frogs, toads, numerous tiny creatures, such as water boatman, pond skaters, freshwater leeches, pond snails and water beetle larvae and insects such as dragonflies. Moreover, creating a wildlife pond maps well with existing initiatives undertaken by the department such as putting up bird boxes and hedgehog homes as the pond will be a valuable resource for wildlife such as birds, hedgehogs and other mammals.

### *Proposed site for the construction of pond and its size:*

We recommend the size of the pond to be constructed should be around 6m x 4m with a depth of around 0.6m~1m



*Site of pond<sup>43</sup>*

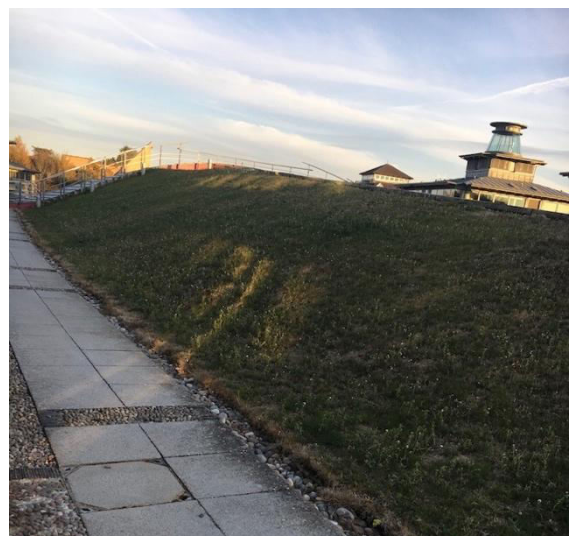
### *Alternative Options*

Before arriving at the solution of constructing a wildlife pond, we considered the alternative of revamping a dilapidated green roof on the campus.

Green roofs are high in maintenance, even though they support a lot of life. Moreover, given that the existing roof has a steep slope, it is difficult to maintain. One solution to overcome this problem would be to plant wildflower species all over the roof.

This will not only attract different kinds of species such as bees but will be good for pollination as well.

We believe that since there are already so many different species on the campus as noted earlier,




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<sup>43</sup> Photo taken by authors

this revamp will not have a significant impact for improving the biodiversity. Since we are not adding something different to the campus by revamping the green roof and given the costs of undertaking this initiative, we cannot justify recommending the restoration of the green roof over the constructing of a wildlife pond, given the vast array of benefits a pond offers to the centre. However, this initiative should be considered if it is not possible to construct the pond.

## *Next Steps*

### *Estimating the Costs*

### *Centre for Mathematics Green Roof<sup>44</sup>*

- Construction & Installation<sup>45</sup>: Free (If we can get enough volunteers to dig the pond – this will take only a few hours)
- PVC / EPDM Liner - £2.6~£3 per sq. m - £100-130
- Base Sand - £30-£40
- Plants (To be determined through consultation with gardeners)
- Decoration – Lining with stones / pebbles (Optional)

Total Cost ~ £300-£400

Here we have assumed that we don't need a water filter for the wildlife pond. It is a reasonable assumption as to keep the water healthy and a hub for a variety of habitats, we can plant a mix of submerged oxygenators, floating aquatics, deep water aquatics and marginal plants. If we add a water filter, although we believe we don't require one, then it will cost another £100 and the problem of providing a power supply.

## *Budget*

As for the budget, constructing a small pond in the proposed site will cost a several hundred pounds. Since the Maths department has a limited budget for biodiversity, it is not feasible for them to construct a pond without additional support and resource. To undertake this initiative, the University will have to work in tandem with the department. Moreover, since a lot of the initiatives undertaken by the department have involved the local community, we think it will be beneficial if we can gather volunteers within CMS to dig the pond which will help save construction costs.

## *Considerations*

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<sup>44</sup> Photo taken by authors.

<sup>45</sup> For full steps of construction, please refer to this article: <https://www.saga.co.uk/magazine/home-garden/gardening/wildlife/how-to-make-a-wildlife-pond>

### ***Design - Plants<sup>46</sup>***

Some submerged oxygenators that can be added are “Hair grass (*Eleocharis acicularis*), hornwort (*Ceratophyllum demersum*) and water crowfoot (*Ranunculus aquatilis*) which are ideal. Frogbit (*Hydrocharis morsus-ranae*) or water hawthorn (*Aponogeton distachyos*) are perfect floating plants, while dwarf water lilies can be placed in the deepest part of the pond” (Cox, 2013).

