



photo credit: Living Juicy

# Biodiverse Design in the Intelligent City

**Mike Wells**

**B** BIODIVERSITY BY DESIGN

...we had already created enough problems before climate change...

# LIVING BEYOND OUR MEANS



## NATURAL ASSETS AND HUMAN WELL-BEING

Statement from the Board

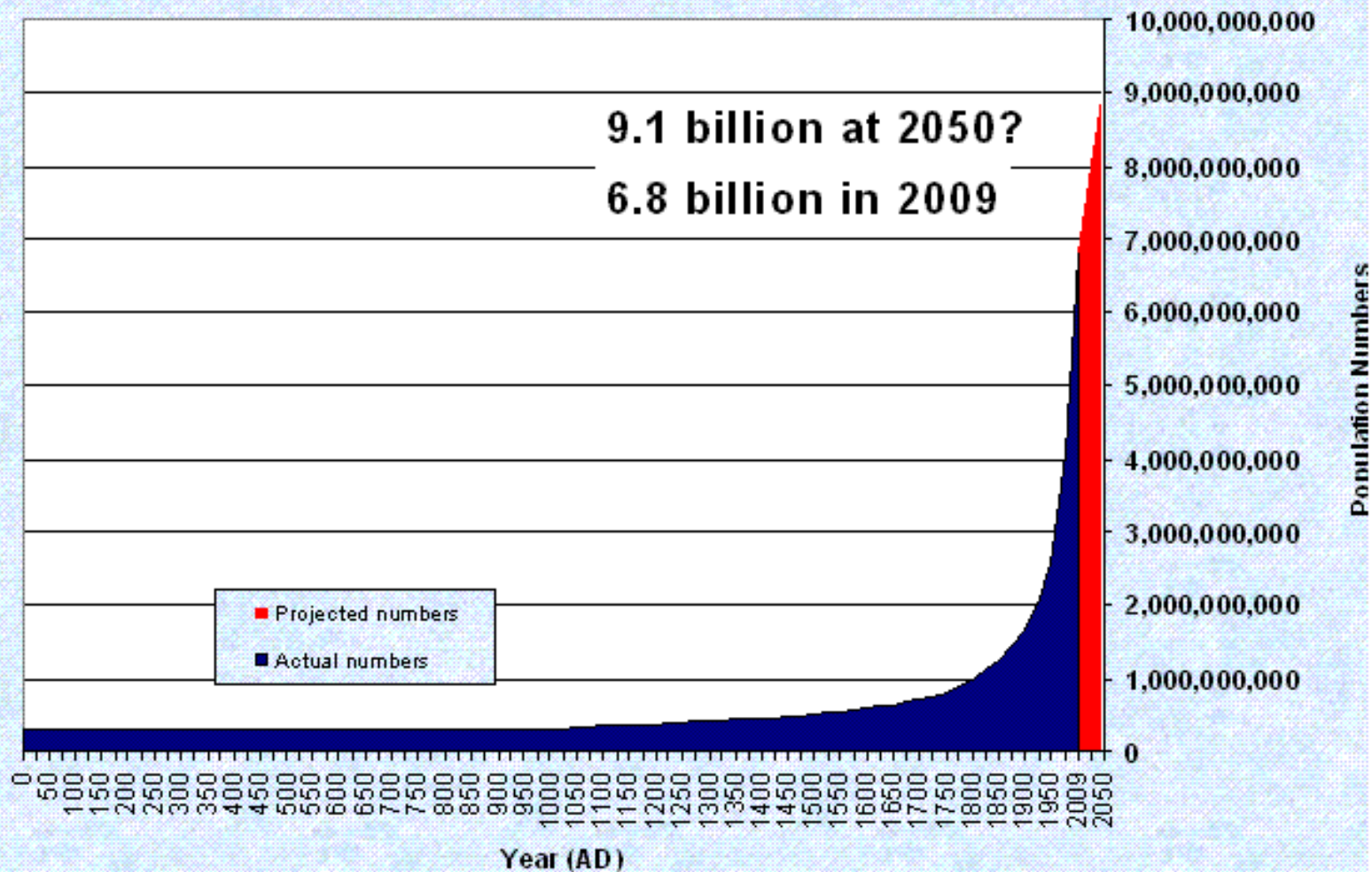


MILLENNIUM ECOSYSTEM ASSESSMENT

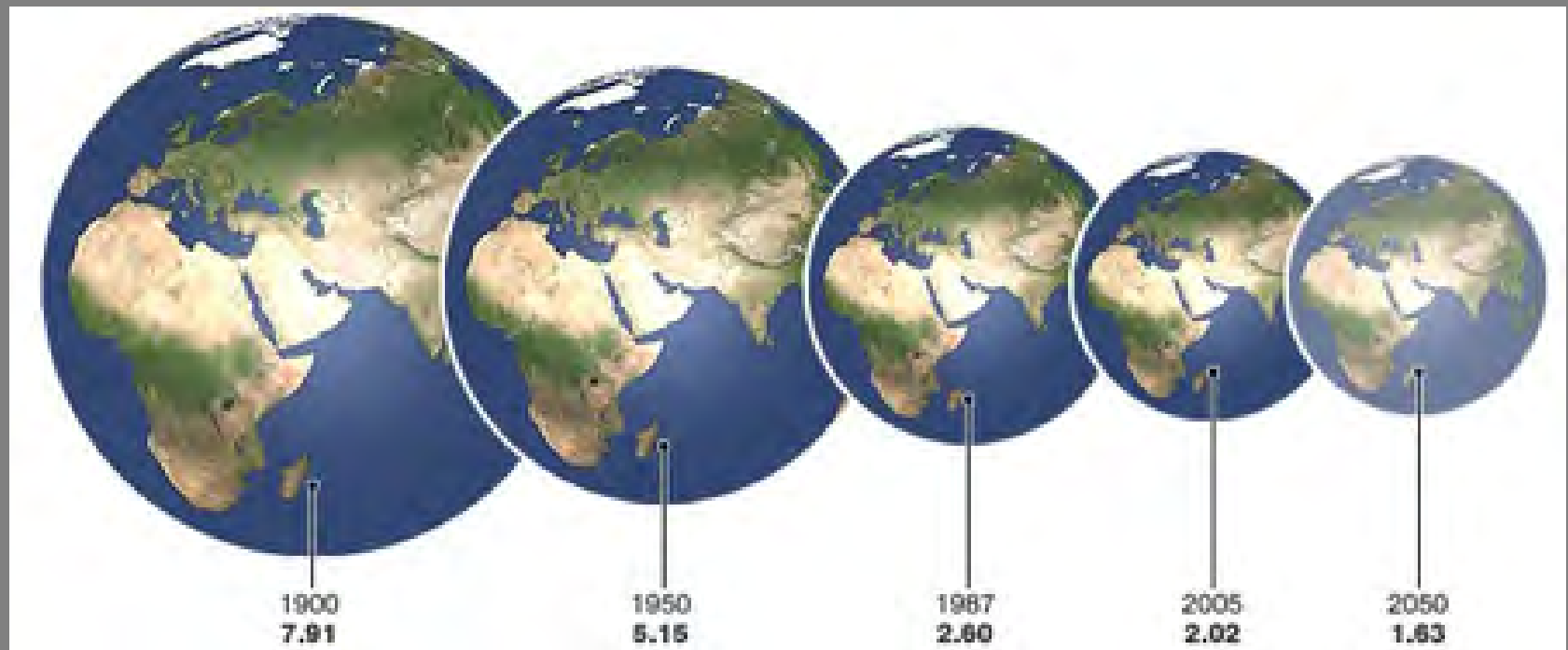
# World population growth

Optimum Population Trust

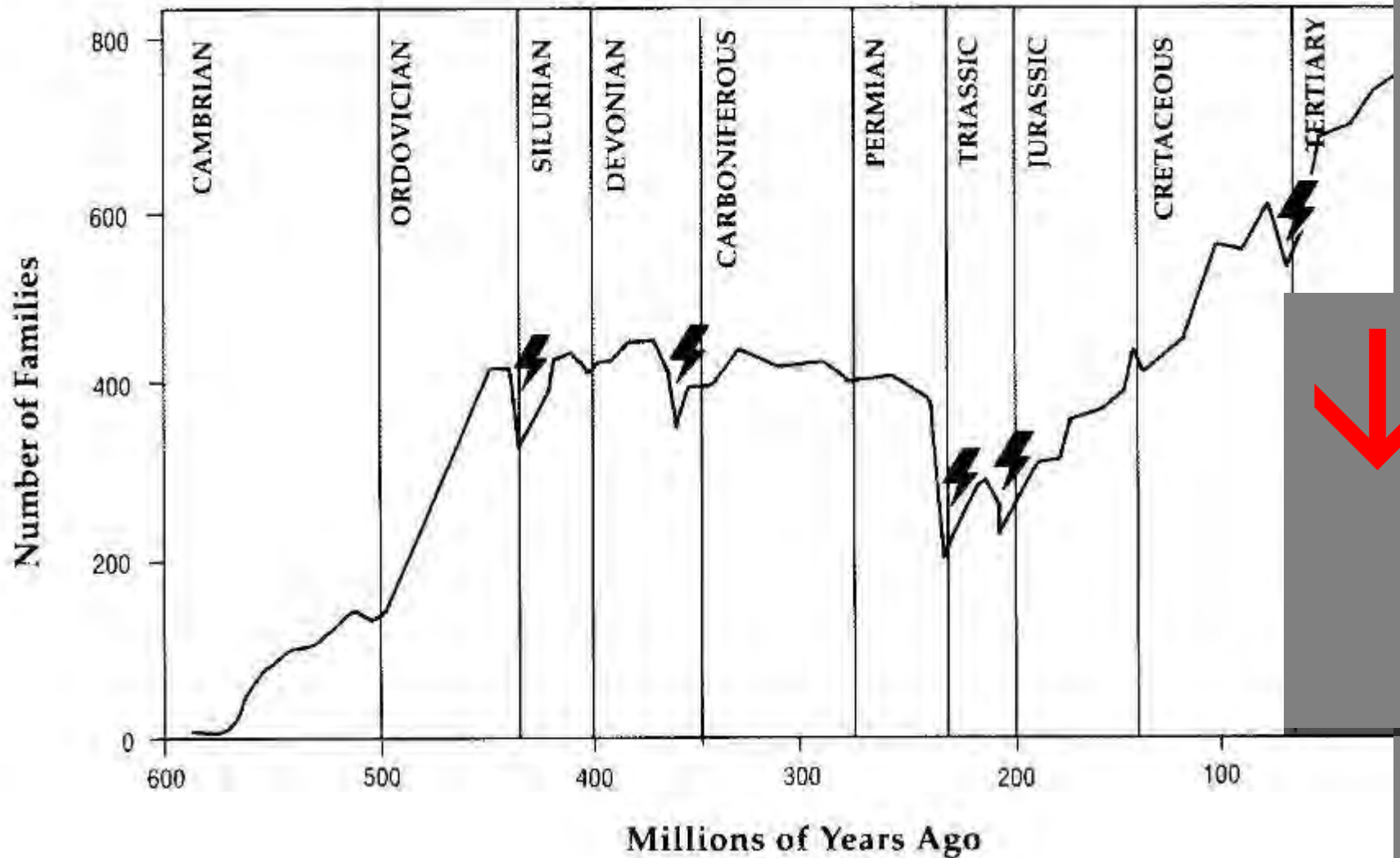
Source: United Nations 2008-based Medium Variant Projection



# Change in hectares of available land per person from 1900







Previous mass extinctions from E.O. Wilson 'The Diversity of Life (1992)















LOW CLEARANCE  
2.8m

ROAD SUBJECT TO  
FLOODING  
INDICATORS SHOW DEPTH









Man-induced climate change is increasing increases the risks and the harm we have already caused to our isolated support system



1968

# The Economics of Climate Change

The Stern Review



NICHOLAS STERN

CAMBRIDGE







*'We cannot solve our problems with the same thinking we used when we created them.'*

Albert Einstein

If we were cats we would have all but  
used up our nine lives!



