# Biodiversity in Dublin: A case study approach

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**Introduction: Urban biodiversity and its importance**

The importance of biodiversity has been recognised at international level and its preservation and management is supported through key international agreements, such as the Rio Convention (Convention on Biological Diversity, 1992), and nationally, through the National Biodiversity Action Plan. In Ireland, at a more local scale, most local authorities (e.g. Dublin City Council, 2008) have developed Local Biodiversity Action Plans to address the key objectives for biodiversity protection and management within their administrative areas.

It is a common perception that biodiversity exists mainly in rural locations and this perception may be supported by the predominance of designated sites (e.g. Special Areas of Conservation, Special Protection Areas and Natural Heritage Areas) in rural areas. Given that approximately 40 per cent of the Irish population lives in rural areas (Orsini & Williams, 2009) the designated sites are indeed very important and their designation allows them particular protection.

However, as Ireland's population becomes increasingly urbanised, the role and management of urban biodiversity is becoming more important not only due to the encroachment of urban areas into previously undeveloped lands (i.e. urban sprawl) but also the recent trend towards increasing residential densities (Residential Density Guidelines, 1999). These have heightened the role for proper recognition, protection and management of biodiversity in urban areas.

The Greater Dublin Area has come under particular development pressure in recent years with exceptional rates of demographic and economic growth. Between 2002 and 2006 the population grew by 8.2 per cent (CSO, 2006). Allied with this growth, an exponential increase in development rates was observed with housing completions in excess of 22,000 in quarters 1 and 2 of 2006 compared with approx. 13,000 for the same period in 2002 and 6,600 in 2009 (CSO, 2009).

Whilst considerable literature exists on the maintenance and enhancement of biodiversity in urban areas in other jurisdictions (Europe and US), there is a paucity of literature relating to the Irish context, particularly with regard to the relatively new phenomenon of medium to high-density residential developments in Irish settings.

This research takes a case study approach in documenting and evaluating current practice with regard to biodiversity conservation, management and enhancement in urban areas.

**Methodology**

The study used an evidence-based approach to analysing the key principles of habitat protection, creation and enhancement for incorporating biodiversity into medium to high-density urban development. A representative sample of urban case study sites was selected from the administrative areas of Fingal County Council and Dún Laoghaire-Rathdown County Council, County Dublin.

**Case study selection**

Fingal County Council and Dún Laoghaire-Rathdown County Council form part of the Greater Dublin Area (GDA). Until recently, these administrative areas experienced accelerated housing development at increasingly higher densities. Fingal is located to the north and west of the GDA and holds many of the growing suburbs of County Dublin. The administrative area is the fastest growing local authority in housing numbers nationally and has extensive agricultural and greenbelt lands within its boundary, which have come under sustained pressure. Dún Laoghaire-Rathdown County Council lies to the south of the GDA and is constrained by the Dublin and Wicklow Mountains and the Dublin Bay coastline. Both administrative areas represent important growth regions within the GDA, with a mixture of suburban and rural landscapes. While the rate of housing development has declined sharply due to the economic slow-down, both administrative areas have experienced pressure on biodiversity resources and, due to their geographical locations, are likely to do so again as housing demand returns.

Seven sites were selected as case studies from four urban sectors radiating out from the city core that broadly reflect the differing urban environments across both areas (Table 1.1). The four urban sectors considered were (i) Inner Urban; (ii) Inner Suburban; (iii) Outer Suburban and (iv) Outer Town (RIAI, 2002).

**Case study review**

**Table 1.1 Summary of case study typologies**

| Site | Typology | Built space | Average units per ha | Age |
|---|---|---|---|---|
| Monkstown | Inner urban | 20% | 13 | Circa 19th century |
| Castleknock | Inner suburban | 25% | 41 | 1980-2002 |
| Dundrum | Inner suburban | 30% | 30-90 | 1970-2000s |
| Ongar | Outer suburban | 30% | 38 | Circa 2002 |
| Stepaside | Outer suburban | 35% | 105 | Circa 2004 |
| Swords | Outer suburban | 15% | 24 | Circa 1973 |
| Lusk | Outer town | 30% | 28 | Circa 2002 |

The selection took account of the potential for further development and the extent of open space, both private and public. Selection sought a balance between new development areas and more mature neighbourhoods where biodiversity has had an opportunity to become established.

**Biodiversity evaluation**

A set of key urban biodiversity indicators were defined through literature review to describe the biodiversity resources within the selected case study sites. The study used the key biodiversity indicators of habitat type, habitat quality, tree diversity, tree structural diversity and breeding bird diversity. A preliminary assessment of study sites was carried out using aerial photographs. Habitats were recorded in the field to Level 3 of the standard Heritage Council scheme (Fossitt, 2000). Surveys were restricted to accessible areas. Private gardens were not included within the walkover survey. Tree structure diversity was categorised as Young, Semi-mature, Mature or Over-mature. Breeding bird transects were carried out to identify species-richness in each study site. Abundance was measured according to the DAFOR scale: D = Dominant, A = Abundant, F = Frequent, O = Occasional, R = Rare.

