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IBPC · RESOURCE CENTRE · SCIENTIFIC COUNCIL

People and nature: consolidation of scientific studies on the benefits

Health · Productivity · Quality of life · November 2026

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1. Purpose, scope and method

This report consolidates the scientific studies cited in the IBPC document collection that measure, through quantified results, the benefits of the presence of nature and biodiversity for health, productivity and quality of life. It goes back to the original publications, checks the figures in circulation in the sector and flags the corrections to be made.

1.1. Purpose

The arguments about the human benefits of urban nature, used by property-sector players as well as by the IBPC (International Biodivercity Property Council) for its BiodiverCity labels, rest on scientific studies that are most often cited second-hand, through summary reports (Terrapin Bright Green, CESE, Socotec, WEF) or conference materials. The purpose of this document is to build a single reference base, verified and sourced, that can be used by all those who cite these studies: project owners, designers, assessors and investors.

1.2. Scope

The scope covers the primary studies, meta-analyses and reports cited in the IBPC document collection, inventoried on 27 September 2026 (see Annex A). Fifty-eight references are analysed: forty studies from the document collection, divided into six domains (physical health and recovery; stress, mental health and well-being; cognition, attention and education; productivity and work; social behaviour and safety; economic and property value), fourteen additional references used for the presentation given at the Busan Housing Forum on 28 October 2026, and four studies from an inventory of references received in September 2026, verified at source on 20 November 2026 (records 55 to 58). Two reference syntheses absent from the document collection (Twohig-Bennett and Jones 2018; White et al. 2019) were added to provide a consolidated point of comparison for the individual studies, several of which are old and have small sample sizes.

1.3. Method

- Full reading of the accessible documents in the IBPC collection (seven documents converted to text, about 130,000 words) and extraction of all references carrying a quantified result on people.
- Verification of each study on the web: publisher's page, DOI, institutional repositories, open-access full text where it exists. The figures retained are those of the abstract or of the text of the original publication.
- Systematic comparison between the published figures and those in circulation in secondary sources; each record includes a line “Gap with figures in circulation”. The gaps are summarised in chapter 5.
- Assessment of the level of evidence: type of publication (peer-reviewed, commissioned report, company case study), sample size, design (experimental, cohort, cross-sectional, meta-analysis).

> **Point to note.** Several figures widely circulated in the property sector (sales up 40%, productivity up 6 to 12%, willingness to pay of 20 to 25%) do not match the original publications or come from extrapolations by Terrapin Bright Green. They are identified in each record. The national monetary amounts (millions or billions of dollars) cited in Économie de la biophilie [The Economics of Biophilia] are projections, not study results, and must not be presented as such. On health topics, this report sets out published results; it does not constitute medical advice, and uses in a label's sales argument must be reviewed by the IBPC Scientific Council.

2. Theoretical frameworks used

Three frameworks structure the literature: the biophilia hypothesis, attention restoration theory and stress recovery theory. They explain the mechanisms through which nature acts and make it possible to classify the studies.

2.1. The biophilia hypothesis

Formulated by Edward O. Wilson (Biophilia, 1984) and then developed with Stephen Kellert (The Biophilia Hypothesis, 1993), it posits an innate predisposition in human beings to seek contact with other forms of life. IBPC training material (2022) cites it as a foundation: “human beings have innate genetic predispositions that lead them to need relationships with other forms of life, even in a purely visual way”. Terrapin's 14 Patterns of Biophilic Design (2014) translate this hypothesis into design categories (visual and non-visual connection with nature, presence of water, dynamic light, prospect and refuge).

2.2. Attention restoration theory (Kaplan 1995)

Stephen Kaplan, The restorative benefits of nature: toward an integrative framework, Journal of Environmental Psychology, vol. 15, no. 3, 1995, pp. 169-182 (https://doi.org/10.1016/0272-4944(95)90001-2). Directed attention, which intellectual work requires, becomes fatigued; natural environments restore this capacity through four properties: being away, soft fascination (fascination), extent and compatibility. This framework underpins the cognition studies (Berman 2008, Faber Taylor and Kuo 2009, Lee 2015) and some of the productivity studies.

