30 novembre 2017
Workshop Services écosystémiques urbains: entre chercheurs et professionnels d'espaces verts

Services écosystémiques et biodiversité urbaine: regard critique

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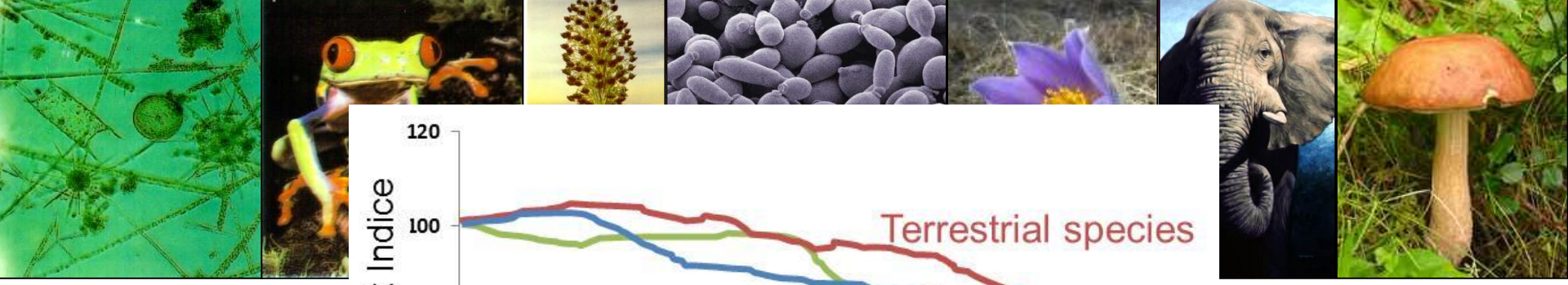
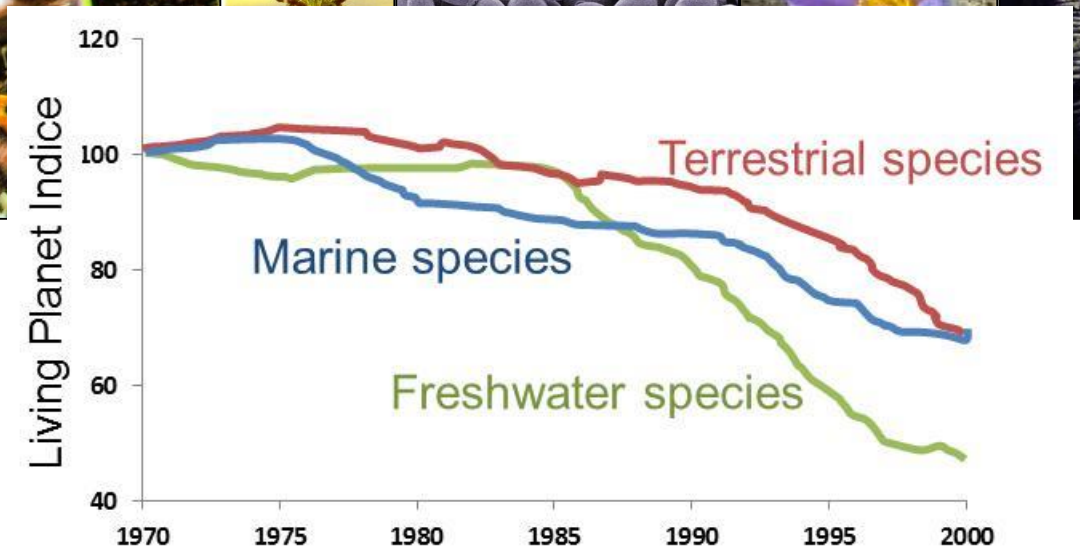
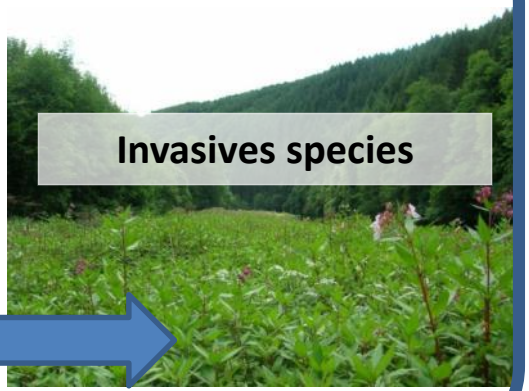
LIÈGE université
Gembloux
Agro-Bio Tech

Introduction:
la biodiversité, des parcs nationaux aux villes



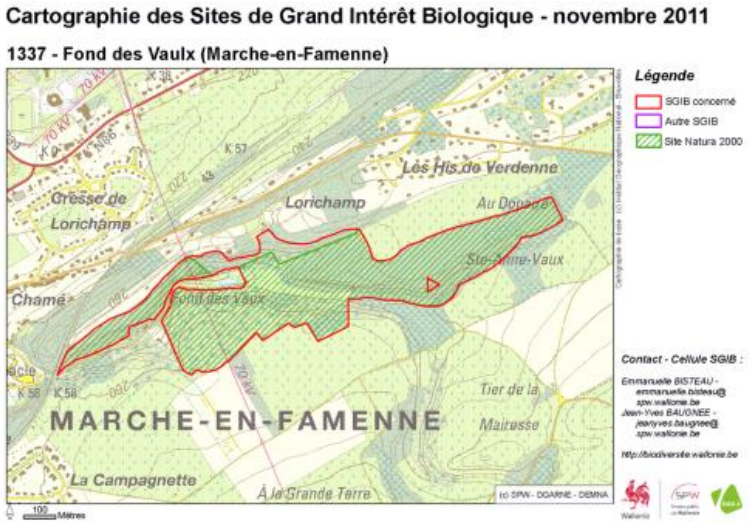


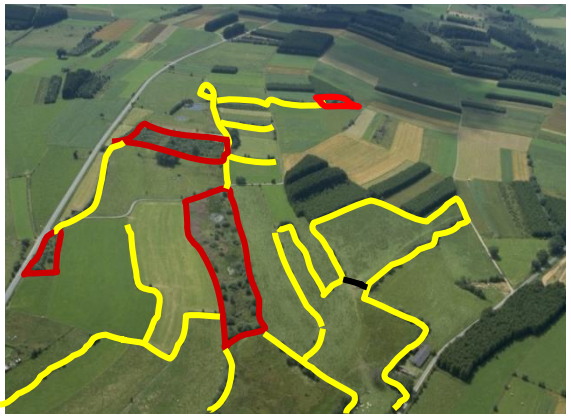
CLIMATE CHANGE / EUTROPHISATION

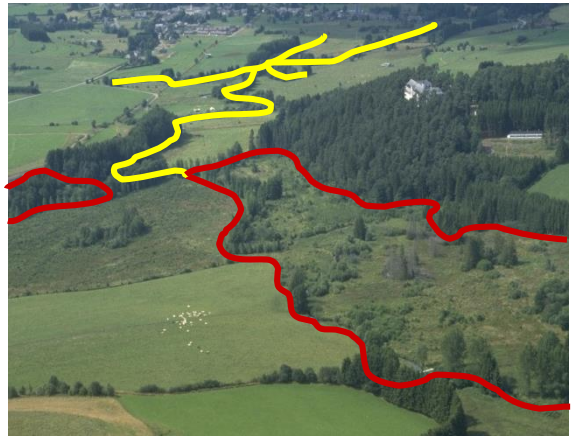
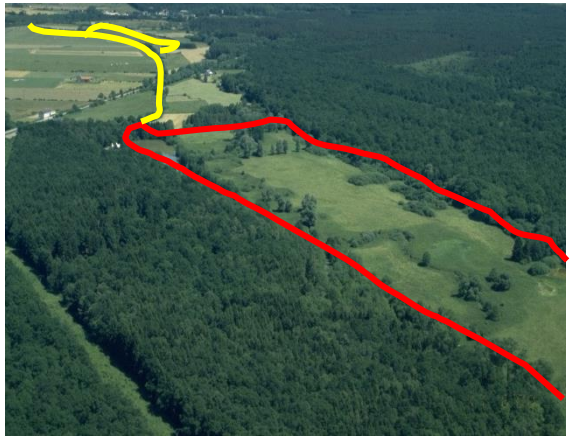
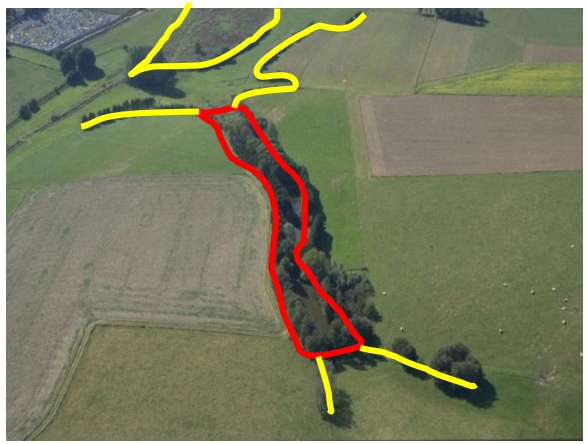