What positive changes can we make as  
a predominantly urban species?

By designing for and with biodiversity as the basis of ecosystem goods and services, simultaneously at the macro, meso, and micro scales, we increase our chances of achieving one-planet living, as well as limiting the damage of climate change and improving the quality of our lives

**Nine principles** for securing multiple  
benefits **from and for biodiversity** in  
urban design



**Principle 1:** Mandatory assessment of ecosystem services, ecological footprinting & sustainable sourcing of materials for all new development & refurbishment



**Mechanisms:** integrate ecosystem services values into national, regional and local accounting, establish traceability networks, implement Nagoya Protocol



**Metrics:** increase in true traceable sustainable materials, preservation of biodiversity source and carbon sink areas e.g wetlands, forests and reefs

**Globally ecosystem goods and  
services are worth  
c. £22 trillion/year  
(£22,000,000,000/yr)  
(range £10-£36 trillion)**

**or 2 x GLOBAL GDP**

*Robert Costanza*

Food including  
fisheries,  
agriculture  
pollination

Fuel and  
Carbon  
Sequestration

Microclimatic  
amelioration

Tourism

The air we  
breathe

Adaptability  
and resilience  
to changing  
environment

Aesthetic  
pleasure for  
quality of life

Structural  
Protection

Building  
Materials and  
Clothing

Sea defences  
and flood risk  
managment

Medicines  
and Healing  
Environments

Bio-  
indication  
and early  
warning  
systems

Soil creation &  
preservation

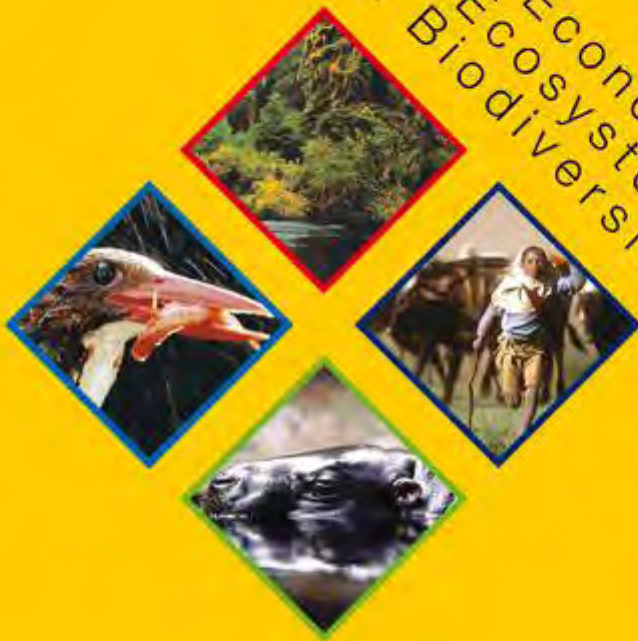
Pollution  
abatement,  
including air and  
water cleansing

Improved  
business profile,  
consents and  
and sales

Vital  
Place  
Making

All wood  
products

The Economics  
of Ecosystems  
& Biodiversity



TEEB FOR BUSINESS  
EXECUTIVE SUMMARY

# Nagoya Protocol Implementation Fund

## June 2011

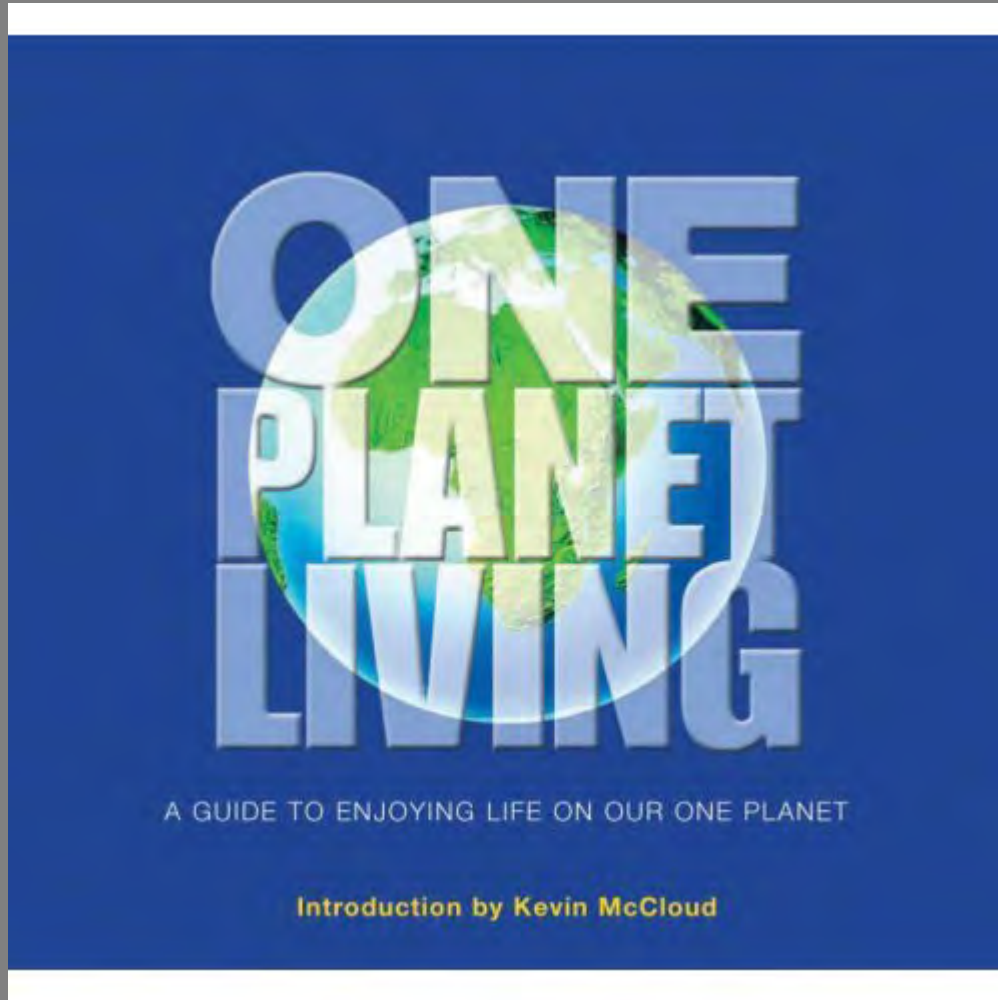
*'We see this as a groundbreaking opportunity to **add economic and social value to biodiversity and genetic resources**, in particular to local and indigenous communities who have in the past not benefited as they should'*

Monique Barbut, CEO and Chairperson of the  
Global Environment Facility



# The Natural Choice: securing the value of nature





- 1 Zero carbon
- 2 Zero waste
- 3 Sustainable transport
- 4 Sustainable materials
- 5 Local and sustainable food
- 6 Sustainable water
- 7 Land use and wildlife
- 8 Culture and heritage
- 9 Equity and local economy
- 10 Health and happiness

N.B. **‘THRIVING’** - NOT JUST **‘LIVING’**!

# Ecological Footprint



- ..is the total of the different land use types (built up areas, grazing and crop land, managed forest land, energy land and fishing grounds) required for production and consumption of human goods and services (food, housing, transport, other consumables) and disposal of the waste.
- Ecological footprints are usually expressed in hectares, or hectares per capita (per person), for a given year







©

FSC

100%

From well-managed forests

Cert no. TT-COC-1110

[www.fsc.org](http://www.fsc.org)

© 1996 Forest Stewardship Council



**Principle 2** : Promote sustainable and naturally produced urban and peri-urban food production



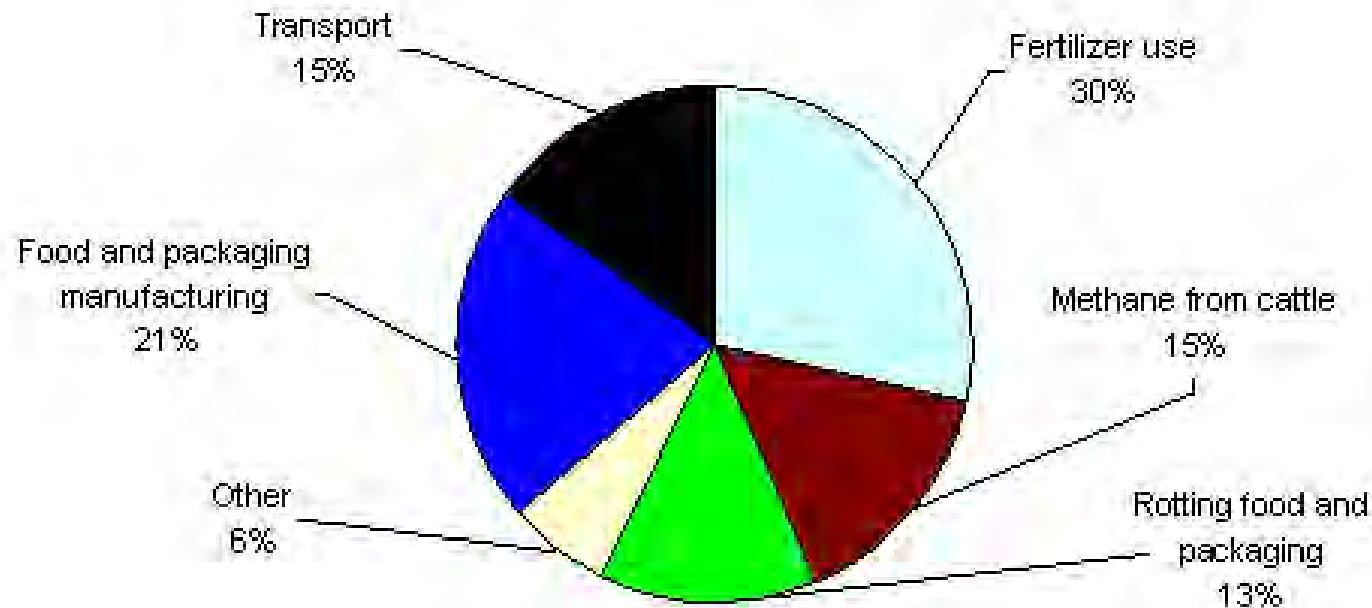
**Mechanisms**: urban agriculture and permaculture, community food projects, foodroofs and facades etc