Field survey sheets and an Access database were designed for data recording and analysis prior to the field study. Database forms were set up and used as recording sheets to maintain consistent recording of information in the field. Data analysis of biodiversity resources from the described typologies formed the basis for outlining constraints and opportunities for biodiversity management and prescribing best practice methods in the planning and development process.

## Results

**Case study 1. Monkstown**

The habitat number was low and habitat quality was moderate to low (Table 2.1). The treelines, hedgerows and individual trees were of moderate quality owing to their species-richness, semi-natural character and maturity. Habitats of low value were artificial and composed largely of non-native species. They had low species-richness and low wildlife value.

The diversity of tree species was moderate with a total of 12 species, four of which were native (Table 2.2). The strawberry tree and yew provided an element of rarity within the area. The site had a high proportion of mature trees, indicative of the age of the development. (Table 2.3)

Breeding bird diversity was moderate (Table 2.4). Sixteen species of bird were recorded on site. All bird species recorded, with the exception of the heron and hooded crow, were breeding on site, which was indicative of the high number of mature trees and good cover available. The heron also used the site as a night roost. Its presence was indicative of the site's proximity to the coast and the availability of mature trees.

**Table 2.1 Habitat type and quality**

| Habitat types | Habitat quality |
|---|---|
| Treelines | Moderate |
| Hedgerows | Moderate |
| Scattered trees and parkland | Moderate |
| Flower beds and borders | Low |
| Amenity grassland | Low |

**Table 2.2 Tree diversity**

| Natives | Abu | Non-natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Ash | F | Beech | F | Laurel | F |
| Holly | F | Cordyline | O | Lime | O |
| Strawberry tree | R | Laburnum | O | Norway maple | O |
| Yew | R | Laurel bay | O | Walnut | R |

**Table 2.3 Tree structural diversity**

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Rare | Occasional | Frequent | Rare |

**Table 2.4 Breeding bird diversity**

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Blackbird | A | Blue tit | F | Greenfinch | R |
| Wren | A | Swift | O | Song thrush | R |
| Robin | A | Feral pigeon | O | Hooded crow | R |
| Wood pigeon | F | Chaffinch | O | Dunnock | R |
| Magpie | F | Great tit | O | | |
| Starling | F | Grey heron | R | | |

**Case Study 2. Castleknock**

A total of five habitats were recorded (Table 3.1). The site supported some semi-mature and mature treelines, with moderate species diversity, which were of highest value (Tables 3.2. and 3.3). Other habitats were composed of non-native species with limited wildlife value.

Overall tree diversity was low and most trees were newly planted and immature (Table 3.2 and 3.3). Many of the newly planted trees were natives while the older established trees were non-native species, indicating increased use of more native tree species in planting. Trees were located in clusters throughout the development with mature specimens forming small stands with closed canopies.

Fourteen species of breeding birds were recorded; however, the abundance of individual species recorded was relatively low (Table 3.4). The greatest bird activity was recorded to the south and east of the site where there was a concentration of vegetation in treelines and adjacent back gardens. Here the treelines formed a continuous canopy and extend into the surrounding area.

**Table 3.1 Habitat type and quality**

| Habitat types | Habitat quality |
|---|---|
| Treelines | High – Moderate |
| Hedgerows | Moderate |
| Scattered trees and parkland | Moderate |
| Ornamental or non-native shrub | Moderate-Low |
| Amenity grassland | Low |

**Table 3.2 Tree diversity**

| Natives | Abu | Non-natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Rowan | A | Horse chestnut | F | Cherry | O |
| Ash | F | Lime | F | Pine | O |
| Birch | F | | | Sycamore | O |
| Aspen | O | | | | |

**Table 3.3 Tree structural diversity**

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Dominant | Frequent | Frequent | None |

**Table 3.4 Breeding bird diversity**

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Starling | A | Wood pigeon | O | Greenfinch | R |
| Blackbird | F | Collared dove | O | Chaffinch | R |
| Magpie | F | Robin | O | Goldcrest | R |
| Wren | F | Blue tit | O | Hooded crow | R |
| Rook | O | Pied wagtail | R | | |

**Case study 3. Dundrum**

Habitat diversity was moderate and there were a number of semi-natural habitats mainly centred on the stream (Table 4.1). The woodland and hedgerow habitats formed bankside vegetation along the course of the stream. A mature, well-structured hedgerow occurred on site. It formed a typical A-shape with a wide, dense base and narrowing towards the top. The hedgerow supported several native species, typical of those found in Irish hedgerows. It extended beyond the boundary of the development and formed links into the wider landscape.

Tree diversity was high (Table 4.2). The majority of trees on site were recently planted and immature (Table 4.3). However, mature specimens were located within the woodland and some had been successfully retained within new development.

Breeding bird diversity was moderate (Table 4.4). While many of the species present were typical of urban habitats, some species, including wren, robin, chaffinch and dunnock, were associated with hedgerows.