790 000 ha

4 ha

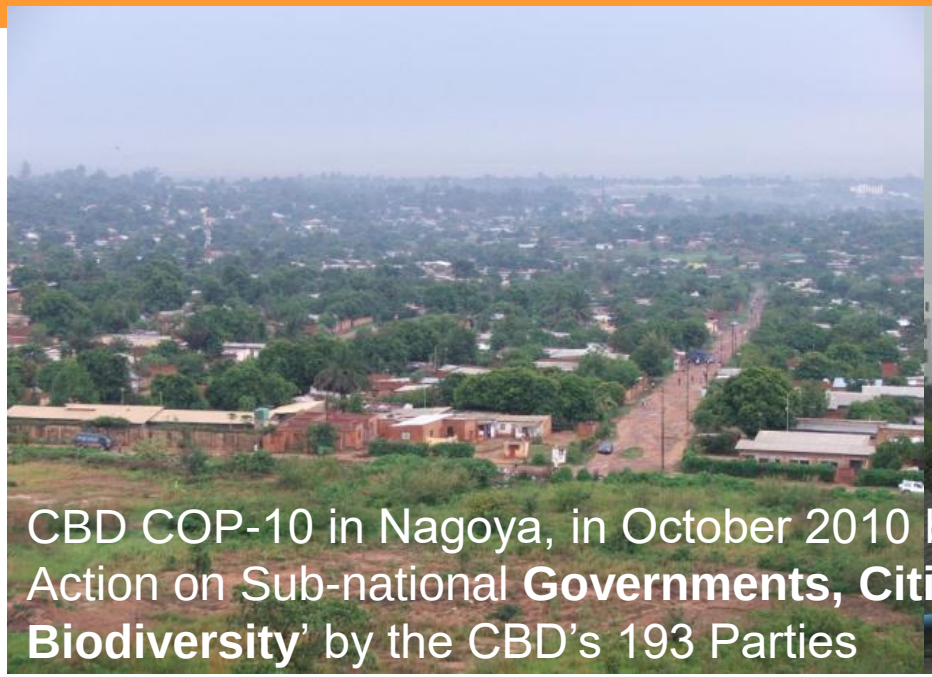


Réseaux écologiques :

Surface et Connectivité



CBD COP-10 in Nagoya, in October 2010 by the official endorsement of ‘The Plan of Action on Sub-national **Governments, Cities and Other Local Authorities for Biodiversity**’ by the CBD’s 193 Parties

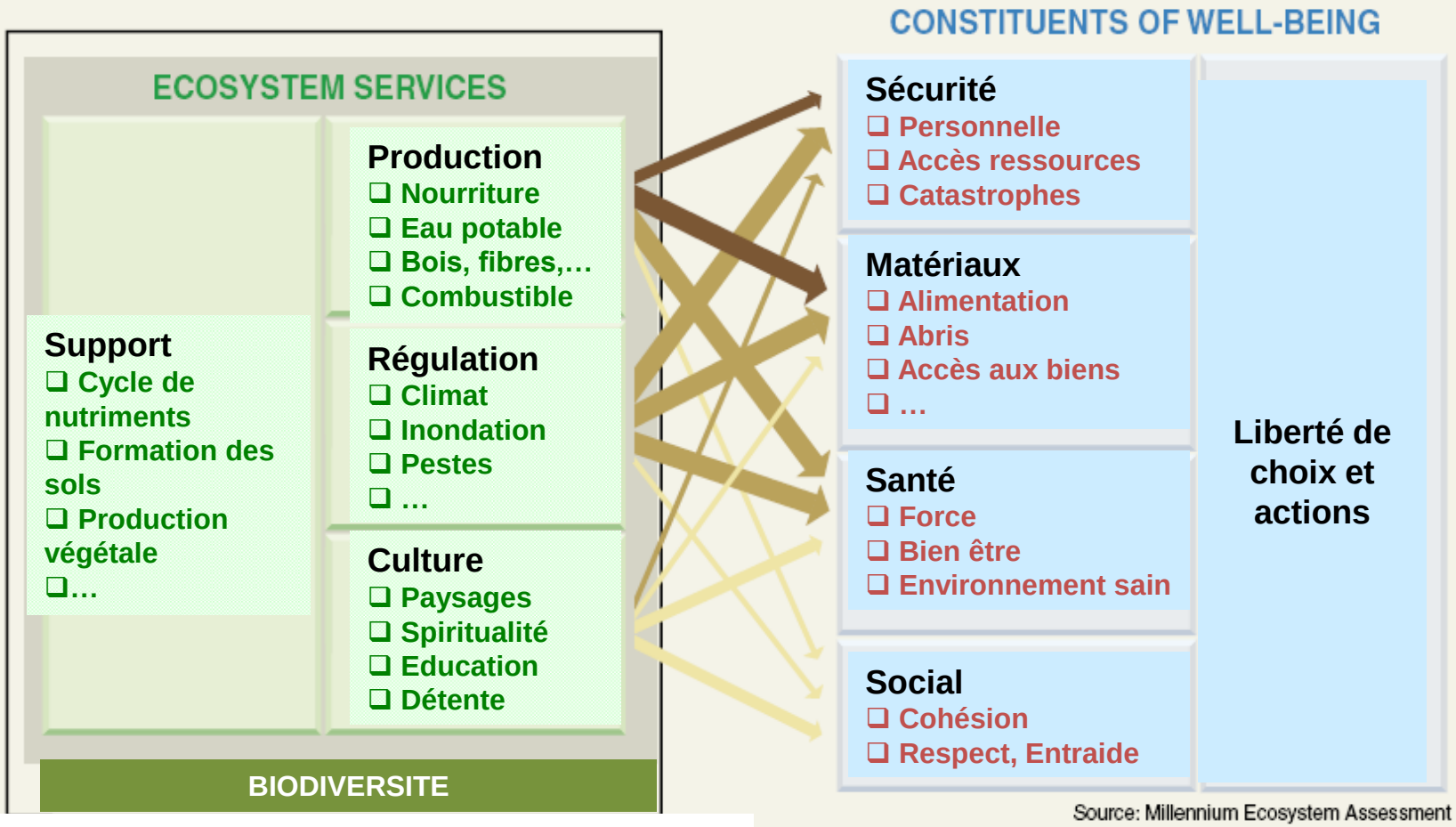
… et finalement la ville

More than half of the world's population lives in cities and more than two thirds are expected to live in cities by 2050 (UN, United Nations, 2010).

UN (United Nations), 2010. World Urbanization Prospects: The 2009 Revision. UN Department of Economic and Social Affairs, Population Division, New York.
http://esa.un.org/wup2009/unup/index.asp?panel

Pourquoi la biodiversité urbaine ?