We can also arrange a “mixture of dwarf reed mace (*Typha minima*), branched bur-reed (*Sparganium erectum*), *Hippuris vulgaris* and pretty blue *Iris pseudacorus* on the shelf around the side” (Cox, 2013).

Plants that spread on the surface, such as ivy-leaved duckweed, provide shade for creatures under the water and also a space to hide for invertebrates.

### ***Maintenance<sup>47</sup>***

Wildlife ponds are generally low maintenance. Even during summer months, 10 minutes per week will be more than enough to keep the pond in great shape.

A small net may be required for skimming fallen leaves, debris etc. and one can use barley straw to control the amount of algae.

### ***Monitoring***

It is highly recommended that the green impact team set up a monitoring scheme. This could be as simple as an open log for people to note down different species they observed in the pond and their perception of it. It could also be more elaborate and quantitative. We believe monitoring the species in the pond should be a fairly simple and easy task.

### ***Risks and Contingencies***

The main risk of building a wildlife pond is that survivability of the selected plants. Plants should be selected carefully and in consultation with the gardeners and the nursery. Also, another point to keep in mind is that due to the “risk of invasive species spread always buy your pond plants from reputable nurseries” (Cox, 2013).

There is also a risk to small children from the neighbourhood, some signs are needed be put up nearby the pond area to warn of dangers to small children.

## **9.2.2 Herchel Smith Building Courtyard<sup>48</sup>**

### ***Objective***

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<sup>46</sup> For list of aquatic plants and their suitability for a wildlife pond, please refer to Appendix-1.

<sup>47</sup> For guidance on how to maintain wildlife ponds, please refer to this article:

<https://www.saga.co.uk/magazine/home-garden/gardening/advice-tips/summer-garden/summer-care-for-ponds>

<sup>48</sup> All photos taken by authors

The Herchel Smith Building (HSB) is situated next to the Addenbrooke's Hospital and houses University of Cambridge Department of Psychiatry. The department's green impact team hope to improve green space coverage, biodiversity, and occupant well-being on site. A potential location for intervention is the building courtyard. The objective of this case study is to explore potential interventions and make recommendation based on feasibility and cost.

### ***Context and Constraints***

Initiatives at HSB site will be constrained by three main factors, namely limited space available, high uncertainty in future plan of the building and site, and limited funding available. The courtyard is a space about 5m by 8m, enclosed on three sides by the building facade. Currently, there is a small planting space about 0.5m by 2m in size, and a picnic bench in the middle as the courtyard also serves as a popular gathering spot during lunch breaks (Figure 1). The new initiative therefore needs to fit within this spatial constraint. The HSB site is also scheduled to be torn down and will undergo re-planning in five years. It follows that the recommended initiative should be flexible and portable enough to adapt to future uncertainty. Both the Cambridge Energy & Environment team and the green impact team seek a low-cost solution. In the following sections, upfront and running costs for the recommended solution and potential alternatives will be discussed in this case study.

### ***Methodology***

The above project constraints were collected from site visit and discussions with the green impact team. Solutions and alternatives were produced from desk-based research. Reviewed resources include literature on urban biodiversity, past case studies of similar initiatives, and various web sources on gardening.



*Fig 1: the courtyard*

### ***Recommended Solution***

The recommended solution is to construct a semi-portable green wall with climbing plants on the facade (area in red box in Figure 2). This is the favored solution because it makes the



most use out of limited space, bears more potential for biodiversity, is reasonably portable and flexible, and is easy and affordable to set up.



*Fig 2: space for green wall initiative*

The main components of such a green wall are planter setup on the ground, frame attachment to the building facade, and a proper selection of climber plants. There are several variations regarding planter and frame set up. Conventional rectangular planter boxes can be constructed and placed at the foot of the wall. Then, timber frame or wire mesh can be attached to the facade (as seen in Figure 3). Alternatively, there are modular box-trellis units one can purchase and arrange along the wall (e.g. the IKEA BARSO trellis with base plate featured in Figure 4); in this case, it would take 2-3 such modules to cover the space.