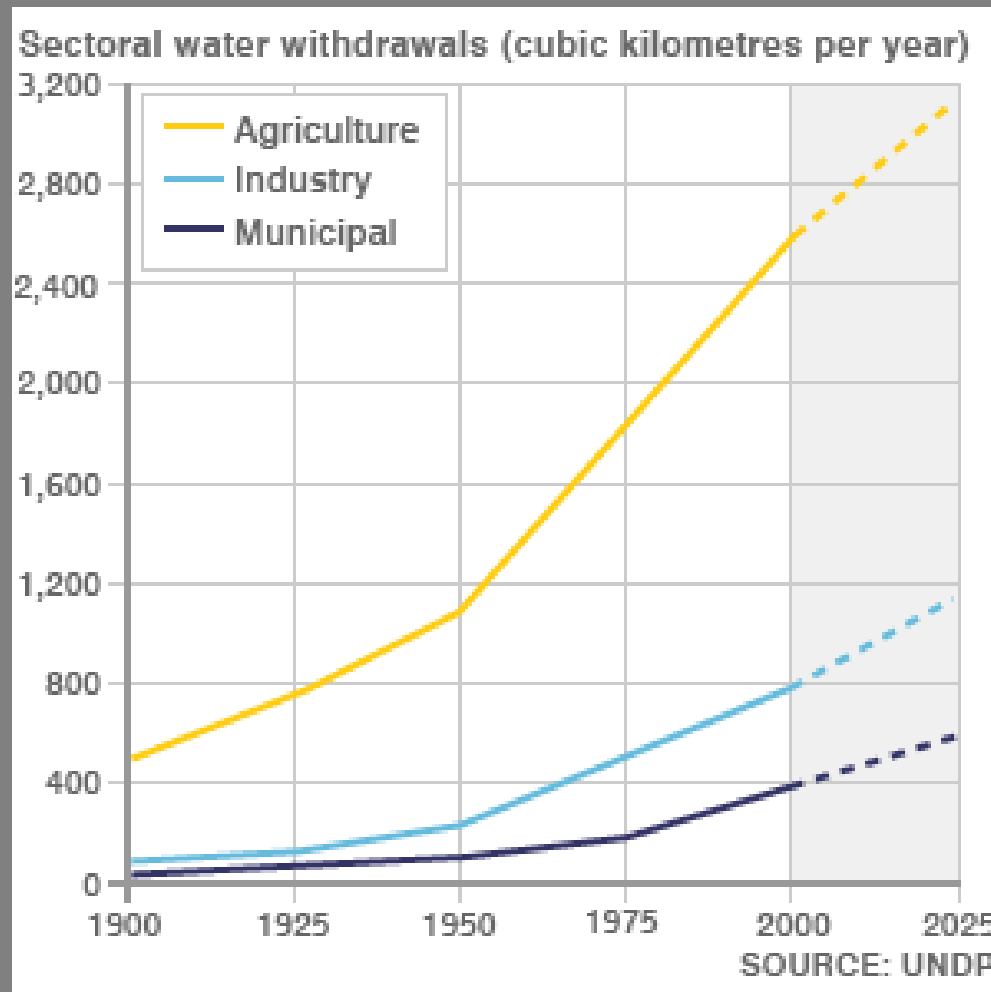
**Metrics**: reduced ecological, water and carbon footprint, improved human wellbeing and social cohesion, wildlife benefits

# Reduce carbon of transport, packaging and food waste

Carbon Emissions from food consumption  
(126 million tonnes annually, 20% of UK's total emissions)



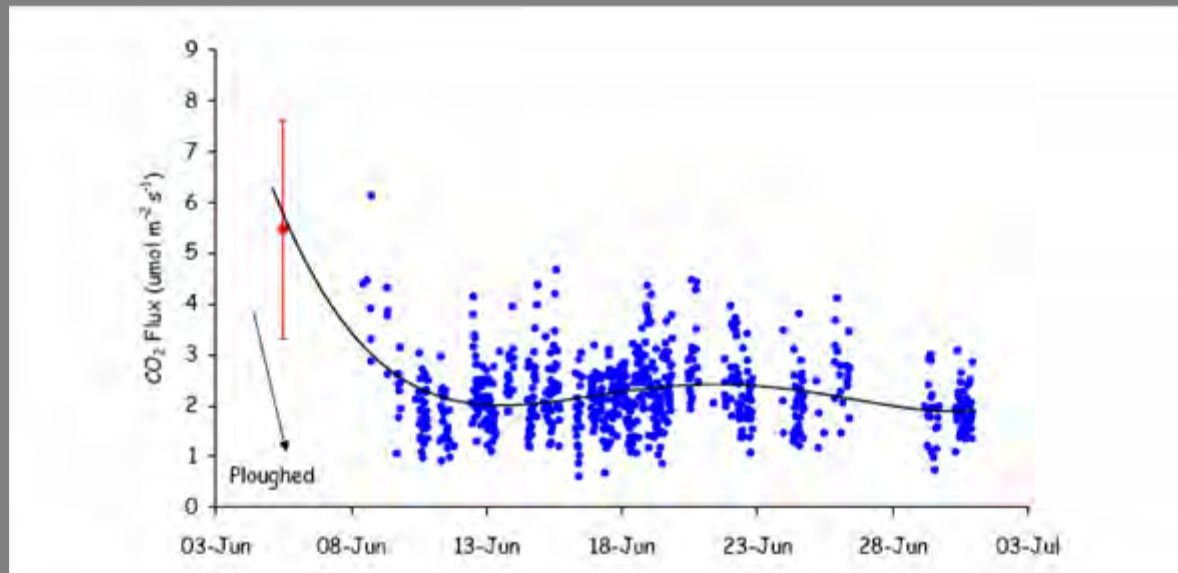
# Growing agricultural water use





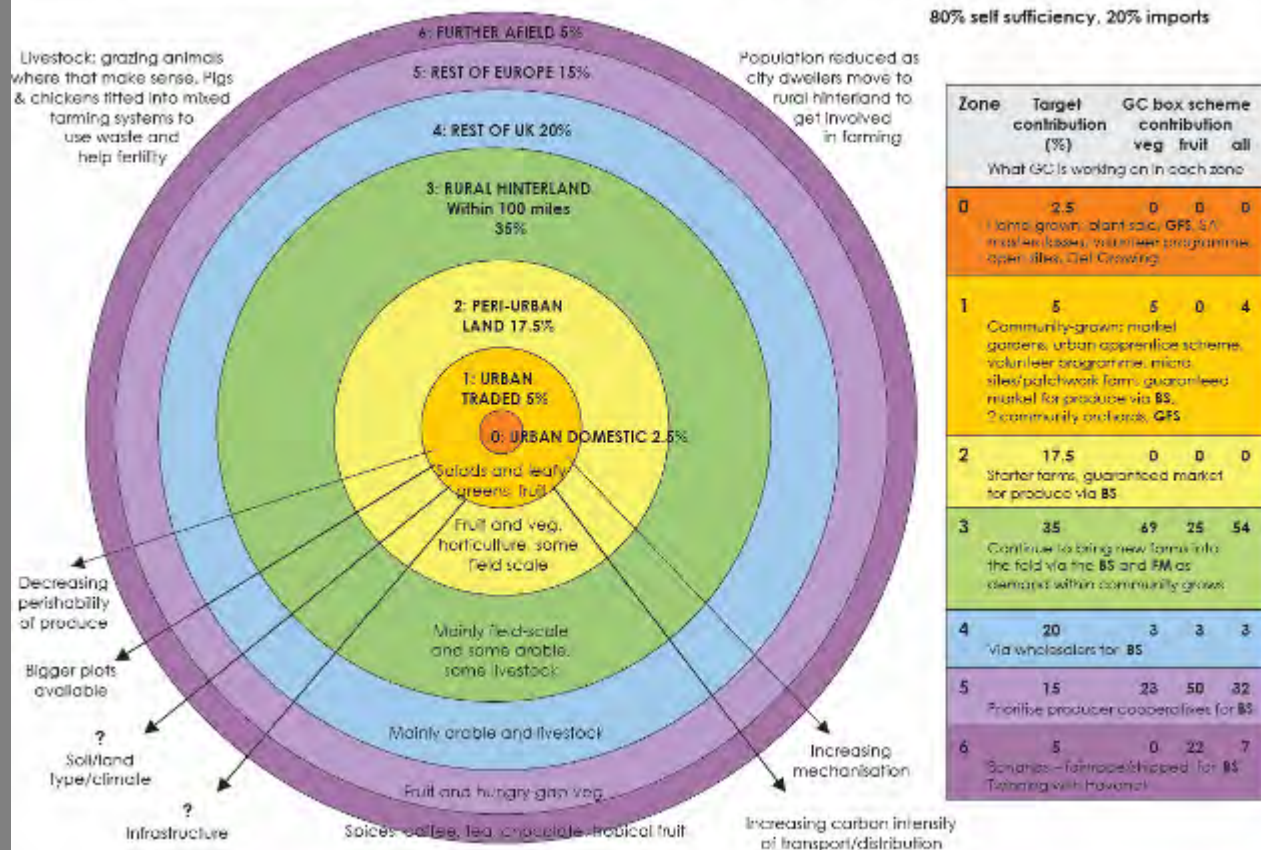


# Carbon loss from soils at ploughing



# London, UK, Borough of Hackney, seeking greater food sustainability

**GROWING COMMUNITIES' FOOD ZONE DIAGRAM: What a sustainable re-localised food system might look like in the future.**







Multi-functional  
food allotment,  
Northern Ireland,  
UK

# Community food and nature rooftop garden, Reading, UK





# St Petersburg Rooftop Gardening Society





# Traditional biodiverse orchards - for urban communities



# Waste heat to vegetables, USA supermarket



# Brooklyn Grange Rooftop Farm, New York



# Competitive hydroponics: Omega Systems Canada







The  
Continuous  
Productive  
Urban  
Landscape  
– Havana  
Cuba



# Decline in pollinators e.g. bees



Tastier, higher value  
cheese from cows  
raised in more  
biodiverse meadows



**Principle 3:** Promote water harvesting, attenuation, cleansing and storage combined where possible with natural systems



