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RENATU: a tool for assessing the ecological potential of an industrial or urban site for non-specialist users

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Abstract : The biodiversity strategy of companies is part of their financial and social performance. Urban, Industrial and Linear Transport Infrastructures (UILTI) integrate green spaces. For these, managers are asking for tools to assess and monitor their biodiversity. RENATU is a potential biodiversity indicator. It is composed of several indices that concern ecosystem features. The more complex the environment, the greater the taxonomic diversity. The complexity of the ecological components, measured by the indices, is indicative of the potential for hosting plant and animal species (insects, arthropods, butterflies, birds, mammals, etc.). A total of 96 sites were used to test this indicator. The results demonstrate the homogeneity of the ecological indices. An evaluation by means of a user questionnaire was used to confirm its relevance as a potential biodiversity management tool. Such an indicator is part of the corporate social responsibility strategy. It enhances both financial and social performance.

Keywords : Potential Biodiversity Indicator, assessment tool, management tool, green right-of way

RENATU : un outil d'évaluation du potentiel écologique d'un site industriel ou urbain pour des utilisateurs non spécialisés

Résumé : La stratégie de biodiversité des entreprises fait partie de leur performance financière et sociale. Les infrastructures de transport urbaines, industrielles et linéaires (ITUIL) intègrent des espaces verts. Pour ceux-ci, les gestionnaires sont demandeurs d'outils d'évaluation et de suivi de leur biodiversité. RENATU est un indicateur de biodiversité potentielle. Il est composé de plusieurs indices qui concernent les caractéristiques des écosystèmes. Plus l'environnement est complexe, plus la diversité taxonomique est importante. La complexité des composantes écologiques, mesurée par les indices, est révélatrice du potentiel d'accueil des espèces végétales et animales (insectes, arthropodes, papillons, oiseaux, mammifères etc.). Au total, 96 sites ont été utilisés pour tester cet indicateur. Les résultats démontrent l'homogénéité des indices écologiques. Une évaluation par le biais d'un questionnaire adressé aux utilisateurs a permis de confirmer sa pertinence en tant qu'outil potentiel de gestion de la biodiversité. Un tel indicateur s'inscrit dans la stratégie de responsabilité sociale des entreprises. Il permet d'améliorer les performances financières et sociales.

Mots clés : Indicateur de biodiversité potentielle ; outil d'évaluation ; outil de gestion ; emprise verte.

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1. INTRODUCTION

1.1 Why evaluate and manage industrial and urban green rights-of-way?

Today's global economy requires companies to be able to synergise the ability to take biodiversity into account with business models (Carbone et al. 2013; Bara et al. 2021; Farza et al. 2021). Urban, Industrial and Linear Transport Infrastructures (UILTI) integrate green spaces. These are considered by the managers of these infrastructures, public authorities and public or private organisations, as spaces of the urban green network (Vandermeulen et al. 2011). Following the recommendations of scientists, public authorities and managers are attempting to reduce the negative effects of UILTI on biodiversity (Brown et al. 2006; Jackson & Fahrig 2011; Foures & Pech, 2015; Opoku, 2019) and to renature cities (Connop et al. 2016; Matsler 2019). The Industrial and Urban Green Spaces (IUGS) which correspond to the green spaces of the UILTI play a role in the strategies of public authorities and companies (Guetté et al. 2017; Opoku 2019; Suppakittpaisarn et al. 2019). These UILTI are attracting the attention of managers, scientists and public authorities because they impact on the status of biodiversity (Vergnes et al. 2013; Redon De et al. 2015; Guetté et al. 2017) and the services provided by nature to people in cities but also in compagnies (Bomans et al. 2010; Tzoulas and James 2010; Van Oudenhoven et al. 2012; Zhang et al. 2014; Connop et al. 2016).

The biodiversity strategy of companies is part of their financial and social performance. It enhances financial performance and social performance (Wolf et al. 2018; Krause et al. 2019). It is recognised that green rights-of-way of UILTI have positive effects on biodiversity (Ranta 2008; Penone et al. 2012; Vergnes et al. 2013; Foures & Pech, 2015; Clevenot et al. 2017). For example, for Linear Transport Infrastructures (LTI), they provide corridors favouring the proliferation of both plant and animal species (Penone et al. 2012; Foures & Pech, 2015; Redon De et al. 2015). Compared to industrial agricultural areas or dense urban spaces, LTI rights-of-way are considered highly attractive areas for fauna and flora (Ranta 2008; Ascensao et al. 2012; Penone et al. 2012; Foster 2014; Foures & Pech 2015; Redon De et al. 2015; Mimet et al. 2016). These refuges serve plant species (Redon De et al. 2008; Penone et al. 2012), pollinating insects (Hopwood 2008), amphibians (Le Viol et al. 2009; Clevenot et al. 2018), birds (Guetté et al. 2017) and small mammals (Bellamy et al. 2000; Ascensao et al. 2012). For managers, it is increasingly a question of considering, protecting, and making UILTI even more attractive for biodiversity. However, Kok et al. (2020) note that there are few operational tools that can be easily used by operators to assess biodiversity. The indicators proposed by scientists, particularly ecologists, are ecologically robust but often difficult for use by public or private business operators (Battista et al. 2016; Broszeit et al. 2017; Bezombes et al. 2018). This paper presents a tool consisting of an indicator that is both ecologically robust and simple to use. It aims to address the challenges of producing science-based indicators that can be applied as a management tool.

1.2 Issues and objectives of an indicator

An indicator measures the state and evolution of biodiversity or a natural environment, its composition and anthropogenic impacts (Bowers and Boutin 2008; Burrascano et al. 2011; Di Battista et al. 2016; Liquete et al. 2016; Guetté et al. 2017). It may consist of a set of precise physical, chemical or biological measurements, such as the number of individuals or the number of taxa in a given area. The European Environment Agency (EEA) defines an indicator as "a measure, usually quantitative, that can be used to illustrate and report in a simple way on complex phenomena related to biodiversity, including trends and progress over time" (European Environment Agency 2005).

Infrastructure managers need indicators that are user-friendly, efficient, scientifically reliable, and simple to use (Levrel 2007; Shakel 2009; Vandermeulen et al. 2011). The existing indicators are made up of various criteria leading to an index (Vergnes et al. 2013; Moreno Pires et al. 2014; Haaland & Van den Bosch 2015). There is simplification, but for many researchers it is well known that the state of a habitat or the presence of certain structural indicators of the ecosystem are representative of greater complexity (Lavorel & Garnier 2002; Garnier et al. 2004; Shipley et al. 2006; Levrel, 2007; King 2016; Liquete et al. 2016;

Guetté et al. 2017). This indicator brings together a number of ecological features relating to an environment or space (Garnier et al. 2004; Geijzendorffer and Roche 2013; Di Battista et al. 2016). This complexity is significant for biodiversity due to the variety of functions within the ecosystem and its evolutionary capacities (Elmqvist et al. 2003; Chillo et al. 2011; Arponen 2012). Biodiversity provides also ecosystem services, which benefit human societies and compagnies (Anton et al. 2010; Feld et al. 2010; Liquete et al. 2016).

An indicator thus makes it possible to simplify the reality of biodiversity by selecting criteria that make it understandable. It can also be composed of management elements that are favourable to biodiversity, such as the late mowing of lawns to encourage nesting by certain birds. It is thus a tool for synthesis, evaluation but also for communication, as it enables the elements collected in the field to be transformed into a set of scores (King 2016). An indicator of potential biodiversity also makes it possible to take stock of the state of an area, and as such can also serve as a benchmark for assessing the effectiveness of a certain type of management (Gosselin & Larrieu 2020). Thus, it allows a diagnosis to be made for a given area and for management actions to be planned (Smyth et al. 2007; Fürst et al. 2010). It also facilitates communication, on the one hand towards the general public. It can be used as a management tool in sustainable development strategies of the compagnies (Smyth et al. 2007; Jégou et al. 2012; Brunbjerg et al. 2018).

The indicator RENATU – as in RENATUration of UILTI - presented in this article is the result of work carried out by scientific laboratories in ecology and geography and by the operational, managerial and construction personnel of the UILTI within the framework of the ITTECOP programme (http://www.ittecop.fr/en/) and others firms, and especially SNCF, Eiffage, PSA and Lidl. This indicator is not a scientific ecological indicator but it aims to meet the needs of professionals who want to have a tool that is easy to use but ecologically valid. This indicator does not replace the scientific indicators that can be used in addition. In this article we first present the way to implement RENATU indicator; Then it is presented how the RENATU indicator is valid as an ecological assessment tool and as an environmental management tool in companies; finally, these results are discussed before the conclusion.

2. HOW TO IMPLEMENT RENATU?

Two conditions are sought for the RENATU indicator: it must be ecologically relevant and it must be ergonomic for professionals (Shakel 1991; Diapan et al. 2019). In order to develop the RENATU indicator and validate it (Fig.1), a review of the scientific literature was conducted on indicators. RENATU consists of several indices concerning ecological structures and management elements for plant species, generally based on the recognition of plant physiognomy, and ecological structural components of the site. For this study it was tested on the rights-of-way of UILTI in France, mainly in the Île-de-France region and in other parts of France in relation to industrial sites (Fig. 2). The validation of the indicator is based on ecological data collected at the same time from eleven sites and on a RENATU ergonomics survey of users.

2.1 Fields of study and choices of patches

A green space, a right-of-way bordering a linear transportation infrastructure or within an industrial area, is composed of several landscape elements, from different sectors. They are by definition habitats: they are made up of plants (grass, shrubs, trees), aquatic elements (pond, river, ditch) and are likely to shelter a variety of flora and fauna. The objective is to carry out a study design of the characteristics of this green space. This design allows one to identify the sites where surveys are being out using RENATU. It also shows the efforts made in terms of ecological management by comparing the results of the surveys carried out with RENATU. It is a tool for monitoring and tracking the ecological status of a green space.

First, one must take the time to look at and observe the green space: what is it made of, are there several habitats: they are made up of plants (grass, shrubs, trees), aquatic elements (pond, river, ditch) and are likely to shelter a variety of flora and fauna.