Un point de vue humain



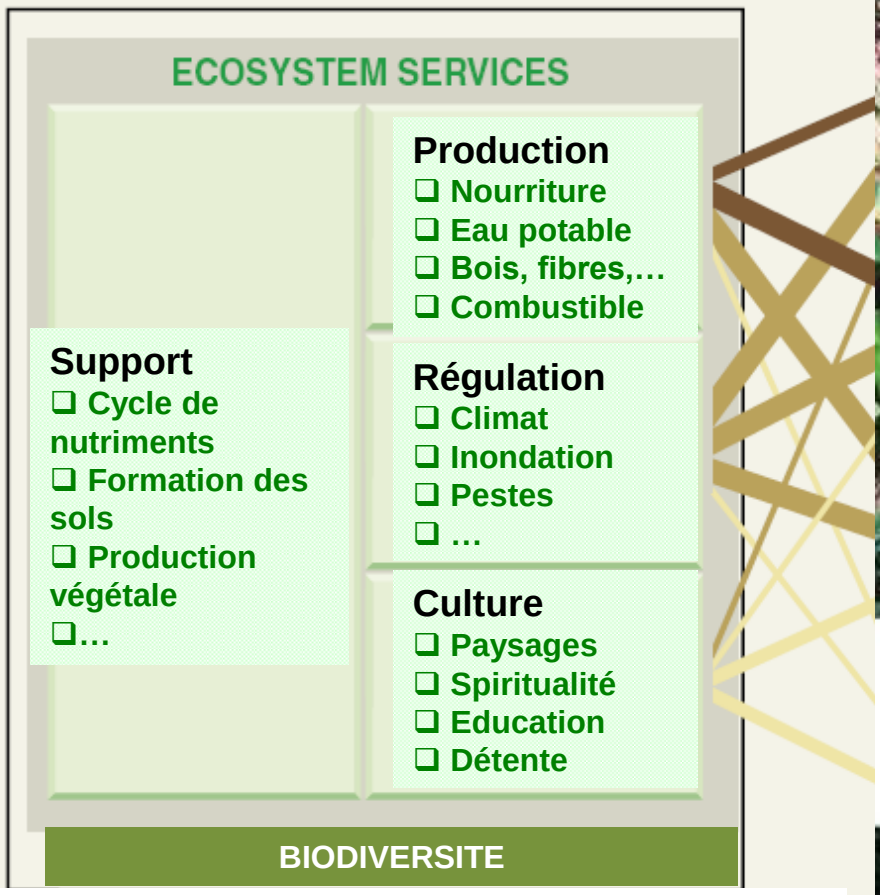
Source: Millennium Ecosystem Assessment

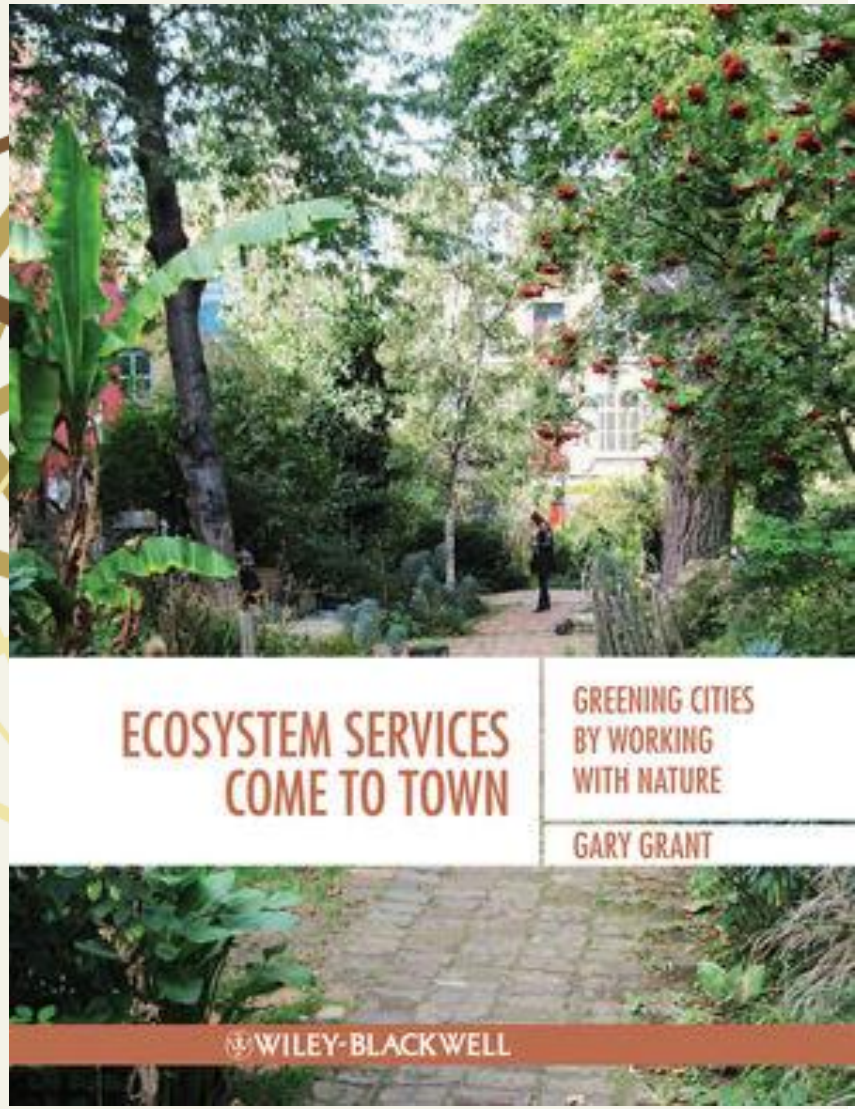
Les bénéfices que les populations humaines obtiennent des fonctions des écosytèmes

Table 1
Classification of important ecosystem services in urban areas and underlying ecosystem functions and components.

Functions and components	*Ecosystem service*	*Examples*	*Examples of indicators/proxies*
Energy conversion into edible plants through photosynthesis	Food supply	Vegetables produced by urban allotments and peri-urban areas	Production of food (tons yr^{-1})
Percolation and regulation of runoff and river discharge	Water flow regulation and runoff mitigation	Soil and vegetation percolate water during heavy and/or prolonged precipitation events	Soil infiltration capacity; % sealed relative to permeable surface (ha)
Photosynthesis, shading, and evapotranspiration	Urban temperature regulation	Trees and other urban vegetation provide shade, create humidity and block wind	Leaf Area Index; Temperature decrease by tree cover$\times m^2$ of plot trees cover (°C)
Absorption of sound waves by vegetation and water	Noise reduction	Absorption of sound waves by vegetation barriers, specially thick vegetation	Leaf area (m^2) and distance to roads (m); noise reduction dB(A)/ vegetation unit (m)
Filtering and fixation of gases and particulate matter	Air purification	Removal and fixation of pollutants by urban vegetation in leaves, stems and roots	O_3, SO_2, NO_2, CO, and PM_{10} μm removal (tons yr^{-1}) multiplied by tree cover (m^2)
Physical barrier and absorption on kinetic energy	Moderation of environmental extremes	Storm, floods, and wave buffering by vegetation barriers; heat absorption during severe heat waves	Cover density of vegetation barriers separating built areas from the sea
Removal or breakdown of xenic nutrients	Waste treatment	Effluent filtering and nutrient fixation by urban wetlands	P, K, Mg and Ca in $mgkg^{-1}$ compared to given soil/water quality standards
Carbon sequestration and fixation in photosynthesis	Climate regulation	Carbon sequestration and storage by the biomass of urban shrubs and threes	CO_2 sequestration by trees (carbon multiplied by 3.67 to convert to CO_2)
Movement of floral gametes by biota	Pollination and seed dispersal	Urban ecosystem provide habitat for birds, insects, and pollinators	Species diversity and abundance of birds and bumble bees
Ecosystems with recreational and educational values	Recreation and cognitive development	Urban parks provide multiple opportunities for recreation, meditation, and pedagogy	Surface of green public spaces (ha)/inhabitant (or every 1000 inhabitants)
Habitat provision for animal species	Animal sighting	Urban green space provide habitat for birds and other animals people like watching	Abundance of birds, butterflies and other animals valued for their aesthetic attributes

Quelles fonctions ?





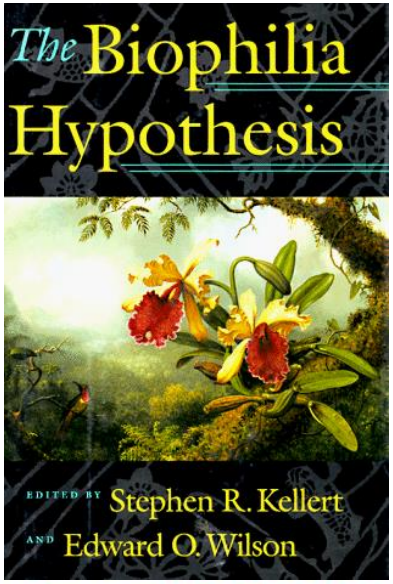
BIOPHILIE

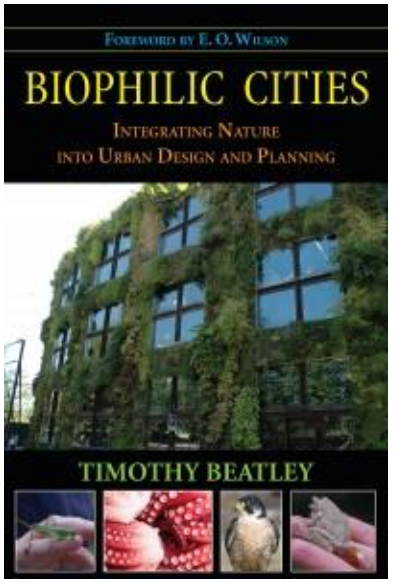
« Biophilia…

is the innately emotional affiliation of human beings to other living organisms ….

Life around us exceeds in complexity and beauty anything else humanity is ever to encounter

Edward O. Wilson
The Biophilia Hypothesis





Benefit	Description	Examples
Psychological well-being	Positive effect on mental processes	Increased self-esteem [32,60,61] Improved mood [58,32] Reduced anger/frustration [62] Psychological well-being [13,63,64] Reduced anxiety [65] Improved behaviour [15]
Cognitive	Positive effect on cognitive ability or function	Attentional restoration [12,14,46,66,67] Reduced mental fatigue [63] Improved academic performance [68] Education/learning opportunities [49,55] Improved ability to perform tasks [15] Improved cognitive function in children [69] Improved productivity [35,68]
Physiological	Positive effect on physical function and/or physical health	Stress reduction [37,70,71] Reduced blood pressure [45,32] Reduced cortisol levels [70] Reduced headaches [37] Reduced mortality rates from circulatory disease [24] Faster healing [9] Addiction recovery [43] Perceived health/well-being [59] Reduced cardiovascular, respiratory disease and long-term illness [11] Reduced occurrence of illness [15,35]


Biodiversité & Biophilie
www.arp-astrance.com/solutions/batiment-durable/ingenierie-ecologique-biodiversite-nature-en-ville.html
Rechercher
arp . astrance
L'immobilier fait sens
SOCIÉTÉ
SOLUTIONS
RÉFÉRENCES
CONTACT
Recherche..
Biodiversité* & Biophilie**
En 2009, pour la première fois de l'histoire de l'humanité, plus de la moitié de la population vit en ville.
Selon les prévisions des Nations Unies, le nombre de citadins devrait augmenter de 72 % d'ici 2050 pour atteindre 6,3 milliards et représenter 67 % de la population. La population urbaine sera alors équivalente à la population mondiale de 2002.
Les conséquences néfastes de l'urbanisation sur les écosystèmes et les services qu'ils nous rendent ont créé un besoin urgent pour le développement de villes plus soutenables.
Prendre en compte la biodiversité dans les projets immobiliers.
Les vingt dernières années ont été marquées par l'émergence de l'écologie urbaine et l'essor des problématiques liées à la conservation de la biodiversité en ville. Les demandes des citadins pour plus de « Nature » en ville se font ressentir de manière de plus en plus prégnante.
Face à ces enjeux à la fois écologiques et sociétaux, arp-astrance a développé des solutions pour mieux prendre en compte la biodiversité dans les projets immobiliers.
Nos offres visent à concilier aménagements, préservation de la biodiversité et usages, non
BÂTIMENT DURABLE
Politique de développement durable, RSE & Immobilier
Article en cours d'élaboration, merci de votre compréhension.
Démarche environnementale & Certification (HQE, BREEAM, LEED, PASSIVHAUS, BBC, LBC, WELL, SKA ...)
Nos équipes de certification sont spécialistes des enjeux, opportunités et questions traités dans...
Commissioning & Performance énergétique
En matière de performance énergétique, les résultats tangibles sont issus de la combinaison de 3...
FR

Un regard critique sur la relation biodiversité – services écosystémiques en milieu urbain


Quelles fonctions ?
OPTIGRÜN.DE
Quelle biodiversité

- Connaissances: études 1) en milieux naturels ou semi-naturels ou 2) conditions contrôlées

- Services écosystémiques: urbains ≠ non-urbains.