**Mechanisms:** Sustainable integrated, biodiverse urban drainage, smart storage technologies



**Metrics:** reduced heat island effect, increased amenity in heat wave, reduced flood hazard, reduced maintenance costs, can be reduced infrastructure cost

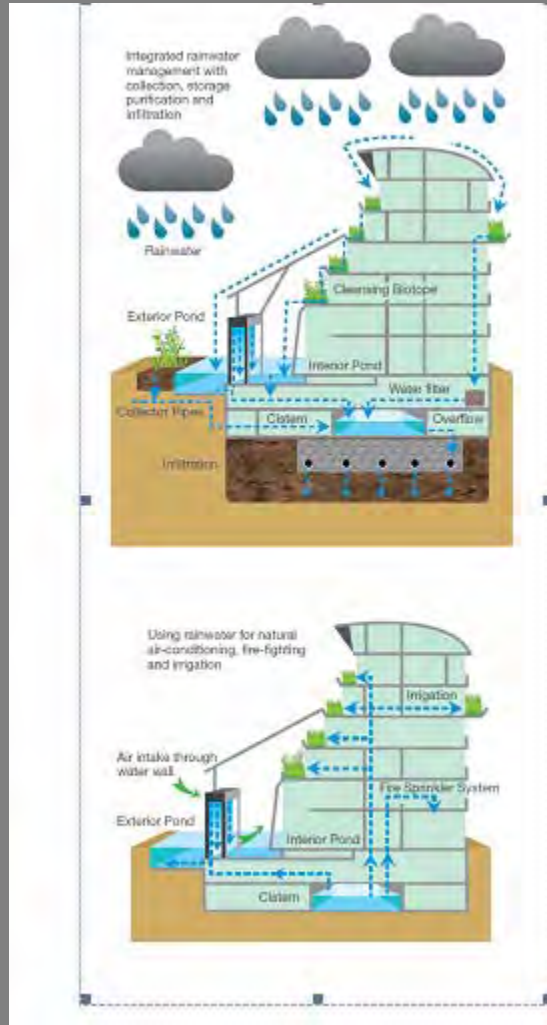


**018530 - SWITCH WP2.1**

## **Sustainable Water Management in the City of the Future**

Integrated Project  
Global Change and Ecosystems

# Singapore's 'Active Beautiful Clean' Manual for Surface Water Management

















# Sky-marshes and urban roadside biodiverse flowering wet meadows











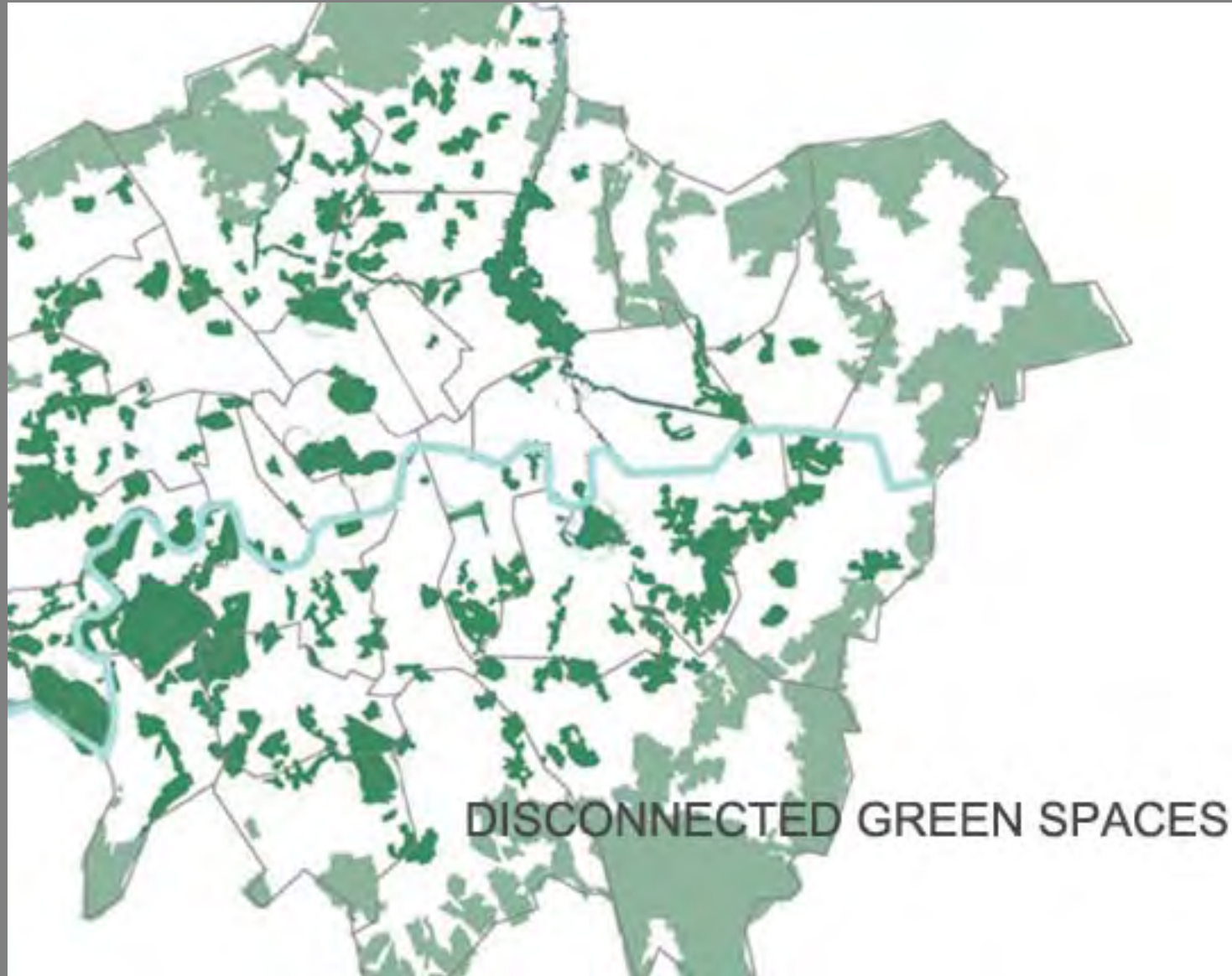
**Principle 4:** promote green infrastructure to increase connectivity and resilience of urban and peri-urban ecosystems



**Mechanisms:** restore major coastal ecosystems and river corridors, map and link habitat remnants, form green webs and multifunctional networks at all scales



**Metrics:** favourable conservation status of quality indicator species, reduced flooding and heat island, cleaner air and water, urban biofuel, urban food etc.