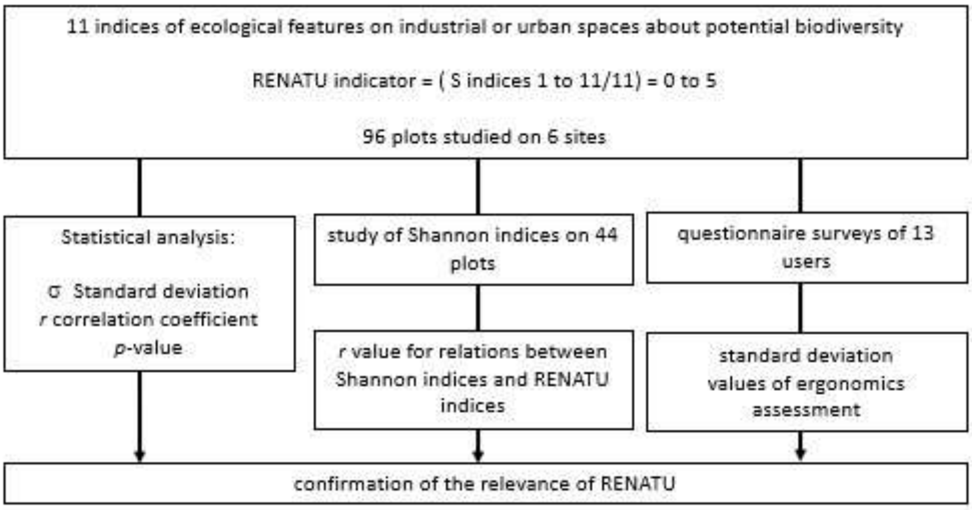

Figure 1: methodological approach to develop and validate the RENATU indicator

First, one must take time to look at and observe the green space: what is it made of, are there several habitats (grass, grove, wood, hedge, pond, etc.)? If nuances in plant composition and landscape form are detected, then it is advisable to separate them and decide that there are two or three habitats rather than just one: this analysis is part of a landscape ecology approach (Forman & Godron 1981; Fahrig et al. 2011). There is no standard dimension to conducting a survey. It can be carried out over an area of a few m² or over much larger areas if the habitat is homogeneous. As shown in Fig. 1, in order to assess RENATU, with three kinds of process were applied.

For this study and to test RENATU, 96 surveys were carried out on the right-of-way of an LTI, the tramway line 2 located in the eastern part of the Greater Paris Metropolis (*Metropole du Grand Paris,* or MGP) (Figs. 2 and 3), a survey along the SNCF line at the Sèvre-Ville d'Avray station in the west of Paris and industrial sites belonging to the company PSA (Fig.3). The choice of the survey patch depends on the site, but the size of the 10 x 10 m quadrat was taken as a basis for analysis to make our comparative study more scientifically robust. The only exception is the small 1 m x 1 m survey patches used for species surveys to calculate the Shannon Indicator, used because it is easy for comparisons with RENATU and easy to be used by managers.

The tramway 2 right-of-way was chosen as an example of an urban LTI. It crosses various types of urban fabric: very dense urban spaces, made up of parks, socioeconomically rich and poor neighbourhoods, and housing and business districts - particularly La Défense business district (48°53'36'' N - 2°14'18'' E). The T2 tramway line was put into service in 1997. It extends over 17.9 km and mainly serves the business district of La Défense. The average density of the urban population is around 10,000 inhabitants per km² but the line crosses sectors of the MGP where urban parks are located (Fig.3).

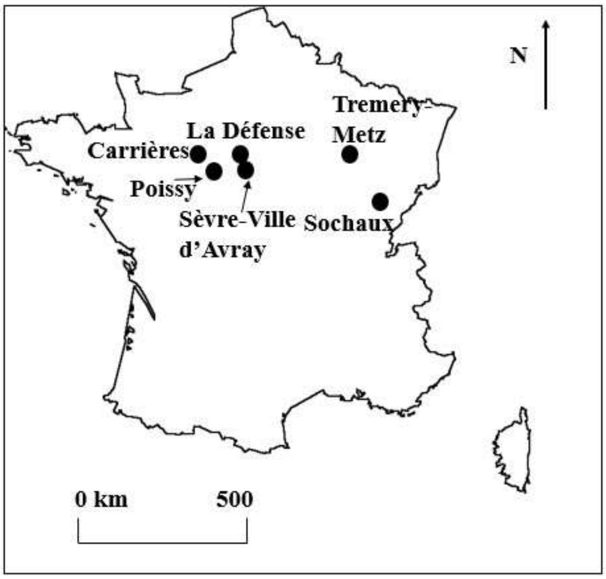

Figure 2: location map of the 6 studied in France

43 RENATU surveys were carried out in 2017 along this urban tramway line, which has green rights-of-way whose landscape varies along the route. Of the 43 surveys, 20 corresponded to the stations themselves and 23 were carried out between stations. In 2019, we carried out analyses of the

floristic composition on certain tramway 2 sites where analyses were carried out with RENATU. A survey was carried out along the SNCF line at the Sèvre-Ville d'Avray station west of Paris (48°49'39''N - 2°12'03'' E). The other surveys were carried out on industrial sites belonging to the PSA group: in the Paris region, 13 surveys were carried out at Carrières-sous-Poissy (48°56'55''N - 2°02'22''E) and 10 at the Poissy Expertise Centre (48°55'46''N - 2°02'44''E); there were 21 surveys at Sochaux in the Bourgogne-Franche Comté Region (47°30'55''N - 6°49'55''E) and 8 at Tremery-Metz (49°14'33''N - 6°12'53''E), in eastern France (Fig. 2). All these sites are located in an urban context with contrasts in density, with the highest density at the tramway 2 stations serving the La Défense district in the Greater Paris Metropolitan area. The biogeographical regions are comparable, in France, with ecological environments characteristic of plains in a temperate oceanic climate.

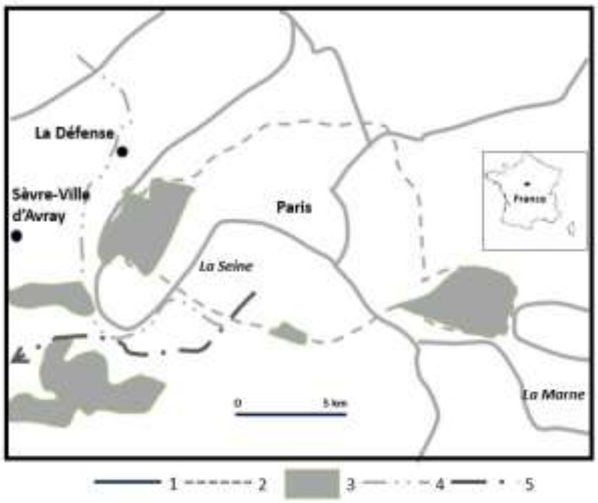

Figure 3: map of the Paris Region with the two sectors studied (1.gey lines: rivers and river waterways; 2. Dashed grey line: boundary of the municipality of Paris; 3. Green area: main Parisian green spaces; 4. Pink line: Tramway 2 route; 5. Yellow dashed line: railway line

2.2 The RENATU indicator

The RENATU indicator provides information on the potential for potential biodiversity that would develop in the environment under study. It consists of 11 indices that assess the state of biodiversity estimated by ecological structural components (Poorter et al. 2010) and descriptors that provide information on the ecological management of green rights-of-way. This indicator has been constructed from the analysis of various existing indicators that make it possible to estimate a site's ecological potential and biodiversity carrying capacity (Larrieu & Gonin 2008; Fürst et al. 2010; Parks & Mulligan 2010; Hjort & Luoto 2012; Moreno Pires et al. 2014; Clevenot et al. 2017; Gosselin & Larrieu 2020).

This indicator is composite, as proposed by H.Levrel (2007): 11 indices describe stratification, woody species richness, trees bearing micro-habitats, the herbaceous stratum and its management, leaves and flowers of herbaceous species, fences, walls and hedges (when present on the site), the presence of invasive alien species, the presence of biodiversity facilities and the proximity of biodiversity reservoirs. Like other indicators (Fürst et al. 2010; Parks & Mulligan 2010; Hjort & Luoto 2012; Moreno Pires et al. 2014; Clevenot et al. 2017; Gosselin & Larrieu 2020), RENATU estimates ecological structures and potential biodiversity using indices that are descriptors of the environment (Mc Donnell & Hahs 2008). This ecological state of the environment can be interpreted by ecological structures concerning potential biodiversity as others indicators such as Gosselin and Larrieu (2020) proposed for forests. For example, the presence of dead wood on the ground indicates that it is an ancient woodland and therefore of the site and allows us to consider the presence of insects, larvae and decomposing worms that feed but also serve as prey for other insects or birds. The indicator is constructed in such a way that it will pick up on this complexity (Mc Donnell & Hahs 2008). All indices are rated using a scale of 0 to 5. The 11 indices are as follows, with 3 indices for rating species in the herbaceous stratum.

2.2.1 Stratification

The more complex and varied the landscape of the study site, the more likely it is to be biologically diverse (Burrascano et al. 2011). The diversity of strata (large trees, medium trees, shrubs, thickets, herbaceous strata, etc.) influences the diversity of plant species, habitats (and therefore resources) and shelters for fauna. The more complex the environment, the greater the taxonomic diversity (insects, birds, arthropods, butterflies, mammals including bats and squirrels) (Fahrig et al. 2011; Gosselin & Larrieu 2020). The floristic composition and the microclimatic and light characteristics vary according to strata, providing a diversity of habitats, resources and refuges for species (Burrascano et al. 2011; Gosselin& Gonin 2020). A study conducted in the Binjiang Forest Park in Shanghai shows that vegetation complexity and structure have a positive effect on the compositions (richness and abundance) of bird communities (Yang et al. 2015). For example, more species are found on lawns and in woodlands where shrubs are present than in those without (Yang et al. 2015). A stratum is considered to be present if it occupies a significant area set at least 20% of the space (1/5th) (Gosselin & Gonin 2020). Stratification is scored as follows: Artificial bare soil (pavement, concrete, etc.): Artificial bare ground (bitumen, concrete ...): 0; bare soil without vegetation: 1; 1 vegetation stratum: 2; 2 strata: 3; 3 strata: 4; > 4 strata: 5. Bare soil can be colonized by pioneer plants and shelter a specific fauna, the pedofauna, which is why it does not get a zero score.

