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Ecomimicry for Barking Riverside: Achieving locally contextualised biodiversity-led multifunctional urban green infrastructure



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Ecomimicry for Barking Riverside

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1. What is it about?

Urban Green Infrastructure (UGI) has the potential to provide multifunctional ecosystem service benefits in urban areas. Central to this is biodiversity conservation. It is being increasingly realised that biodiversity is central to supporting diverse ecosystem services that can contribute to urban resilience and thus to quality of life for urban communities. To support locally important biodiversity there is a need to design UGI for target species/habitats rather than relying on the assumed benefits of installing something green (i.e. green wash).



Small-scale green roof bike shelter: an example of multifunction UGI
[\[www.greenroofshelters.co.uk\]](http://www.greenroofshelters.co.uk)

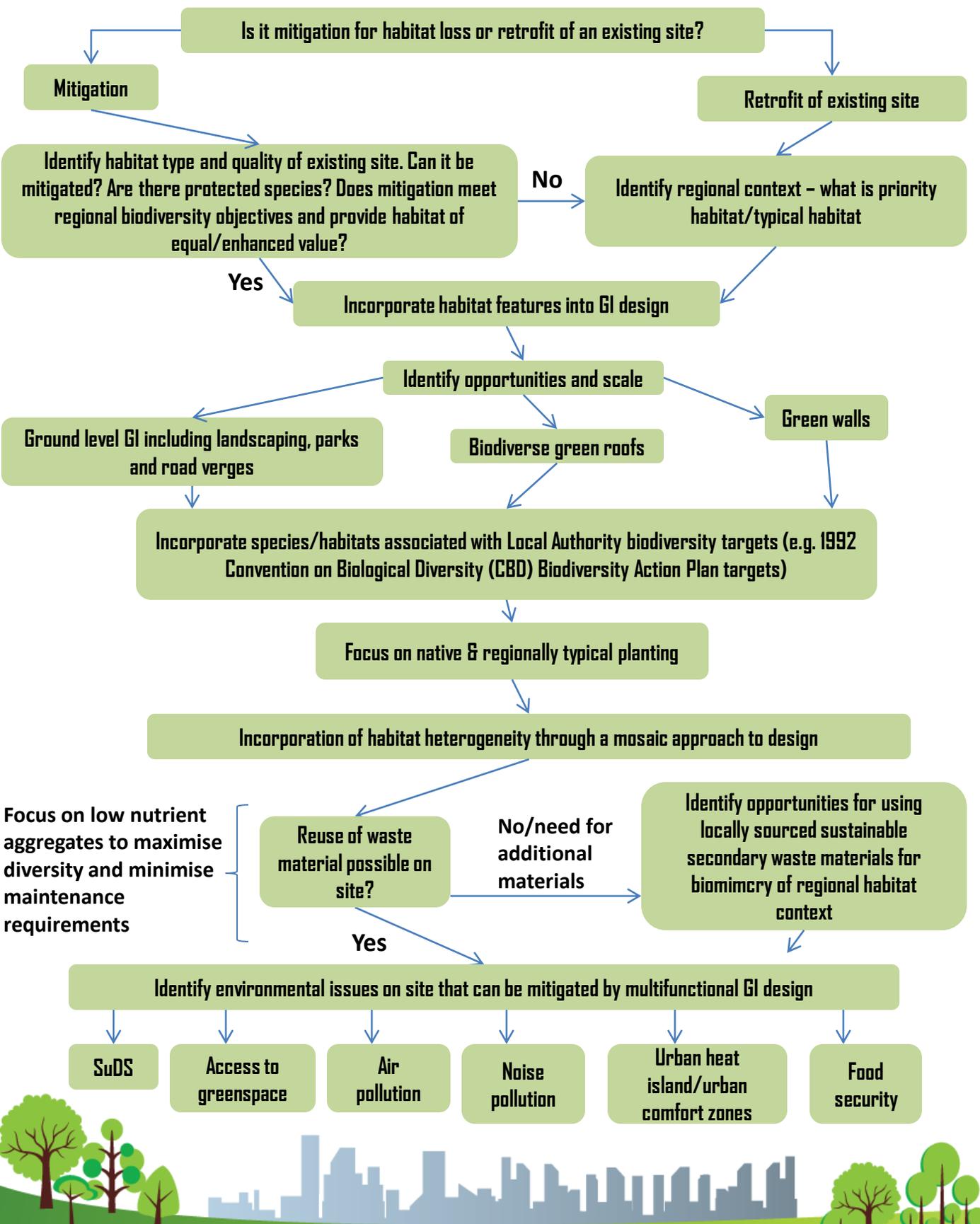


Biosolar roof at the Olympic Park, London, that incorporated ecomimicry principles into the design

2. Ecomimicry design principles

Taking inspiration from natural and semi-natural habitats (biomimicry) is central to the design of UGI in order to restore ecosystem services in urban areas. However, it is possible to take this further by incorporating 'ecomimicry'. This is the practice of taking inspiration in design from substrates, plant diversity and habitat structure typical of local habitat of regional, national or international conservation value. By adopting these design principles it is possible to achieve biodiverse and multifunctional UGI that provides broad ecosystem services and meets development mitigation targets in terms of the protection and conservation of biodiversity.