  3 causes:

  1) urbains: conditions biotiques et abiotiques altérées
  2) fonctionnement des espèces peut avoir été modifié (production de graines, durée de vie, espèces exotiques,…)
  3) décisions humaines et facteurs socio-économiques

Ecosystem disservices

have been defined as ‘functions of ecosystems that are perceived as negative for human well-being’

Table 2
Suggestions for UEDS indicators used in scientific literature.

UEDS	Indicators	References
Plants and their pollens can cause allergies or poisoning	Allergenic potential of respective plants	Lyytimäki et al. (2008), Lyytimäki and Sipilä (2009), Dobbs et al. (2011), Escobedo et al. (2011), Pataki et al. (2011), Arnold (2012), Douglas (2012), Nowak (2012), Roy et al. (2012), Gómez-Baggethun and Barton (2013), Kabisch and Haase (2013), and Seamans (2013)
Extensively managed (green) areas are considered unpleasant, ugly or unsafe	Area of non-illuminated parks	Bolund and Hunhammar (1999), Tzoulas et al. (2007), Lyytimäki et al. (2008), Lyytimäki and Sipilä (2009), Escobedo et al. (2011), Douglas (2012), Hofmann et al. (2012), Kovacs (2012), Roy et al. (2012), Gómez-Baggethun and Barton (2013), and Kabisch and Haase (2013)
Plants can decrease air quality (emissions of VOC and PM, emissions in course of maintenance)	Emissions of volatile organic compounds (VOC), emissions from maintenance activities, concentrations of particulate matter (PM) in air	Bolund and Hunhammar (1999), Dobbs et al. (2011), Escobedo et al. (2011), Manning (2011), Pataki et al. (2011), Nowak (2012), Roy et al. (2012), Gómez-Baggethun and Barton (2013), Seamans (2013), and Franck et al. (2014)
Sounds, smells, and behaviour of plants or animals cause anxiety	Abundance of undesired species	Bolund and Hunhammar (1999), Savard et al. (2000), Lyytimäki et al. (2008), Roy et al. (2012), Gómez-Baggethun and Barton (2013), and Seamans (2013)
Maintaining green spaces generates costs (financial, energy, opportunities)	Maintenance cost for urban green areas	Lyytimäki et al. (2008), Escobedo et al. (2011), Kirkpatrick et al. (2011), Nowak (2012), Roy et al. (2012), and Seamans (2013)
Damage to structures/people by biological activity	Percentage of tree species susceptible to damage, percentage of trees yielding fruits, number of aged trees, amount of affected infrastructure	Lyytimäki et al. (2008), Dobbs et al. (2011), Escobedo et al. (2011), Roy et al. (2012), and Gómez-Baggethun and Barton (2013)
Animals can be disease vectors	Geographical range of respective diseases	Tzoulas et al. (2007), Lyytimäki et al. (2008), Escobedo et al. (2011), Douglas (2012)
Plants can block views	Number and size of trees near buildings	Lyytimäki et al. (2008), Kirkpatrick et al. (2011), Roy et al. (2012), and Gómez-Baggethun and Barton (2013)
Decrease in water quality/quantity	Amount of water used for plant growth	Escobedo et al. (2011), Pataki et al. (2011), Roy et al. (2012), and Seamans (2013)
Harmful species damage those species that are cared for	Not applicable to UEDS (in agriculture, EDS manifests as production loss, resp. pesticide costs)	Lyytimäki et al. (2008) and Escobedo et al. (2011)
Urban green and blue spaces can obstruct traffic infrastructure	Amount of affected traffic infrastructure	Lyytimäki et al. (2008) and Lyytimäki and Sipilä (2009)
Soil nutrient input	Not applicable to UEDS (in agriculture, EDS manifests as production loss, resp. amelioration costs)	Escobedo et al. (2011) and Pataki et al. (2011)
Displacement of endemic species	Population development of endemic species	Escobedo et al. (2011) and Roy et al. (2012)
Introduction of invasive species	Population development of invasive species	Escobedo et al. (2011)
Presence of protected species can restrict other uses of an area	Not applicable	Lyytimäki et al. (2008)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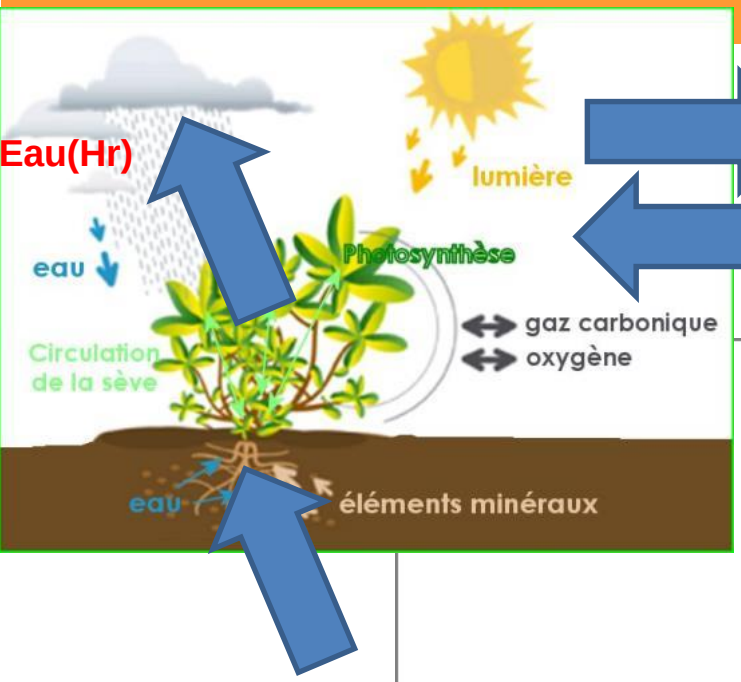
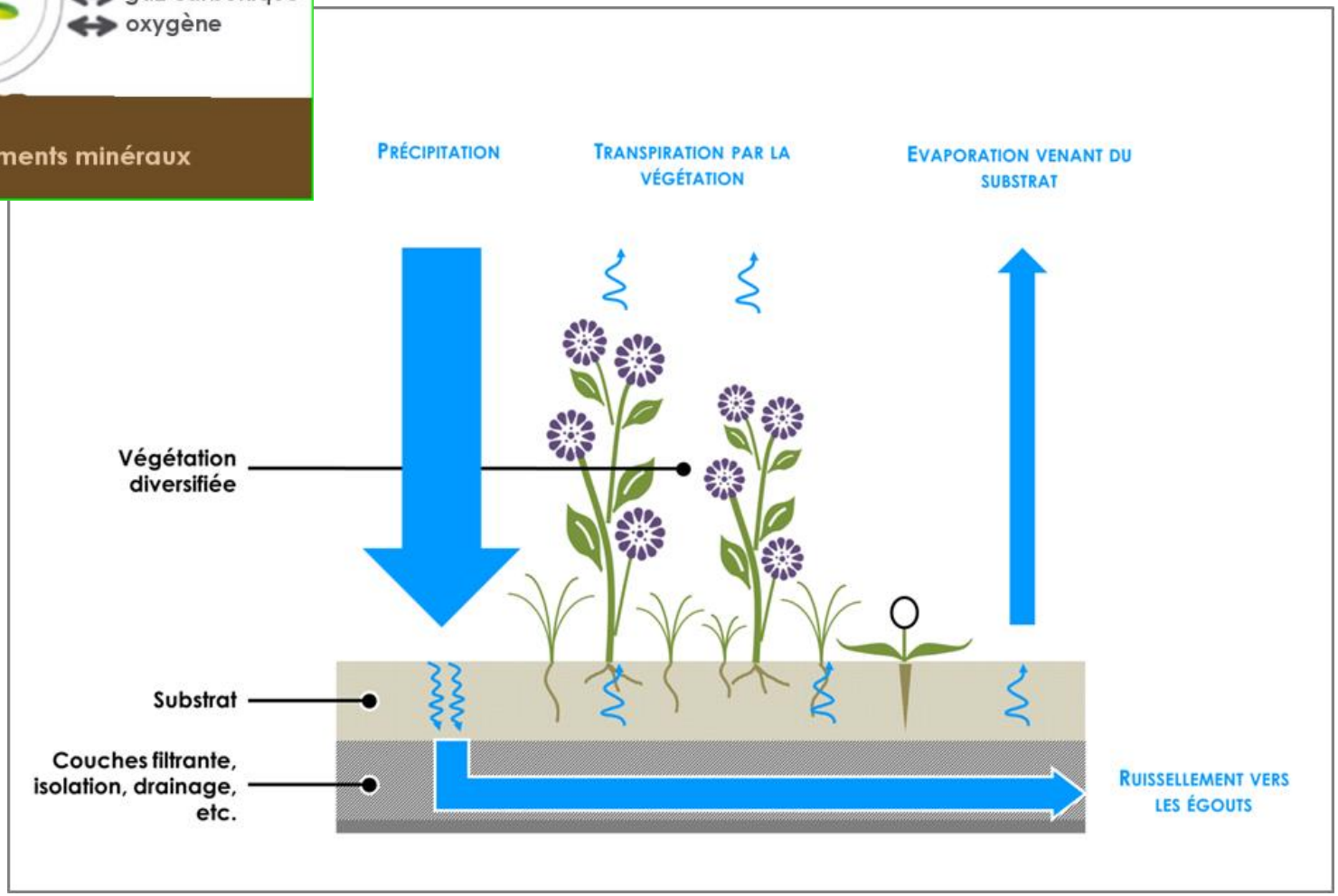