DISCONNECTED GREEN SPACES

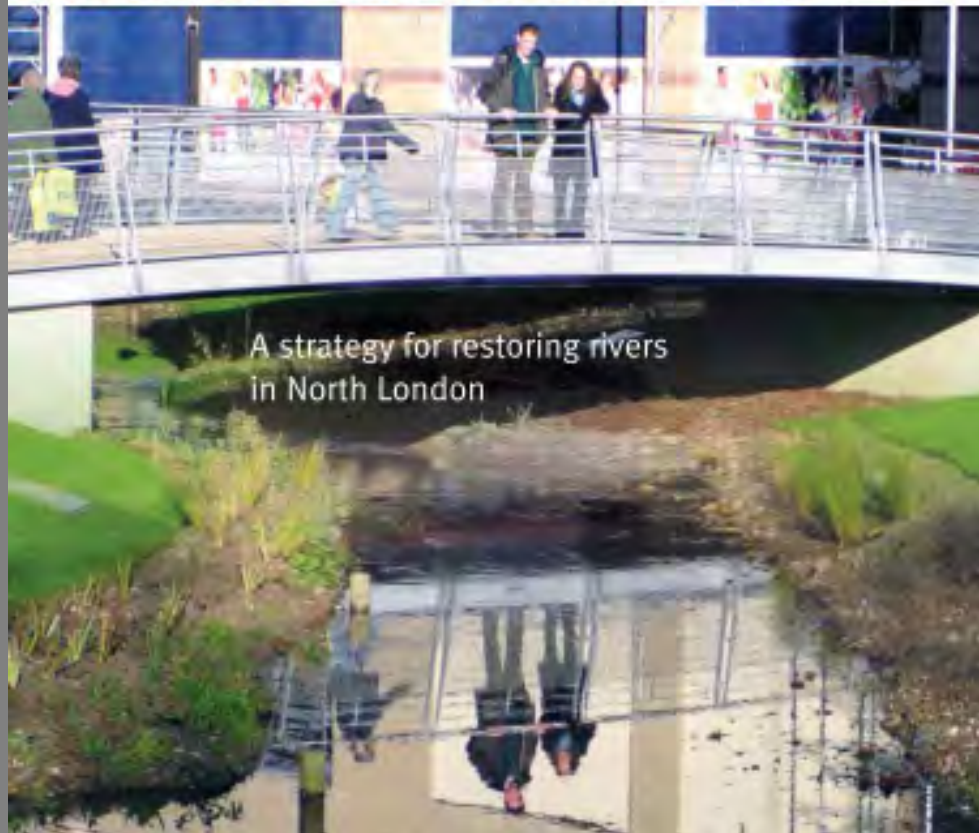




RECONNECTED GREEN SPACES

CORE SITES/ REMNANTS  
EXPANDED OR BUFFERED

# bringing your rivers back to life





# Charter Quay urban river restoration, Kingston, London





Safe links  
for wildlife  
over and  
under  
transport  
corridors



# Shade-giving, wind-break, dust trapping, air-conditioners



# Indicators of success







The UK's Longest  
Living Wall –

Westfield, London,  
UK

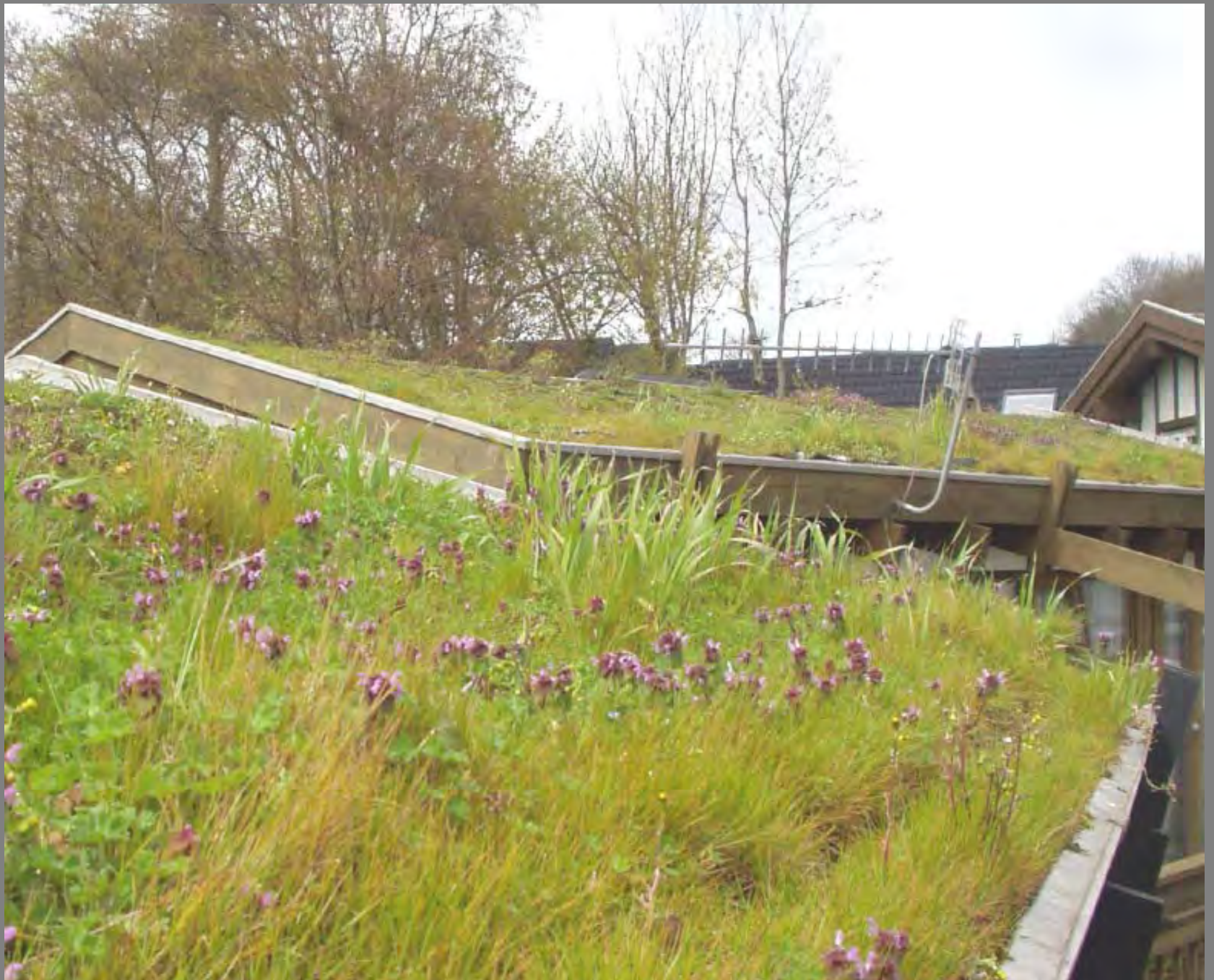
True retail therapy

Photo Credit: Gary Grant/AECOM

Protection of structures against weathering & pollution whilst providing niches for beneficial fauna









# A place for true rarities





# Symbiosis of nature and power generation







# Cultural landscapes of ethnic minorities – can still support native biodiversity



# Possible Guiding Principles for Green Infrastructure Strategy

GI should be:

- Mandatory social space for workers

- Should be the PRIMARY consideration, before built form design or other infrastructure

- Factored into land values

- Widely distributed and interconnected

- Functional at different geographical scales

- Multifunctional

- Locally distinctive

- Accessible

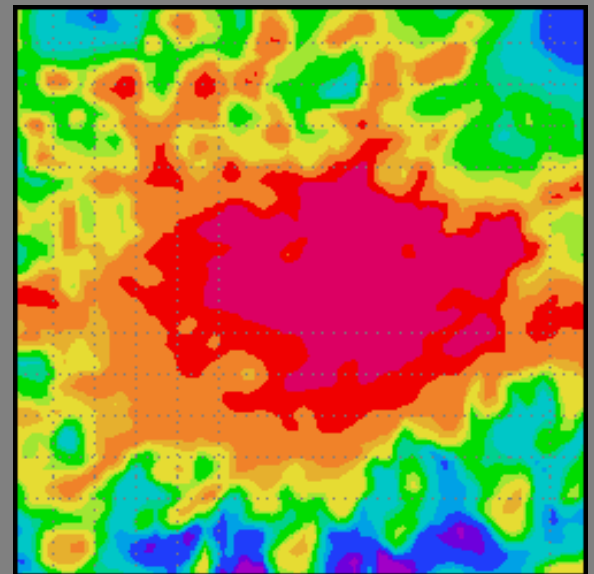
- Delivered by cross-departmental and organisational partnerships

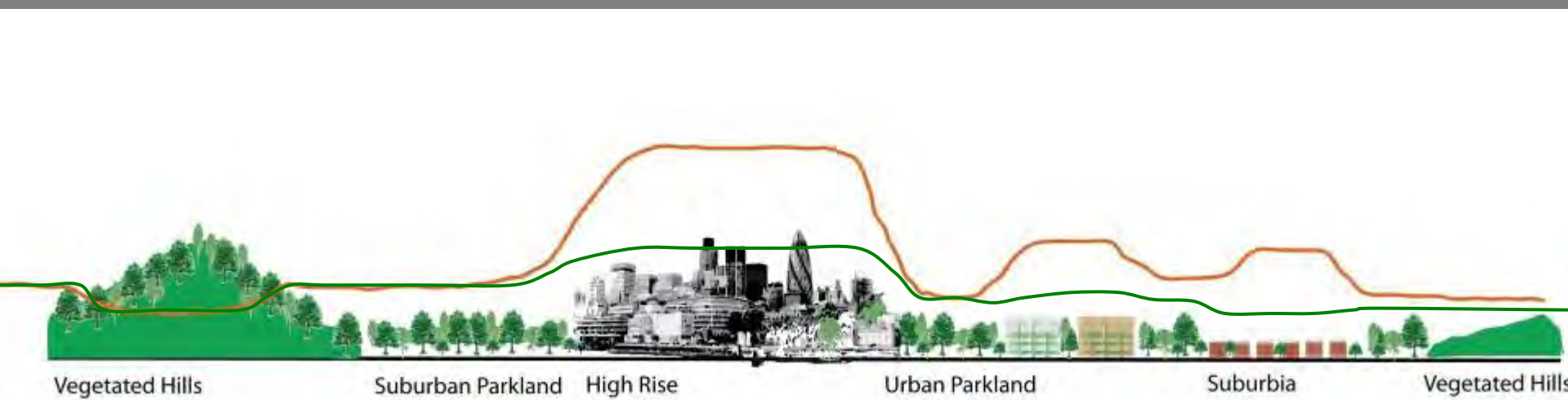
- Well-funded to function in perpetuity





=





- Current Heat Island effect
- Potential effect with abundant, lush vegetation



# Intertidal vegetation storm and tsunami buffers





**Principle 5:** Adopt 'biophilic design' approaches for health and well-being and multiple other benefits



**Mechanisms:** focus on biodiversity, natural materials, green connectivity, ubiquity and abundance, celebration of water, mixture of wooded and open landscapes, internal greening, cooling, air and water cleaning...



**Metrics:** public satisfaction indices, reduced absenteeism, increased productivity, accelerated convalescence, reduced societal and individual medical expenditure

# Fighting urban pathologies



# Life-Support

## Incorporating Biodiversity into Community Strategies

Journal of Environmental Psychology (1991) 11, 201-230

### STRESS RECOVERY DURING EXPOSURE TO NATURAL AND URBAN ENVIRONMENTS<sup>1</sup>

ROGER S. ULRICH\*, ROBERT F. SIMON<sup>†</sup>, BARBARA D. LOSITO,  
EVELYN FIORITO<sup>†</sup>, MARK A. MILE<sup>†</sup> and MICHAEL ZELSON<sup>†</sup>

\* College of Architecture, Texas A & M University,  
College Station, Texas 77843-3137 and  
<sup>†</sup> Department of Psychology, University of Delaware,  
Newark, Delaware, U.S.A.

#### Abstract

Different conceptual perspectives converge to predict that if individuals are stressed, an encounter with most unthreatening natural environments will have a stress reduction effect.

Wiley, pp. 27-36.

2



### Effects of Gardens on Health Outcomes: Theory and Research

Roger S. Ulrich

### EVIDENCE BASED PUBLIC HEALTH POLICY AND PRACTICE Greenspace, urbanity and health: relationships in England

Richard Mitchell, Frank Popham

**Objectives:** To determine the association between the percentage of greenspace in an area and the standardized rate of self-reported "not good" health, and to explore whether this association holds for areas exhibiting different combinations of urbanity and income deprivation.

**Design and setting:** Cross-sectional, ecological study in England.

**Participants:** All residents of England as at the 2001 Census.

**Main outcome measures:** Age and sex standardized rate of self-reported "not good" health status.

**Results:** A higher proportion of greenspace in an area was generally associated with better population health. However, the association varied according to the combination of area deprivation and urbanity. There was no significant association between greenspace and health in areas with high deprivation and low urbanity.

Journal of Epidemiology and Community Health 2007;61:681-683. doi: 10.1136/jech.2006.066100

#### Health data

Residents in the study had been asked to complete a questionnaire in the past 12 months. A response rate of 70% was achieved. The standardized rate (SMR) for not good health was 1.00 in the study area.

### Green space, soundscape and urban sustainability: an interdisciplinary, empirical study

Katherine N. Irvine<sup>a\*</sup>, Patrick Devine-Wright<sup>b</sup>, Sarah R. Payne<sup>b</sup>, Richard A. Fuller<sup>c</sup>, Birgit Painter<sup>a</sup> and Kevin J. Gaston<sup>c</sup>

biology  
**letters**

Community ecology

Biol. J.

doi:10.1098/rsbl.2007.0.122

Published online

### Psychological benefits of greenspace increase with biodiversity

Richard A. Fuller<sup>1,\*</sup>, Katherine N. Irvine<sup>2</sup>, Patrick Devine-Wright<sup>2,†</sup>, Philip H. Warren<sup>1</sup> and Kevin J. Gaston<sup>1</sup>



### Human health and nature conservation Ecotherapy could be beneficial, but we need more robust evidence

We call animals in their natural habitat wild implying danger. Research that focuses on reducing society's capacity for choice. These views from contemporary anthropology contrast with the biological, evolutionary, and ecological view of the influential American ecologist Edward Wilson. Wilson coined the concept of biophilia: "The connection that human beings subconsciously seek and need with the rest of life." This view, emphasizing connection with nature, builds on behaviorist theories of conditioning.

The therapeutic implication of biophilia is ecotherapy: restoring health through contact with nature. British author Gregory Bateson's theoretical framework for improving health through conserving nature incorporated a "sense of unity of biosphere and humanity" that engenders connection, restoration, and respect for self and planet. The Society for Companion Animal Studies promotes pets for health, a topic discussed by McNichols and colleagues in this issue. Benefits may come from...