Processes for achieving biodiversity-led multifunctional urban green infrastructure (UGI)



Focus on low nutrient aggregates to maximise diversity and minimise maintenance requirements





Barking Riverside pre-development

3. Recent history of the Barking Riverside site

Originally marshland, the site was drained and a coal-fired power station was built in the 1920s. Deindustrialisation of urban areas brought closure to the power station in the 1980s and the site remained unmanaged until purchased in 1994. Largely covered in pulverised fly ash (PFA) during the operation of the power station, the site developed a rich mosaic of habitats from saline lagoons to flower-rich areas and drought-stressed scrub. The combination of low nutrient friable substrates and lack of management intervention meant that the site developed a diverse and important biodiversity including wildflowers, insects, birds, reptiles and mammals.

4. The development and planning consent

Planning consent was sought to create a new community on the site comprising approximately 11,000 homes, and associated infrastructure. Central to the planning consent was recognition of the semi-natural state of the brownfield (post-industrial) site and the challenge of conserving the multifunctional ecosystem service values of the site within the new community. This included conserving the value of the site as a haven for biodiversity through innovative greenspace creation, the inclusion of green roofs on properties, and UGI-focused Sustainable Drainage Systems (SuDS). Following planning consent, Barking Riverside Ltd began a rolling programme of construction on the new development in 2010.



Artist's impression of the Barking Riverside Development



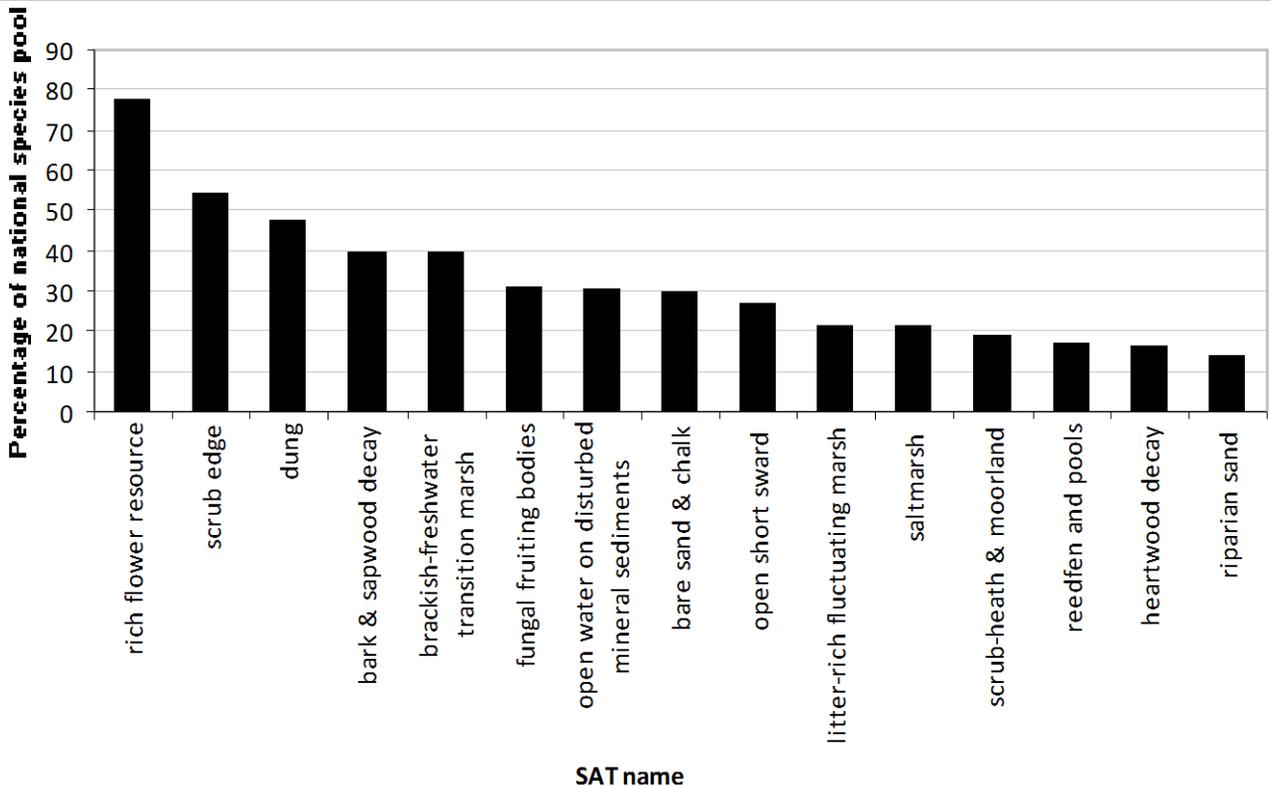
“brownfield sites can represent the last remnants of urban wildspace, the last unmanaged areas in our urban and peri-urban landscapes”