**Table 4.1 Habitat type and quality**

| Habitat types | Habitat quality |
|---|---|
| Depositing/lowland rivers | High-Moderate |
| Broadleaved woodland | High-Moderate |
| Treelines | Moderate |
| Neutral grassland | Moderate |
| Hedgerows | Moderate |
| Amenity grassland | Low |
| Ornamental non-native shrubs | Low |
| Recolonising bare ground | Low |

**Table 4.2 Tree diversity**

| Natives | Abu | Non-natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Ash | A | Beech | F | Hornbeam | O |
| Alder | F | Chestnut | F | Pine | O |
| Birch | F | Field maple | F | Copper beech | R |
| Grey willow | F | Lime | F | Grey alder | R |
| Rowan | F | Sycamore | F | Holm oak | R |
| Sally | F | Cherry | O | Larch | R |
| Oak | O | Cypress | O | Walnut | R |

**Table 4.3 Tree structural diversity**

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Abundant | Frequent | Occasional | Rare |

**Table 4.4 Breeding bird diversity**

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Wood pigeon | A | Blue tit | O | Collared dove | R |
| Blackbird | F | Goldfinch | O | Dunnock | R |
| Magpie | F | Mistle thrush | O | Jackdaw | R |
| Wren | F | Robin | O | | |
| Chaffinch | O | Rook | O | | |

**Case study 4. Ongar**

Habitat diversity was low (Table 5.1) and dominated by areas of amenity grassland with immature planted trees within the new development. Some good quality, semi-natural habitat comprising broadleaved woodland had been retained from the pre-existing landscape and incorporated into the development. A substantial area of formerly agricultural grassland surrounded the woodland. It was relatively species-poor and had been allowed to grow tall. The grassland species were allowed to flower and set seed, thus providing habitat and foraging for a range of species and enhancing its wildlife value.

Tree diversity was high with a total of nineteen species recorded, seven of which were native (Table 5.2). Young trees were abundant within the new development, while mature specimens were located along the periphery (Table 5.3).

Bird diversity was high (Table 5.4). However, bird calls and sightings from within the site were rare. This is attributed to the lack of suitable habitat within the site. The mature broadleaved woodland located to the southeast of the site and the boundary treeline hosted a high diversity of birds.

### Table 5.1 Habitat type and quality

| Habitat types | Habitat quality |
|---|---|
| Broadleaved woodland | High - Moderate |
| Treelines | High - Moderate |
| Dry meadows and grassy verges | Moderate - Low |
| Scattered trees and parkland | Moderate - Low |
| Amenity grassland | Low |

### Table 5.2 Tree diversity

| Natives | Abu | Non-natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Ash | A | Lime | D | Common walnut | R |
| Birch | A | Horse chestnut | A | Copper beech | R |
| Hawthorn | A | Sycamore | A | Larch | R |
| Oak (Pedunculate) | F | Beech | O | Lilac | R |
| Elder | O | Willow | O | Scots pine | R |
| Silver birch | O | Beech | R | | |
| Holly | R | Cherry | R | | |

### Table 5.3 Tree structural diversity

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Abundant | Occasional | Abundant | Rare |

### Table 5.4 Breeding bird diversity

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Magpie | A | Greenfinch | O | Wood pigeon | O |
| Wren | A | Blue tit | O | Song thrush | R |
| Rook | A | Swallow | O | Collared dove | R |
| Jackdaw | F | House martin | O | Mistle thrush | R |
| Chaffinch | F | Goldfinch | O | Goldcrest | R |
| Blackbird | F | Hooded crow | O | Pied wagtail | R |
| Dunnock | O | Starling | O | | |

**Case study 5. Stepaside**

Habitat diversity was high with a total of ten habitat types recorded within the study area (Table 6.1). Some of these were semi-natural habitats that had good species diversity, good structure and are therefore were rated as high biodiversity value. They included the stream, mature treelines and broadleaved woodland and were located along the boundary of the site. These habitats were remnants of the previous landscape and they reflected similar habitats within the surrounding landscape. A stream was incorporated into the development and fitted with a mammal ledge to allow for the passage of otter. The site had also incorporated some scrub and hedgerow internally from the original landscape. These were of moderate species-richness and moderate to poor structure. The hedgerow was retained in isolation and was not connected to the network of hedgerows in the wider landscape, which reduced its value as a corridor for movement. A pond, which lacks fringing vegetation, provided some habitat and a valuable source of water for animals, especially birds. These habitats were rated as moderate to low in value. The site included a Sustainable Drainage System that collected run-off water from around the site and channelled it via grassed collection systems into the pond area. This provided a more sustainable means of surface water collection and added biodiversity value by creating new habitats.