*Fig 3: planter-box-and-mesh setup<sup>49</sup>*

<sup>49</sup> <http://greenscreen.com/dev/how-to-prune-a-wall-mounted-green-facade-green-wall/>



*Fig 4: pre-assembled module; source: IKEA*

The advantage of this solution is that it meets constraint well. This setup makes use of the vertical space and create more visible green space without encroaching into the gathering space. With the proper plant selection, this expanded green space could attract more pollinators than conventional planter boxes. It is relatively easy and affordable to set up, as no digging or other forms of permanent changes need to be made. It is relatively portable and adaptable; when the building is torn down, the setup can either be moved elsewhere, or the planters can be cleared out till the site work is completed.

The main disadvantage is that it will require more stakeholder consultation and engagement. In planning phase, project teams should consult with gardeners to ensure proper selection of plants and to clarify maintenance requirements. The team should also engage with staff at HSB site to explore green wall concepts, elicit support and volunteer participation in the installation, maintenance, and monitoring of the green wall. Last but not least, extensive coordination with building managers and future construction crew is needed; the current green impact team should keep a written record of relevant information (e.g. useful contacts, maintenance requirements) to ensure smooth handover to future teams.

### *Alternative Options*

Before arriving at the recommended solution, two alternatives - planter boxes and portable equipment such as bird boxes - were considered. Specifically, planter boxes, while easy to set up and portable, would have limited impact on biodiversity due to limited size. Given that the space is enclosed in a high-traffic area without readily available bird habitats, the hypothesis is that bird boxes would have limited effect on biodiversity; although, if the reconstructed site permits, bird boxes could be installed and the effects should be monitored to justify future interventions.

<b>Solution/Criteria</b>	<b>Effective use of space</b>	<b>Positive impact on biodiversity</b>	<b>Ease of implementation and affordability</b>
<b>Green Wall</b>	Very effective use of space (vertical and ground)	Potentially higher impact	Moderate difficulty and cost (£43 per planter box with trellis on Amazon, will need 2-3 units)
<b>Planter boxes</b>	Limited use of space (ground only)	Limited impact	Low difficulty and cost (£40 for a 79cm x 19cm x 19cm planter on Amazon)
<b>Bird boxes</b>	Very limited use of space	Unclear	Low difficulty and cost (£15 for 4 on Amazon)

### *Next Steps*

### *Estimating costs*

Upfront costs:

- Material: £90 - £140 (2-3 planter boxes with trellis)
- Plants: depending on the plant and package weight, can range from £3 to £15 (from searches on Amazon)
- Labor: with all materials in place, the set up should take less than 5 hours. Labor costs can thus range from £40 to £75. This cost can be offset by recruiting volunteers.

Running costs (to be determined through consultation with gardeners):

- Material: fertilizer, irrigation
- Labor: pruning and other maintenance activities

### *Design and maintenance*

General considerations for plant selection<sup>50,51</sup>

- Matching a plant's growth habit to the type of installation
- Choosing plants based upon seasonal cycles
- Selecting appropriate plant material based upon the client's commitment to maintenance
- Choosing mixed plantings to ensure the long term success of the project
- Using native plants

<sup>50</sup> From a US source on plant selection and maintenance:  
[http://greenscreen.com/docs/Plants/greenscreen\\_Guidelines%20for%20Plant%20Selection.pdf](http://greenscreen.com/docs/Plants/greenscreen_Guidelines%20for%20Plant%20Selection.pdf)

<sup>51</sup> From a UK source on plant selection and maintenance:  
<https://www.rhs.org.uk/advice/profile?PID=380>

### *Monitoring*

It is highly recommended that the green impact team set up a monitoring scheme. This could be as simple as an open log for people to note down different species they observed and their perceptions of the space. It could also be more elaborate and quantitative; for example, this could involve bee counting and identification as part of the Great British Bee Count initiative<sup>52</sup>.