2.2.2 Lignified and woody species richness

The biodiversity associated with each woody species is different and increases globally with the number of species (Burrascano et al. 2011; Moser et al. 2015; Gosselin & Gonin 2020). A greater number of species increases the number of ecological niches available for fauna (Burrascano et al. 2011; Gosselin & Gonin 2020). Woody plant richness also increases the vegetation richness of other plant strata (Larjavaara 2008). Gamfeldt et al. (2013) show that the vegetation richness of the other strata was 31% higher with 5 tree species as compared to only one. In urban areas, Yang et al. (2015), show that a diversity of woody species supports a larger bird community. A study in the Greater Paris Metropolis shows that the specific richness of birds is related to the abundance and diversity of trees and shrubs (Husté et al. 2006). A diversity of woody plants favours the diversity and abundance of pollinating insects (Ebeling et al. 2008; Henning & Ghazoul 2012).

To calculate this index, it is necessary to cover the area studied and count the different woody species (trees and shrubs) present. A score is then attributed according to the following scale: 0 ligneous species: score 0; 1 ligneous species: 1; 2 ligneous species: 2; 3 ligneous species: 3; 4 and > 4 ligneous species: 5. Invasive and horticultural species are counted, because even if they are of less interest for biodiversity, they can be useful for certain species, especially in urban areas where nature is not very present, such as *Buddleia davidii*. The threshold of 4 species was selected by referring to the one used in the PBI (Gosselin & Larrieu 2020). In the PBI, the threshold is 5 species, however, it is used for forest stands that are often richer in species than the UILTIs green rights-of-way. The threshold of 4 species was selected with reference to the one used in PBI (Gosselin & Larrieu 2020).

2.2.3 Trees supporting microhabitats

Trees may have small habitats, known as microhabitats, on their branches and trunks (Burrascano et al. 2011). They allow different species to complete their life cycle and increase the carrying capacity of biodiversity on a site (Gosselin & Larrieu 2020). Its autumnal flowering provides insects with a food resource when pollen and nectar are scarce. Birds feed on its fruit and its foliage provides a place of refuge and nesting for them. Gosselin and Larrieu (2020) list the microhabitats that can be found on a tree. It is also on this list that the indicator is based, to which are added standing dead trees. In order to calculate this indicator, the area studied must be covered by identifying and counting the microhabitats on the trees. The rating scale is based on the one used in PBI, which is based on forest stand management boards. The greater the number of trees affected by micro-habitats, the greater the potential biodiversity. A maximum score is given to stands with at least 6 microhabitats per hectare (Gosselin & Larrieu 2020), as described in the scoring table (Table 1).

Table 1: RENATU index score on microhabitats

Surface studied	Score = 0	Score = 2	Score = 5
≤ 1000 m²	0 tree	1 tree	> 1 tree
1000 to 1999 m²	0 tree	> 1 tree	> 2 trees
2000 to 4999 m²	0 tree	> 2 trees	> 3 trees
> 5000 m²	0 tree	2 to 5 trees	> 6 trees

2.2.4 Herbaceous stratum and its management

With regard to herbaceous stratum, two indices should be considered: the physiognomy of the landscape of the area (maintenance, nature and frequency of mowing or cutting) and the variety of species, considered in the following indices. Here we consider the maintenance of the herbaceous stratum with the practice of mowing, cutting, or grazing. The later and more widely spaced the mowing, or cutting, the more it promotes pollination and the presence of wildlife – such as insects, butterflies, mammals, and birds - for reproduction (egg-laying, nesting) or nutrition (Bowers and Boutin 2008). The spacing of mowing or reduced grazing increases the variety of species in the herbaceous stratum. In Germany, Haenke et al. (2009) observed that the diversity of *Syrphideae* was positively correlated with the density and diversity of the floral resource.

A diversity of plants in a variety of shapes provides pollinating insects with resources adapted to their morphology. Finally, diverse plants will have different flowering dates offering a continuously available resource for pollinators (Muratet et al. 2007; Allsopp et al. 2008). In turn, increasing pollinator abundance increases the reproductive success of plants (Fontaine et al. 2005; Albrecht et al. 2012) and the number of insectivorous and granivorous birds. Late-mown grasslands have higher specific richness and average butterfly abundance than grasslands mown early or several times (Dover et al. 2000; Hunter & Hunter 2008; Huang et al. 2015). Differentiation mowing on the same site, such as mosaic mowing, makes it possible to create different environmental conditions, such as a varied floral procession, and to meet the needs of various species (Haynes & Cronin 2003; Prevedello & Viera 2010). A point bonus is therefore awarded if mosaic mowing is used. Scoring is based on the type of management with: 0 if use of plant protection products and frequent mowing; 1 if more than 3 mowings per year; 2 if more than 2 mowings per year; 3 if late mowing between mid-June and mid-July (for temperate regions); 4 if 1 late mowing from September to mid-November or grazing; and, 5 if mosaic mowing.

2.2.5 Species of herbaceous stratum (three indices)

The variety of plant characteristics is representative of specific diversity (Shipley et al. 2006) and makes the system more resilient to disturbances (Diaz & Cabido 2001). The indicator here is therefore based on the determination of simple criteria to distinguish flower types into three categories: flower shape, leaf shape (Reich et al. 2007) and flower colour. These plant characteristics are easy to assess and some are considered an attractive criterion for pollinators and are therefore representative of floral diversity. The more different characteristics there are, the more varied the species, the more biodiversity the environment carries, and the more attractive the environment is for pollinating insects. The observation makes it possible to count, from spring onwards, the flowers of different colours: white, red, pink, purple, blue, pink, yellow, or green and to attribute a score: 0 if no coloured flowers; 1 if one colour; 2 if 2 colours; 3 if 3 colours; 5 if more than 4 colours. The equivalent approach is applied for leaf shapes (thin, wide, cut, compound, etc.) with the following scores: 0 if no leaf shape; 1 if 1 shape; 2 if 2 shapes; 3 if 4 if 3 shapes; and 5 if more than 4 shapes. Flower shapes are also counted: umbel, flower head, cluster, with more or less petals. The following score is given: 0 if 0 flower shapes; 1 if 1 shape; 2 if 2 shapes; 3 if 3 shapes and 5 if more than 4 shapes.

2.2.6 Fences, walls and hedges

Many natural areas of industrial sites are surrounded by fences. Fences and walls (Huang et al. 2019), if vegetated or made of stone, serve as refuges, nesting sites and resources. All these elements are therefore positive for potential biodiversity (Poschlod et al. 2017; Assandri et al. 2018). If they are made up of plant hedges, their role is even more important (Baudry et al. 2000; Lecq et al. 2017). Fences play the role of plant support and this in turn promotes biodiversity. A separation consisting of continuous vegetation without fences allows animals to take refuge and cross them. This index is characterised by the following scores: 0: isolated environment, fence without vegetation, mesh, smooth wall; 1: fence supporting 1 or 2 plant species; 3: fence with more than 2 plant species or wall with crevices; 4: continuous vegetation without fence; 5: complex vegetation hedge.

2.2.7 Alien Invasive Species (AIS)

Allien Invasive Species (AIS) are unfavourable to biodiversity when they are highly competitive and hinder the development of diverse and local flora and/or fauna. AIS are the second leading cause of biodiversity loss worldwide (Richardson et al. 2000; Williamson 2006; Keller et al. 2011; Lampinen et al. 2015). AIS are most likely to settle in disturbed and fragmented environments (Hansen & Clevenger 2005) or in wastelands (Muratet et al. 2007). LTI alter the environment and its conditions and in turn promote their establishment and dispersal (Hansen & Clevenger 2005; Mortensen et al. 2009; Lampinen et al. 2015). The rating of this index is based on the premise that the more AIS depend on these green spaces, the more they will compete with and take the place of native flora, decreasing the floristic diversity of the site (Richardson et al. 2000). These AIS are also likely to colonise and impoverish the surrounding environment. On the other hand, pollinators are more adapted to the native flora with which they have co-evolved (Frankie et al. 2005; Hopwood 2008). One study showed that roadsides restored by planting native flora had twice the abundance and richness of wild bees than those dominated by exotic species (Hopwood 2008). In California, Frankie et al. (2005) found that *Apis mellifera* L. and wild bees were more attracted to native rather than exotic flora. The score is as follows: 5: if no AIS; -1: if rare individuals (1 to 3) isolated; -4: if small groups of individuals (< 5); -5: if large groups of individuals.

2.2.8 Facilities for biodiversity

Insect hotels, piles of dead wood, dry stone walls, ponds, nesting boxes, and gardens are all facilities for biodiversity. Many small infrastructures (Poschlod & Braun-Reichert 2017) promote biodiversity because they increase the capacity of reception, refuge and nesting and thus serve at the same time as resource sites for certain species: a dry-stone heap favours the presence of reptiles such as the wall lizard, *Podacris muralis*; piles of dead wood on the ground favour saproxylic insects, fungi, and lichens. Care must be taken to leave this wood in place. Dead wood of different sizes and species provide more interesting habitats, so the greater the volume of dead wood, the higher its value for biodiversity (Humphrey & Bailey 2012). If the site does not contain facilities, the index is removed. If there is one facility a score of 4 is given, if there are more than 2 facilities a score of 5 is given.

2.2.9 Proximity of a biodiversity reservoir

Reservoirs of biodiversity are sites labelled for their natural value, protected areas such as Natura 2000 sites in Europe, natural reserves, etc. They may be parks and gardens, woods, forests, various natural areas. Their proximity favours the movement of certain species, amphibians for example moving a few hundred metres. These movements are favoured if there are environments that facilitate connections, such as corridors or vegetation elements that are not very far away, known as “Japanese footsteps”, green spaces, gardens, footpaths, allowing the link between the biodiversity reservoir and the sampled site (Correa Ayram et al. 2016; Albert et al. 2017). Bergès et al. (2020) have developed methods for assessing the effects of proximity or remoteness of biodiversity patches.

The proximity of biodiversity reservoirs has an impact on the richness of neighbouring ordinary environments with border effects (Brudvig et al. 2009; Bergès et al. 2020). According to Correa Ayram et al. (2016), the distance of dispersal of species, whether fauna or flora, is the main factor recognised as a criterion for promoting connectivity. This distance is also accompanied by the presence of ecological corridors that allow connectivity (Correa Ayram et al. 2016; Albert et al. 2017). Scoring is done as follows: 0: if the distance to a biodiversity reservoir is greater than 2 km; 1: if the distance is between 1 and 2 km with ecological corridors; 3: if the distance is between 500 m and 1 km with ecological corridors; 4: if the distance is between 100 and 500 m with ecological corridors; 5: if the distance is less than 100 m with ecological corridors; the presence of infrastructure that intercepts travel, such as a wall or highway are scored 0 even if the proximity is significant.