5. Open Mosaic Habitat on Previously Developed Land

Brownfield sites in the Thames Gateway represent the last remnant pockets of wildspace in urban areas and thus some of the last sites to support a broad range of ecosystem services. Central to this is the biodiversity that can be found on these sites. A network of brownfield sites in the East Thames Corridor have been recorded supporting invertebrate populations of national importance along with a host of other key conservation priority groups including birds (e.g. black redstart, linnet), reptiles (adders, grass snakes), amphibians (great crested newts). and mammals (water vole, bats). The importance of brownfield habitat was officially recognised recently when Open Mosaic Habitat (OMH) on Previously Developed Land was added to the UK Biodiversity Action Plan as a Priority Habitat.

Brownfield sites are under greatest pressure from Thames Gateway development. The highest quality sites are being lost to development at an alarming and unsustainable rate. For development in the region to be environmentally sustainable, nationally important invertebrate populations in the region must be protected. Redevelopment of urban greenspace represents an opportunity to achieve this. By incorporating the floral diversity and diversity of habitat features typical of brownfield sites into urban landscape design it is possible to make our urban landscapes more permeable to biodiversity and create connectivity between key brownfield and semi-natural sites in the region.



Habitat associations of invertebrate assemblages on Thames Corridor brownfield sites
(Data from Buglife All of a Buzz project analysed using Natural England's ISIS software)



6. Opportunities for habitat creation

The value of brownfield sites lies in the complexity of microhabitats within the wider mosaic combined with a lack of regular management intervention. This combination supports species throughout their lifecycles. Central to this is availability of open flower-rich resources disturbed randomly to ensure that substantial standing seed head resources are left for over-wintering insects. This resource is juxtaposed against other essential components of the brownfield mosaic. These components include:

- shelter belts of mid/late successional trees and bushes;
- early successional ruderal and scrub habitats;
- south facing slopes;
- bare disturbed ground that heats up rapidly;
- a variety of aggregates;
- ephemeral pools/standing water;
- seasonal wet areas or inundation communities.

This habitat mosaic and rotational disturbance regime is thus something that should be aspired to through ecomimicry in urban green infrastructure design at Barking Riverside.



7. Key invertebrate assemblages and associated habitats at Barking Riverside

Rich flower resource



This assemblage is commonly recorded on sites with a diverse and abundant flora with a long flowering season. Assemblage associated with open, drier areas and with low levels of management, or with areas prone to drought and nutrient-stress. These conditions prevent scrub development and maintain the diverse flora which provides nectar and pollen resources. The presence of stems of plants or areas of bare ground for nesting is also a requirement for the occurrence of this assemblage.

Reedfen and pools



This assemblage type is characterised by a number of invertebrate groups, particularly two-winged flies and beetles, and is largely restricted to mires and fens. Supporting sites tend to be floodplains or lake margins. Such sites tend to experience significant water-level fluctuations but the substratum rarely dries out completely. Elements of this assemblage type can occur extensively around the margins of ponds and ditches, particularly in association with beds of tall monocots.

Open short sward



Associated with lowland habitats where grazing or cutting of vegetation over calcareous soils limits the development of taller vegetation. Soils are generally nutrient poor restricting the development of grasses and encouraging the widespread development of broad-leaved-herbs. A mosaic of bare ground, shorter vegetation and taller scrub vegetation is considered to be important to provide habitat requirements for nesting, feeding and for thermophilic larvae. South facing slopes and floristic diversity are considered to be a particularly valuable features.

Bare sand & chalk



Contains species associated with the hot dry soil conditions normally found on bare ground in early successional habitats. Assemblages are generally also dependent upon the proximity of other structural vegetation to satisfy all life cycle requirements, nectar and pollen for food and stems and leaf litter for nesting. Such habitat can be maintained by a range of disturbance processes both natural and anthropogenic. Many associated species have thermophilic larvae and therefore bare ground on south facing slopes is particularly valuable for this assemblage.



7. Key invertebrate assemblages and associated habitats at Barking Riverside

Seepage



Associated with groundwater sources which constantly saturate the soil, resulting in soils containing a high proportion of organic matter. Vegetation is often limited and deadwood is an important component of these seepages. Such conditions tend to be found in limestone and some chalk districts.

Scrub edge



Assemblage represents species associated with early successional habitat matrices and close sward grass matrices. The assemblage is most commonly recorded in scattered scrub or woodland interspersed with open areas of grassland, heathland or early successional vegetation types. Assemblages are linked to scrub management and the maintenance of graded edge habitats. This assemblage would be associated with drier areas of the sites where scrub develops but succession to woodland is prevented by disturbance.

