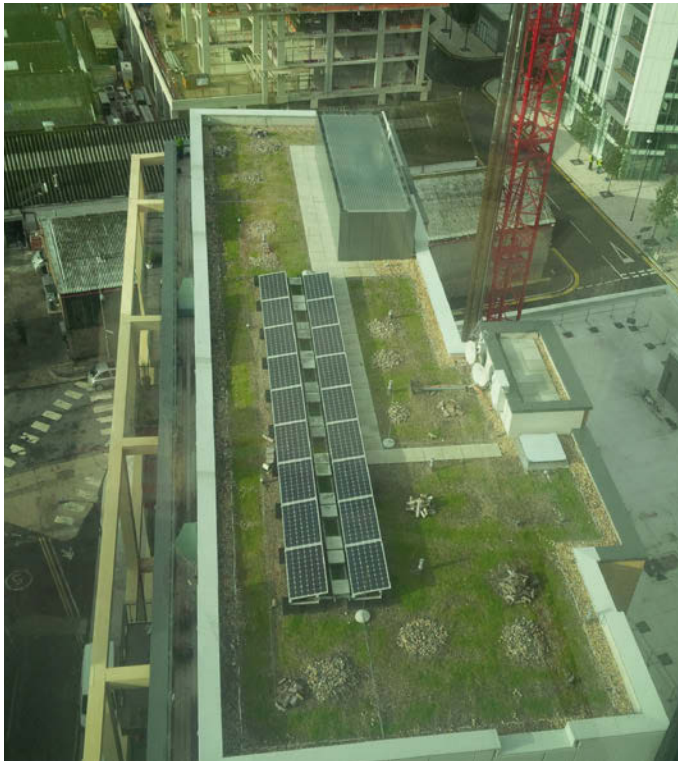
SkyGarden
GREEN SOLUTIONS

BIO-DIVERSITY

BIO-DIVERSITY AND GREEN ROOFING

Urban bio-diversity is closely linked to bio-diverse roofing as this offers in some places the only urban solution to achieving greening where ground based landscape cannot produce the diversity required or does not exist.

Biodiversity refers to the variety of species within focal ecosystems, the genetic variations they contain, and the processes that are functionally enriched by the diversity of ecological interactions.



Having the correct range of the plants, habitat areas and short and a long term evolution policies are crucial when developing a sustainable urban bio-diversity plan.

HABITAT DEFINITION

The habitat of a species describes the environment over which a species is known to occur and the type of community that is formed as a result. More specifically, "habitats can be defined as regions in environmental space that are composed of multiple dimensions, each representing a biotic or a biotic environmental variable.

DESIGN PROCESS

Sky Garden will design and install systems with a plant habitat profile that meets all demands of the site bio-diverse system requirements, harvest regionally sourced material for ground based habitats to encourage a range of insects, bees and ground based birds and provide wall based habitats for other flying species. The inclusion of nectar and pollen sources suitable to sustain foraging species like bees is also important so flowering spreads of selected plants are very important in the roof systems we construct.

COMPONENT SELECTION

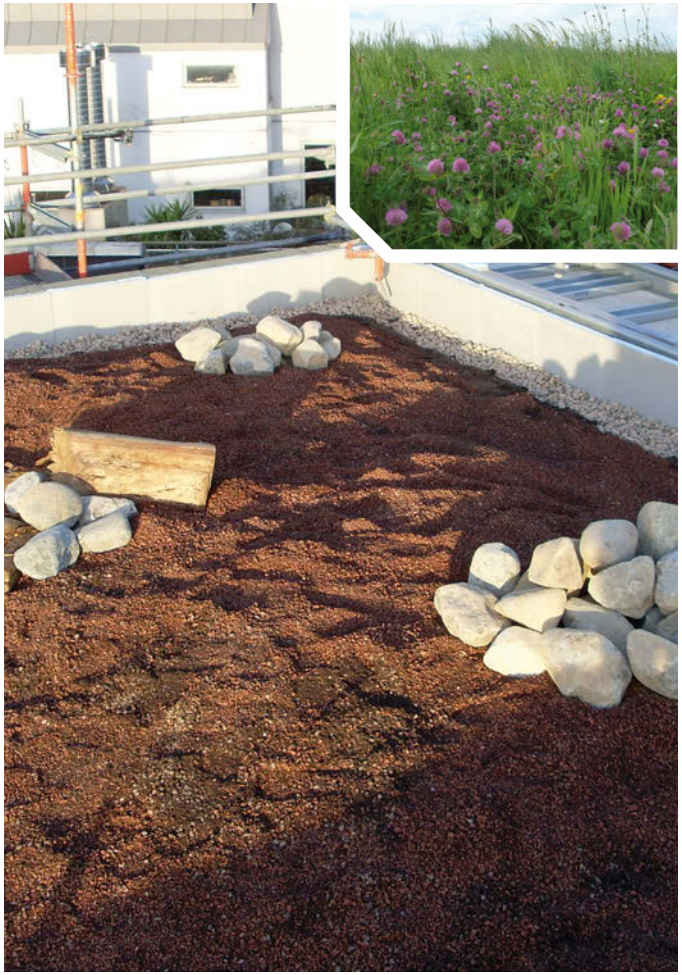
Systems should contain a percentage of site or local elements, a high percentage of recycled material (within substrate / drainage or plant material) and where imported material sources should be as close to the site as viable.