Table 2: Table of indices making up the RENATU indicator with their respective values. The final score corresponds to the average of all the values

Index		Scoring system
Stratification		Artificial bare ground (bitumen, concrete ...): 0; Bare soil without vegetation: 1; 1 vegetation stratum: 2; 2 strata: 3; 3 strata: 4; > 4 strata: 5
Lignified and woody species richness		0 ligneous species: score 0; 1 ligneous species: 1; 2 ligneous species: 2; 3 ligneous species: 3; 4 and > 4 ligneous species: 5
Trees supporting micro-habitats		The count and score depend on the size of the site under study. See Table 1
The herbaceous stratum and its management		0 if use of plant protection products and frequent mowing; 1 if more than 3 mowings per year; 2 if more than 2 mowings per year; 3 if late mowing between mid-June and mid-July (for temperate regions); 4 if 1 late mowing from September to mid-November or grazing and 5 if mosaic mowing
Species of herbaceous stratum	Colours of the flowers	0 if no coloured flowers; 1 if one colour; 2 if 2 colours; 3 if 3 colours; 5 if more than 4 colours
	Leaf shapes	0 if no leaf shape; 1 if 1 shape; 2 if 2 shapes; 3 if 4 if 3 shapes; and 5 if more than 4 shapes
	Flowers shapes	0 if 0 flower shapes; 1 if 1 shape; 2 if 2 shapes; 3 if 3 shapes and 5 if more than 4 shapes
Fences, walls and hedges		0: isolated environment, fence without vegetation, mesh, smooth wall; 1: fence supporting 1 or 2 plant species; 3: fence with more than 2 plant species or wall with crevices; 4: continuous vegetation without fence; 5: complex vegetation hedge
Alien Invasive Species, AIS		5: if no IAS; -1: if rare individuals (1 to 3) isolated; -4: if small groups of individuals (< 5); -5: if large groups of individuals
Facilities for biodiversity		If the site does not contain facilities, the index is removed. If there is one facility a score of 4 is given, if there are more than 2 facilities a score of 5 is given
Proximity of reservoir		0: if the distance to a protected area is greater than 2 km; 1: if the distance is between 1 and 2 km with ecological corridors; 3: if the distance is between 500 m and 1 km with ecological corridors; 4: if the distance is between 100 and 500 m with ecological corridors; 5: if the distance is less than 100 m with ecological corridors

3. RESULTS

Table 2 shows all the indices making up the RENATU indicator with their respective values. The final score is the average of all values considering only the indices used: some sites do not have some of the parameters such as AIS, a fence or a protected area nearby. These data correspond to scores established by a score for each index. The RENATU indicator is therefore composite. It can be summarised by an average of the index values and this average varies according to the presence or absence of biodiversity facilities, which represent a bonus. We calculated the standard deviation of the values taken for each index and for each location. The values fluctuate between 0.7 and 1.5. This indicates a low dispersion between values. No value outweighs the others. The optimal value is therefore 5, which means that the RENATU user can compare the values of the indicator spatially and chronologically. A map or a distribution scheme of the sites of a UILTI makes it possible to visualise the more or less rich sectors and those on which managers can focus their ecological management efforts. The effects of this management can be visualized over time by comparing changes in scores.

3.1 Statistical validation

The data are made up of variables which are the indices evaluated between 0 and 5. We assess the homogeneity of these data using the standard deviation, which is used to measure the amount of variation or dispersion of a set of values (Skouloudis et al. 2019). A low standard deviation indicates that the values tend to be close the expected value. The smaller the standard deviation, the more homogeneous the population.

However, as it is done frequently in research on this type of data (Burrascano et al. 2011; Guetté et al. 2017; Assandri et al. 2018), we also calculated the *p*-

values and the correlation coefficient *r* for each variable or index.
For the 96 sites studied with the RENATU tool, the study of the relationship between the parameters and the means makes it possible to suggest an equivalent contribution of the indices that make up RENATU (Table 3). These comparisons are carried out using the scatterplot and the calculation of *r* for the 96 values compared, and the *p*-value.

Table 3: Comparison between rated indices and the values of RENATU indices, using the standard deviation σ, the correlation coefficient r, and the p-value

Indices statistically compared with the average of the values of the 96 measurements of the sites with RENATU	σ	*r*	*p*-values
Stratification	1.04	0.55	0.10
Lignified and woody species richness	1.58	0.51	0.01
Trees supporting micro-habitats	2.24	0.61	0.06
The herbaceous stratum and its management	1.58	0.29	0.01
Colours of flowers	1.19	0.33	0.01
Leaf shapes	1.26	0.56	0.01
Flowers shapes	1.15	0.43	0.01
Alien Invasive Species	3.20	0.33	0.01

In order to ensure that each index that makes up RENATU contributes approximately the same amount, statistical tests (calculation of standard deviation, simple linear Pearson correlation coefficients, calculation of *p*-value) were carried out for the 96 sites studied. According to these tests, a significant positive correlation of the RENATU indices was found, with a correlation coefficient *r* between 0.3 and 0.5. The *p*-values are all well below 0.05. However, as this difference is quite small and in order to meet one of the main objectives of RENATU (i.e., a simple calculation for use by managers who are not necessarily familiar with more complex calculation methods), it was decided not to weigh the indices considered in the development of RENATU. The RENATU indicator can therefore be considered as a balanced tool whose varied scoring makes it possible to strengthen the estimation of potential biodiversity.

3.2 Ecological validation

The ecological validation of the indicator is based on the comparison between the averages obtained by the RENATU indicator and ecological analyses (Table 4).

Table 4: RENATU and Shannon Index values for 11 study sites, the Shannon's index was calculated only for plants

Tramway 2 sites	RENATU	Shannon index
Meudon-sur-Seine	3.75	2.93
Jacques Henri Lartigue	3.875	3.01
Brimborion	2.75	2.78
Musée de Sèvres	4.25	3.01
Parc de Saint-Cloud	3.375	2.80
Les Milons	3.5	2.98
Les Coteaux	4.625	3.01
Suresnes Longchamp	4.25	3.01
Puteaux	2	2,49
Faubourg de l'Arche	2,25	2,82
Les Fauvelles	1,875	2,54

For this purpose, we carried out surveys of the species present at 44 plots studied on 11 sites along tramway line 2 because only these sites could be accessed for plant quadrat analysis. Security constraints did not allow surveys to be carried out at the other sites. However, the statistical results show that the data are sufficiently redundant with respect to the other 96 sites to consider the analysis of the 11 sites with 44 plots as relevant. They present heterogeneous results with RENATU indicator and it is useful to compare these results with those obtained with the species analysis. These surveys were carried out on 1 m x 1 m quadrats on which the number of species present was counted. Samples of herbaceous stratum were chosen for comparison: the Shannon index was calculated only for plants. The Shannon index is an index of species diversity comparing the population of each species with the total population of the sample. Four quadrats were sampled on each of the 11 selected.
The analysis was then applied using the Shannon index (Burrascano et al. 2011; Di Battista et al. 2016), which gives optimal values approaching 1. These values, calculated using the Shannon index, are multiplied by 5 to compare them with the RENATU indicator. A trend curve and the Pearson correlation coefficient *r* were calculated.
According to Table 4 and Fig. 4, the statistical comparison of the RENATU (ordinates) and Shannon index (abscissa) values shows a strong relationship between the two values for the 11 study sites with an *r* = 0.8939498. The Shannon index supports the relevance of the RENATU indicator.
The RENATU indicator can therefore be considered as a balanced tool whose varied scoring strengthens the estimate of potential biodiversity. Moreover, it is relevant from an ecological point of view since its estimate of biodiversity corresponds to that of biodiversity measured using the Shannon biodiversity index.

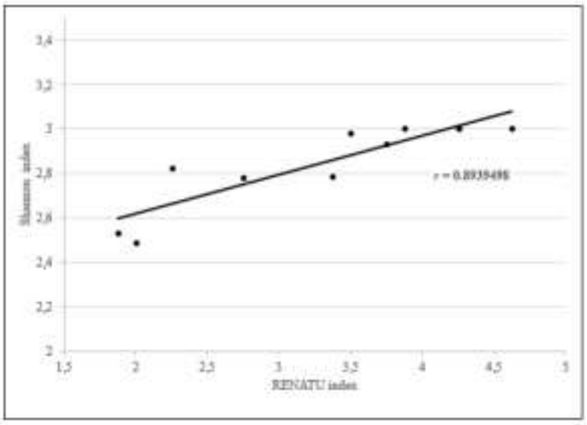

Figure 4: scatterplot representing RENATU indicator values and Shannon index values for the 11 stations in the sample of 96 sites studied with correlation coefficient r

3.3 Ergonomic validation

Our objective here is to assess the qualities of RENATU as a tool to assist in the evaluation of UILTI green areas and its ergonomics (Shakel 1991; Dempsey et al. 2005; Lowe et al. 2019; Shakel 2009). RENATU should enable UILTI managers to autonomously assess the potential for biodiversity to be hosted on portions of the infrastructure right-of-way. Ergonomics is assessed using criteria that measure the tool's functionalities. According to the literature (Shakel 1991; Djapan et al. 2019), these criteria are defined in table 5.
A questionnaire survey (Lowe et al., 2019) was sent to 36 RENATU users to evaluate the tool using criteria that they rated on a scale of 0 to 5, depending on the degree of satisfaction: effectiveness, reliability, ease and quality of learning, satisfaction, flexibility and cost. 5 is the maximum score given. Means and standard deviations are calculated in order to interpret these results.
According to the table 6 and the questionnaire survey of RENATU users, the σ values indicate that the dispersion is low overall: this shows that users have a fairly homogeneous opinion. The mean value of the tool's rating is as follows, for a potential maximum rating of 5: 4.7 for efficiency, 4.2 for reliability, 4.2 for ease and quality of learning, 4.3 for satisfaction, 3.8 for flexibility, 3.8 for cost. However, the RENATU indicator is free of charge.