## Table 6.1 Habitat type and quality

| Habitat types | Habitat quality |
|---|---|
| Stream | High |
| Treeline | High |
| Mixed broadleaved woodland | High - Moderate |
| Scrub | Moderate |
| Pond | Moderate - Low |
| Scattered trees and parkland | Moderate - Low |
| Immature woodland | Moderate - Low |
| Hedgerow | Moderate - Low |
| Ornamental non-native shrubs | Moderate - Low |
| Amenity grassland | Low |

## Table 6.2 Tree diversity

| Natives | Abu | Natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Ash | F | Rowan | O | Sycamore | F |
| Elder | F | Salix sp. | O | Beech | O |
| Downy birch | O | Oak (pedunculate) | R | Pine | R |
| Hazel | O | Wych elm | R | | |
| Holly | O | Lime | F | | |

Tree species diversity was moderate (Table 6.2) and there was an abundance of immature trees within the development, with semi-mature and mature specimens retained along the

boundaries of the site (Table 6.3). There were a higher proportion of natives to non-natives, which was unusual among the developments and indicated a greater use of native species in the planting scheme.

Breeding bird diversity was moderate (Table 6.4). The high quality, semi-natural habitats were largely located along the edge of the development and bird activity was greatest in that area.

**Table 6.3 Tree structural diversity**

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Dominant | Frequent | Frequent | Rare |

**Table 6.4 Breeding bird diversity**

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Blackbird | A | Mallard | O | Magpie | R |
| Rook | A | Robin | O | Mistle Thrush | R |
| Starling | F | Swallow | O | Pied Wagtail | R |
| Blue tit | O | Wood pigeon | O | | |
| Chaffinch | O | Goldfinch | R | | |

**Case study 6. Swords**

Habitat diversity was high within the site (Table 7.1). The development was located adjacent to the Ward River Valley Park, which provided the main source of high quality habitats within the study area. Habitats of highest value were the semi-natural habitats including oak-ash-hazel woodland, broadleaved woodland, mature treelines and river. In addition, such a large area of high quality semi-natural habitat is generally rare within the urban landscape. Habitats within the housing development were low quality and limited to amenity grassland and treelines.

Tree diversity was high within the study area (Table 7.2). This was largely owing to the tree-species richness and the abundance of mature woodland along the river. However, trees were also numerous within the development and, with time, these will mature and improve in value. Mature, native treelines were distinguished from other treelines in the study area. There was good tree structural diversity within the overall site, which supported a range of age groups from young to over-mature (Table 7.3).

Breeding bird diversity was high, with a total of 24 species recorded (Table 7.4). This likely resulted from the diversity, quality and maturity of habitats on site. The occurrence of grey wagtail and moorhen was associated with the river. Blackcap, bullfinch and mistle thrush were associated with the mature woodland.

**Table 7.1 Habitat type and quality**

| Habitat types | Habitat quality |
|---|---|
| Oak-ash-hazel woodland | High |
| (Mixed) broadleaved woodland | High |
| Eroding/upland rivers | High |
| Treelines | High-Moderate |
| Marsh | Moderate |
| Drainage ditches | Moderate |
| (Mixed) broadleaved woodland | Moderate |
| Hedgerows | Moderate-Low |
| Amenity grassland | Moderate-Low |
| Flower beds and borders | Low |
| Scattered trees and parkland | Low |
| Treelines | Low |

**Table 7.2 Tree diversity**

| Natives | Abu | Non-natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Common alder | O | Common lime | F | Black poplar | R |
| Ash | O | Field maple | O | Cherry | R |
| Downy birch | O | Horse chestnut | O | Common whitebeam | R |
| Hazel | O | Italian alder | O | Crack willow | R |
| Silver birch | O | Norway maple | O | Cypress | R |
| Wild cherry | O | Pine | O | Grey poplar | R |
| Elm | R | Sycamore | O | Larch | R |
| Common rowan | R | Apple | R | Spruce | R |
| Pedunculate oak | R | Beech | R | Sweet chestnut | R |

**Table 7.3 Tree structural diversity**

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Frequent | Abundant | Frequent | Occasional |

**Table 7.4 Breeding bird diversity**

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Blackbird | A | Robin | F | Moorhen | O |
| Blue Tit | A | Starling | F | Rook | O |
| Magpie | A | Blackcap | O | Swallow | O |
| Wood Pigeon | A | Coal Tit | O | Swift | O |
| Wren | A | Collared Dove | O | Bullfinch | R |
| Chaffinch | F | Grey Wagtail | O | Goldfinch | R |
| Great Tit | F | Jackdaw | O | Hooded Crow | R |
| House Sparrow | F | Mistle Thrush | O | Song Thrush | R |

**Case study 7. Lusk**

Habitat diversity was low and habitat quality was moderate to low (Table 8.1). A hedgerow was the only semi-natural habitat on site. This had a moderate to high diversity of hedgerow plants but it was partially severed.

Tree diversity was moderate (Table 8.2). Most trees on site were newly planted or semi-mature. Mature trees were rare (Table 8.3). Immature trees generally support a limited amount of wildlife, mostly birds and some invertebrates.