Bio-diverse and brown roof construction will utilise varied depths of substrate to create a range of different habitats.

Demolition waste can be incorporated once screened for contaminants but more commonly used for surface habitat creation.

Boulders, rock piles, sand and gravel beds, logs and seasoned wood encourage diversity and development of ground dwelling species.

Water management to hold water in designed wet land areas can be considered at design stage to further add system diversity.



HABITAT CONSTRUCTION

Habitat piles do not need to be large but should be numerous and away from the roof edge. Habitat piles are generally formed on a 1m² template every 50-250m² of roof area.

Invertebrate and insect hibernacula are part of the surface habitat design. These consist of natural materials arranged in a random design to replicate nature.

Bare areas with no vegetation encourage foraging for birds providing there has been allowance for invertebrate species development.

FORAGING PROVISION

Suitable plant species with pollen and nectar foraging potential will be required to ensure system sustainability for bee species in particular.

CONTOUR AND FINISH

Surface contour and a range of substrate, aggregates, sand and soil blends will offer a range of seed germination zones. A well contoured system will allow a wider range of plant species to evolve in a range of micro climates that would not be seen if the system was laid flat.

HABITAT FUNCTION

HABITAT CREATION

The major function of a bio-diverse / brown roof system is to achieve the requirements of the local BAP (Bio-Diversity Action Plan) or project bio-diversity assessment.

These documents will provide the key species of invertebrate, birds, bats and bees that the roof system aims to encourage.

SUBSTRATE CONTOURING

A contoured system provides greater diversity for invertebrate and key plant species development. A light contour will produce shelter belts that will maximise system diversity and encourage greater development than a flat system.

A contour of 20-50mm is normal to achieve a diverse surface finish although deeper is possible in accordance with roof construction management.

SURFACE HABITAT CONSTRUCTION

Surface habitats comprise

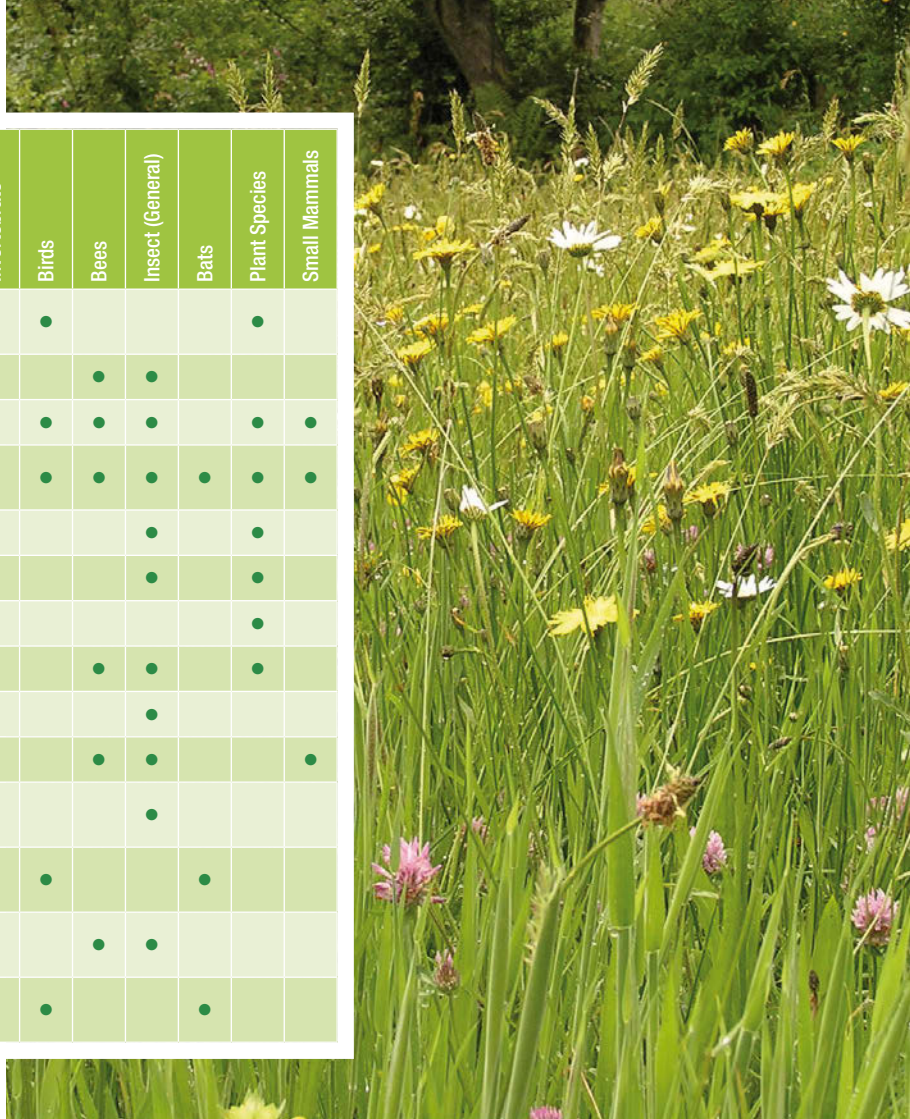
- sand bases that drop 50mm into the substrate bed to encourage invertebrates
- seasoned log, rock and aggregate piles (screened if necessary) for a range of insect and bird species
- local plant material
- bare areas will allow for foraging by birds if the system has been constructed to encourage invertebrate development