2.3. Stress recovery theory (Ulrich 1991)

Roger Ulrich and his co-authors (Stress recovery during exposure to natural and urban environments, Journal of Environmental Psychology, 1991) show that exposure to natural scenes produces faster physiological recovery (skin conductance, muscle tension, blood pressure) than exposure to urban scenes. This framework explains the results on cortisol, heart rate variability and length of hospital stay. The IBPC Scientific Council refers to Roger Ulrich's work on the subject of health.

2.4. Determinants of health

This training material draws on the WHO definition (1946) and on the model of the social and environmental determinants of health (Bauer et al. 2003). The claim that "80% of health status is attributable to social and environmental determinants" is not sourced in the material and has not been retained as a study result.

3. Summary of quantified results

The table below summarises, for the fifty-eight references analysed, the most tangible quantified result and the level of evidence. The detailed records in chapter 4 give the context, the qualifications and the links; the fourteen rows that follow correspond to the references of the Busan presentation and the last four to the supplementary inventory.

Domain	Study	Key result	Evidence
Health	Ulrich 1984	Post-operative stay -8.5% (7.96 versus 8.70 days), fewer analgesics	Seminal, n = 46
Health	Walch et al. 2005	Analgesics -22% per hour, cost -21% with 46% more light	Prospective, n = 89
Health	Beauchemin and Hays 1996	Hospital stay -2.6 days (-15%) in a sunny room	Retrospective
Health	Benedetti et al. 2001	Hospital stay -3.67 days (bipolar patients, east-facing rooms)	Retrospective, n = 602
Health	Park et al. 2010	Cortisol -13.4 to -15.8%, pulse -3.9 to -6%, parasympathetic activity +56 to +102%	Field study, n = 280
Health	Ohtsuka et al. 1998	Blood glucose from 179 to 108 mg/100 ml (-40%) after a forest walk	No control group, n = 87
Health	Li 2010	NK cell activity increased more than 30 days after a forest stay	Review, small sample sizes
Health	Lanki et al. 2017	Heart rate -2.5 bpm, systolic pressure -3.6 mmHg in an urban forest	Field study, n = 36
Health	James et al. 2016	Mortality -12% (greenest quintile), cancers -13%, respiratory -34%	Cohort, n = 108,630
Health	Twohig-Bennett and Jones 2018	All-cause mortality OR 0.69, diabetes OR 0.72, reduced cortisol and blood pressure	Meta-analysis, 143 studies
Well-being	Alvarsson et al. 2010	Stress recovery 9 to 37% faster with nature sounds	Lab, n = 40
Well-being	Kahn et al. 2008	Faster heart rate recovery in front of a real window; screen has no effect	Lab, n = 90
Well-being	Bratman et al. 2015	Rumination and subgenual prefrontal activity reduced after 90 min in nature	Randomised, n = 38
Well-being	Alcock et al. 2014	Mental health improved 3 years after moving to a greener area	Cohort, n = 1,064
Well-being	Barton and Pretty 2010	Self-esteem d = 0.46, mood d = 0.54; gains from 5 minutes	Meta-analysis, n = 1,252