### *Risks and contingencies*

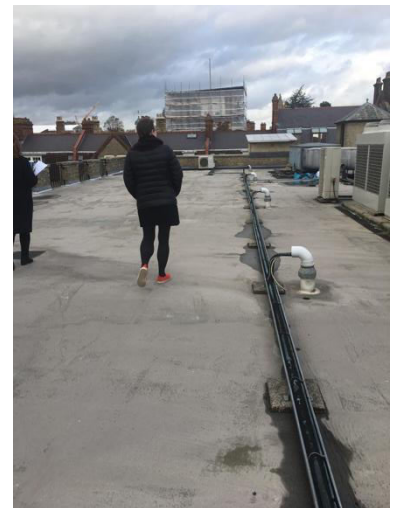
The two main risks with the recommended solution are impact on building structure and survivability of the plants. If a box-trellis setup was used, the plants would be detached from the building structure, and the impact should be minimal. However, there is risk that regular irrigation (especially in summer) could pose concerns. This should be discussed with property managers prior to implementation. If it was later discovered that the climber plants do impact building structure, then non-climber plants could be grown instead. Another risk is survivability of the selected plants. There would always be a risk of them not blooming or wilting under unusual weather conditions, despite proper plant selection at the initial phase. In this case, it is recommended that the green impact team or the site gardeners have some spare seeds in storage, so that re-planting could start with little delay.

## **9.2.3 Sociology Department**

The Sociology Department moved into the current building at 16 Mill Lane due to building work disruption and dust at the previous New Museums site building. They are due to move back into the original building in 2020 and 16 Mill Lane will be demolished.

### *About the space*

It is a large, flat L-shaped roof space. Due to low railings and health and safety concerns, regular unsupervised access to the roof is not possible and so this is a limitation on what could be implemented here.



### *Limitations*

It is not possible to have water bearing structures due to leakages through the roof. Anything which requires regular upkeep would not be suitable since there is only



<sup>52</sup> <https://friendsoftheearth.uk/bee-count>



limited access. The building is going to be demolished in two years, so this limits any long term plans.

### *Possible biodiversity improvement strategies*

Bat boxes would be ideal for this type of space since they require little maintenance and don't affect the roof space. However, once bats take up residence they tend to stay long term. In this particular case, with the building being demolished so soon this is not a viable option.

Bird boxes could be installed for local and seasonal birds. However, there is a peregrine falcon which nests in the Pitt building nearby (see image), which may prey on young birds. Increasing the number of birds in the area is unlikely to have a negative effect, and measures which help the falcons are useful in themselves. Having such a prominent species present is an indicator of high levels of biodiversity. Some kind of surveillance for the falcon could even be set up.



In the long term, if the building was not going to be demolished, more drastic measures could be implemented. The structure could be improved, for example by installing new railings and making the space accessible. This would significantly increase the possibilities for improving the space and increasing biodiversity.

*Pitt building where the peregrine falcon nests*

### *Alternative Space*

In meeting with the green impact team at the Sociology department, we discovered that when the department move back to their building on the New Museums site, they have access to a small triangular garden which is believed to be a remaining section of the original Cambridge Botanic Garden (see image). We believe this space could benefit from biodiversity improvement.

Given the constraints, we think that planting wildflowers on the small triangular garden will be the most effective solution to increase biodiversity in the area. This was recommended taken in consideration the fact that planting wildflowers beautify the environment with range and vibrancy of plants and flowers. Benefits of wildflowers are immense, as they provide habitat for insects, which can attract birds and also provides shelter for small animals such as hedgehogs. Moreover, planting wildflowers seeds are very inexpensive and at the



same time require very low maintenance. It will also improve the aesthetics of the site due to the presence of a variety of flowers. Thus, given the constraints and benefits wildflower species offer, it is a suitable solution to improve the biodiversity in the area.

### *Alternative Solution that can be considered*

Before arriving at the solution of planting wildflowers, we considered the alternative of building a rain garden<sup>53</sup>. We believe building the rain garden would have been an ideal solution to increase biodiversity in the garden, given that there are downpipes in the area. But since the area is quite small and rain gardens are generally built 3m away from the building to reduce the likelihood of property damage, it is difficult to determine whether enough space is available for the rain garden to be built. For this we recommend the department to consult an expert who has prior experience in building rain gardens. Expert consultation is necessary to determine answers to questions such as whether the soil is appropriate? Is there enough space to build the rain garden at the site? What will be the cost of building the rain garden?