WALL BASED HABITATS

Some identified species will not be ground dwelling so wall habitats will be required to allow these species to develop on site.

HABITAT TYPE AND SPECIES BENEFIT

Habitat Type	Invertebrate	Birds	Bees	Insect (General)	Bats	Plant Species	Small Mammals
Bare non-vegetative areas to encourage a range of species and increases bird foraging capacity	●	●				●	
Sand areas for burrowing species with south facing contours	●		●	●			
Stone piles, 20-50mm on sand beds to aid insect and bee development	●	●	●	●		●	●
Rock piles, 100-400mm for small mammal and insect habitat construction	●	●	●	●	●	●	●
Aggregate piles to maximise plant species diversity				●		●	
Substrate mounds to maximise plant species development				●		●	
Surface contours to vary species establishment						●	
Soil and bark areas to increase bio-diverse function	●		●	●		●	
Rope coils to provide invertebrate habitats	●			●			
Log piles to encourage a range of species	●		●	●			●
Seasoned wood pile loggery with bark attached for beetles and other invertebrates	●			●			
Wall mounted habitat and nesting boxes for bird and bat species, bat bricks		●			●		
Insect hibernacula for many flying species including lacewing and ladybird			●	●			
Perches for foraging birds, key plant species that encourage night flying insects that will increase bat foraging capacity		●			●		



SUBSTRATES AND DRAINAGE

DRAINAGE

A key function of any green roof is in its ability to manage water, a bio-diverse system is constructed considering the need for water storage or run off plans without compromising the structural weight calculation allowances or the sustainability of the surface vegetation.

SUBSTRATE

The substrate depth will ultimately define the type of vegetation that will establish. Substrate depths of 50-250mm are not unusual and the only criteria is that the depth is sufficient for the selected plant species to prosper and that the roof meets the required construction parameters.

More plant diversity is possible in deeper substrate areas whilst stress tolerant species will thrive in shallower areas.

Varied substrate depths, surface contour and habitat provision are proven to increase invertebrate colonisation and areas of non-vegetated areas will encourage foraging by key bird species if invertebrate species have been considered.

Substrates can include site materials, soils and aggregate but this material must be tested and screened for contaminates before being blended with locally imported material.

Site material for habitat construction is also considered.

Substrates are designed to be compliant with roof water management processes and these must be considered at the design and planning stage to ensure sustainability.

SUBSTRATE MIXES

Substrates should comprise 80-90% crushed screened aggregate.

A maximum of 20% organic content of which a max 5% should be compost to minimise combustion issues.

Substrate grades should be a percentage of 0-20mm, 20-40mm, 40-60mm and 60mm+ to maximise system performance and surface sustainability.

Substrate mix should contact a percentage of aggregate fines, green waste, composted bark, pine and sand.

Base layers should comprise larger grade aggregate that can aid drainage and water management.

VEGETATION

SELF SEED

Traditional brown roof systems are designed to self populate, these systems are not generally controlled and although they meet functional and environmental targets are not aesthetic and often do not contain enough species diversity to provide suitable foraging potential for insect and invertebrate species development.

CONTROLLED SYSTEMS

Seeded systems with deeper substrate areas for plug and larger plant material provide 20-40 species and meet BREEAM, ecological and functional requirements. Roofs still take up to 24 months to fully establish and require maintenance to manage invasive or damaging specimens.