# Klinikum, Basel - biophilic healing

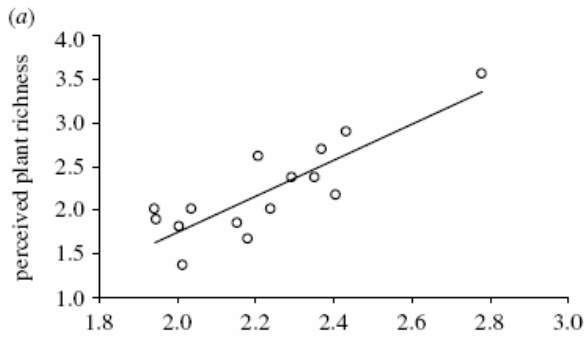




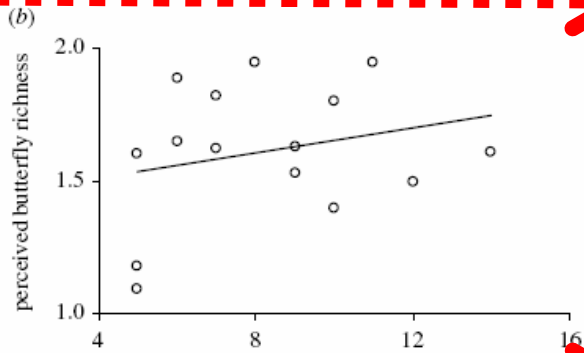
# An ideal view for patients in Switzerland



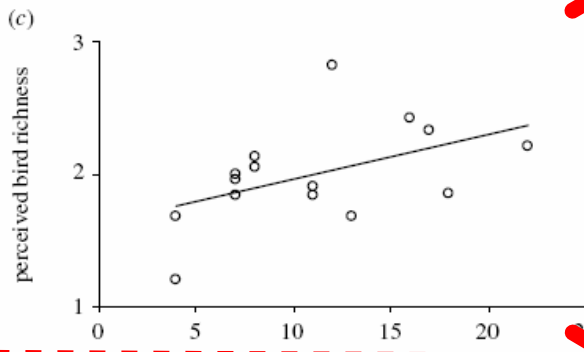
Perceived



Plants



Butterflies



Birds

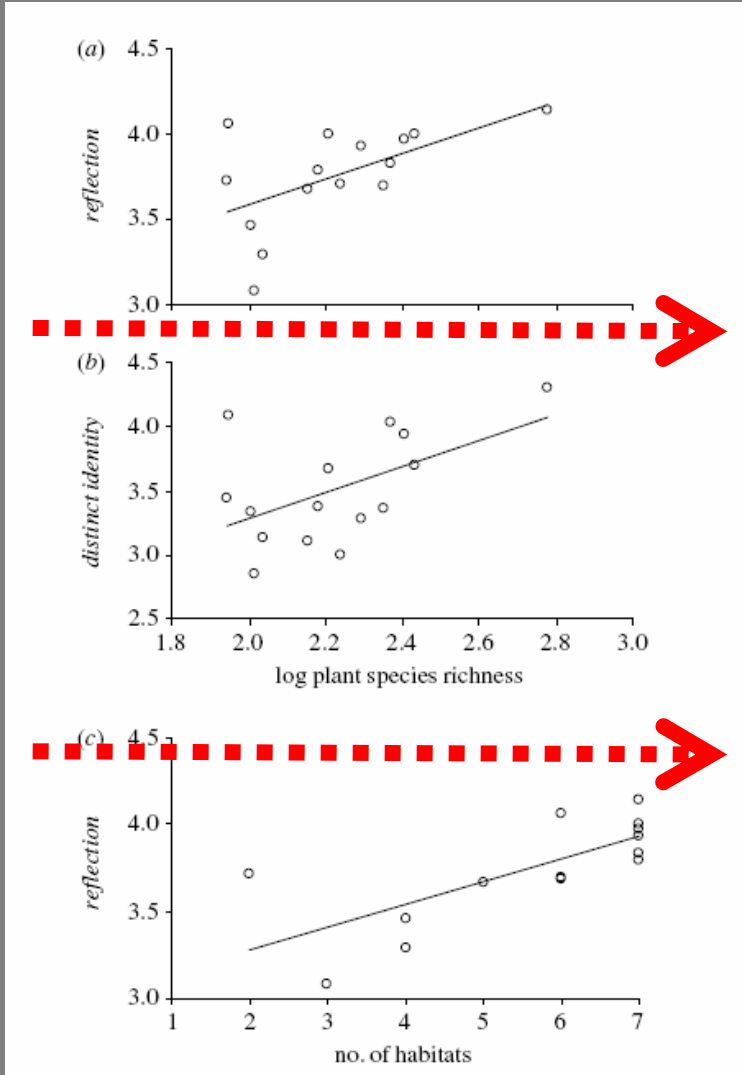


Figure 2. Relationship between perceived and sampled species richness of (a) plants, (b) butterflies and (c) birds. The relationship in the plant data remains highly significant on removal of right-hand data point. See text and table 1 for explanation of units.

Actual



Perceived



Actual

‘reflection’ versus plant species-richness

‘distinct identity’ versus plant species-richness

‘reflection’ versus number of habitats present



The Theory,  
Science, and  
Practice of Bringing  
Buildings to Life

# Biophilic Design

Stephen R. Kellert · Judith H. Heerwagen · Martin L. Mador





...encouraging a recall of instincts..



# Promoting species and imagery of beneficial psychological 'affect'

## THE BAT HOUSE

Abstract geometry, a sense of wonder, beauty, discovery, fun, inspired by birds or flight, a sense of excitement, a sense of play, and a sense of connection to the natural world.

**THE BAT HOUSE**  
The Bat House is a series of three, abstract, geometric structures that are designed to provide a habitat for bats. The structures are made of wood and are designed to be both functional and aesthetically pleasing. The structures are designed to be both functional and aesthetically pleasing. The structures are designed to be both functional and aesthetically pleasing.

**THE SITE**  
The site is a natural area with a pond and a path. The site is a natural area with a pond and a path. The site is a natural area with a pond and a path.

**THE DESIGN**  
The design is a series of three, abstract, geometric structures that are designed to provide a habitat for bats. The structures are made of wood and are designed to be both functional and aesthetically pleasing. The structures are designed to be both functional and aesthetically pleasing.

**THE CONCEPT**  
The concept is a series of three, abstract, geometric structures that are designed to provide a habitat for bats. The structures are made of wood and are designed to be both functional and aesthetically pleasing. The structures are designed to be both functional and aesthetically pleasing.



# **Green Streets, Not Mean Streets**

*In an inner city neighborhood, the greener the residence, the lower the crime rate.*

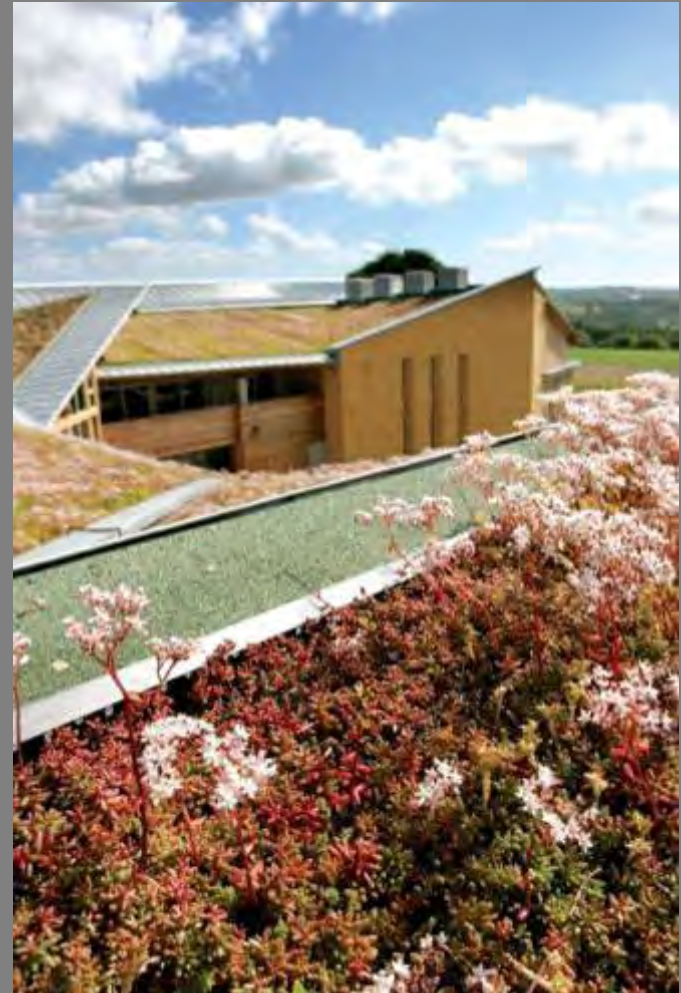


Reduced  
crime

Kuo, Illinois  
USA



# Increasing productivity in the workplace: Rivergreen Offices, Newcastle, UK



# Gateway House Basingstoke – Peter Foggo /Charles Funke





# Increased business rental values Arlington Business Parks, UK





# Enhanced real estate values

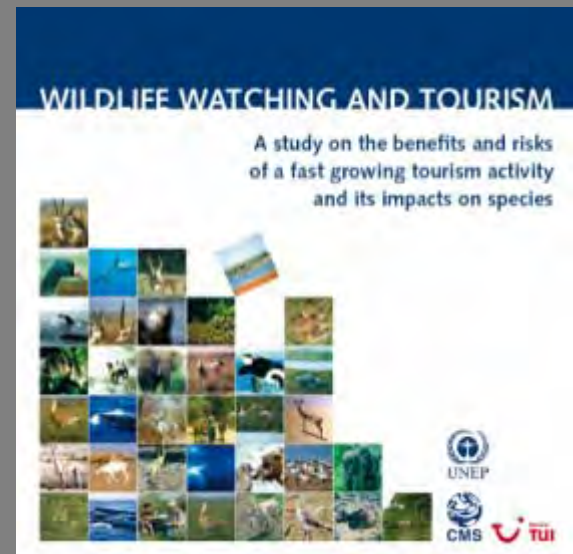
‘It is interesting that in most of the cases studied, properties that directly overlook a park cluster at around **5% to 7% above** an identical property in the same market area, but outside the influence of the park.....but up to **to 34%.**

Cabe Space, UK



# Contribution to tourism strategy

20% to 40 % of all international tourists **have an** interest in some form of wildlife watching  
(but such activity must be carefully controlled and wardedened)





Contribution to commercial strategy of attracting top talent - Singapore City of Gardens *and Water*