Breeding bird diversity was low (Table 8.4). The lack of mature vegetation was reflected in the limited variety and number of bird species recorded on site. There were no substantial areas of mature vegetation adjacent to the development that could act as a core habitat for species to disperse from into the surrounding new developments. This will affect the potential for biodiversity to expand in the area over time. The hedgerow supported the main concentration of bird species that were recorded in the area. Although the hedgerow was unconnected to the wider landscape and had limited potential as a corridor, it acted as a small habitat patch or stepping stone for mobile species such as birds. The adjacent gardens were immature and supported only amenity grassland, which had limited value for wildlife.

## Table 8.1 Habitat type and quality

| Habitat types | Habitat quality |
|---|---|
| Hedgerow | Moderate |
| Scattered trees and parkland | Moderate - low |
| Treeline | Low |
| Amenity grassland | Low |
| Flower beds and borders | Low |

## Table 8.2 Tree diversity

| Natives | Abu | Non-natives | Abu | Non-natives | Abu |
|---|---|---|---|---|---|
| Ash | F | Lime | F | Pine | R |
| Silver birch | F | Apple | R | Rowan* | R |
| Rowan | F | Larch | R | | |
| Wild Cherry | R | Norway maple | R | | |
| Wych elm | R | Norway spruce | R | *non-native variety | |

## Table 8.3 Tree structural diversity

| Young | Semi-mature | Mature | Over-mature |
|---|---|---|---|
| Dominant | Rare | Rare | None |

## Table 8.4 Breeding bird diversity

| Species | Abu | Species | Abu | Species | Abu |
|---|---|---|---|---|---|
| Wren | F | Greenfinch | O | Swallow | O |
| Blackbird | O | Robin | O | Wood pigeon | O |
| Blue tit | O | Rook | O | Song thrush | R |

**Table 9.1. Summary of case study biodiversity characteristics**

| Case study area | Number of habitats per case study area | Habitat quality ratio High: Medium: Low | Number of tree species per case study area | Tree species Native: Non-native ratio | Tree structural diversity in order of greatest frequency Young: Semi-mature: Mature: Over-mature | Number of bird species per case study area |
|---|---|---|---|---|---|---|
| Monkstown | 5 | 0:3:2 | 12 | 4:8 | M/S/Y/O | 16 |
| Castleknock | 5 | 1:3:1 | 9 | 4:5 | Y/S/M | 12 |
| Dundrum | 8 | 2:3:3 | 21 | 7:14 | Y/S/M/O | 13 |
| Ongar | 5 | 2:2:1 | 19 | 7:12 | Y/M/S/O | 20 |
| Stepaside | 10 | 3:6:1 | 13 | 9:4 | Y/S/M/O | 13 |
| Swords | 12 | 4:5:3 | 27 | 9:18 | S/Y/M/O | 24 |
| Lusk | 5 | 0:2:3 | 12 | 5:7 | Y/S/M | 9 |

## Discussion

### Adding biodiversity value to a new or existing development.

Habitats of highest biodiversity value are those that support native flora and fauna in natural or semi-natural communities. Habitats are termed 'semi-natural' where the habitat is composed of native species but where there is a degree of human intervention, such as grazing or mowing (European Union, 1992). Natural and semi-natural habitats are valued above artificial or heavily modified habitats because they support a complement of native plant and animal species that have developed in balance with each other and reflect the abiotic environmental conditions present at that site. Natural and semi-natural communities are becoming increasingly rare in the wider landscape (NPWS, 2008) due to land use modification primarily associated with agriculture and urbanisation.

The space available for biodiversity, and the quality of that available space, is often diminished through urbanisation (European Commission, 2004). It is for this reason that effort is focused on minimising the potential impacts of development by identifying practical means of protecting, enhancing and creating habitats within new and existing development. The objective of this work is therefore to find means of assimilating or recreating habitats within the urban environment that most closely resemble their natural or semi-natural counterparts and thereby represent a more significant contribution to the biodiversity resource within the wider landscape.

The habitats of highest biodiversity value within the study areas are those that were incorporated into developments from the pre-development landscape or that have had sufficient time to mature and develop into valuable habitat. Mature woodland, treelines and river habitats achieve high value ratings within this study. These habitats were retained as existing features in the Dundrum, Ongar, Stepaside and Swords case studies. Woodland and trees in particular can take many years to re-establish following construction. Once incorporated, they add increasingly high biodiversity value to the sites and limit the duration

of construction impact on wildlife. Bird species use mature trees and hedgerows for cover and are more likely to return to a site if there is suitable habitat available.

The most common habitat types of moderate biodiversity value within the case studies are hedgerows, treelines, scattered trees and parklands. These habitats are predominantly young or immature and have the potential to achieve a high biodiversity rating with time. Other habitats of moderate biodiversity value that occur infrequently are neutral grassland, dry meadow and grassy verge, scrub, pond, marsh and drainage ditch. These semi-natural habitats commonly occur within the wider landscape and provide habitat for a variety of species. However, they are rarely incorporated or created within developments. They also have the potential to provide 'stepping-stones' and corridors for species movement within the landscape.

Habitats of low biodiversity value offer good potential for enhancement. Amenity grassland is the most common habitat found within all study areas and is of very limited biodiversity value. Flower beds and borders and ornamental non-native shrubs were also common habitats of low biodiversity value. These habitat types have high potential for enhancement through alternative species composition and management.