Table 5: criteria making up the definition of ergonomics (adapted from the literature for RENATU)

Ergonomic criteria	Definition (from technical and scientific literature)
Efficiency	Efficiency is the criterion for assessing the operational relevance of the results obtained by the tool. Is it an effective tool for the intended use? Does it lead to results that allow for process improvements? (Shakel 2009; Djapan et al. 2019)
Reliability	Are the results obtained useful, comparable to others obtained by the same or comparable methods and do they allow for action that is operationally effective? The reverse would be that they are flawed and do not allow, for example, the monitoring of biodiversity quality at the study site (Shakel 1991; Shakel 2009; Djapan et al. 2019).
Ease and quality of learning	Is the tool easy to understand, use and interpret? Does it lead to improved user skills? (Houé & Guimaraes 2014; Decaro & Stokes 2013; Miles 2017; Djapan et al. 2019)
Satisfaction	Is the tool pleasant to use, does the user feel satisfaction in using it and getting the results? The criterion is important to help improve workforce efficiency at work (Armitage et al. 2008; Burns 2015; Rosson & Caroll 2020).
Flexibility	Is the tool adaptable, capable of being adapted to a variety of situations while maintaining its effectiveness? (Shakel 1991; Shakel 2009)
Cost	What is the cost of the tool and is it cost-effective and commensurate with the investment? Given that the RENATU tool is free, it is the marginal cost that is questioned, first of all that of the personnel who use it: is the tool economically profitable enough for the organisation to justify devoting human time to it? Does it correspond to a saving on marginal costs (environmental financial risks, brand image, other)? (Vazquez & Carmelo 2004; Vandermeulen et al. 2011)

Table 6: table of mean values and standard deviations of the scores of ergonomics assessments carried out by RENATU users in several compagnies

	Efficiency	Reliability	Ease and quality of learning	Satisfaction	Flexibility	Cost
Average	4.7	4.2	4.2	4.3	3.8	3.8
σ = STANDARD DEVIATION	0.44	0.55	0.55	0.44	0.55	0.56

Some quotes from RENATU users helped to qualitatively clarify the assessment. Concerning efficiency, one of the users specified that *"The results obtained following the use of the indicator allow for the review of management methods and improve them if necessary. It therefore makes it possible to improve the processes after an in-depth study and analysis of the readings"*. Concerning reliability, another notes that: *"RENATU is a tool that allows us to assess and monitor the quality of biodiversity at a site over time*". On the ease and quality of learning, one user wrote: *"The tool will also help to understand the importance of adapting a management method that is beneficial for the environment and for the company. In addition, the tool may also help to raise users' awareness of biodiversity"*. Concerning the flexibility and adaptability of the tool to needs, one user explains: *"It is also possible to use it upstream, i.e., in anticipation of a future project (to take biodiversity into account from the very beginning of the project, not only as a marketing tool or obligation) but also as a tool for monitoring biodiversity over a longer period of time. It is therefore adaptable to different sites and adaptable over time"*. Finally, concerning costs, several users evoked interests in terms of brand image.

4. DISCUSSION

From a statistical and ecological point of view, the limitations of this tool are related to the difference in scoring between the criteria. For example, the assessment of AIS differs from other scoring modalities. It constitutes a lower weight to the contribution of the overall RENATU score, but it is very useful to strengthen the conditions for assessing biodiversity. It also helps to better identify opportunities for improving the biodiversity of sites by applying management strategies. The indicator makes it possible to consider the biodiversity present on the site, particularly plant biodiversity.

The objective is to carry out a study design of the characteristics of this green space. This design allows one to identify the sites where surveys are being out using RENATU. It also shows the efforts made in terms of ecological management by comparing the results of the surveys carried out with RENATU. It is a tool for monitoring and tracking the ecological status of a green space. A plan can be drawn up, for example, in the form of a photo that can be integrated into a drawing software on which the different units of the landscape corresponding to the places where the surveys are carried out are delimited. This plan can also be mapped and represented with GIS and requires GPS surveys of the sites. It makes it possible to return over time to the same sites where the measurement of the RENATU indicator indices is carried out and thus to map evolution, for example by highlighting the benefits of good management practices.

However, the RENATU indicator is only a means of estimating biodiversity and does not replace a fauna and flora inventory that effectively reflects the reality of the state of biodiversity. RENATU is inexpensive because it is designed by scientists who offer it to users free of charge. However, according to the table of standard deviations and means of the cost evaluation by users, the cost does not seem to be totally satisfactory because of the investment of time spent to appropriate the tool and to use it in the field.

Managers of industrial green spaces and of linear transport infrastructures have the ambition to promote biodiversity (Huste et al. 2006; McKinney 2008; Pickett et al. 2011). Scientific studies in ecology concerning these green rights-of-way in the UILTI show that they have an interesting biodiversity with a wealth of different animal and plant species (Muratet et al. 2007; McKinney 2008).

5. CONCLUSION

The green spaces of the UILTI can fill this role provided that they are enhanced and their biodiversity carrying capacity is improved. However, managers need tools to assess these biodiversity carrying capacities. However, as Skouloudis et al. (2019) write: *"All business entities are dependent to biological diversity and the planetary spectrum of ecosystem services either directly or indirectly"*. Businesses are integrating biodiversity considerations into the economy (Karlsson-Vinkhuyzen et al. 2017; Opoku 2019). Biodiversity valuation is part of the assessment of public policies and business strategies (Vandermeulen et al. 2011; King 2016). For Di Battista et al. (2016) the evaluation of biodiversity is even a good indicator of the environmental quality of a place: it is easy to understand why public policies value urban biodiversity (Shwartz et al. 2014; Guetté et al. 2017). Operators and managers of public spaces, industrial green rights-of-way and UILTI need tools to assess and monitor actual or potential biodiversity relevant to these green rights-of-way. The objective of these tools is to monitor the effectiveness of management measures taken and to contribute to eco-innovation (Fernando et al. 2019). Most often they are composite indicators (Machado 2004; Garcia-Garcia et al. 2016).

The RENATU indicator makes it possible to estimate the potential for hosting biodiversity in UILTI rights-of-way. It is used to guide management practices to preserve and improve biodiversity on the sites. The RENATU tool is designed as a means of assessing potential biodiversity (Gosselin & Larrieu 2020) and allows monitoring over time. The indicator is flexible and adaptable and can be modified according to the type of UILTI, field observations and the means available to the company. Elements can be added or removed. Its ergonomics make it possible to raise awareness of biodiversity among managers. It also makes it possible to encourage management measures that promote the improvement of biodiversity. Like many approaches related to the natural environments, RENATU develops an interest in the workplace and an attachment to the environment being maintained (Brown & Raymon 2007): the responses to

RENATU's ergonomics questionnaire attest to this interest in green rights-of-way. It contributes to raising biodiversity awareness and motivating employees to improve the biodiversity of their sites (Couvet et al. 2008; Dempsey et al. 2005; Cosquer et al. 2012; Colleony et al. 2017).

The question here is part of a reflection on performance (Sirola & Pitesa 2018): is the cost of outsourcing to a consultancy firm no doubt capable of providing more robust fauna and flora inventory results more profitable than that of internalising increased capacity and data production by employees? Improving the work behaviour and well-being of employees is the result of complex systems (Burns 2015; Silva et al. 2019) in which numerous experiments have shown the beneficial role of the practice of biodiversity assessment and management (Petersen et al. 2019) since the Millennium Ecosystem Assessment (2005). Overall benefits include the quality of work and the well-being of employees (Chin & Chou 2013).

This approach is part of the efforts to develop indicators that make it possible to interpret various data concerning biodiversity and also to communicate these data easily: many scientific publications report on these efforts. In particular, several authors question the relationships between biodiversity indicators and ecosystem services (Feld et al. 2010; Geijzendorffer and Roche 2013; Broszeit et al. 2017). Di Battista et al. (2016) and Broszeit et al. (2017) question the relationship between indicators of the environmental status of natural environments and knowledge of ecosystem services. For Geijzendorffer and Roche (2013), biodiversity indicators provide indisputable information on ecosystem services. Tulloch et al (2011) propose to use indicators of ecological status, such as RENATU, to measure management effectiveness. The question posed above concerns the cost-effectiveness of the company or organization's investment in ecological monitoring and management with the integration of knowledge objectives for improved environmental management (Raymond et al. 2010; Broszeit et al. 2017; Heshmatol Vaezin et al. 2022). The level of results expected in biodiversity analysis and their frequency must be assessed economically, as there is an economic interest of taking biodiversity into account (Béné 2008; Nunes & VandDerBergh 2011; Tulloch et al. 2011; Fernando et al. 2019). The RENATU indicator is therefore designed as a potential solution that is ecologically reliable enough to respond to management challenges. Such an indicator is part of the corporate social responsibility strategy (Kabeche & Vergotte, 2013; Bonet-Fernandez et el. 2014). It enhances both financial and social performance. It contributes to the enhancement of land capital.

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7. BIBLIOGRAPHY

Albert, C.H., Rayfield, B., Dumitru, M., Gonzalez, A. (2017). Applying network theory to prioritize multispecies habitat networks that are robust to climate and land-use change. Conservation Biology, 31, 1383-1396 DOI: https://doi.org/10.1111/cobi.12943

Albrecht, M., Schmid, B., Hautier, Y., Müller, C. B. (2012). Diverse pollinator communities enhance plant reproductive success. Proceedings of the Royal Society of London B: Biological Sciences. 279, 4845-4852 https://doi.org/10.1098/rspb.2012.1621

Assandri, G., Bogliani, G., Pedrini, P., Brambilla, M. (2018). Beautiful agricultural landscapes promote cultural ecosystem services and biodiversity conservation, Agriculture. Ecosystems and Environment. 256, 200-210 https://doi.org/10.1016/j.agee.2018.01.012

Allsopp, M.H., de Lange, W.J., Veldtman, R. (2008). Valuing insect pollinisation services with cost of replacement. PLoS ONE. 3(9): e3128. Doi: https://doi.org/10.1371/journal.pone.0003128

Anton, C., Young, J., Harrison, P.A., Musche, M., Bela, G., Feld, C.K., Harrington, R., Haslett, J.R., Pataki, G., Rounsevell, M.D.A., Skouros, M., Sousa, J.P., Sykes, M.T., Tinch, R., Vandewalle, M., Watt, A., Settele, J. (2010). Research needs for incorporating the ecosystem service approach into EU biodiversity conservation policy. Biodiversity and Conservation. 19, 2979-2994 DOI: https://doi.org/10.1007/s10531-010-9853-6

Armitage, D., Marschke, M., Plummer, R. (2008). Adaptive co-management and the paradox of learning. Global Environmental Change. 18, 86-98 https://doi.org/10.1016/j.gloenvcha.2007.07.002