Eau(Hr)
lumière
eau
Photosynthèse
gaz carbonique
oxygène
Circulation
de la sève
eau
éléments minéraux


PRÉCIPITATION
TRANSPIRATION PAR LA VÉGÉTATION
EVAPORATION VENANT DU SUBSTRAT
Végétation diversifiée
Substrat
Couches filtrante, isolation, drainage, etc.
RUISSELLEMENT VERS LES ÉGOUTS

Landscape and Urban Planning 104 (2012) 356–363

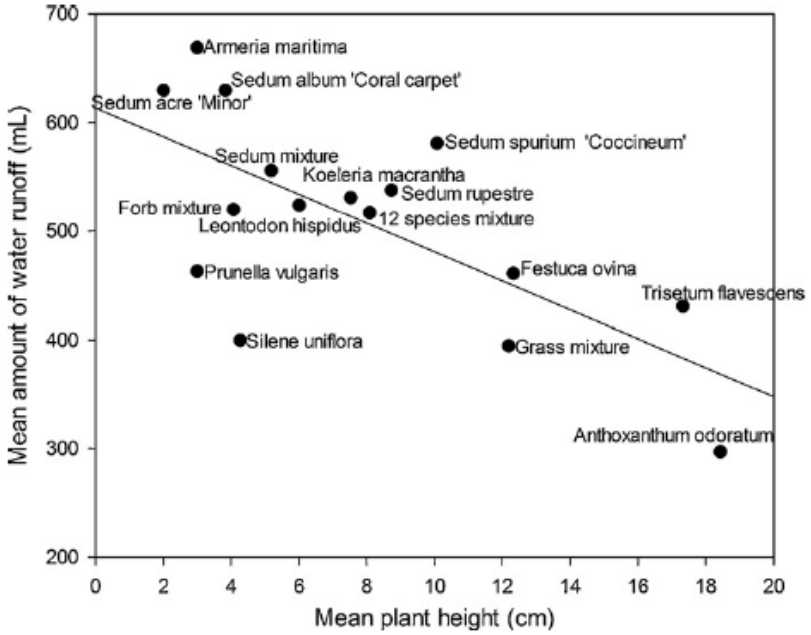
Contents lists available at SciVerse ScienceDirect

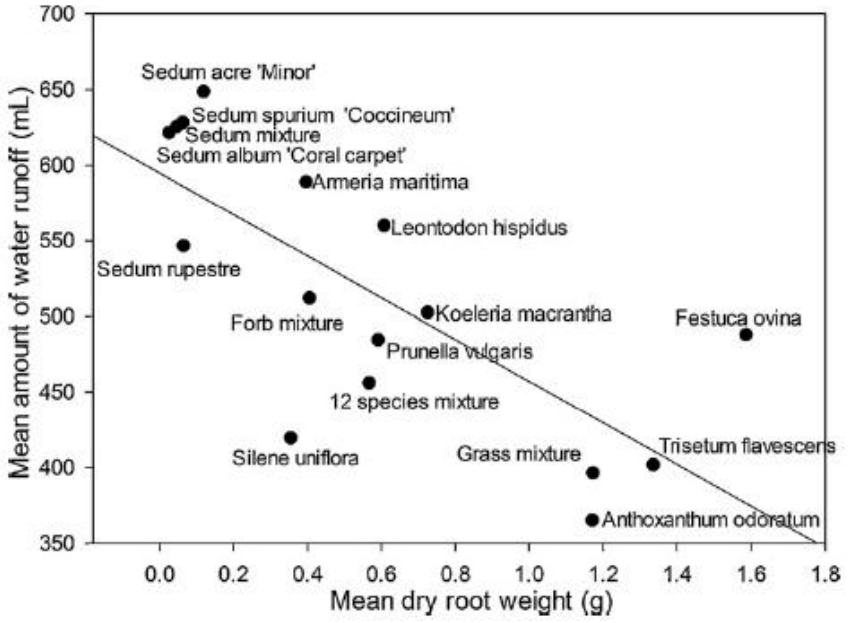
Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Amount of water runoff from different vegetation types on extensive green roofs: Effects of plant species, diversity and plant structure

Ayako Nagase[a,*], Nigel Dunnett[b,1]





Les caractéristiques morphologiques des espèces influencent la quantité d'eau retenue

TOUTES LES ESPECES N'ONT PAS MEME LA CAPACITE A RENDRE UN SE

Contents lists available at SciVerse ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

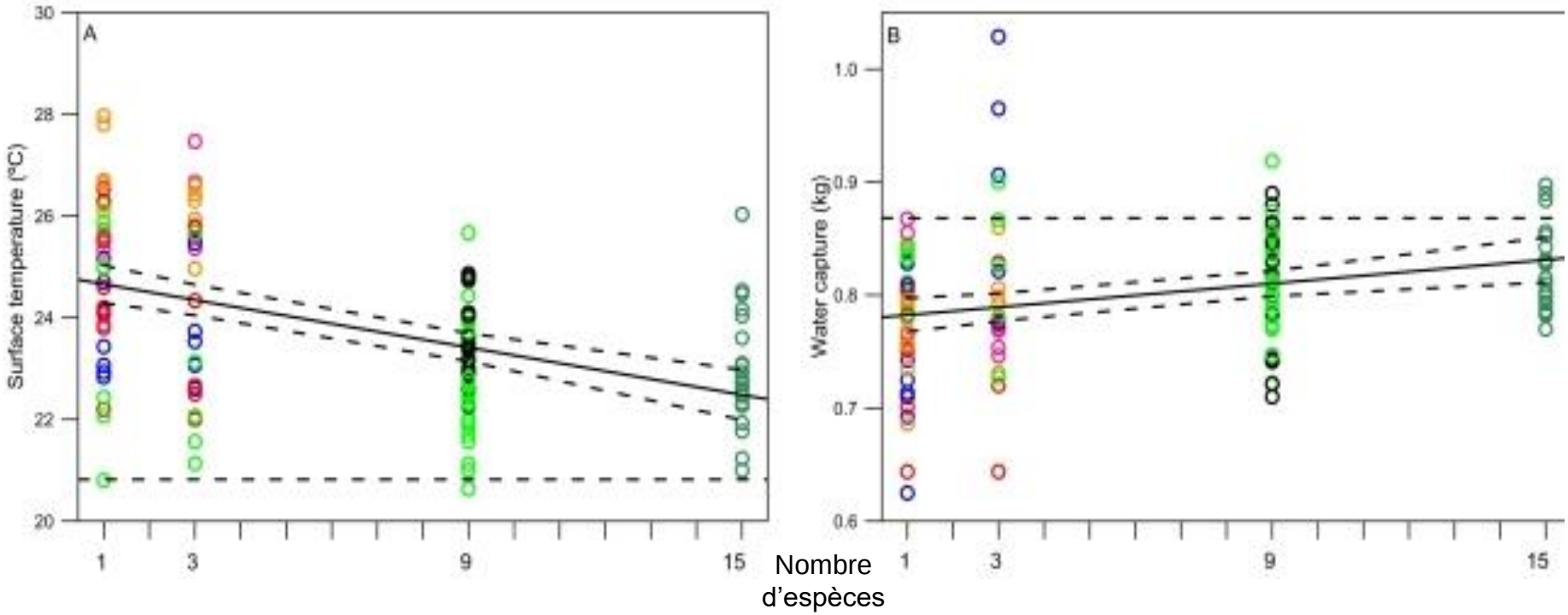
Review

Potential benefits of plant diversity on vegetated roofs: A literature review

Susan C. Cook-Patton [a,*], Taryn L. Bauerle [b]

Table 1
Green roof services and predicted impacts of increased plant species diversity.

Services provided by green roofs	Predicted impact of diversity on green roof performance	Relevant citations
Temperature regulation (Bowler et al., 2010; Teemusk and Mander, 2010) and mitigation of urban heat islands (Castleton et al., 2010). Green roof plants:	Increased plant productivity, structural complexity, and constancy of coverage will improve rooftop insulation	Del Barrio (1998)[a]; Kolb and Schwarz (1986)[a,b]
• reflect more sunlight than conventional rooftops • improve rooftop insulation	Increased productivity and constancy of coverage will increase reflectance and cooling via evapotranspiration	Alexandri and Jones (2008)[b]; Kumar and Kaushik (2005)[b]; Lundholm et al. (2010)[a,b]; Verheyen et al. (2008)[a]



La diversité des espèces influence la quantité de SE

Landscape and Urban Planning 122 (2014) 152–159

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

Living roof preference is influenced by plant characteristics and diversity

Kate E. Lee[a,*], Kathryn J.H. Williams[a], Leisa D. Sargent[b], Claire Farrell[a], Nicholas S. Williams[a]

HIGHLIGHTS

- Living roofs with tall, green, grassy vegetation were highly preferred.
- Flowers increased living roof preference.
- Plant diversity increased preference overall, but decreased preference for most preferred vegetation.
- Psychological restoration was associated with the most preferred living roof.