Traditional landscape design relies on planting new trees, ornamental shrubs, flower beds and borders and amenity grassland. There is potential to diversify development design by protecting and creating a diversity of habitat types. Maintaining larger open spaces with high habitat diversity, which are allowed to develop and mature over time, can maximise the potential for biodiversity value. A mosaic of grassland, scrub, woodland and wetland creates the greatest species-richness and structural diversity.

The early consideration of biodiversity resources is of greatest importance when incorporating biodiversity into development. A basic habitat assessment is required to identify biodiversity features on site. This process helps determine the viability of the development at an early stage by identifying major constraints, such as protected sites. In the event that no major constraints are identified, it will identify features, such as trees, woodland or watercourses, that require early consideration in the design phase and that present opportunities for biodiversity enhancement within the proposed development. A number of key elements should be identified within the landscape, including existing areas of low biodiversity value suitable for development, existing areas of biodiversity value and existing linear features with potential as wildlife corridors. The footprint of the development should be designed to avoid impacts on areas of high biodiversity value. Areas of semi-natural habitat should be incorporated into the development where possible. Extensive areas of heavily modified habitat, such as brownfield sites, improved agricultural grassland and arable land, have a low biodiversity value and are generally most suitable for development.

**Woodlands and trees**

Woodlands with complex, mature structure are of greatest biodiversity value. They take decades or centuries to develop and are therefore not easily recreated. Newly planted areas will take more than 30 years to begin to resemble mature woodlands. Woodlands typically consist of layered vegetation, starting with the upper canopy of mature trees. An understorey of shrubs and ground flora, which is specially adapted to shade and moisture, develops

beneath this. Poorly structured woodland can be diversified by creating an understorey of native shrubs within the woodland that mimics its natural structure or, more simply but slowly, by removing any management, such as mowing and clearing, beneath the existing tree canopy. By not over-managing or tidying the area, the understorey and ground flora will evolve naturally with the other components of woodland structure, such as leaf litter, dead wood, fungi and microorganisms. Design should seek to maintain mature specimens and clusters with the view to replicating the natural structure of high quality woodland. The Swords case study provides an example of high quality, semi-natural woodland adjacent to the development.

The Stepaside and Castleknock case studies show a high proportion of native species used in new planting schemes. Using native species is preferable as it increases the distribution of native habitats and native trees support a greater variety of associated fauna. The choice of tree species will need to be cognisant of the location, and tree planting schemes should use species appropriate to the environmental conditions of the site, including soil conditions, availability of space and aspect. The eventual size of the individual trees in relation to the green space and surrounding buildings must be taken into consideration. Native species, such as ash, silver birch, downey birch, rowan, wild cherry and occasionally wych elm, are used in new planting throughout the case studies. Many of these are suitable for streets and confined places. Large open areas can support large specimens such as oak.

Many new developments have poor tree structural diversity, as the majority of individual trees are young or semi-mature. This will improve over time as trees mature. Monkstown is an example of a mature development where tree structural diversity is good, and individuals occur across the range of age classes from young to over-mature, with the highest abundance in the mature age class. Mature specimens will generally host a high level of biodiversity. In natural woodland conditions, over-mature trees will fall and create new spaces for young seedlings and saplings. However, in heavily managed conditions, and where public safety and perception are important, this is unlikely to occur naturally. Where it is not feasible to allow large quantities of deadwood to remain, cut boughs and logs could be left to decompose naturally in certain areas, in an effort to recreate woodland conditions. New planting will be required, as natural regeneration of seedling and saplings is unlikely to occur under intensively managed conditions. The Monkstown case study also provides an example of how rare native trees, such as the strawberry tree and yew, can be grown successfully in urban environments, enhancing species richness and increasing the stock of native species that have now become rare within the wider landscape.

**Hedgerows and shrubs**

Many sites support hedgerows. The Dundrum case study provides an example of mature, species-rich hedgerows with good structure incorporated into an urban development. Hedges of native species, including hawthorn, hazel and blackthorn, provide an alternative to common urban hedge species, such as grizalinia or beech, that have very limited wildlife value. Less common species, such as yew, holly and spindle, can also be used, or interspersed with more common species to enhance diversity.

Many of the sites support ornamental non-native shrubs. These are labour intensive and expensive planting regimes. There is potential for substituting native shrubs for ornamental and non-natives. Native species have the advantage of being adapted to the Irish climate and

conditions and are more likely to thrive. Using shrubs on the edge of wooded areas to grade into other habitats, such as grassland, can improve structural diversity. Where appropriate, the diversity of species can be broadened to include non-native wildlife-friendly species. Many non-native species are valuable for wildlife but should be used in a limited capacity. They produce copious nectar and provide essential cover for nesting, roosting and hibernating wildlife. However, it is vital that advice is sought to ensure that no invasive species are used. With careful planning, a planting scheme can be devised to produce flowering and fruiting through the year. This provides an almost continuous food source for wildlife. Allowing leaf litter to accumulate encourages the presence of invertebrates that live in the soil underneath. As many species live in the leaf litter below as they do in the branches and leaves above. Avoid the use of mulch, which prohibits birds from foraging in the soil for invertebrates.