Domain	Study	Key result	Evidence
Well-being	White et al. 2019	Good health OR 1.59 and well-being OR 1.23 from 120 min per week	Cross-sectional, n = 19,806
Well-being	Grahn and Stigsdotter 2003, 2010	Fewer stress-related illnesses with frequent visits; Refuge, Nature, Species richness	Survey, n = 953
Well-being	Fuller et al. 2007	Psychological benefits increasing with plant and bird richness	Cross-sectional, n = 312
Well-being	Wells and Evans 2003	Buffering effect of nature on children's stress ($p < 0.001$ for self-esteem)	Cross-sectional, n = 337
Well-being	Cooper Marcus and Barnes 1995	90% of hospital garden users report improved mood	Report, n = 143
Cognition	Berman et al. 2008	Working memory +1.5 digits (about +20%) after a walk in nature	Seminal, n = 38
Cognition	Faber Taylor and Kuo 2009	Children with ADHD: improved concentration after 20 min in the park, d = 0.52 to 0.77	Experimental, n = 17
Cognition	Faber Taylor et al. 2002	View of greenery: 20% of the variance in girls' self-discipline	Quasi-experimental, n = 169
Cognition	Lee et al. 2015	40 s view of a green roof: fewer errors, sustained attention	Randomised, n = 150
Education	Heschong Mahone Group 1999	Progress +20% in maths and +26% in reading; scores +7 to 18%	Report, n > 21,000
Education	Nicklas and Bailey 1996	Results +5 to 14% in daylit schools; -17% in windowless classrooms	Report, small sample
Productivity	Elzeyadi 2011	Sick leave 57 h versus 68 h depending on the view; up to 10% of the variance	Conference, n = 175
Productivity	Heschong Mahone Group 2003	Calls handled 6 to 12% faster; cognitive tests +10 to 25% with a view	Report, n ≈ 300
Productivity	Nieuwenhuis et al. 2014	Productivity +15% after plants were added to a bare office	Field study, n = 33 to 81
Productivity	Dravigne et al. 2008	82% of employees satisfied with plants and a window versus 60% without	Survey, n = 449
Productivity	Romm and Browning 1994	ING headquarters: absenteeism -15%; energy savings $2.6 million per year	Company case study
Social	Kuo and Sullivan 2001a	Aggression and violence reduced by one third to one half of a standard deviation; mediated by attention	Quasi-experimental, n = 145
Social	Kuo and Sullivan 2001b	Crimes -52% between the most and the least greened buildings; 7 to 8% of variance	Observational, 98 buildings
Economics	Heschong Mahone Group 2003 (retail)	Sales +0 to 6% on average with daylight (up to 40%; +40% in the 1999 study)	Report, 73 stores
Economics	Wolf 2005	Willingness to pay +9% (small cities) to +12% (large cities) with trees	Self-report survey
Economics	Laverne and Winson-Geideman 2003	Office rents +7% (landscaping) and +7% (shading); -7.5% if screening	Hedonic, 270 leases
Economics	Benson et al. 1998	Full water view +58.8%, lakefront +126.7%	Hedonic, 7,305 sales
Economics	Harnik and Welle 2009	Sacramento: $19.9 million per year in avoided health spending; +5% value near parks	NGO report

Domain	Study	Key result	Evidence
Economics	Asterès / UNEP 2016	+10% green spaces: €56 million (asthma) and €38 million (hypertension) saved per year	Commissioned modelling
Economics	Ahamada et al. 2007	Flat +17% in the immediate vicinity of a green space (via CESE)	To be checked against the text
Economics	Chen et al. 2022 (review)	Price premium +3.4 to 4.6% (100 m), +16.9% (neighbourhood park), up to +20%	Narrative review
Economics	Trojanek et al. 2018	Warsaw: +2.8 to 3.1% on average, +8.0 to 8.6% for new-builds within 100 m	Hedonic, n = 43,075
Economics	Jim and Chen 2010	Hong Kong: neighbourhood parks +16.88% in dense high-rise housing	Hedonic, n = 1,471
Health	Bowler et al. 2010	Urban park -0.94 °C by day, -1.15 °C at night compared with built-up areas	Meta-analysis, 47 studies
Climate	Jenerette and Herrmann 2023	Sequestration 1.1 to 3.0 t C/ha/yr (4 to 11 t CO2), storage 25.7 t C/ha (94 t CO2)	Synthesis, 154 cities
Health	Kardan et al. 2015	+10 street trees per block = health perceived as with +$10,000 of income or 7 years younger	Cross-sectional, n = 31,109
Productivity	WorldGBC 2014	Operating costs 90% staff, 9% property, 1% energy; air +8 to 11%	Industry report
Economics	Kats 2003	Green building: $48.87 to $67.31 per square foot net over 20 years, of which $36.89 to $55.33 from productivity and health	Commissioned modelling
Biodiversity	GROOVES 2017-2019 / Muratet et al. 2024	36 roofs: 400 plant species, 611 invertebrates; substrate the leading factor	Field study + article
Well-being	Unep-Ipsos 2013	More than 70% of Europeans consider proximity to a green space very important when choosing their home	Poll, 3 countries
Health	City of Paris / APUR 2021	Paris urban heat island about 2.5 °C; woods 2 to 4 °C cooler; up to 8 °C in 2003	Institutional report
Sites	IBPC (Challenger, Cap 3000, Bolloré Nantes)	139 plant species and 50 birds; 4,282 m^2 de-sealed; employee survey not found	Site data
Market	Uptake of the BiodiverCity label	67 (2020), more than 250 out of 500 (2023) confirmed online; more recent counts not verified online	Communication
Summary report	Terrapin 2012	-8.5% stay, 10% absences, +6 to 7% calls, sales +15 to 40%, scores +5 to 18%	Summary report
Health	Lovasi et al. 2008	Asthma in 4-5 year olds: prevalence -29% per standard deviation of street tree density (RR 0.71); hospitalisations not significant	Ecological, 42 areas
Social	Gilstad-Hayden et al. 2015	+10% tree canopy: violent crime -15%, property crime -14% (New Haven)	Spatial cross-sectional, one city
Social	Donovan and Prestemon 2012	Street trees and large trees: fewer crimes; small trees obstructing the view: more	Observational, n = 2,813
Health	Eisenman et al. 2019	No consensus on a reduction in asthma by trees through air quality	Interdisciplinary review