ABSTRACT

Living, or green roofs, are increasingly built in cities for their environmental benefits, however there is little evidence about how to maximise their aesthetic appeal. Because preferences for landscapes can be determined by vegetation characteristics we surveyed the preferences of 274 Australian office workers using 40 living roof images which systematically manipulated plant life-form, foliage colour, flowering, diversity and height. These preferences were compared to those for a bare concrete roof. The potential restorativeness of the most preferred living roof and the concrete roof were also assessed. Results showed that all living roofs were preferred over the concrete roof; however preferences differed according to vegetation characteristics. The most preferred and restorative living roof had taller, green, grassy and flowering vegetation, while lower-growing red succulent vegetation was least preferred. Participants preferred a productive landscape, with green foliage and flowering consistently preferred. Participants with a stronger connection to nature consistently assigned higher preferences to taller, compared to lower-growing, vegetation. Increasing diversity was associated with higher preferences overall, but decreasing preferences for highly preferred vegetation. This research makes an important contribution to understanding employee preferences in the unique context of urban living roof landscapes.

What are the Benefits of Interacting with Nature?

Lucy E. Keniger [1,*], Kevin J. Gaston [2], Katherine N. Irvine [3] and Richard A. Fuller [1]

Int. J. Environ. Res. Public Health **2013**, *10*, 913-935

When drawing conclusions from the existing literature, this review suggests caution is appropriate. There were several general methodological limitations that recurred throughout the body of reviewed literature. Firstly, much of the evidence has been derived from self-report questionnaires, particularly in the studies focused on psychological and social benefits. Secondly, sampling bias may have influenced results in some cases, especially for studies that recruited participants *in situ*. Thirdly, the reviewed studies were generally conducted over relatively short time frames leaving our understanding of the long-term benefits of interacting with nature unstudied. Lastly, many experimental studies did not include an appropriate control group therefore confounding variables such as age, gender and personal values may have influenced the results.

nature. It has been shown that interactions with nature can deliver a range of psychological well-being, cognitive, physiological, social, tangible and spiritual benefits and that access to green space and natural areas is important for facilitating activities that are beneficial for human well-being. However, because the evidence is mostly descriptive, little is known about the mechanisms that are important for delivering these benefits and so key questions still remain. What characteristics of natural settings (e.g., biodiversity, level of disturbance, proximity, accessibility) are important for triggering a beneficial interaction? How do these characteristics vary in importance between different cultures, geographic regions and socio-economic groups? These are important directions for future research if


Quelle biodiversité?
OPTIGRÜN.DE
Quelle biodiversité

Landscape and Urban Planning 103 (2011) 102–108

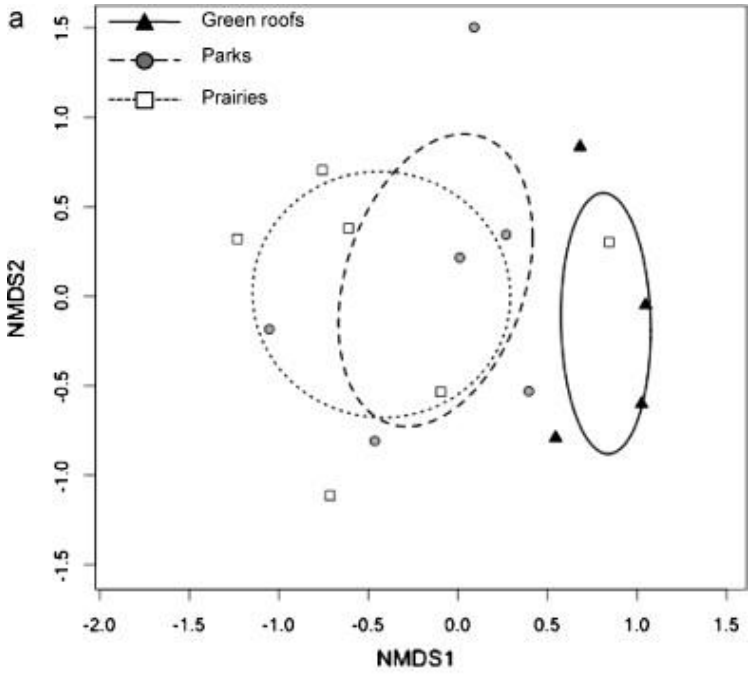
Contents lists available at ScienceDirect

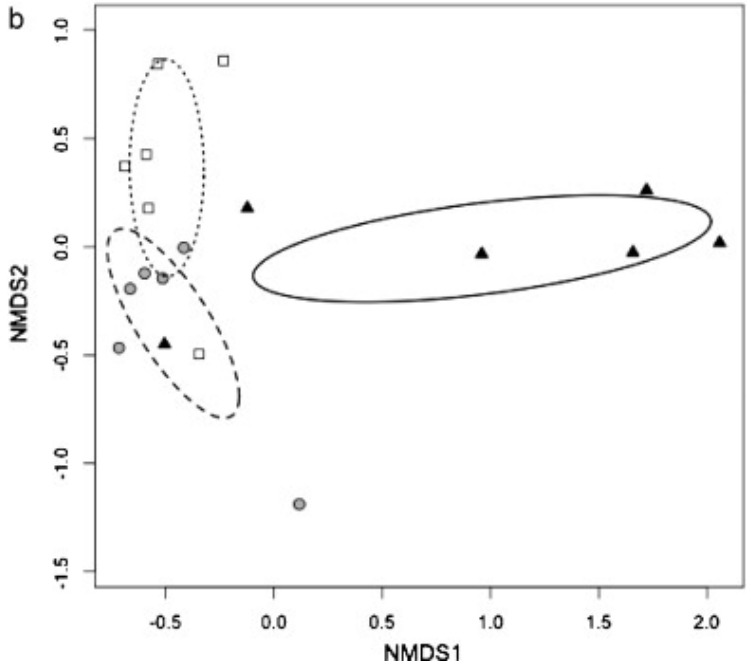
Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

A comparison of bee communities of Chicago green roofs, parks and prairies

Rebecca Tonietto[a,b,*], Jeremie Fant[b], John Ascher[c], Katherine Ellis[d], Daniel Larkin[b]





50 YEARS WITH IMPACT Journal of Applied Ecology

Journal of Applied Ecology 2014, 51, 1643–1649 doi: 10.1111/1365-2664.12333

FORUM

Do green roofs help urban biodiversity conservation?

Nicholas S. G. Williams[1]*, Jeremy Lundholm[2] and J. Scott MacIvor[3]

[1]*School of Ecosystem and Forest Science, The University of Melbourne, Richmond, Vic. 3121, Australia;* [2]*Department of Biology, Saint Mary's University, Halifax, NS B3H 3C3, Canada; and* [3]*Biology Department, York University, Toronto, ON M3J 1P3, Canada*

Summary

1. Green roofs are novel ecosystems that are increasingly common in cities. While their hydrologic and energy saving benefits are well-established, green roofs have also been proposed as having significant value for conserving biodiversity.

2. We evaluate six hypotheses that describe the purported biodiversity conservation benefits of green roofs. Green roofs largely support generalist species particularly insects, but their conservation value for rare taxa, and other taxonomic groups especially vertebrates, is poorly documented. Further, their ability to replicate biotic communities in the context of ecological restoration is largely untested, as is their potential to connect ground-level habitats.

3. *Synthesis and applications*. Given the evidence, green roof proponents should use restraint in claiming conservation benefits and it is premature for policymakers to consider green roofs equivalent to ground-level urban habitats. Ecologists need to work with the industry to evaluate green roof biodiversity and help design green roofs based on ecological principles to maximize biodiversity gains.

Journal of Applied Ecology 2010, **47**, 966–975 doi: 10.1111/j.1365-2664.2010.01857.x

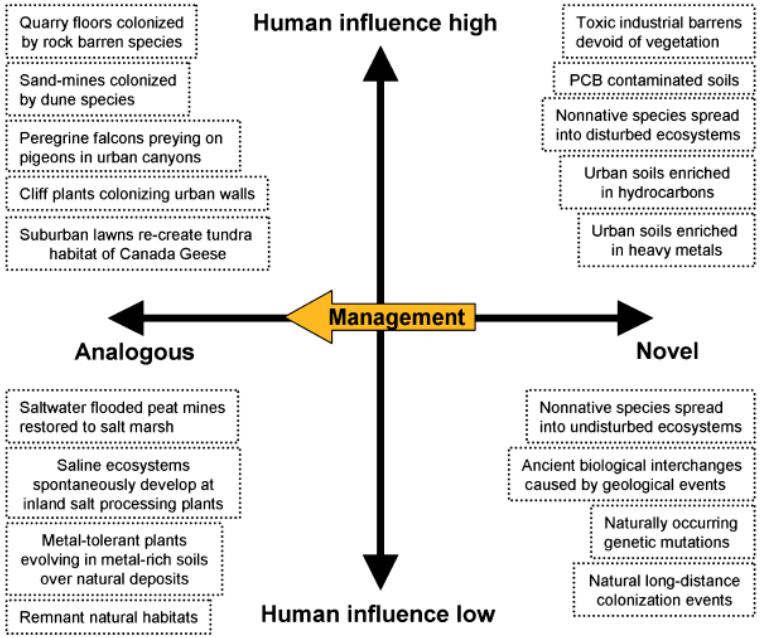
MINI-REVIEW

Habitat analogues for reconciliation ecology in urban and industrial environments