HIGH AESTHETIC REQUIREMENTS

Where bio-diversity is required pre-grown blankets can be produced that increase the aesthetic delivery whilst maintaining the bio-diversity of the system. Species within the blanket mirror the range of species used as seed or plug and are blended with surface habitat requirements.

A correct bio-diverse system will contain a range of seeded, plug planted and more mature (possibly site preserved specimens) The range will include herbs, grasses, alpines, wildflower, cornflower and herbaceous species.

%	Vegetation	Sun ● Shade ●
6%	Agrimonia eupatoria	● ●
6%	Anthyllis vulneraria	●
4%	Centaurea nigra	●
3%	Clinopodium vulgare	● ●
3%	Echium vulgare	● ●
6%	Galium verum	● ●
2%	Hypericum perforatum	● ●
6%	Knautia arvensis	●
5%	Leontodon hispidus	● ●
4%	Leucanthemum vulgare	● ●
1%	Linaria vulgaris	●
6%	Lotus corniculatus	● ●
4%	Malva moschata	● ●
4%	Origanum vulgare	●
3%	Plantago media	● ●
6%	Primula veris	● ●
6%	Prunella vulgaris, l	● ●
5%	Ranunculus acris	● ●
5%	Ranunculus bulbosus	● ●
4%	Reseda lutea	● ●
6%	Sanguisorba minor ssp. Minor	● ●
5%	Silene Vulgaris	●
GRASS SPECIES WITHIN MIX		
4%	Briza media	● ●
40%	Cynosurus cristatus	● ●
27%	Festuca ovina	● ●
20%	Festuca rubra ssp. Juncea	● ●
5%	Phleum bertolonii	● ●
4%	Trisetum flavescens	● ●

BAPS AND REGULATIONS

Bio-diversity action plans are national templates of aspirations to protect a range of habitats and focal species and local where key species and habitat action plans are implemented.

The UK BAP was published in 1994, the UK was the first country to produce a national plan. The plan describes the biological resources of the UK and provided detailed plans for conservation of these resources.

Local council / borough plans highlight projects outlining key habitats and species in different ecosystems within the parameters of the plan area. This may include coastal and flood plain, roofs, chalk and acid grassland, open landscape, woodland, meadow and pasture.

The plan lists species and habitats required to allow identified species to prosper.

London Bio-Diversity Partnership (LBP) established in 1996 produced the London BAP which highlights 28 regional action plans, 14 habitats and 11 focal species.

All habitat action plans are designed to support these species.

When designing a bio-diverse roof system, it is also important to consider the following:

- Building and NHBC regulations
- bio-diversity guidelines and roof management plans
- structural plans and aspect / location considerations

LONDON BAP 1996

(identified species or groups)

MAMMALS

Bats (all species)
Hedgehogs

BIRDS

Black Redstart
House Sparrow
Peregrine

INVERTEBRATES

Oak Hook-Tip Moth
German Gairy Snail
Stag Beetle
Bees

VEGETATION / FUNGI

Tiered Tooth Fungi
Mistletoe
Black Poplar

COMPLETING THE CYCLE

REGIONAL BIO-DIVERSITY

Although one focus of regional bio-diversity is roof management, it is combined with ground based assessments to complete a thorough regional plan.

Roof water control can be profoundly important to the sustainability of some of these fragile urban ecosystems so increasingly roof and ground based systems are combining resources to achieve an overall target.

The controlled management of water along with species identification and plant management begins to achieve the broad targets set by the various regional plans.

Protecting and providing areas of roof where species can be developed in an isolated fashion is proving both successful and rewarding in the urban environment.

There are 25 species of native bumblebee of which 13 have been identified with London. In the past 3 years 4 species have disappeared.

By providing suitable habitats and large enough areas of bio-diversity, changing the urban environment will have significant effects on species provision, environmental balance, reduction in heat island effects, air pollution and carbon reduction performance.

BIO-DIVERSE SUMMARY

A bio-diverse system should:

- be compliant of site and local bio-diversity action plans;
- have considered site identified species that benefit from the roof construction process;
- have used local and site materials within substrates and habitat construction;
- have been constructed using material with known sources and traceability;
- use materials, habitats and plant species to maximise foraging potential and species interaction.

A highly aesthetic bio-diverse roof is not necessarily an ecologically functional one.

A successful system:

- offers a range of plant species a variety of development environments through contour and material choice;
- incorporates bare areas which offer invertebrate, ground dwelling bee and spider species development capacity as well as improving foraging capacity for bird and bat species;
- provides a range of foliage plants to support larval and pupae stages of insects that will also increase bird foraging capacity;
- ensures plant evolution will be self sustainable and the system will develop ecological and environmental function with minimal intervention.

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