**Grasslands**

The most widespread habitat within the study areas was amenity grassland, which is created using standard ryegrass mixes. These mixes typically contain very few species and are mostly non-native. The management of amenity grassland is typically intensive mowing, creating a short, homogenous sward of very limited biodiversity value. Amenity grassland creates an impression of well-maintained, open green space in urban areas and is appropriate in certain situations. However, its dominance in built areas reduces the potential extent of other, more diverse habitats within the limited open space of the urban environment.

The alternatives to amenity grassland are to replace some of it with other habitats described above, or to create more species-rich grassland through reseeding or management. The key to establishing species-rich grassland is creating and maintaining low nutrient levels in the soil. Soils that have nutrients added through artificial fertiliser take a long time to deplete and support the growth of only a few vigorous herbs. Reuse of top-soil from grasslands with moderate to good species-richness during landscaping will encourage natural vegetation to redevelop.

Other methods of creating a more species-rich sward include the use of wildflower seeds, of local provenance where possible. Use of hay from nearby wildflower meadows provides a good source of seeds but these are hard to obtain in large quantities.

Moderate quality grasslands can be diversified over time through good management. The Ongar case study is an example of how a grassland with moderate species-richness can be enhanced by allowing areas to grow tall during the summer months. This allows existing flowers to grow and set seed. It also provides habitat and a food source for birds and invertebrates such as butterflies. Grass cuttings should be collected after mowing to help lower the nutrient levels in the soil over time and help improve species diversity. Chemicals such as herbicides, pesticides and fungicides should be avoided where possible as these reduce species diversity and interrupt the natural flow of nutrients in the ecosystem.

A verge of un-mown grassland on the edge of more intensive grasslands can enhance species and structural diversity. In the Dundrum case study, many more species occur in the un-mown grass verge than in the adjacent amenity grassland. Altering the mowing regime in certain areas will create structural diversity in grassland areas. Other options involve leaving certain areas un-mown for periods during the summer season or maintaining a strip of tall grass at the base of hedgerows to create habitat diversity.

Low intensity managed areas can create the impression of neglect among the public. Where public perception is an issue a swathe can be cut around or through tall grass or wildflower areas to show that the area is being managed and not abandoned. In addition the use of interpretive signage can be used to show that the management is part of a local biodiversity initiative.

Alternative uses of amenity grasslands can also be incorporated into developments. A valuable alternative is the implementation of Sustainable Drainage Systems in new sites such as Stepaside. SuDS are described further below.

**Wetlands**

Water is vital for all life forms. In urban areas where hard surfaces predominate, there can be a lack of available water for species. Water features can dramatically enhance the biodiversity value of the site by creating habitat for wetland plants and attracting wildlife such as birds and invertebrates. Watercourses should be maintained as close to their natural state as possible. In the Swords case study, the river shows a high level of naturalness where there is a mixture of open banks and over-hanging bankside vegetation. Where planting is required, species should be native and vegetation should form a gradient from herbaceous emergent species at the water's edge to taller woody species on the bank. The threat posed by invasive species has been cited as one of the principal causes of biodiversity losses globally (Millennium Ecosystem Assessment, 2005). It is important to ensure that invasive species are not used in terrestrial or aquatic planting schemes. Watercourses and ponds provide an easy conduit for invasive species to spread and extra care should be taken in relation to planting near waterbodies. Maintaining a buffer of semi-natural vegetation around the perimeter of the pond or along the bank of the watercourse will help prevent run-off from adjacent areas, particularly amenity grassland, entering the water. Excess nutrients cause a build-up of nutrients and eventually eutrophication, which lead to lower oxygen levels in the pond and lower the diversity of plant and animal species that can survive within it.

Culverting of watercourses should be avoided where possible. Where unavoidable, stream crossings should use good culverting design and construction. The Stepaside case study is an example of a new culvert incorporating a wide mammal ledge where species such as otter can pass through safely.

It is important to avoid building on floodplains and to incorporate these features into the design as flood protection and water management features where appropriate. The Swords case study shows an example of how retained floodplain can provide an important landscape element that provides excellent biodiversity value while enhancing the amenity value of the site.

Artificial wetlands such as those used in Sustainable Drainage Systems (SuDS) provide an opportunity to combine effective water management and habitat creation. Built-up areas are traditionally drained using underground pipe systems, which are designed to prevent flooding locally by conveying the water away as quickly as possible. This can alter the natural flow patterns and can lead to problems of flooding elsewhere in the catchment. Surface water drainage methods that take account of quantity, quality and amenity issues are collectively referred to as Sustainable Drainage Systems (SuDS). The Stepaside case study provides an example of a SuDS system incorporated into a high-density urban development. In addition

to treating run-off from the site, the grassed swales convey surface water run-off and provide an alternative use for amenity grassland; and ponds that receive run-off from the development prior to discharge to a watercourse act as valuable biodiversity features. The management of surface water run-off from development has become a significant feature of landscape planning in recent time and is likely to grow in importance as climate patterns produce increased rainfall at high intensity. Swales and other areas of permeable surfaces allow rainfall to percolate into the ground and help reduce the overall effects of intense rainfall events.