Table 1 · Summary of quantified results by study. Sources: original publications verified in September and November 2026; n = sample size.

3.1. Overall reading

- Health: the short-term physiological effects (cortisol, pulse, blood pressure) are measured repeatedly and consistently; the long-term effects (mortality -12%, diabetes OR 0.72) rest on large recent cohorts and meta-analyses, which today form the strongest argument.
- Well-being and mental health: the benefits appear after just a few minutes of exposure, level off at around two hours per week and increase with species richness (Fuller 2007; Grahn and Stigsdotter 2010), which distinguishes biodiversity from mere “greenery”.
- Cognition and education: gains of 15 to 26% on tests or school progress, with widely varying sample sizes (from 17 children to 21,000 pupils).
- Productivity: the robust orders of magnitude are modest (6 to 12% in speed, 15% on an objective task, 11 hours of sick leave per year); the published monetary amounts are extrapolations.
- Economics: the value premiums are real but lower than those in circulation (sales 0 to 6% on average, willingness to pay 9 to 12%, rents +7%).
- Additions in version 1.2: two studies link tree canopy and street trees to lower crime (New Haven, Portland), in the same direction as Kuo and Sullivan 2001; on asthma, the favourable association observed in New York (-29% per standard deviation of tree density) is ecological, and the review by Eisenman et al. 2019 concludes that there is no consensus on an effect through air quality.

4. Detailed records by domain

Each record presents the title of the study, its authors, its year, the measurement context, the outcome described, the results obtained, the link to the publication, the language, the level of evidence and any gap with the figures in circulation.

4.1. Physical health and recovery

The studies in this group measure objective physiological effects: length of hospital stay, medication use, cortisol, blood pressure, blood glucose, immunity and mortality. This is the most robust foundation of the corpus, with a cohort of more than 100,000 people and a meta-analysis of 143 studies.

4.1.1. Record 1 · Roger S. Ulrich (1984)

Study title	View through a window may influence recovery from surgery
Author(s)	Roger S. Ulrich (University of Delaware)
Year(s)	1984 (hospital records 1972-1981)
Publication	Science, vol. 224, no. 4647, pp. 420-421 · DOI 10.1126/science.6143402
Language	English

Measurement context	A 200-bed hospital in Pennsylvania (United States). 46 patients who had undergone a cholecystectomy, matched in pairs (23 with a window onto a grove of trees, 23 with a window onto a brick wall). Retrospective observational study based on records.
Outcome described	Health: length of post-operative hospital stay, use of strong analgesics, negative comments from nursing staff.
Results	Post-operative stay of 7.96 days (view of trees) versus 8.70 days (view of a wall), that is about -8.5%. Negative nursing comments: 1.13 versus 3.96 per patient. Doses of strong analgesics markedly lower between day 2 and day 5. Seminal study of “stress recovery theory”.
Web link	https://doi.org/10.1126/science.6143402
Level of evidence	Seminal study, peer-reviewed (Science). Very small, retrospective sample: high historical value, limited statistical power.
Gap with figures in circulation	Figures consistent with those reported by Terrapin (Économie de la biophilie [The Economics of Biophilia], 2015). The dollar amounts ($93 million per year across the United States) are Terrapin extrapolations, not results of the study.
Secondary source	Terrapin, Economics of Biophilia (French edition 2015); Terrapin, 14 Patterns of Biophilic Design (2014).