Scrub-heath & moorland



This assemblage type is characterised by a wide range of invertebrate groups, but beetles and spiders represent important components. It is associated with nutrient-poor acid soils where herbaceous or dwarf shrub vegetation is dominant, although trees and taller shrubs can be an important component of the overall habitat. It occurs on both damp and dry soils. On Thames coastal sites, invertebrates from this assemblage are most likely to be associated with areas of low scrub possessing a certain degree of floral diversity.

Dung



Characterised by beetles and two-winged flies. Assemblages are associated with the presence of grazing livestock on a site and absence of veterinary broad spectrum de-wormers which are considered to impact invertebrates within this assemblage. Horse grazing on the BR site may explain the presence of the dung assemblage.



7. Key invertebrate assemblages and associated habitats at Barking Riverside

Heartwood decay



Species tend to be associated with small pockets of heartwood decay and a proportion of two-winged flies have aquatic or semi aquatic larvae within waterlogged decayed woody tissues. The species tend to be associated with old growth and require space for sunlight to reach trunk and main boughs to increase temperatures for larval development and adult flight. Also open areas with flowers and shrubs because the adult stages of many insect species feed on pollen and nectar.

Bark & sapwood decay



This assemblage type is characterised by beetles which are found in and around trees and shrubs, particularly older specimens. Primarily associated with the death and decay of outer woody tissues and with sap runs. Adjacent areas of flower-rich forbs and shrubs are important for the adult stages of many species in this group. As with the heartwood decay assemblage, this type is likely to be associated with old growth woodland, scrub, or even individual trees within the site, as well as with the flower-rich areas found on drier, disturbed areas.

Data for this overview of Barking Riverside key Open Mosaic Habitat assemblages was taken from the site Environmental Impact Assessment Ecological Survey : *Barking Riverside (2004) Ecological survey and assessment: Environmental statement technical appendix 9, Barking Riverside Ltd, Renwick Rd London, UK.*

Analysis of key invertebrate assemblages on the site prior to development is taken from a consultancy report produced for London Wildlife Trust: *Connop, S. (2010) Barking Riverside ISIS Invertebrate Assemblage Analysis. Report produced by the University of East London Sustainability Research Institute.*

Descriptions of habitat features of conservation value associated with the assemblages of ecologically restricted species recorded at the Barking Riverside site are taken from Natural England's ISIS invertebrate analysis tool supporting literature: *Drake, C.M., Lott, D.A., Alexander, K.N.A. and Webb, J. (2007) Surveying terrestrial and freshwater invertebrates for conservation evaluation. Natural England Research Report NERR005, Peterborough, UK. and Lott, D., Alexander, K.N.A., Drake, C.M. and Foster, G.N. (2007) ISIS Invertebrate Species – habitat information system: Specific Assemblage Type Descriptions. Report produced by for Natural England, Stenus Research, Leicestershire.*



8. How can ecomimicry be achieved at Barking Riverside?

In order to begin to conserve the diversity of species found on the Barking Riverside site prior to development and to effectively mitigate these assemblages of national conservation importance within the new development, it is vital that ecomimicry of the habitats supporting these species is embedded into the design of urban green infrastructure for the site. The key opportunities for ensuring this happens are:

Green roof design



Incorporation of brownfield habitat features into landscaping



Creation of small-scale brownfield nature reserves



9. Ecomimicry in green roof design

Green roof design at Barking Riverside needs to move away from industry standard green roof systems vegetated with sedum blankets to biodiverse systems incorporating brownfield habitat features. This should include:



Blending different recycled aggregates to create different thermal properties, different water retention properties (therefore different rates of drying out), and different levels of organic matter. Thus supporting a greater variety of floral species.



Creating microtopography – a range of different substrate depths (75 to 200 mm) can provide diverse habitat niches suitable for different plant species. Creation of mounds can provide refugia for plants during drought spells.



Diverse wildflower floral mixes provide for a broad range of pollinators. They also create greater tolerance to environmental extremes such as drought and waterlogging. Planting lists should mimic species on Thames Corridor brownfield sites.



Deadwood piles provide a resource for saproxylic invertebrates. They also provide a refugia from environmental extremes for plants and insects.



9. Green roofs



Rubble piles provide refugia for plants and animals. They provide shelter for insects, but also create shading that alters the microclimate of the substrate. This can create different moisture regimes impacting floral development.



Creation of ephemeral wet areas can have substantial biodiversity benefits. Many species associated with brownfield sites are dependent upon such sources of standing water within which predatory species such as fish are not able to persist.



Permanent wetland areas can also be created on green roofs. This can provide a varied hydrological regime for broader floral and faunal biodiversity in addition to providing for wetland species associated with brownfield sites and a source of water for birds.