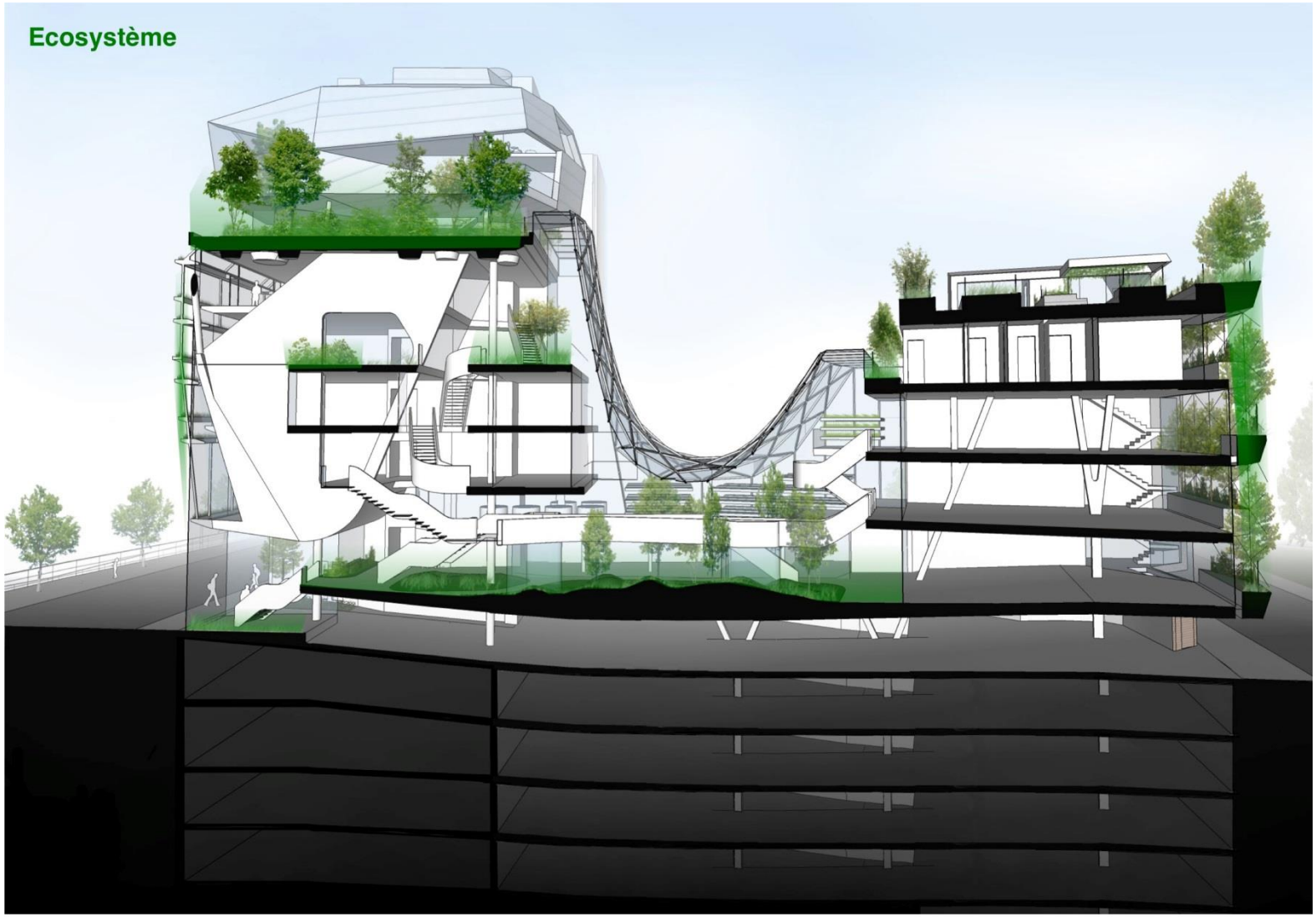
Jeremy T. Lundholm[1]* and Paul J. Richardson[2]

Habitats analogues

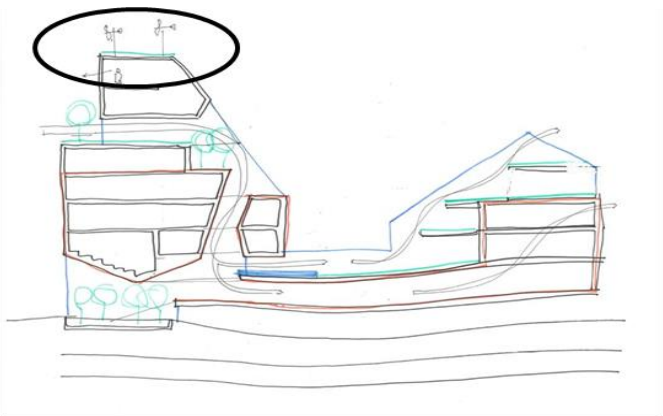
Certains des écosystèmes les plus anthropisés peuvent être en mesure de soutenir de la biodiversité indigène, car ils ressemblent de façon structurelle ou fonctionnelle aux écosystèmes naturels, aux habitats ou aux microsites qui sont présents ailleurs.



Ecosystème



Toiture verte semi extensive
Ecosystème 'libre'
Accueil de la biodiversité sauvage



Modèle

Ecosystèmes référence

Structure hétérogène et éléments d'acceuil de la petite faune

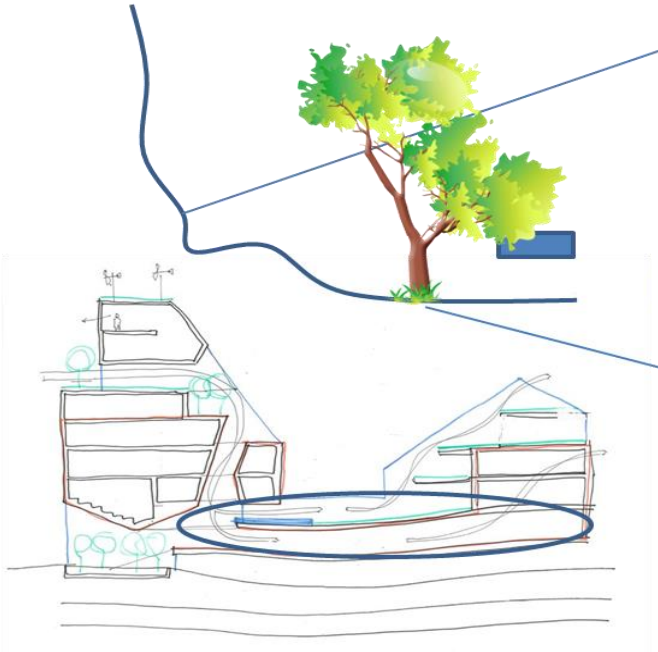
Espèces végétales natives disponibles ou à produire (espèces rares)

Thymus pulegioides, Silene nutans, Scabiosa columbaria, Dianthus armeria, Dianthus carthusianorum, Silene vulgaris, Campanula rotundifolia, Leucanthemum vulgare, Papaver argemone, Potentilla erecta, Clinopodium vulgare, Origanum vulgare, Galium verum, Stachys officinalis, Hypericum perforatum, Prunella vulgaris, Salvia pratensis, Anthyllis vulneraria, Primula veris et Briza media
(Source Ecosem sprl)

Jardin d'ombre
Ecosystèmes 'libre' et jardiné
Zone de détente

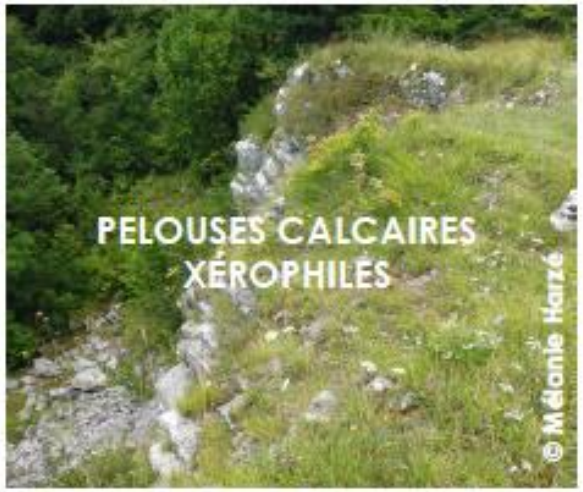
Modèle

Ecosystème référence

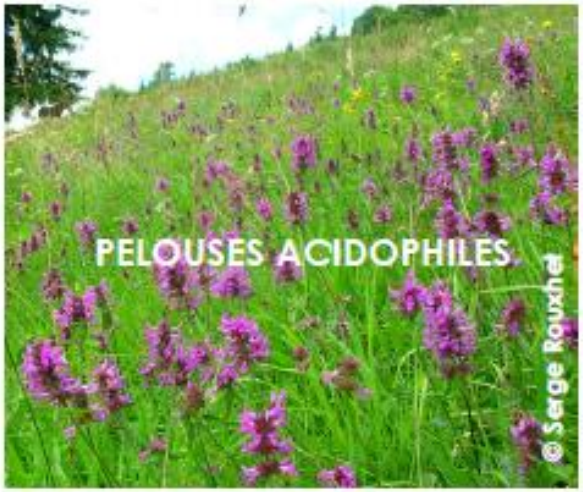


Espèces végétales natives disponibles ou à produire (espèces rares)

Achillea millefolium, Campanula trachelium, Clinopodium vulgare, Anthriscus sylvestris, Hesperis matronalis, Hypericum hirsutum, Prunella vulgaris, Valeriana officinalis, Eupatorium cannabinum, Digitalis purpurea, Myosotis sylvestris, Alliaria petiolata, Succisa pratensis, Geranium pyrenaicum, Malva sylvestris, Ranunculus acris et *Primula elatior, Polypodium vulgare, Asplenium scolopendre (Source ECOSEM sprl)*


PELOUSES CALCAIRES
XÉROPHILES
© Mélanie Harzé


PELOUSES CALCAIRES
MÉSO-XÉROPHILES
© Serge Rouxhet


PELOUSES ACIDOPHILES
© Serge Rouxhet


PRAIRIES DE BASSE ALTITUDE
© Serge Rouxhet


PRAIRIES SUB-
MONTAGNARDES
© Serge Rouxhet


LANDES SÈCHES
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Pelouses calcaires xérophiles

► Carte : cartographie de l'aire de répartition des pelouses calcaires xérophiles en Belgique, d'après Kuijken, E., Dufrêne, M., & Tack, J. (2003) .