Arponen, A. (2012). Priotizing species for conservation planning. Biodiversity and Conservation. 21, 875-893 https://doi.org/10.1007/s.10531-012-0242-1

Ascensao, F., Clevenger, A., Grilo, A.P., Filipe, C., Santos-Reis, M. (2012). Highway verges as habitat providers for small mammals in agrosilvopastoral environments. Biodiversity and Conservation. 21, 3681-3697 https://doi.org/10.1007/s10531-012-0390-4

Bara N., Gautier F., Giard V., 2021. Problèmes méthodologiques posés par les systèmes de valorisation dans les modèles économiques de management industriel, Revue Française de Gestion Industrielle, 35 (1): 40-56 https://doi.org/10.53102/2021.35.01.905

Baudry, J., Bunce, R.G., Burel, F. (2000). Hedgerows: an international perspective on their origin, function and management. Journal of Environmental Management. 60, 7-22 https://doi.org/10.1006/jema.2000.0358

Bellamy, P.E., Shore, R.F., Ardeshir, D., Treweek, J.R., Sparks, T.H. (2000). Road verges as habitat for small mammals in Britain. Mammal Review. 30, 131-139 https://doi.101046/j.1365-2907.2000.00061.x

Béné, C.D.L. (2008). Contribution values of biodiversity to ecosystem performance: a viability perspective. Ecological Economics. 68, 14-23 https://ideas.repec.org/a/eee/ecolec/v68y2008i1-2p14-23.html

Bergès, L., Avon, C., Bezombes, L., Clauzel, C., Duflot, R., Foltête, J-C., Gaucherand, S., Girardet, X., Spiegelberger, T. (2020). Environmental mitigation hierarchy and biodiversity offsets revisited through habitat connectivity modelling. Journal of Environmental Management. 256: 109950 [on line] https://doi.org.10.1016/j.jenvman.2019.109950

Bezombes, L., Gaucherand, S., Spielberger, T., Gouraud, T., Kerbiriou, C. (2018). A set of organized indicators to conciliate scientific knowledge, offset policies requirements and operational constraints in the context of biodiversity offsets, Ecological Indicators, 93, 1244-1252 https://doi.org/j.ecolind.2018.06.027

Bigard C., Pioch S., Thompson J.D. (2017). The inclusion of biodiversity in environmental impact assessment: Policy-related progress limited by gaps and semantic confusion, Journal of Environmental Management, 200: 35-45 https://doi.org/10.1016/j.jenvman.2017.05.057

Bomans, K., Steenberghen, T., Dewaelheyns, V., Leinfelder, H., Gulinck, H. (2010). Underrated transformations in the open space – The case of an urbanized and multifunctional area. Landscape and Urban Planning, 94, 196–205 https://doi.org/10.1016/j.landurbplan.2009.10.004

Bonet-Fernandez, D., Petit, I., Lancini, A. (2014). L'économie circulaire : quelles mesures de la performance économique, environnementale et sociale ? Revue Française de Gestion Industrielle. DOI : https://doi.org/10.53102/2014.33.04.791

Bowers, K., Boutin, C. (2008). Evaluating the relationship between floristic quality and measures of plant biodiversity along stream bank habitats. Ecological Indicators. 8, 466-475 https://doi.org/10.1016/j.ecolind.2007.05.001

Broszeit, S., Beaumont, N.J., Uyarra, M.C., Heiskanen, A-S., Frost, M., Somerfield, P.J., Rossberg, A.G., Texeira, H., Austen, M.C. (2017). What can indicators of good environmental status tell us about ecosystem services? : reducing efforts and increasing cost-effectiveness by reapplying biodiversity indicator data. Ecological Indicators. 81, 409-442 DOI: 10.1016/j.ecolind.2017.05.057

Brown, D., Raymon C. (2007). The relationship between place attachment and landscape values: toward mapping place attachment. Applied Geography. 27, 89-111 https://doi.org/10.1016/j.apgeog.2006.11.002

Brown, G.P., Phillips, B.L., Webb, J.K., Shine, R. (2006). Toad on the road: use of roads as dispersal corridors by cane toads (*Bufo marinus*) at an invasion front in tropical Australia. Biological Conservation. 133, 88-94 https://doi.org/10.1016/j.biocon.2006.05.020

Brudvig, L.A., Damschen, E.I., Tewksbury, J.J., Haddad, N.M., Levey, D.J. (2009). Landscape connectivity promotes plant biodiversity spillover into non-target habitats. PNAS. 106, 9328-9332 www.pnas.org/cgi/doi/10.1073/pnas.0809658106

Brunbjerg, A.K., Hale, J.D., Bates, A.J., Fowler, R.E., Ronsenfeld, E.J., Sadler, J.P. (2018). Can patterns of urban biodiversity be predicted using simple measures of green infrastructure? Urban Forestry & Urban Greening. 32, 143-153 http://doi.org/10.1016/j.ufug.2018.03.015

Burns, H. (2015). Transformative sustainability pedagogy: learning from ecological systems and indigenous wisdom. Journal of Transformative Education

13, 259-276 https://doi.org/10.1177/1541344615584683

Burrascano, S., Sabatini, F.M., Blasi, C. (2011). Testing indicators of sustainable forest management on understorey composition and diversity in southern Italy through variation partitioning. Plant Ecology. 212: 829-841 https://doi.org/10.1007/s11258-010-9866-y

Carbone, V., Blanquart C., Zeroual, T. (2013). « Green-lean » ou « green-agile »? Les determinants des pratiques logistiques vertes. Revue Française de Gestion Industrielle. 32, 1 https://doi.org/10.53102/2013.32.01.689

Chillo, V., Anand, M., Ojeda, R.A. (2011). Assessing the use of functional diversity as a measure of ecological resilience in arid rangelands. Ecosystems. 14, 1168-1177 https://www.jstor.org/stable/41505941

Chin, P-H. & Chou, S.Y. (2013). A conceptual analysis of cognitive moral development and altruistic behavior in work place, International Journal of Business and Social Science, 4, 9-14 https://www.ijbssnet.com/journal/index/1914

Clevenot L., De Chastenet C., Frascaria-Lacoste N., Jacob P., Raymond R., Simon L., Pech P. (2017). Do Linear Infrastructures provide a potential corridor for urban biodiversity? Case study in Greater Paris, France. Cybergeo: European Journal of Geography. URL: http://cybergeo.revues.org/27895

Clevenot, L., Carre, C., Pech, P. (2018). A review of the factors that determine whether stormwater ponds are ecological traps and/or high-quality breeding sites for amphibians. Frontiers in Ecology and Evolution. 6: 40. https://doi.org/ 10.3389/fevo.2018.00040

Connop, S., Vandergert, P., Eisenberg, B., Collier, M.J., Nash, C., Clough, J., Newport, D. (2016). Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban infrastructure. Environmental Science & Policy. 62, 99-111 https://doi.org/10.1016/j.envsci.2016.01.013

Correa Ayram, C.A., Mendoza, M.E., Etter, A., Pérez Salicrup, D.R. (2016). Habitat connectivity in biodiversity conservation: a review of recent studies and applications. Progress in Physical Geography. 40, 7-37 https://doi.org/10.1177/0309133315598713

Cosquer, A., Raymond, R., Prevot-Julliard, A-C. (2012). Observations of everyday biodiversity: a new perspective for conservation? Ecology and Society. 17: http://dx.doi.org/10.5751/ES-04955-170402

Couvet, D., Jiguet, F., Julliard, R., Levrel, H., Teyssedre, A. (2008). Enhancing citizen contributions to biodiversity science and public policy. Interdisciplinary Sciences Review. 33, 95-103 http://dx.doi.org/10.1179/030801808X260031

Decaro, D.A., Stokes, M.K. (2013). Public participation and institutional fit: a social-psychological perspective. Ecology and Society. 18, 40 http://dx.doi.org/10.5751/ES-05837-180440

Dempsey, P.G., McGorry, R.W., Maynard, W.S. (2005). A survey of tools and methods used by certified professional ergonomists, Applied Ergonomics, 36, 489-503 https://doi.org/10.1016/j.apergo.2005.01.007

Di Battista, T., Fortuna, F., Maturo, F. (2016). Environmental monitoring through functional biodiversity tools. Ecological Indicators. 60, 237-247 https://doi.org/10.1016/j.ecolind.2015.05.056

Díaz, S. & Cabido, M. (2001). Vive la difference: plant functional diversity matters to ecosystem processes. Trends in Ecology & Evolution. 16, 646-655 https://doi.org/10.1016/S0169-5347(01)02283-2

Djapan, M., Macuzic, I., Tadic, D., Baldissone, G. (2019). An innovative prognostic risk assessment tool for manufacturing sector based on the management of the human, organizational and technical/technological factors. Safety Safe. 119, 280-291 https://doi.org/10.1016/j.ssci.2018.02.032

Dover, J., Sparks, T., Clarke, S., Gobbett, K., Glossop, S. (2000). Linear features and butterflies: the importance of green lanes. Agriculture, Ecosystems and Environment. 80, 227-242 https://doi.org/10.1016/S0167-8809(00)00149-3

Ebeling, A., Klein, A.M., Schumacher, J., Weisser, W.W., Tscharntke, T. (2008). How does plant richness affect pollinisator richness and temporal stability of flower visits? Oikos. 117, 1808-1815 https://doi.org/10.1111/j.1600-0706.2008.16819.x

Elmqvist, T., Folke, C., Nystrom M., Peterson G., Bengtsson J., Walker B., Norberg J. (2003). Response diversity, ecosystem change, and resilience. Frontiers in Ecology and Environment. 1, 488-494 https://doi.org/10.1890/1540-9295(2003)001[0488:RDECAR]2.0.CO;2

European Environment Agency (2005). EEA core set of indicators. Technical Report, EEA https://www.eea.europa.eu/publications/technical_report_2005_1/file

Fahrig, L., Baudry, J., Brotons, L., Burel, F., Crist, T. O., Fuller, R. J., Sirami, C., Siriwardena, G., M., Martin, J.-L. (2011). Functional landscape heterogeneity and animal biodiversity in agricultural landscapes. Ecology letters. 14, 101–112 https://doi.org/10.1111/j.1461-0248.2010.01559.x

Farza K., Ftiti Z., Hlioui Z., Louhichi W., Omri A. (2021). Does it pay to go green? The environmental innovation effect on corporate financial performance, Journal of