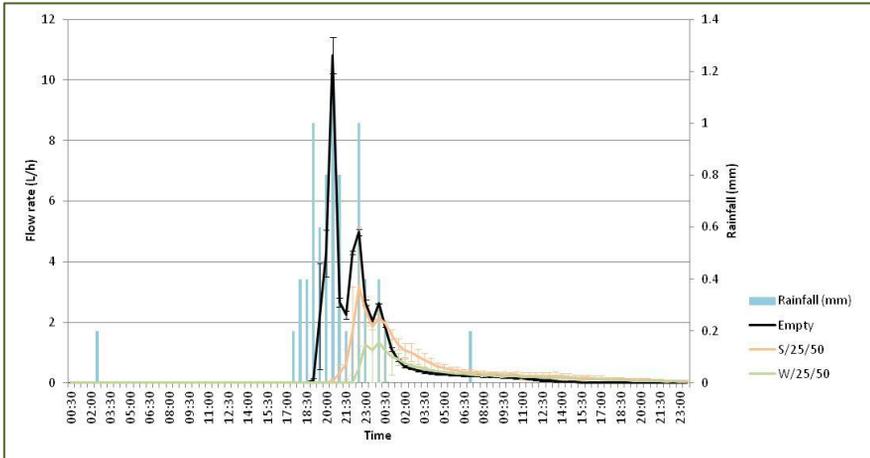


Nesting/hibernation habitat – bug hotels provide nesting opportunities for pollinators enabling them to exploit the wildflower resources.



9. Green roofs

Research carried out at Barking Riverside as part of TURAS has demonstrated that biodiverse roofs have greater value in terms of ecosystem service provision than equivalent industrial standard systems. A field experiment provided evidence that biodiverse green roofs perform better than equivalent sedum systems for wildlife such as pollinators. They also perform as well as or better than sedum green roofs systems for both water attenuation and thermal insulation. Moreover, costs for biodiverse green roof systems are comparable with equivalent sedum-based systems with both systems substantially cheaper than intensive and semi-intensive green roof solutions.



Further reading on biodiverse green roof design and benefits:

- www.livingroofs.org
- Connop, S. and Nash, C. (2014) Barking Riverside Green Roof Experiment: Phase 2. London: University of East London.
- Connop, S., Nash, C., Gedge, D. Kadas, G, Owczarek, K and Newport, D. (2013) TURAS green roof design guidelines: Maximising ecosystem service provision through regional design for biodiversity. TURAS FP7 Milestone document for DG Research & Innovation.
- Gedge, D. Grant, G., Kadas, G. and Dinham, C. (2012) Creating green roofs for invertebrates: A best practice guide. Buglife Report, Peterborough, UK.
- Kadas G. 2006. Rare Invertebrates Colonizing Green Roofs in London. Urban Habitats. 4, 66-86.
- Nash, C., Clough, J., Gedge, D., Newport, D., Ciupala, M.A and Connop, S. (2015) Initial insights on the biodiversity potential of biosolar roofs: A London Olympic Park green roof case study. Israel Journal of Ecology & Evolution: Green Roof Special Edition.



10. Brownfield landscaping

By combining urban landscaping design principles with brownfield habitat features it is possible to enhance the biodiversity value, ecosystem service provision and aesthetics of small-scale urban green infrastructure interventions. Using such a multidisciplinary approach makes urban areas more permeable to biodiversity, enhancing the role that urban areas can play in supporting wildlife that is disappearing from the broader landscape. It also provides a mechanism for achieving much more focused mitigation for habit loss during site development and achieves landscaping with lower management requirements than comparable traditional landscaping resulting in lower costs and reduced fertiliser and fossil fuel inputs.

Inset 01 - Plan View of Projects Office Entrance

Inset 02 - Plan View of Sand Bank Bee Habitat

Inset 03 - Section Drawing Through Bee Bank

Inset 01 - Notes:

- 1) Sand Bank Bee Habitat.
- 2) Planting Pocket set 5m into the bank creating a sheltered mass of nectar rich flowering shrubs.
- 3) Ornamental woodland set 1m into the bank providing shelter and further shade.

- Nectar rich flowering shrubs
- Struck Planting
- Overwintering habitat - tessellated areas set on a 1 year rotation
- Herbaceous Planting
- Indigenous Hedger
- Stone Drain
- Clover & Wildflower
- Shade plants within bark mulch and log piles
- Bee Habitat Land Bank
- Proposed Trees
- Arsenic Cut Grass

Inset 02 - Notes

A habitat will be created for bees such as the Brown Banded Carder Bee and the London B&W Doves, the Mining Bee, Andrena Fictor. Bees burrow into sandy cliff faces and banks where it is warm dry and safe from predators.

This habitat will be created part way in the soil bank and come out with an additional bank, created by layers of different sized stone aggregate.

The bottom of this area will be a haven of nectar rich shrubs and herbaceous plants including:

Red Dead Nettle
Sedum 'Goldenrod'
Salvia officinalis 'Purpurea'
Rudbeckia 'Black seed sunset'
Euphorbia
and wild flower

The bottom of the bank will be laid out like a dry garden with large boulders and plants, all grass areas on the bank will be rich in clover and wild flower species.