Record 1 · View through a window may influence recovery from surgery. Verified online, September 2026.

4.1.2. Record 2 · Jeffrey M. Walch (2005)

Study title	The effect of sunlight on postoperative analgesic medication use: a prospective study of patients undergoing spinal surgery
Author(s)	Jeffrey M. Walch, Bruce S. Rabin, Richard Day, Jessica N. Williams, Krissy Choi, James D. Kang
Year(s)	2005
Publication	Psychosomatic Medicine, vol. 67, no. 1, pp. 156-163 · DOI 10.1097/01.psy.0000149258.42508.70
Language	English
Measurement context	University hospital in Pittsburgh (United States). 89 patients who had undergone spinal surgery, grouped according to the sunny or dim side of the same unit. Prospective observational study.
Outcome described	Health and costs: use and cost of opioid analgesics, perceived pain and stress.
Results	Patients on the sunny side exposed to light 46% more intense on average ($p = 0.005$); analgesic use per hour 22% lower ($p = 0.047$); cost of painkillers 21% lower ($p = 0.047$); lower perceived stress ($p = 0.035$); marginally lower pain ($p = 0.058$).
Web link	https://doi.org/10.1097/01.psy.0000149258.42508.70
Level of evidence	Peer-reviewed, prospective, modest sample, not randomised: moderate evidence.
Gap with figures in circulation	Figures confirmed (46%, -22%, -21%). This concerns daylight and not vegetation: to be filed under “connection to nature through daylight”.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 2 · The effect of sunlight on postoperative analgesic medication use: a prospective study of patients undergoing spinal surgery. Verified online, September 2026.

4.1.3. Record 3 · Kathleen M. Beauchemin (1996)

Study title	Sunny hospital rooms expedite recovery from severe and refractory depressions
Author(s)	Kathleen M. Beauchemin, Peter Hays
Year(s)	1996

Publication	Journal of Affective Disorders, vol. 40, no. 1-2, pp. 49-51 · DOI 10.1016/0165-0327(96)00040-7
Language	English
Measurement context	Hospital psychiatric unit (Alberta, Canada). Patients hospitalised for severe depression, in sunny or dark rooms. Retrospective observational study.
Outcome described	Mental health: length of hospital stay.
Results	Average stay of 16.9 days in a sunny room versus 19.5 days in a dark room, that is 2.6 days fewer (-15%, $p < 0.05$).
Web link	https://doi.org/10.1016/0165-0327(96)00040-7
Level of evidence	Peer-reviewed, brief report, retrospective, no randomisation: weak to moderate evidence.
Gap with figures in circulation	The Terrapin document gives 16.7 days; the publication gives 16.9 days (difference of 2.6 days confirmed). The sample size of 174 patients cited by Terrapin could not be verified online.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 3 · Sunny hospital rooms expedite recovery from severe and refractory depressions. Verified online, September 2026.

4.1.4. Record 4 · Francesco Benedetti (2001)

Study title	Morning sunlight reduces length of hospitalization in bipolar depression
Author(s)	Francesco Benedetti, Cristina Colombo, Barbara Barbini, Euridice Campori, Enrico Smeraldi
Year(s)	2001 (observations 1996-1998)
Publication	Journal of Affective Disorders, vol. 62, no. 3, pp. 221-223 · DOI 10.1016/S0165-0327(00)00149-X
Language	English
Measurement context	San Raffaele Hospital, Milan (Italy). 415 unipolar patients and 187 bipolar patients hospitalised for depression, in east-facing (morning sun) or west-facing rooms. Retrospective naturalistic observation.
Outcome described	Mental health: length of hospital stay.
Results	In bipolar patients, stay shorter by 3.67 days on average in rooms exposed to morning sun; no effect in unipolar patients; significant effect for summer and autumn admissions.
Web link	https://doi.org/10.1016/S0165-0327(00)00149-X
Level of evidence	Peer-reviewed, brief report, retrospective, adequate sample size: moderate evidence.
Gap with figures in circulation	Figure confirmed (-3.67 days). Qualification to be added: effect limited to bipolar patients. The saving of $271,904 cited by Terrapin is an extrapolation.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 4 · Morning sunlight reduces length of hospitalization in bipolar depression. Verified online, September 2026.