Substrat (calcaire, superficiel: 6-10 cm)

- 60% minéral calcaire, 20% limon argileux, 20% M.O.
- « Substrat léger pour toitures vertes » ZINCO

• *Bromus erectus*
Brome dressé

Graminée vivace
50cm à 1m de hauteur

Floraison de mai à juillet

• *Erysimum cheiri*
Giroflée des murailles

Herbacée vivace
20 à 80cm de hauteur
Nectarifère et pollinifère

Floraison de mars à avril

• *Fragaria vesca*
Fraisier des bois

Herbacée vivace
5 à 25cm de hauteur
Pollinifère et nectarifère, source de fruits pour la faune

Floraison de avril à juillet

• *Hieracium pilosella*
Piloselle

Herbacée vivace
10 à 15cm de hauteur
Nectarifère

Floraison de mai à septembre.

• *Poa compressa*
Pâturin comprimé

Graminée vivace
25-50cm de hauteur

Floraison de juin à septembre

• *Potentilla neumanniana*
Potentille printanière

Herbacée vivace
5-20cm de hauteur
Nectarifère et pollinifère

Floraison de mars à juin

• *Sedum acre*
Orpin âcre

Herbacée vivace
4 -8cm de hauteur
Nectarifère et pollinifère

Floraison de mai à août

• *Sedum album*
Orpin blanc

Herbacée vivace
10-30cm de hauteur
Nectarifère et pollinifère

Floraison de juin à août

• *Sedum rupestre*
Orpin des rochers

Herbacée vivace
20 à 40cm de hauteur

Floraison de juin à août

• *Teucrium chamaedrys*
Germandrée petit-chêne

Graminée vivace
10-30cm de hauteur
Nectarifère, à valeur patrimoniale forte

Floraison de mai à septembre

Espèces	Cycle de vie	Hauteur	Intérêt	Floraison - époque & couleur
				J F M A M J J A S O N D
Dianthus carthusianorum, Œillet des chartreux	V	20-50 cm	N & P	
Helianthemum nummularium, Hélianthème commun	V	sous-arbrisseau rampant	N & P	
Hippocrepis comosa, Fer à cheval	V	10-30 cm		
Campanula persicifolia, Campanule à feuilles de pêcher	V	40-80 cm		
Digitalis lutea, Digitale à petites fleurs	V	0,5 à 1m		
Helleborus foetidus , Héllébore fétide	V	20-80 cm	N	
Inula conyzae, Herbe aux mouches	V	0,5-1m		
Lithospermum officinale, Grémil officinal	V	30-80 cm		
Silene nutans, Silène penché	V	20-50 cm	N	
Arenaria serpyllifolia, Sabline à feuilles de serpolet	A	5-25cm		
Echium vulgare, Vipérine commune	B	30-80 cm	N	
Verbascum lychnitis, Molène lychnite	B	0,5 à 1-2 m		
Teucrium botrys, Germandrée botryde	A ou B	10-40cm		
Scleranthus annuus, Scléranthe annuel	A	5-15cm	N & P	
Rumex acetosella, Petite oseille	V	10-50cm	N & F	
Verbascum thapsus, Bouillon blanc	B	0,5 à 1-2m	N & P	
Papaver argemone, Coquelicot Argémone	A	10-40cm	P	
Gagea villosa, Gagée des champs	V	5-20cm		
Geranium robertanum, Géranium Herbe à Robert	A ou B	20-40cm	N	

Figure 3 - Noue infiltrante à ouvette en son creux pour écouler les petits épisodes pluvieux et le début et/ou la fin des épisodes plus rares afin d'éviter les flaques. Source Architecture & Climat.

Figure 4 - Noue infiltrante avec enrochement linéaire en son point bas afin de limiter l'apparition de flaque. Ce massif n'est pas drainé par une évacuation vers un exutoire mais permet de stocker temporairement une partie des eaux de ruissellement. Toute l'eau stockée dans la noue et son enrochement sera ensuite infiltrée dans le sol. Source Architecture & Climat.

Figure 5 - Noue à évacuation superficielle. Le sol est très peu perméable. Les eaux stockées sont évacuées à débit régulé vers un exutoire via un orifice au pied de la noue. Cet orifice doit être très régulièrement entretenu pour éviter toute obstruction. Source Architecture & Climat.

Figure 6 - Noue drainante sur un sol très peu perméable. Les eaux stockées dans la noue s'infiltrent dans le substrat superficiel et sont drainées dans un massif qui évacue les eaux à débit régulé vers un exutoire. Source Architecture & Climat.

Figure 8 - Noue mixte, à la fois infiltrante et drainante, sur un sol moyennement perméable. Source Architecture & Climat.

Mégaphorbiaies

Sol riche (en éléments minéraux et organiques)

- Sols humides, crues périodiques (en bords de ruisseaux), pauvre en azote

Famille	Espèces	Nom commun	Cycle de vie	Hauteur	Intérêt biodiversité faunistique	Floraison											
						Ja	F	Mai	Av	Mai	Juin	Juil	Ao	S	O	N	D
Rosaceae	*Filipendula ulmaria*	Fausse Spirée	vivace	environ 1 m	P												
Ranunculaceae	*Thalictrum flavum*	Pigamon des rives	pérenne	souvent > 1 m	N et P												
Hypericaceae	*Hypericum tetrapterum*	Millepertuis à quatre ailes	vivace	30-60 cm	N et P												
Lamiaceae	*Stachys palustris*	Epiaire des marais	vivace	40 cm à 1 m	N et P												
Caprifoliaceae	*Valeriana repens*	Valériane rampante	vivace	30 cm à 1.50 m	P												
Apiaceae	*Angelica sylvestris*	Angélique sauvage	bisannuelle	souvent > 1 m	N et P												
Lythraceae	*Lythrum salicaria*	Herbe aux coliques	vivace	50 cm à 1 m	N et P												
Primulaceae	*Lysimachia vulgaris*	Grande Lysimaque	vivace	50 cm à 1 m	P												
Onagraceae	*Epilobium parviflorum*	Epilobe à petites fleurs		30 cm à 80 cm	N et P												
Onagraceae	*Epilobium hirsutum*	Epilobe à grandes fleurs		souvent > 1 m	N et P												
Asteraceae	*Eupatorium cannabinum*	Eupatoire chanvrine	vivace	6-12 dm	N et P												
Asteraceae	*Cirsium oleraceum*	Cirse maraîcher	vivace	jusqu'à 1,50 m	N et P												
Polygonaceae	*Persicaria bistorta*	Renouée bistorte	vivace	20 cm à 80 cm	N et P												
Cyperaceae	*Carex acutiformis*	Fausse Laiche aigue	vivace	40 cm à 1 m													
Poaceae	*Phalaris arundinacea*	Baldingère faux-roseau	vivace	80 cm à 200 cm	N et P												
Poaceae	*Phragmites australis*	Roseau commun	vivace	3 -5 m													
Typhaceae	*Sparganium erectum*	Rubanier dressé	vivace	50 cm à 1 m	P												
Urticaceae	*Urtica dioica*	Grande ortie	vivace	50 cm à 1 m	N et P												
Poaceae	*Holcus lanatus*	Petite fenasse	vivace	40 cm à 80 cm													
Polygonaceae	*Rumex acetosa*	Oseille	vivace	30 cm à 1 m	P												
Fabaceae	*Vicia cracca*	Vesque craque	vivace	1-2m, grimpante	N et P												
Caryophyllaceae	*Lychnis flos-cuculi*	Silène fleur de coucou	vivace	Hémicryptophyte érigé (<1m)	N et P												
Fabaceae	*Lotus uliginosus*	Lotier des fanges	vivace	30 cm à 80 cm	N et P												
Juncaceae	*Juncus effusus*	Jonc diffus	vivace	40 cm à 80 cm	P												
Polygonaceae	*Persicaria bistorta*	Renouée bistorte	vivace	20 cm à 80 cm	N et P												
Poaceae	*Dactylis glomerata*	Dactyle pelotonné	vivace	20 cm à 1 mètre													

Rendez-nous visite

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