Inset 03 - Section Drawing Through Bee Bank

Layers of aggregate, sizes from 1-20mm

Boulders to support the structure and retain aggregate.

D/F Clark Contractors	
Barking Riverside Ltd	02 10 2008
Projects Office	MT-0-A2
Bee Habitat	DFC 1047 1044
	LAK
	DFC
	DFC

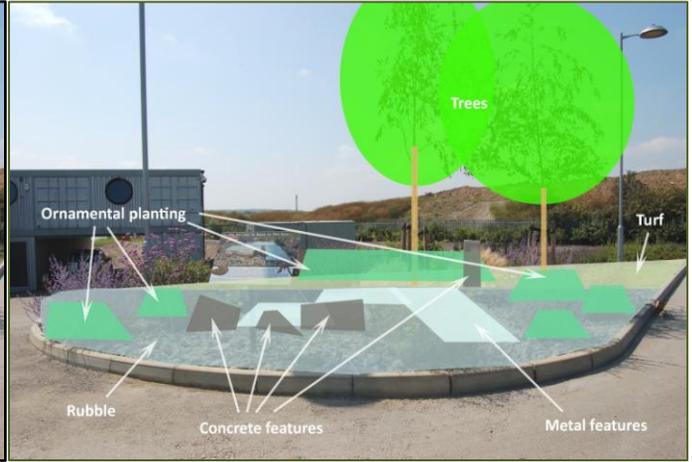
Notes

1. To be left from the planting
2. Contractors must check all dimensions on the drawings and report any discrepancies to the landscape architect
3. The drawings are intended for use by the contractor
4. The drawings are intended for use by the contractor

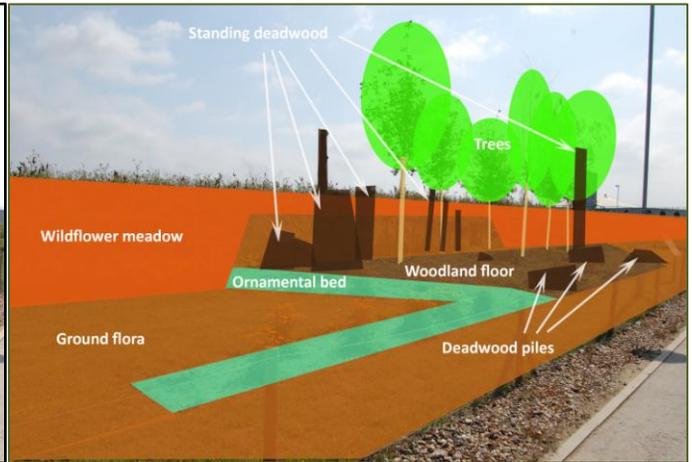
Brownfield landscaping designs - DF Clark Ltd designed and installed an innovative brownfield landscaping trial at Barking Riverside site offices. This landscaping has been monitored by TURAS researchers to assess its performance and to compare it to more traditionally designed landscaped areas of the development.

10. Brownfield landscaping

Examples of habitat features that can be incorporated into brownfield landscaping include:



Ornamental planting of nectar and pollen-rich plants combined with rubble, concrete features and sculpted metal features provides forage for pollinators, niches for ground beetles and basking areas for lizards and thermophilic insects