We think building a rain garden will be an effective solution to increase biodiversity in the area as planting flowers, bushes and shrubs and a range of species provide a natural habitat for insects and other species. Moreover, rain gardens provide ground cover may be beneficial for small animals such as hedgehogs. Finally, rain gardens provide the additional benefit of utilising water and mimicking the natural water retention of undeveloped land. Thus, the key takeaway is to consult an expert to determine the feasibility of building a rain garden in the garden. If feasible, rain garden will be a nice addition to improve biodiversity due to their immense benefits, given the constraints of the space and low maintenance required.

### *Next Steps*

#### *Estimating the Costs*

Planting wildflower species in the garden would be rather inexpensive given that it is a small space and native wildflowers seeds are quite cheap. It should cost somewhere around £50-£100

#### *Considerations*

- It may require work for initial setup, such as preparing the soil and weeding, but eventually wildflower species are very low maintenance.
- The department should consult a reputable nursery to determine which native wildflower seeds would be appropriate to buy for the site. Seeds chosen should be suitable to the various soil types and situation. Where possible, one should obtain seed of British origin. Moreover, grass can be vigorous and out compete flowers – to combat this, one can introduce semi-parasitic plants.

### *Monitoring*

It is highly recommended that the green impact team set up a monitoring scheme. This could be as simple as an open log for people to note down different species they observed

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<sup>53</sup> For information on the design, construction and maintenance of the rain garden, including suggested plants species, please refer to : <https://raingardens.info/wp-content/uploads/2012/07/UKRainGarden-Guide.pdf>

in the garden and their perception of it. It could also be more elaborate and quantitative. We believe monitoring the species in the garden should be a fairly simple and easy task.

## 10. Conclusion

Increasing biodiversity helps to conserve and protect existing species, has positive implications for human health and wellbeing and helps to improve the health of the planet itself. Interventions to increase biodiversity can be targeted at animals and insects, plants and amphibians. Furthermore, small-scale interventions can be extremely low-cost or even just require free natural resources. To optimize biodiversity, we recommend combining different interventions targeted at different species. Our research has found that there is no ‘one size fits all’ biodiversity intervention strategy. The best strategy will depend upon the characteristics of the site available, financial resources and the number of volunteers among many other factors. Our case studies demonstrate the contextual nature of biodiversity intervention strategies with sociology providing a fitting example of how important it is to examine proposed spaces for intervention before deciding which strategy to use. Overall, we hope the importance of biodiversity and the small-scale, low-cost nature of these interventions will motivate different departments at the University of Cambridge and community volunteers to follow our recommendations.

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## 12. Appendix

### 1. British Aquatic Plants – For a Wildlife Pond

Common name	Latin name	Description	Habitat
Amphibious bistort	<i>Persicaria amphibia</i>	Bright pink spikes of flowers, large floating leaves. Loved by dragonflies.	Deep water
Arrowhead	<i>Sagittaria sagittifolia</i>	White flowers with purple middles.	Shallow water
Brooklime, water speedwell	<i>Veronica beccabunga</i>	Tiny blue flowers that spreads across the pond surface.	Bog garden, pond edge or shallow water.
Common cottongrass	<i>Eriophorum angustifolium</i>	Fluffy cotton wool-like seedheads on grassy foliage.	Bog garden, pond edge or shallow water. Prefers acidic soil.
Devils bit scabious	<i>Succisa pratensis</i>	Round purple flowers.	Bog garden
Dwarf lesser spearwort	<i>Ranunculus flammula subsp. minimus</i>	A dwarf version of lesser spearwort. Yellow buttercup flowers.	Bog garden, pond edge or shallow water
Flowering rush	<i>Butomus umbellatus</i>	Beautiful pink and purple clusters of flowers.	Shallow water
Fringed waterlily, floating heart	<i>Nymphoides peltata</i>	Star-shaped yellow flowers with floating leaves.	Shallow to deep water
Frogbit	<i>Hydrocharis morsus-ranae</i>	Tiny lily pad-style leaves with a delicate white flower, overwinters at bottom of pond.	Floats freely on the surface in summer
Giant duckweed	<i>Spirodela polyrhiza</i>	Large leaves with a reddish tint forming a mat on the surface.	Floats freely on the surface