## **Principle 6:** Promote ecosystem complexity



**Mechanisms:** Devise diverse appropriate species and habitat mixtures, bespoke to place and task

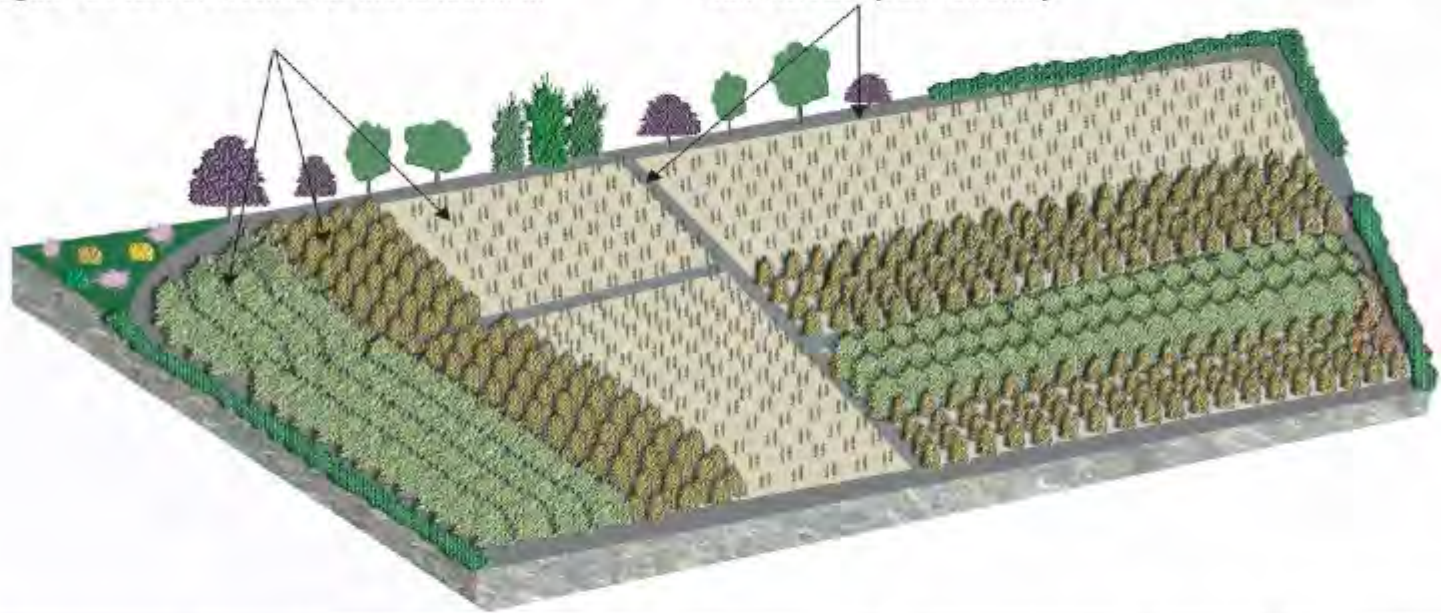


**Metrics:** Reduced failure of plantings, reduced incidence & duration of invasive species outbreaks, improved ecosystem service performance

# Integrated Pest Management Depends on Biodiversity

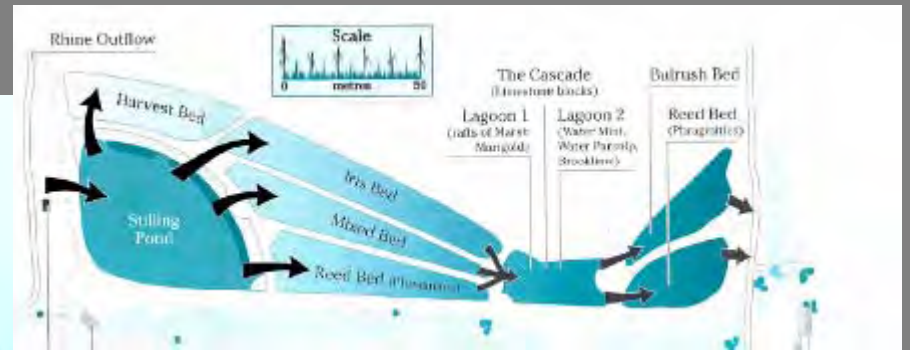
The three colors represent 1-, 2-, and 3-year-old willow biomass crops. This age distribution is maintained by harvesting the portion of the field with 3-year-old willow each dormant season. An annual harvest of a portion of the crop provides a regular stream of income for the landowner.

Spaces are left between the crops to facilitate access to the crop for harvesting and maintenance. Headlands, up to 10 m wide, at the ends of the rows provide space to turn harvesting equipment around. Planting these spaces with a selected mix of species can increase plant diversity.



*Figure 5. Representation of a typical field planting design for willow biomass crops. The area contains three age classes, with a number of different willow varieties in each. Mixing varieties across the field increases landscape diversity and may help reduce impacts from potential pests and diseases. (Modified from Anon 1996, created by J Ballard.)*









Deadwood is  
important to  
healthy  
woodland  
ecosystems

## **Principle 7:** Design built form to safeguard biodiversity



**Mechanisms:** wildlife overpasses and underpasses, increased visual noise of facades, considerate lighting, careful drainage design



**Metrics:** reduced quantity and species range of bird strike, reduced faunal fatalities, increased proximity of species to residents, reduced number of traffic accidents









# BIRD-FRIENDLY URBAN DESIGN GUIDELINES

Integrating Natural Systems with Human Activities

DRAFT REPORT SEPTEMBER 2010



[calgary.ca/landuse](http://calgary.ca/landuse) | call 3-1-1





Visual noise is best when natural and multifunctional



# Risks to birds and bats – and solutions



**Principle 8:** Instigate ecological landscape management and aftercare



**Mechanisms:** community wardens, work parties, community orchards and farms, public-private-charity partnerships, new models



**Metrics:** reduced 'locational autism', progressive ecosystem maturation and stable development







**Principle 9:** Set Ecological Targets for all urban developments and then measure success



**Mechanisms:** detailed inventory of environmental baseline including trends, appropriate and practical monitoring protocols, involve additional agencies



**Metrics:** species richness and diversity, rarity, water quality, air quality, bird song etc.



**KEY**

	(1) IT Street Groenery
	(2) plaza entrance and water theatre
	(3) performance area
	(4) basement orchard
	(5) mill spaces
	(6) waterfall
	(7) swales
	(8) still lake
	(9) concourse
	settling pond
	(10) wet woodland
	(11) reeds
	(12) marsh
	(13) polishing pond
	cascaodes
	dense urban planting
	water directed from roofs to ground



# PLAN



# TARGET SPECIES

- 1 Priority species for nature conservation
- 2 Flagship: species that could symbolise scheme success

indicator species/umbrella species that indicate healthy populations of supporting species and/or good semi-natural environmental conditions

- 3 Indicator of good populations of small mammals
- 4 Indicator of good populations of small birds
- 5 Indicator of good populations of fish/ amphibians
- 6 Indicator of good populations of invertebrates
- 7 Indicator of good water quality
- 8 Species with special aesthetic qualities or interest to man e.g. conspicuous beauty, song or tendency to use artificial refuges

# KEY

- DPS** Dominant plant species
- WQ** Water quality
- AA** Appropriate area
- Pair Breeding** (Bird icon)
- Feeding** (Red 'F' icon)

**J F M A M J J A S O N D**

Biodiversity Target	Shrub Roofs	Grassland Roofs	Planted facades	Densely wooded area	Reeds and Settlement pond	Wet Woodland	Marsh	Polishing Pond with Rafts	Flowing Water and Still Ponds-Urban	Streetscape Planting
<b>Target Species</b>										
<b>Siberian Wren</b> <i>Muscivora sibirica</i> 3, 4										
<b>Blues</b> <i>Crocidalis lasiosa</i> <i>Crocidalis sudanensis</i> 6										
<b>Redwings</b> Several species										
<b>Reithren Bat</b> <i>Eptesicus reiberti</i> 6, 8										
<b>Dussumbert Bat</b> <i>Myotis dussumieri</i> 7, 11										
<b>Big Eared Myotis</b> <i>Myotis macrodactyla</i> 5										
<b>Moorhen</b> <i>Gallinula chloropus</i> 5										
<b>Eastern Spot-billed Duck</b> <i>Anas boschasensis</i> 7, 11										
<b>Little Egret</b> <i>Egretta garzetta</i> 2, 3										
<b>European Sparrowhawk</b> <i>Accipiter nisus</i>										





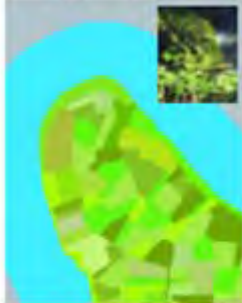






Bringing it all together:  
two examples from  
London, UK

Marshland/Wet Woodland



1874

Industrialised



1890

Brownfield Ecology



1937

Brownfield Ecology



1990

First Phases of Development



2005



2015

High Density - High Ecology



2021



























**TIDAL TERRACES** reed bed

This panel features illustrations of two birds in flight at the top. Below them are stylized reeds and plants in shades of orange and green. A circular inset on the right shows a close-up of a bird's head. There are several blocks of small text interspersed with the illustrations.

**TIDAL TERRACES** saltmarsh

This panel shows illustrations of various birds, including a blue bird and a white bird, among stylized saltmarsh plants. The background is a light green with wavy lines representing water or mudflats. A circular inset on the right shows a close-up of a bird's head. There are several blocks of small text interspersed with the illustrations.

**TIDAL TERRACES** foreshore

This panel features a large illustration of a crab in the center. To the left are jellyfish, and to the right are two birds. The background is light green with wavy lines. A circular inset on the right shows a close-up of a bird's head. There are several blocks of small text interspersed with the illustrations.



















# ....demonstrate how biodiversity can 'fit' into a logical hierarchy of design....

## Landscape Strategies

### Movement

**A diagrammatic neighbourhood showing key routes and relationships.** Each residential neighbourhood has an ecological (east-west) route linking the neighbourhood square with the park or the riverside. It also has tree-lined access routes 'thruing' the area, and is linked to other key spaces with pedestrian routes (north-south).

**Strategic Hierarchy of route types**  
 The highest route (dark grey) takes pedestrians, and intersects all routes. The eco-route (blue) will cross all other routes, acting as a traffic calming route when it crosses a tree-lined route, and as a landscape feature when it crosses a pedestrian route. The Pedestrian route always crosses the neighbourhood access routes, providing traffic calming and safe crossings. The Neighbourhood access route 'calms' the Riverside access route by placing calming measures at these nodes.

**The landscape strategy for movement** is set out on the diagram above left. The strategy aim is to create a hierarchy of roads and streets for vehicular use. By this means the needs and desires of the pedestrian are allowed to become the dominant criteria for most streets and squares.