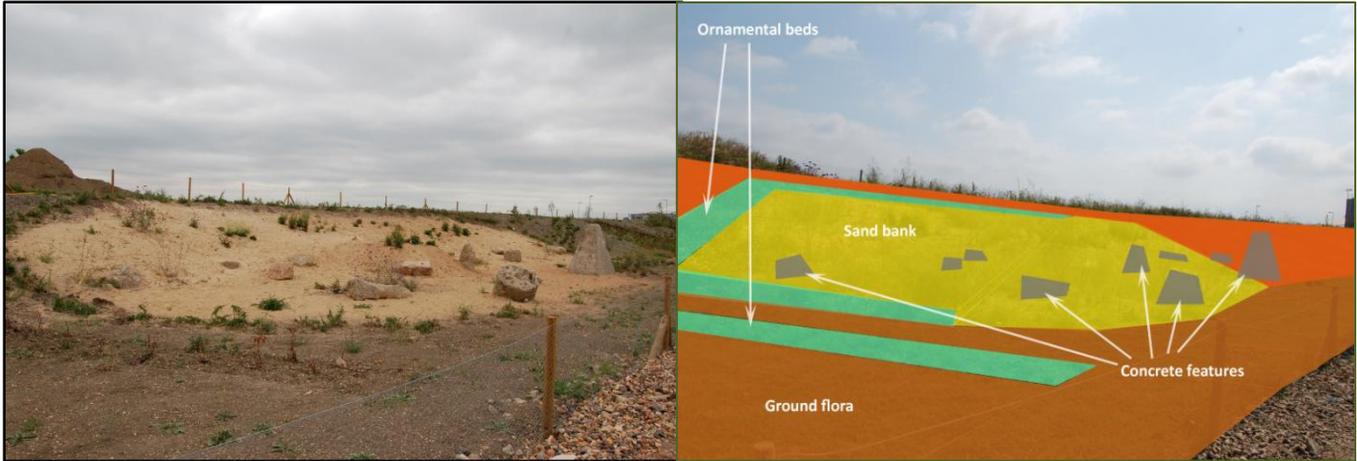


Amenity grass combined with ornamental areas and wildflower areas provide resources for pollinators including grassland insects such as butterflies and bumblebees. Woodland pockets with scrub, deadwood piles and standing deadwood provide vital resources for saproxylic insects and ground beetles such as lesser stag beetles.

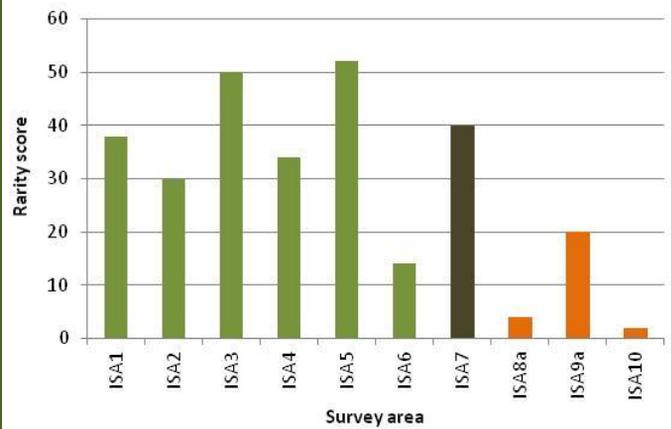
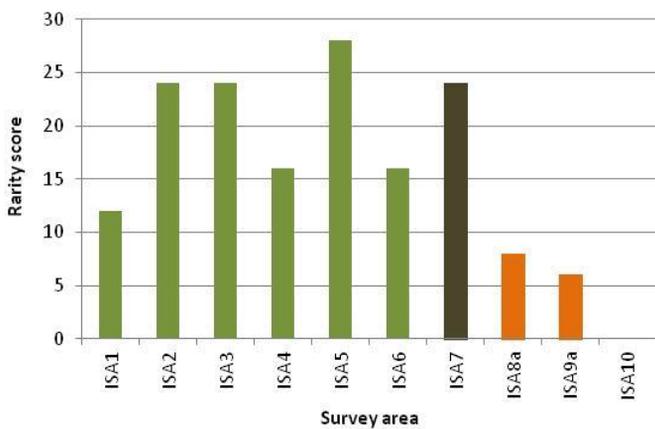


10. Brownfield landscaping

Examples of habitat features that can be incorporated into brownfield landscaping include:



South facing sand banks provide vital nesting resources for solitary bees and wasps. Providing these in close proximity to wildflower areas ensures that habitat features are available over the appropriate spatial scales for these pollinators. Combining these with concrete features and shrub planting provides structural complexity for spiders and basking opportunities for thermophilic insects.



Sweep net surveys and pitfall trap surveys recorded greater total rarity scores for conservation priority Araneae, Coleoptera and Hymenoptera species on brownfield landscaping areas (green bars) than the traditional landscaped areas (orange bars). Rarity scores on brownfield landscaping areas were similar to those recorded on neighbouring brownfield habitat (black bars).

Hairy-footed flower bee (*Anthophora plumipes*) on wallflower on the Barking Riverside brownfield landscaping

Further reading on brownfield habitats, landscaping design and benefits:

- Bodsworth, E., Shepherd, P. & Plant, C. (2005) Exotic plant species on brownfield land: their value to invertebrates of nature conservation importance. English Nature Research Report No. 650. Peterborough: English Nature.
- Buglife (2009) Planning for brownfield biodiversity: a best practice guide. Peterborough: Buglife.
- Connop, S., Clough, J. and Nash, C. (2016) Multidisciplinary urban landscape design guidelines: Barking Riverside green infrastructure opportunities. London: University of East London.
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- Connop, S. Lindsay, R., Freeman, J, Clough, J., Kadas, G. and Nash, C. (2014) TURAS multidisciplinary urban landscape design guidance: Design, incorporation and monitoring of Barking Riverside brownfield landscaping. University of East London, London, UK.
- Connop, S. (2011) Barking Riverside Invertebrate Assemblage Analysis. Report produced for London Wildlife Trust, London.
- Harvey, P.R. (2000) The East Thames Corridor: a nationally important invertebrate fauna under threat. British Wildlife 12, 91-98.