Environmental Management, 300, 113695 https://doi.org/10.1016/j.jenvman.2021.113695

Feld, C.K., Sousa, J.P., Martins da Silva, P., Dawson, T.P. (2010). Indicators for biodiversity and ecosystem services: towards an improved framework for ecosystems assessment. Biodiversity and Conservation. 19, 2895-2919 https://doi.org/10.1007/s10531-010-9875-0

Fernando, Y., Chiappetta Jabbour, C.J., Wah, W-X. (2019). Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: does service capability matter? Resources, Conservation & Recycling, 141, 8-20 https://doi.org/10.1016/j.resconrec.2018.09.031

Fontaine, C., Dajoz, I., Meriguet, J., Loreau, M. (2005). Functional diversity of plant–pollinator interaction webs enhances the persistence of plant communities. PLoS Biol. 4(1), e1 https://doi.org/10.1371/journal.pbio.0040001

Forman, R. T. & Godron, M. (1981). Patches and structural components for a landscape ecology. BioScience. 31, 733-740 https://www.jstor.org/stable/1308780

Foster, J. (2014). Hiding in plain view: vacancy and prospect in Paris' Petite Ceinture. Cities. 40, 124-132

Fourès, J-M., Pech, P. (2015). Prendre le(s espaces de) temps pour maîtriser les impacts diffus générés par les grandes infrastructures de transport terrestre (ITT) sur la biodiversité. VertigO. 15 (2) https://doi.org/10.4000/vertigo.16620

Frankie, G.W., Thorp, R.W., Schindler, M., Hernandez, J., Ertter, B., Rizzardi, M. (2005). Ecological patterns of bees and their host ornamental flowers in two northern California cities. Journal of the Kansas Entomological Society. 78, 227-246 https://doi.org/10.2317/0407.08.1

Fürst, C., Volk, M., Pietzsch, K., Makeschin, F. (2010). Pimp your landscape: a tool for qualitative evaluation of the effects of regional planning measures on ecosystem services, Environmental Management. 46, 953-968 https://doi.org/10.1007/s00267-010-9570-7

Gamfeldt, L., Snäll, T., Bagchi, R., Jonsson, M., Gustafsson, L., Kjellander, P., Mikusiński, G. (2013). Higher levels of multiple ecosystem services are found in forests with more tree species. Nature communications. 4, 1340 https://www.nature.com/articles/ncomms2328

Garcia-Garcia, M-J., Sanchez-Medina, A., Alfonso-Corzo, E., Gonzalez Garcia, C. (2016). An index to identify suitable species in urban green areas. Urban Forestry & Urban Greening. 16, 43-49 https://doi.org/10.1016/j.ufug.2016.01.006

Garnier, E., Cortez, J., Billes, G., Navas, M-L., Roumet, C., Debussche, M., Laurent, G., Blanchard, A.L., Aubry, D., Bellmann, A., Neil, C., Toussaint, J-P. (2004). Plant functional markers capture ecosystem properties during secondary succession. Ecology. 85, 2630-2637 https://doi.org/10.1890/03-0799

Geijzendorffer, I.R., Roche, P.K. (2013). Can biodiversity monitoring schemes provide indicators for ecosystem services? Ecological Indicators. 33, 148-157 https://doi.org/10.1016/j.ecolind.2013.03.010

Gosselin, F., Larrieu, L., 2020. Developing and using statistical tools to estimate observer effect for ordered class data: the case of the IBP (Index of Biodiversity Potential). Ecological Indicators. 110: 105884 [on line] https://doi.org/10.1016/j.ecolind.2019.105884

Guetté, A., Gaüzère, P., Devictor, V., Jiguet, F., Godet, L. (2017). Measuring the synanthropy of species and communities to monitor the effect of urbanization on biodiversity, Ecological Indicators, 79, 139-154 https://doi.org/10.1016/j.ecolind.2017.04.018

Haaland, C. & Van den Bosch, C.K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: a review. Urban forestry & urban greening. 14, 760-771 https://doi.org/10.1016/j.ufug.2015.07.009

Haenke, S., Scheid, B., Schaefer, M., Tscharntke, T., Thies, C. (2009). Increasing syrphid fly diversity and density in sown flower strips within simple vs. complex landscapes. Journal of Applied Ecology. 46, 1106-1114 https://doi.org/10.1111/j.1365-2664.2009.01685.x

Haynes, K.J. & Cronin, J.T. (2003). Matrix composition affects the spatial ecology of a prairie planthopper. Ecology. 84, 2856-2866 https://doi.org/10.1890/02-0611

Heshmatol Vaezin, S.M., Marage, D., Garcia, S. (2022). Cost-effectiveness of Natura-2000 forest contracts for biodiversity conservation. Canadian Journal of Forest Research, https://doi.org/10.1139/cifr-2021-0204

Hopwood, J.L. (2008). The contribution of roadside grassland restorations to native bee conservation. Biological Conservation. 141, 2632-2640 https://doi.org/10.1016/j.biocon.2008.07.026

Houé T., Guimaraes, R. (2014). L'apprentissage du lean management par le jeu : vers une évolution de la pédagogie pour faciliter le développement des compétences. Revue Française de Gestion Industrielle 33, 2. https://doi.org/10.53102/2014.33.02.777

Huang, L., Qian, S., Li, T., Jim, C.Y., Zhao, L., Lin, D., Shang, K., Yang, Y. (2019). Masonry walls as sieve of urban plant assemblages and refugia of native species in Chongqing, China. Landscape and Urban Planning. 191: 103620 [on line] https://doi.org/10.1016/j.landurbplan.2019.103620

Huang, Y., Zhao, Y., Li, S., von Gadow, K. (2015). The effects of habitat area, vegetation structure and insect richness on breeding bird populations in Beijing urban parks. Urban Forestry & Urban Greening. 14, 1027-1039 https://doi.org/10.1016/j.ufug.2015.09.010

Humphrey, J. & Bailey, S. (2012). Managing deadwood in forests and woodlands. Forestry Commission Practice Guide. [on line] http://www.forestry.gov.uk/england-managingdeadwood

Hunter, M.R. & Hunter, M.D. (2008). Designing for conservation of insects in the built environment. Insect Conservation Diversity. 1, 189-196 https://doi.org/10.1111/j.1752-4598.2008.00024.x

Huste, A., Selmi, S., Boulinier, T. (2006). Bird communities in suburban patches near Paris: determinants of local richness in a highly fragmented landscape. Ecoscience. 13, 249-257 https://doi.org/10.2980/i1195-6860-13-2-249.1

Jackson, N.D., Fahrig, L. (2011). Relative effects of road mortality and decreased connectivity on population genetic diversity. Biology Conservation. 144, 3143-3148 https://doi.org/10.1016/j.biocon.2011.09.010

Jégou, A., About De Chastenet, C., Augiseau, V., Guyot, C., Judéaux, C., Monaco, F-X., Pech, P. (2012). L'évaluation par indicateurs : un outil nécessaire d'aménagement urbain durable ? Cybergeo : European Journal of Geography, https://doi.org/10.4000/cybergeo.25600

Kabeche, D.S. & Vergotte, M-H., 2013. Comment faire de l'audit interne un outil de progrès ? Le cas de la gestion du risque sanitaire dans l'industrie agroalimentaire, Revue Française de Gestion Industrielle, 32 (1), 47-70 https://doi.org/10.53102/2013.32.01.688

Karlsson-Vinkhuyzen, S., Kok, M.T.J., Visseren-Hamakers, J. (2017). Mainstreaming biodiversity in economic sectors: an analytical framework. Biological Conservation. 210, 145-156 https://doi.org/10.1016/j.biocon.2017.03.029

Keller, R.P., Geist, J., Jeschke, J.M., Kühn, I. (2011). Invasive species in Europe: ecology, status, and policy. Environmental Sciences Europe. 23 :23 [on line] http://www.enveurope.com/content/23/1/23

King, L.O. (2016). Functional sustainability indicators. Ecological Indicators. 66, 121-131 https://doi.org/10.1016/j.ecolind.2016.01.027

Kok, A., de Olde, E.M., de Boer, I.J.M., Ripoll-Bosch, R. (2020). European biodiversity assessments in livestock science: a review of research characteristics and indicators. Ecological Indicators. 112: 105902 [on line]: https://doi.org/10.1016/j.ecolind.2019.105902

Lampinen, J., Ruokolainen, K., Huhta, A-P. (2015). Urban power line corridors as novel habitats for grassland and alien plant species in South Western Finland. PLoS ONE 10(11): e0142236. doi:10.1371/journal.pone.0142236

Larjavaara, M. (2008). A review on benefits and disadvantages of tree diversity. Open Forest Science Journal. 1, 24-26 DOI: 10.2174/1874398600801010024

Lavorel, S. & Garnier, E. (2002). Predicting changes in community composition and ecosystem functioning from plant traits: revisiting the Holy Grail. Functional Ecology. 16, 545-556 https://doi.org/10.1046/j.1365-2435.2002.00664.x

Le Viol, I., Mocq, J., Julliard, R., Kerbiriou, C. (2009). The contribution of motorway stormwater retention ponds to the biodiversity of aquatic macroinvertebrates. Biological Conservation. 142, 3163-3171 https://doi.org/10.1016/j.biocon.2009.08.018

Lecq, S., Loisel, A., Brischoux, F., Mullin, S.J., Bonnet, X. (2017). Importance of ground refuges for the biodiversity in agricultural hedgerows. Ecological Indicators. 72, 615-626 https://doi.org/10.1016/j.ecolind.2016.08.032

Liquete, C., Cid, N., Lanzanova, D., Grizzetti, B., Reynaud, A. (2016). Perspectives on the link between ecosystem services and biodiversity: the assessment of the nursery function. Ecological Indicators. 63, 249-257 https://doi.org/10.1016/j.ecolind.2015.11.058

Levrel H. (2007). Quels indicateurs pour la gestion de la biodiversité ? Les cahiers de l'IFB, Paris, 99p.