**Connecting to the wider landscape**

The spatial arrangement of habitats can contribute to the biodiversity value of the site. Trees planted in small clusters, such as in the Dundrum and Castleknock case studies, form closed canopies when mature, thereby simulating a woodland canopy. Insects and birds in particular will respond well to this and make use of closed canopy and cover (Walters, 2007). Alternatively, the linear arrangement of trees into treelines can provide corridors for the movement of species and connect habitat patches in a fragmented landscape.

Maintaining and creating linear strips, or corridors, for wildlife movement using semi-natural habitats including watercourses, hedgerows and treelines will help maintain connectivity with the surrounding landscape. Treelines and hedgerows provide important links to the surrounding landscape. The Stepaside and Lusk case studies provide examples of severed hedgerows that were incorporated into developments. These provide an opportunity for enhancement by re-establishing these landscape connections. Transport corridors such as roads, railways, tramlines and canals can be used as wildlife links when appropriately landscaped with good quality semi-natural vegetation.

The corridors and stepping-stones of greatest value are large areas that support high quality semi-natural habitats. 'Stepping stones' can be created using patches of habitat. These are patches of similar habitat close to each other but that are not physically connected. For example, five or six small patches of woodland in the same area can provide a means of movement for some species that do not need continuous cover.

A linear feature designed to help maintain connectivity may have a second function as a buffer zone. Buffer zones can be used to protect habitats or species sensitive to disturbance. Buffer zones are most frequently used along rivers and around other waterbodies.

**Green buildings**

Buildings themselves can provide habitat for wildlife. A number of design features can be added to enhance the potential for biodiversity, such as incorporating green roofs and green walls, which provide habitat and a food source for certain wildlife. Other features such as bat boxes and bird nest boxes can be used as prescribed by a qualified ecologist to compensate for the loss of habitat or enhance the potential of the site. A wide range of artificial structures is available to encourage different species, which can be attached to the outside of buildings. Building design can be adapted to incorporate artificial boxes or voids for use by crevice nesting birds and bats. There is potential for incorporating bat and bird boxes as standard features in underground areas where warm, dry and dark conditions predominate. Features such as ledges, which are sometimes used by kestrels, brick gaps or specialised bricks in building, and gaps between roof tiles or specialist roof tiles, can promote nesting and roosting.

Good garden design, which arranges gardens so that they form a connecting line (back-to-back and side-to-side) and create linkages with adjacent public green space helps to maximise the connection between green spaces.

**The economic value of biodiversity enhancement**

Semi-natural habitats require minimal maintenance. This has two benefits. Firstly, a habitat that is near its natural condition has greater biodiversity value. Secondly, it is less expensive and less time consuming to maintain. It is often more cost-effective to incorporate existing landscape features such as trees, streams or ponds at the outset of the development rather than recreate them at a later stage. Adding existing landscape features to the development is likely to cut down on expensive landscaping and the use of exotic species. The use of native species in landscaping may also be cheaper, as native species are adapted to environmental conditions and are more likely to succeed. This reduces the failure rate of new planting and the need for replacement planting at a later stage. Less intensive management practices are also cheaper because they require less intervention through mowing, reseeding and the use of chemicals.

Studies have indicated that trees in residential areas can increase property values by 6 per cent and 15 per cent (Johnston & Newton, 2004). Shoppers may be willing to pay up to 11 per cent more on leafy streets (University of Washington, 1998).

**Conclusion**

Biodiversity is a limited natural resource that is impacted through urbanisation. Sensitive development and habitat management can protect and enhance biodiversity resources within the urban environment. Mature woodland, mature treelines and riverine habitats had the highest biodiversity value within the case studies recorded. Habitats with moderate biodiversity value, including hedgerows, scattered trees and parklands, occurred frequently and had good potential for enhancement through supplementary planting and mature development with time. Other semi-natural habitats that support biodiversity within the wider landscape, such as semi-natural grasslands, scrub, ponds, marsh or drainage ditches, occur infrequently within the case studies. The most widespread habitat found on all sites is amenity grassland, which has low biodiversity value. Flower beds and borders and ornamental non-native shrubs were also common habitats of low biodiversity value. These habitat types have potential for enhancement through alternative species composition and management. All of the case studies have the potential to support higher levels of biodiversity through diversifying existing habitats or allowing them to mature. The biodiversity value of a site can be enhanced through a number of measures: retaining significant features of biodiversity value at the outset of the development; allowing trees and woodland to mature; diversifying traditional planting schemes to incorporate more native and wildlife-friendly species; diversifying management, such as the use of alternative mowing regimes; and creating a mosaic of habitats within a site.

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