11. Brownfield Nature Reserves

It is also possible to create areas specifically for species associated with brownfield habitat features by incorporating ecomimicry of high quality brownfield sites into the design of small-scale nature reserves or pocket parks. This has been trialled at the University of East London's Docklands campus as part of TURAS and has proved to be a very effective method for creating diverse habitat supporting a range of brownfield species. If designed appropriately the areas can also provide outdoor laboratory research facilities, amenity areas and educational areas for local communities. Creation of small-scale brownfield reserves should include:

Using blends of different low nutrient aggregates, particularly those from recycled sources:



'As dug' quarry chalk



Broken sandstone brick



Thanet sand & recycled sand



Crushed concrete

11. Brownfield Nature Reserves

Other features that can be incorporated in brownfield nature reserves include:



Wildflowers typical of Thames Corridor brownfield sites



Sculpted features can add to the aesthetics of the site design



Organic sculptures can provide an exhibition opportunity for local artists/schools and also create additional niches for wildlife



Information boards provide opportunities to inform communities about local heritage and biodiversity

11. Brownfield Nature Reserves

Wildlife groups and conservation priority species that would benefit from brownfield reserves:



The interface between the soil and bricks/rubble provides a niche for ground beetles like the streaked bombardier beetle (*Brachinus sclopetus*).



Diverse flora provides suitable forage for bumblebees and other pollinators including common carder bees and brown-banded carder bees (*Bombus humilis*).



The habitat structure, particularly the range of vegetation structure, provides niches for spiders.



Birds such as black redstarts and linnets benefit from the habitat features and abundance of insects.



11. Brownfield Nature Reserves

Examples of wildflowers that can be targeted for brownfield reserves in the Thames Corridor include:

Wild carrot (<i>Daucus carrota</i>)	Field scabious (<i>Knautia arvensis</i>)
Autumn hawkbit (<i>Leontodon autumnalis</i>)	Meadow vetchling (<i>Lathyrus pratensis</i>)
Red dead-nettle (<i>Lamium purpureum</i>)	Rough hawkbit (<i>Leontodon hispidus</i>)
Wild parsnip (<i>Pastinaca sativa</i>)	Oxeye daisy (<i>Leucanthemum vulgare</i>)
Red clover (<i>Trifolium pratense</i>)	Common toadflax (<i>Linaria vulgaris</i>)
Common bird's-foot trefoil (<i>Lotus corniculatus</i>)	Hoary plantain (<i>Plantago media</i>)
Red bartsia (<i>Odontites verna</i>)	Cowslip (<i>Primula veris</i>)
Autumn hawkbit (<i>Leontodon autumnalis</i>)	Self heal (<i>Prunella vulgaris</i>)
Narrow-leaved bird's-foot brefoil (<i>Lotus glaber</i>)	Meadow buttercup (<i>Ranunculus acris</i>)
Black horehound (<i>Ballota nigra</i>)	Bulbous buttercup (<i>Ranunculus bulbosus</i>)
Musk mallow (<i>Malva moschata</i>)	Yellow rattle (<i>Rhinanthus minor</i>)
Weld (<i>Reseda luteola</i>)	Common sorrel (<i>Rumex acetosa</i>)
Yarrow (<i>Achillea millefolium</i>)	Small scabious (<i>Scabiosa columbaria</i>)
Common knapweed (<i>Centaurea nigra</i>)	Red campion (<i>Silene dioica</i>)
Greater knapweed (<i>Centaurea scabiosa</i>)	Betony (<i>Stachys officinalis</i>)
Viper's bugloss (<i>Echium vulgare</i>)	Devilsbit scabious (<i>Succisa pratensis</i>)
Lady's bedstraw (<i>Galium verum</i>)	Dark mullein (<i>Verbascum nigrum</i>)
Meadow cranesbill (<i>Geranium pratense</i>)	Tufted vetch (<i>Vicia cracca</i>)
Common catsear (<i>Hypochaeris radicata</i>)	White bryony (<i>Bryonia dioica</i>)

Further reading on brownfield habitats, creation, management and benefits:

- Bodsworth, E., Shepherd, P. and Plant, C. (2005) Exotic plant species on brownfield land: their value to invertebrates of nature conservation importance, Peterborough.
- Buglife (2009) Planning for brownfield biodiversity: a best practice guide. Peterborough: Buglife.
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- Eyre, M. D., Luff, M. L. and Woodward, J. C. (2003) 'Beetles (Coleoptera) on brownfield sites in England: an important conservation resource?', Journal of Insect Conservation, 7(4), pp. 223-231.
- Harvey, P.R. (2000) The East Thames Corridor: a nationally important invertebrate fauna under threat. British Wildlife 12, 91-98.
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- Buglife Brownfield Resource Hub: <https://www.buglife.org.uk/brownfield-hub>
- OMH inventory: <http://habitatsurveys.esdm.co.uk/>
- UEL Beetle Bump Case Study (2014) Available at: <https://www.buglife.org.uk/sites/default/files/UEL%20beetle%20bump,%20London.pdf>



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