Lowe, B.D., Dempsey, P.G., Jones, E.M. (2019). Ergonomics assessment methods used by ergonomics professionals, Applied Ergonomics, 81, 102882, [online], https://doi.org/10.1016/j.apergo.2019.102882

Machado, A. (2004). An index of naturalness. Journal for Nature Conservation. 12, 95-110 https://doi.org/10.1016/j.jnc.2003.12.002

Mc Donnell, M.J. & Hahs, A. (2008). The use of gradient analysis studies in advancing our understanding of the ecology of urbanizing landscapes: current status and future directions. Landscape Ecology. 23, 1143-1155 https://doi.org/10.1007/s10980-008-9253-4

McKinney, M. L. (2008). Effects of urbanization on species richness: a review of plants and animals. Urban ecosystems. 11, 161-176 https://doi.org/10.1007/s11252-007-0045-4

Millennium Ecosystem Assessment (2005). Ecosystems and human well-being: a framework for assessment. New York, Island Press, 155p

Miles, S. 2017. Stakeholder theory classification: a theoretical and empirical evaluation. Journal of Business

Ethics. 142: 437-459. https://doi.org/10.1007/s10551-015-2741-y

Mimet, A., Clauzel, C., Foltête, J-C. (2016). Locating wildlife crossings for multispecies connectivity across linear infrastructures. Landscape Ecology. 31, 1955-1973 https://doi.org/10.1007/s10980-016-0373-y

Moreno Pires, S., Fidelis, T., Ramos, T.B. (2014). Measuring and comparing local sustainable development through common indicators: constraints and achievements in practice. Cities. 39, 1-9 https://doi.org/10.1016/j.cities.2014.02.003

Mörtberg U.M., Balfors B., Knol W.C. (2007). Landscape ecological assessment: A tool for integrating biodiversity issues in strategic environmental assessment and planning, Journal of Environmental Management, 82: 457-470 https://doi.org/10.1016/j.jenvman.2006.01.005

Moser, A., Rötzer, T., Pauleit, S., Pretzesch, H. (2015). Structure and ecosystem services of small-leaved lime (*Tilia cordata*) and black locust (*Robinia pseudoacacia* L.) in urban environments. Urban Forestry & Urban Greening. 14, 1110-1121 https://doi.org/10.1016/j.ufug.2015.10.005

Muratet, A., Machon, N., Jiguet, F., Moret, J., Porcher, E. (2007). The role of urban structures in the distribution of wasteland flora in the Greater Paris Area, France. Ecosystems. 10, 661-671 https://doi.org/10.1007/s10021-007-9047-6

Nunes, P. & VanDerBergh, J. (2011). Economic valuation of biodiversity: sense or non-sense? Ecological Economics. 39, 203-222 https://doi.org/10.1016/S0921-8009(01)00233-6

Opoku, A. (2019). Biodiversity and the built environment: implications for the sustainable development goals (SDGs). Resources, Conservation & Recycling. 141, 1-7 https://doi.org/10.1016/j.resconrec.2018.10.011

Parks, K.E. & Mulligan, M. (2010). On the relationship between a resource-based measure of geodiversity and broad scale biodiversity patterns. Biodiversity and Conservation. 19, 2751-2766 https://doi.org/10.1007/s10531-010-9876-z

Penone, C., Machon, N., Julliard, R., Le Viol, I. (2012). Do railway edges provide functional connectivity for plant communities in an urban context? Biological Conservation. 148, 126-133 https://doi.org/10.1016/j.biocon.2012.01.041

Petersen, E., Fiske, A.P., Schubert, T.W. (2019). The role of social relational emotions for human-nature connectedness, Frontiers in Psychology, 10:2759. https://doi.org/10.3389/fpsyg.2019.02759

Pickett, S.T.A., Cadenasso, M.L., Grove, J.M., Boone, C.G., Groffman, P.M., Irwin, E., Kaushal, S.S., Marshall, V., McGrath, B.P., Nilon, C.H., Pouyat, R.V., Szlaecz, K., Troy, A., Warren, P. (2011). Urban ecological systems: scientific foundations a decade of progress, Journal of Environmental Management, 92, 331-362 https://doi.org/10.1016/j.jenvman.2010.08.022

Poorter, H., Niinemets, U., Walter, A., Fiorani, F., Schurr, U. (2010). A method to construct dose-response curves for a wide range of environmental factors and plant traits by means of a meta-analysis of phenotypic data. Journal of Experimental Botany. 61, 2043-2055 https://doi.org/10.1093/jxb/erp358

Poschlod, P., Braun-Reichert, R. (2017). Small natural features with large ecological roles in ancient agricultural landscapes of Central Europe – history, value, status, and conservation. Biological Conservation. 211, 60-68 https://doi.org/10.1016/j.biocon.2016.12.016

Ranta, P. (2008). The importance of traffic corridors as urban habitats for plants in Finland. Urban Ecosystems. 11, 149-159 https://doi.org/10.1007/s11252-008-0058-7

Raymond, C.M., I. Fazey, M.S. Reed, L.C. Stringer, G.M., Robinson, A.C. (2010). Integrating local and scientific knowledge for environmental management, Journal of Environmental Management, 91, 1766-1777 https://doi.org/10.1016/j.jenvman.2010.03.023

Redon De, L., Le Viol, I., Jiguet, F., Machon, N., Scher, O., Kerbiriou, C. (2015). Road network in an agrarian landscape: potential habitat, corridor or barrier for small mammals? Acta Oecologica. 62, 58-65 https://doi.org/10.1016/j.actao.2014.12.003

Reich, P.B., Wright, I.J., Lusk, C.H. (2007). Predicting leaf physiology from simple plant and climate attributes: a global glopnet analysis. Ecological Applications. 17, 1982-1988, https://doi.org/10.1890/06-1803.1/

Richardson, D. M., Pyšek, P., Rejmánek, M., Barbour, M. G., Panetta, F. D., West, C. J. (2000). Naturalization and invasion of alien plants: concepts and definitions. Diversity and distributions. 6, 93-107 https://doi.org/10.1046/j.1472-4642.2000.00083.x

Rosson, M.B. & Carroll, J.M. (2020). Usability engineering, Morgan Kaufmann Publishers, 448p

Shakel, B. (1991). Ergonomics in design and usability. People and computers: designing for usability. Cambridge, Harrison & A. Monk, 44-64

Shakel, B. (2009). Usability-context, framework, definition, design, and evaluation, Interacting with computers. 21, 339-346 https://doi.org/10.1016/j.intcom.2009.04.007

Shwartz, A., Turbé, A., Julliard, R., Simon, L., Prévot, A-C. (2014). Outstanding challenges for urban conservation research and action. Global Environmental Change. 28, 39-49 https://doi.org/10.1016/j.gloenvcha.2014.06.002

Sirola, N. & Pitesa, M. (2018). The macroeconomic environment and the psychology of work evaluation, Organizational Behavior and Human Decision Processes, 144, 11-24 https://doi.org/10.1016/j.obhdp.2017.09.003

Silva, K.M., Silva, F.J., Machado, A. (2019). The evolution of the behaviour systems framework and its connection to interbehavioral psychology, Behavioral Processes, 158, 117-125 https://doi.org/10.1016/j.beproc.2018.11.001

Skouloudis, A., Malesios, C., Dimitrakopoulos, P.G. (2019). Corporate biodiversity accounting and reporting in mega-diverse countries: an examination of indicators disclosed in sustainability reports. Ecological Indicators. 98, 888-901 https://doi.org/10.1016/j.ecolind.2018.11.060

Smyth, R.L., Watzin, M.C., Manning, R.E. (2007). Defining acceptable levels for ecological indicators: an approach for considering social values. Environmental Management. 39, 301-315 https://doi.org/10.1007/s00267-005-0282-3

Suppakittpaisarn, P., Jiang, B., Slavenas, M., Sullivan, W.C., 2019. Does density of green infrastructure predict preference? Urban Forestry & Urban Greening. 40, 236-244 https://doi.org/10.1016/j.ufug.2018.02.007

Tarabon S., Dutoit T., Isselin-Nondedeu F. (2021). Pooling biodiversity offsets to improve habitat connectivity and species conservation, Journal of Environmental Management, 277, 111425, https://doi.org/10.1016/j.jenvman.2020.111425

Tulloch, A., Possingham, H.P., Wilson, K. (2011). Wise selection of an indicator for monitoring the success of management actions. Biological Conservation. 144, 141-154 https://doi.org/10.1016/j.biocon.2010.08.009

Tzoulas, K., James, P. (2010). Peoples' use of, and concerns about, green space networks: A case study of Birchwood, Warrington New Town, UK. Urban Forestry & Urban Greening. 9, 121–128 https://doi.org/10.1016/j.ufug.2009.12.001

Vandermeulen, V., Verspecht, A., Vermeire, B., Van Huylenbroeck, G., Gellynck, X. (2011). The use of economic valuation to create public support for green infrastructure investments in urban areas. Landscape and Urban Planning. 103, 198-206 https://doi.org/10.1016/j.landurbplan.2011.07.010

Van Oudenhoven, A.P.E., Petz, K., Alkemade, R., Hein, L., De Groot, R.S. (2012). Framework for systematic indicator selection to assess effects of land management on ecosystem services. Ecological Indicators. 21, 110-122 https://doi.org/10.1016/j.ecolind.2012.01.012

Vazquez, M.X., Leon, C.J. (2004). Altruism and the economic values of environmental and social policies, Environmental and Resource Economics, 28, 233-249 https://doi.org/10.1023/B:EARE.0000029919.95464.0b

Vergnes, A., Kerbiriou, C., Clergeau, P. (2013). Ecological corridors also operate in an urban matrix: a test case with garden shrews. Urban Ecosystems. 16, 511-525 https://doi.org/10.1007/s11252-013-0289-0

Williamson, M. (2006). Explaining and predicting the success of invading species at different stages of invasion. Biological Invasions. 8, 1561-1568 https://doi.org/10.1007/s10530-005-5849-7

Wolf A., Gondran N., Brdhag C. (2018). Integrating corporate social responsibility into conservation policy. The example of business commitments to contribute to France National Biodiversity Strategy, Environmental Science and Policy, 86: 106-114 https://doi.org/10.1016/j.envsci.2018.05.007

Yang, G., Xu, J., Wang, Y., Wang, X., Pei, E., Yuan, X., Wang, Z. (2015). Evaluation of microhabitats for wild birds in a Shanghai urban area park. Urban Forestry & Urban Greening. 14, 246-154 https://doi.org/10.1016/j.ufug.2015.02.005

Zhang, B., Xie, G., Gao, J., Yang, Y. (2014). The cooling effect of urban green spaces as a contribution to energy-saving and emission-reduction: A case study in Beijing, China. Building and Environment. 76, 37-43

https://doi.org/10.1016/j.buildenv.2014.03.003

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