Greater pond sedge	<i>Carex riparia</i>	Decorative black seedheads that open to brown seeds in summer.	Bog garden, pond edge or shallow water
Hemp agrimony	<i>Eupatorium cannabinum</i>	Produces clusters of pale pink flowers on upright stems.	Bog garden or pond edge
Hornwort	<i>Ceratophyllum</i>	A submerged oxygenator with feathery foliage.	Floats under water
Ivy-leaved duckweed, star duckweed	<i>Lemna trisulca</i>	A pretty native duckweed that provides shade and habitat for invertebrates.	Submerged
Lesser spearwort	<i>Ranunculus flammula</i>	Yellow buttercups with sprawling foliage.	Bog garden, pond edge or shallow water
Lesser water-plantain	<i>Baldellia ranunculoides</i>	Lime green foliage with very pale purple flowers.	Bog garden, pond edge or shallow water
Marestail	<i>Hippuris vulgaris</i>	Spires of dark foliage, oxygenating. Not to be confused with Equisetum, also known as mare's tail.	Bog garden, pond edge, shallow water or submerged
Marsh cinquefoil, bog strawberry	<i>Potentilla palustris</i>	Maroon star-shaped flowers.	Bog garden, pond edge or shallow water
Marsh marigold, kingcup	<i>Caltha palustris</i>	Buttercup-like bright yellow flowers with rounded leaves.	Bog garden, pond edge or shallow water
Marsh pennywort	<i>Hydrocotyle vulgaris</i>	A creeping plant with glossy, rounded leaves.	Bog garden, pond edge or shallow water
Marsh woundwort	<i>Stachys palustris</i>	Nettle-like spears of flowers.	Bog garden
Meadowsweet	<i>Filipendula ulmaria</i>	Tufty white flowers.	Bog garden, pond edge
Pond waterlily	<i>Nymphaea alba</i>	A large white waterlily that floats on the surface with roots underwater.	Up to 90cm under water (roots)

Purple loosestrife	<i>Lythrum salicaria</i>	Purple spears of flowers on clumps of long stems.	Bog garden, pond edge or shallow water.
Ragged robin	<i>Lychnis flos-cuculi</i>	Tufts of pink flowers on long stems.	Bog garden
Slender club rush	<i>Isolepis cernua</i>	Small stems with white seedheads, an oxygenator.	Shallow water
Spiked water milfoil	<i>Myriophyllum spicatum</i>	Submerged oxygenator with tiny red flowers peeking up above water.	Floats under water
Sweet galingale, cypress root	<i>Cyperus longus</i>	Spikes of foliage with clusters of seeds.	Shallow water
Tufted cottongrass, hare's tail cottongrass	<i>Eriophorum vaginatum</i>	Tufts of cotton wool-like seed heads.	Bog garden, pond edge or shallow water
Water avens	<i>Geum rivale</i>	Brown and peach nodding flowers.	Bog garden
Water cress, fool's water cress	<i>Rorippa nasturtium-aquaticum</i>	Small white flowers and leaves both above and below the surface. Oxygenating.	Shallow water
Water crowfoot	<i>Ranunculus aquatilis</i>	A submerged oxygenator with small white flowers.	Floats freely in deep water, ideally moving
Water forget-me-not	<i>Myosotis scorpioides</i>	Clusters of minute blue flowers.	Bog garden, pond edge or shallow water
Water mint	<i>Mentha aquatica</i>	A scrambling plant with dark leaves and purple globes of flower.	Bog garden or shallow water
Water moss	<i>Fontinalis antipyretica</i>	Dark green submerged stems, an oxygenator.	Floats under water
Water plantain	<i>Alisma plantago-aquatica</i>	Small white flowers with large light green leaves.	Shallow water
Water soldier	<i>Stratiotes aloides</i>	Floating spikes of olive green foliage.	Floats on surface of pond



Yellow iris	<i>Iris pseudacorus</i>	Bright yellow drooping petals with broad green leaves.	Bog garden, pond edge or shallow water
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**Source:** “How to design and build a wildlife pond” – Martyn Cox, 2013 – Saga Magazine

**Note:** Shallow water is anything from 5cm/2" to 20cm/8".