Nevertheless some through traffic contributes to the life of a street so there is an emphasis on designing out speed and for designing in shared surfaces and other measures to ensure that the car does not dictate the quality of space.

Each road, including one with pedestrian and vehicular use, must be seen as an opportunity for attractive landscape architecture with buildings and uses on each side helping to support a safe and lively environment. These are to be road streets.

The neighbourhoods of Parkside West and Dugby's Reach will be as far as possible not constrained with restricted through traffic and traffic calming measures throughout.

Vehicular traffic in Meridian Gardens will be mainly generated by residents and visitors with some retail servicing. Retail traffic will be confined to the north west edge of Meridian Gardens.

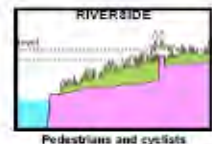
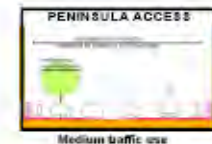
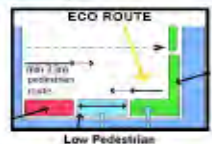
**Key routes for pedestrians:**

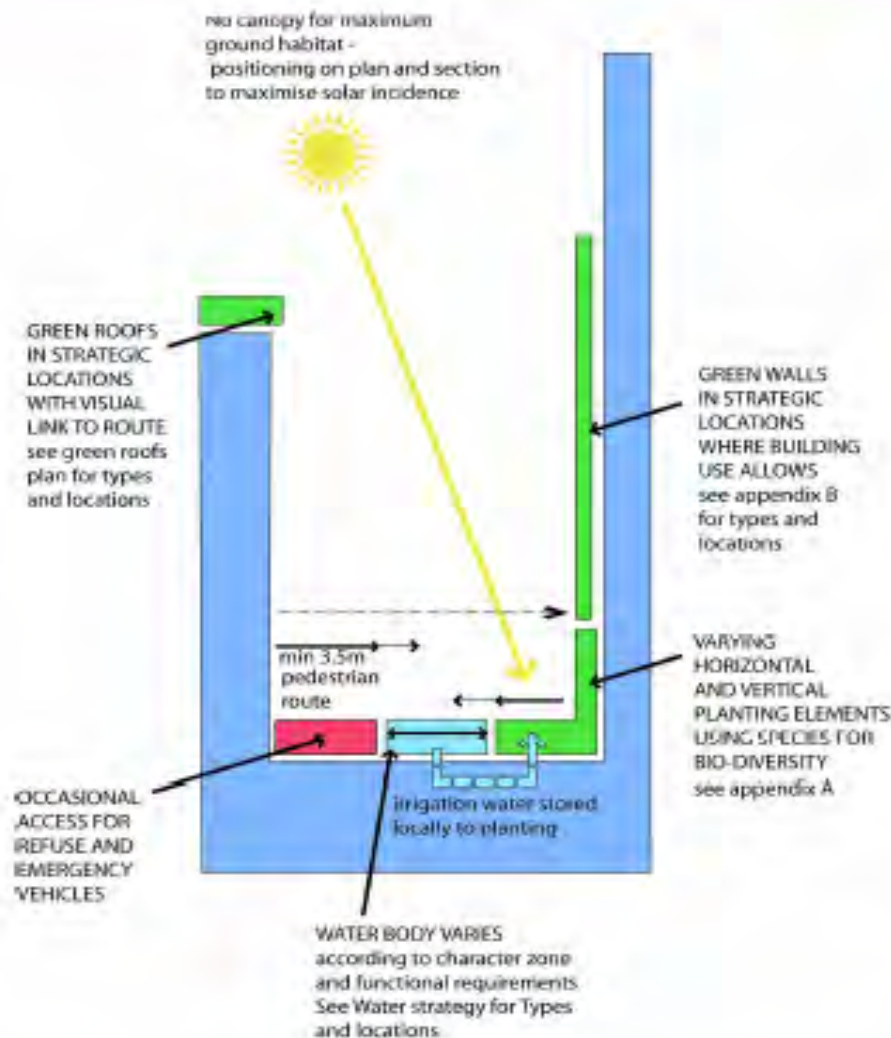
- The central spine in Parkside West. This connects OMI, the schools, residential areas and the station.
- The central spine in Dugby's Reach. This connects OMI, Dugby's Square, the streets of Millennium Square and the Dore.
- East-west routes through Millennium Square and around the Dore, and across Central Park.
- The route around the river bridge.

**Cycling:**

Rapid cycling is discouraged through surface treatment on the pedestrian routes, encouraged along the riverside through provision of an informal shared surface. Cycling is provided with a dedicated north-south route on parkside as part of the sustainable transport corridor.

The landscape strategy defines typologies for streets and the impact of routes passing through squares. Each has strategic objectives together with guidance on appropriate materials and forms. The typologies are indicated at the bottom of the page and relate directly to the strategy diagram. Each typology is developed in more detail in the Routes section.





#### Key Features:

- Low-level planting of native species typical to shaded urban streetfront habitats
- No trees for maximum solar penetration
- Water channels and gravel beds for water storage
- Green facades
- Durable surfaces to accommodate movement

#### Typical Hard Materials:

- Timber decking
- Stone
- Concrete
- Loose gravel

#### Typical Soft Materials:

- Native mosses
- Native lichens
- Native ferns
- Native grasses
- Native of naturalised wildflowers
- Native Ivy

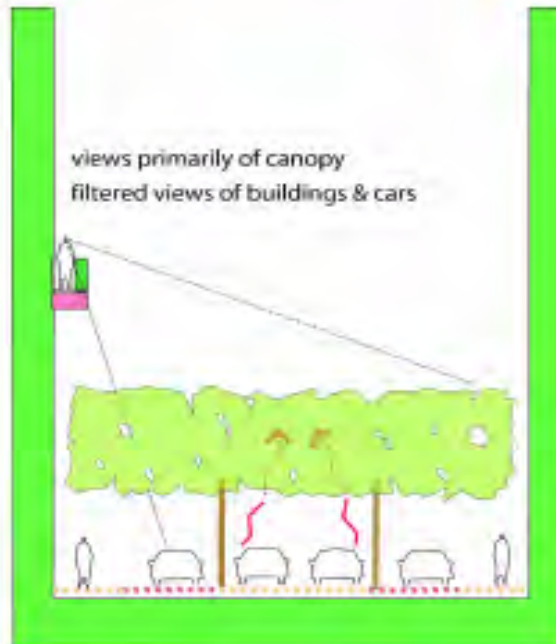
#### Lighting:

- Soft low-level spot lighting
- Cooled lighting

#### Character Zone Change Along Perimeter Length:

- Informal to formal, decreased proportion of soft landscape

## Routes



proportion varies  
with street width

Tree type /  
formality  
varies with  
character zone



### Key Features:

- Shared surface with pedestrian and trafficked areas designated by varied surface paving, allowing easy manoeuvrability
- Predominantly hard landscape with extensive tree canopy to screen views of cars from above
- Light coloured surface treatment for maximum reflectivity
- Clutter free - signage and street furniture minimised

### Typical Hard Materials:

- Treated surface e.g. reclaimed granite sets
- Self-bonding gravel

### Typical Soft Materials:

- Small deciduous trees e.g. Fraxinus excelsior 'Raywood' or Sorbus aria
- Consider roof trained trees as more formal option

### Lighting:

- Uplighting to trees
- Lighting bollards for human scale
- Lights suspended from tree canopy
- Downlights attached to building facades

### Character Zone Change Along Peninsula Length:

- Informal to formal, change in materials - different tree species and surface materials, becoming more formal closer to the Dome

### Ecology:

- Limited artificial refuges for birds or bats on buildings (e.g. House Martin/Swift)



## Roof Masterplan

Illustration of maximum potential



### Increasing property values

Developing recreational spaces on the roofs maximises the potential available building area of the site.

### Reducing the heat island effect

Impermeable building materials reflect heat, raising the local ambient temperature. Plants provide a relatively non-reflective surface and water retained by a green roof both humidifies and cools the air through the process of evaporation and evapotranspiration.

### Noise reduction and filtration of dust and pollutants

Green roofs have excellent sound reduction qualities, both from external sound (up to 20dB) and internal noise (up to 9dB). The vegetation filters airborne pollution and dust particles, removing them from the surrounding environment, air and improving air quality.

### Flood mitigation and storm water management

Soft landscape roofing helps to reduce the risk of flooding, by retaining to 90% of rainwater and reducing water run-off. If applied to 100% of the Greenwich peninsula roofscape (ca. 20 hectares) a minor increase of the green roof build-up (1-40-50cm) could make a major contribution to

required flood mitigation for the whole development and possibly remove the need for construction of a new pumping station.

### Reduced building running costs

A green roof improves the thermal insulation of the building, providing a more balanced temperature within. This reduces heating cost in winter and air conditioning expenses in summer.

### WATER

Green roofs recreate the natural water cycle. Rainfall is absorbed by the soil and plants and returned to the atmosphere by evaporation and plant transpiration.



### INTRODUCTION

Green roofs provide us with direct benefits in terms of enhanced lifestyles and property values. They also help to restore and support the virtuous cycles and balance of our environment - retaining rainfall, cleaning and cooling the air, reducing the heat island effect and providing important wildlife habitat, whilst also preventing building materials and reducing building opening costs.

### Required



### Desired



### EXTENSIVE ROOFS (<100kg/m<sup>2</sup>)

#### Extensive Roofs

Extensive green roofs are the most similar to natural natural vegetation ecosystems and are often a low cost, low maintenance solution. They are light weight and can be installed on structures. Shallow soils can be installed. Installation and maintenance costs are low depending on the seed mix chosen. Plants selected for green roofs are usually hardy, drought tolerant, low maintenance and are able to tolerate a wide range of conditions. Plants selected for green roofs are usually hardy, drought tolerant, low maintenance and are able to tolerate a wide range of conditions.

#### Amenity



#### Ecology



### INTENSIVE ROOFS (>100kg/m<sup>2</sup>)

#### Intensive Roofs

Intensive green roofs support a wider range of plants and animals, and are often used for recreational purposes. They are heavier and require more structural support. Deep soils with a wide range of plants, including trees, can be installed. Installation and maintenance costs are high. Plants selected for intensive roofs are usually hardy, drought tolerant, low maintenance and are able to tolerate a wide range of conditions.

#### Amenity



#### Ecology







ENVIRONMENTAL BRIEFING NOTE

# DESIGNING FOR BIODIVERSITY: PRODUCTIVITY AND PROFIT

APRIL 2011



**Biodiversity by  
Design** with Ken  
Yeang for the  
British Council of  
Offices April  
2011



# GREEN DESIGN

FROM THEORY TO PRACTICE

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## UNDERSTANDING DRIVERS AND SETTING TARGETS FOR BIODIVERSITY IN URBAN GREEN DESIGN

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