4.1.5. Record 5 · Bum Jin Park (2010)

Study title	The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan
Author(s)	Bum Jin Park, Yuko Tsunetsugu, Tamami Kasetani, Takahide Kagawa, Yoshifumi Miyazaki
Year(s)	2010 (experiments 2005-2006)
Publication	Environmental Health and Preventive Medicine, vol. 15, no. 1, pp. 18-26 · DOI 10.1007/s12199-009-0086-9
Language	English

Measurement context	Japan, 24 sites (forest versus city centre). 280 male students (12 per site), crossover design: about 16 minutes of walking then 14 minutes of viewing, in the forest and in the city on alternate days. Measurements of salivary cortisol, pulse rate, blood pressure and heart rate variability.
Outcome described	Health: physiological markers of stress.
Results	In the forest compared with the city: salivary cortisol -13.4% after viewing and -15.8% after walking; pulse rate -6.0% (viewing) and -3.9% (walking); systolic pressure -1.7% and -1.9%; parasympathetic activity (HF) +56.1% after viewing and +102% after walking; sympathetic activity (LF/HF) -18.0% and -19.4%.
Web link	https://doi.org/10.1007/s12199-009-0086-9
Level of evidence	Peer-reviewed, series of controlled field experiments, substantial but exclusively male pooled sample: good level for a short-term physiological effect.
Gap with figures in circulation	The Terrapin document cites cortisol “13.4 to 15.8% lower”: confirmed. The +56.1% parasympathetic activity corresponds to the viewing phase; it reaches +102% when walking.
Secondary source	Terrapin, Economics of Biophilia (2015); 14 Patterns (2014, Park et al. 2009).

Record 5 · The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. Verified online, September 2026.

4.1.6. Record 6 · Yoshinori Ohtsuka (1998)

Study title	Shinrin-yoku (forest-air bathing and walking) effectively decreases blood glucose levels in diabetic patients
Author(s)	Yoshinori Ohtsuka, Noriyuki Yabunaka, Shigeru Takayama
Year(s)	1998 (9 sessions over 6 years)
Publication	International Journal of Biometeorology, vol. 41, no. 3, pp. 125-127 · DOI 10.1007/s004840050064
Language	English
Measurement context	Japan. 87 non-insulin-dependent diabetic patients (29 men, 58 women, 61 years old on average). Forest walks of 3 or 6 km; measurements before and after, no randomised control group.
Outcome described	Health: blood glucose and glycated haemoglobin.
Results	Mean blood glucose falling from 179 to 108 mg/100 ml after the forest walk ($p < 0.0001$), that is about -40%; HbA1c from 6.9% to 6.5%. Decrease of 74 mg (3 km) and 70 mg (6 km), with no significant difference by distance.
Web link	https://doi.org/10.1007/s004840050064
Level of evidence	Peer-reviewed, old study, short, no control group: moderate to weak evidence.
Gap with figures in circulation	Terrapin gives 109 mg (publication: 108 mg) and a comparison with indoor exercise (-21.2%) not found in the abstract.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 6 · Shinrin-yoku (forest-air bathing and walking) effectively decreases blood glucose levels in diabetic patients. Verified online, September 2026.

4.1.7. Record 7 · Qing Li (2010)

Study title	Effect of forest bathing trips on human immune function
Author(s)	Qing Li (Nippon Medical School, Tokyo)
Year(s)	2010 (underlying studies 2005-2008)

Publication	Environmental Health and Preventive Medicine, vol. 15, no. 1, pp. 9-17 · DOI 10.1007/s12199-008-0068-3
Language	English
Measurement context	Japan. Review article summarising several experiments (stays of 3 days and 2 nights in the forest, groups of 12 to 13 adults) with blood samples taken on day 2, day 3, day 7 and day 30; comparison with ordinary working days and city visits.
Outcome described	Health: activity and number of NK (natural killer) cells, anti-tumour proteins, urinary adrenaline.
Results	Activity and number of NK cells significantly higher after a forest stay; urinary adrenaline lower; the increase in NK activity persists for more than 30 days after the stay; city visits do not produce this effect. The 2008 primary studies distinguish a persistence of 30 days in men and 7 days in women.
Web link	https://doi.org/10.1007/s12199-008-0068-3
Level of evidence	Peer-reviewed narrative review; primary studies with very small sample sizes, same team: moderate level.
Gap with figures in circulation	The 30 days / 7 days distinction cited by Terrapin comes from Li et al. 2008 and not from the 2010 review; to be sourced from the 2008 articles.
Secondary source	Terrapin, 14 Patterns of Biophilic Design (2014).

Record 7 · Effect of forest bathing trips on human immune function. Verified online, September 2026.

4.1.8. Record 8 · Timo Lanki (2017)

Study title	Acute effects of visits to urban green environments on cardiovascular physiology in women: a field experiment
Author(s)	Timo Lanki, Taina Siponen, Ann Ojala, Kalevi Korpela, Arto Pennanen, Pekka Tiittanen, Yuko Tsunetsugu, Takahide Kagawa, Liisa Tyrväinen
Year(s)	2017
Publication	Environmental Research, vol. 159, pp. 176-185 · DOI 10.1016/j.envres.2017.07.039
Language	English
Measurement context	Helsinki (Finland). 36 female volunteers; crossover field experiment at three sites (urban forest, urban park, built-up city centre) with 15 minutes of seated viewing then 30 minutes of walking; measurements of blood pressure, heart rate and heart rate variability.
Outcome described	Health: cardiovascular physiology and autonomic nervous system.
Results	Heart rate lower in green environments than in the city centre (-2.46 to -2.69 beats per minute); systolic pressure lower in the urban forest during viewing (-3.64 mmHg); heart rate variability (SDNN) 10.8 ms higher in the urban forest, an indication of increased parasympathetic activity.
Web link	https://doi.org/10.1016/j.envres.2017.07.039
Level of evidence	Field experiment, peer-reviewed, small homogeneous sample; modest effects in absolute terms.
Gap with figures in circulation	IBPC training material (2022) cites Lanki et al. 2017 for the stimulation of the parasympathetic system: consistent with the published indicators, with no figure in the material.
Secondary source	IBPC training material, “Végétal et santé” [Plants and health], 2022.

Record 8 · Acute effects of visits to urban green environments on cardiovascular physiology in women: a field experiment. Verified online, September 2026.

4.1.9. Record 9 · Peter James (2016)

Study title	Exposure to greenness and mortality in a nationwide prospective cohort study of women

Author(s)	Peter James, Jaime E. Hart, Rachel F. Banay, Francine Laden (Harvard T.H. Chan School of Public Health)
Year(s)	2016 (follow-up 2000-2008)
Publication	Environmental Health Perspectives, vol. 124, no. 9, pp. 1344-1352 · DOI 10.1289/ehp.1510363
Language	English
Measurement context	United States, Nurses' Health Study prospective cohort: 108,630 women, 627,008 person-years. Exposure to vegetation measured by the NDVI satellite index within a radius of 250 m and 1,250 m around the home; adjusted Cox models.
Outcome described	Health: all-cause and cause-specific non-accidental mortality; mediation by mental health, physical activity, pollution and social ties.
Results	Mortality 12% lower (95% CI: 6 to 18%) for the highest greenness quintile compared with the lowest; strongest associations for mortality from cancer (-13%) and from respiratory diseases (-34%); mental health (depression) explains about 30% of the association.
Web link	https://doi.org/10.1289/ehp.1510363
Level of evidence	Large prospective cohort, peer-reviewed: high level of evidence (observational, women only).
Gap with figures in circulation	Figures consistent with the CESE opinion 2018 (108,630 women, 8 years, -12%, cancers -13%). Useful additions: -34% for respiratory mortality and mediation by mental health.
Secondary source	CESE opinion 2018, La nature en ville [Urban nature], p. 18 and notes 17-18.

Record 9 · Exposure to greenness and mortality in a nationwide prospective cohort study of women. Verified online, September 2026.

4.1.10. Record 10 · Caoimhe Twohig-Bennett (2018)

Study title	The health benefits of the great outdoors: a systematic review and meta-analysis of greenspace exposure and health outcomes
Author(s)	Caoimhe Twohig-Bennett, Andy Jones (University of East Anglia)
Year(s)	2018
Publication	Environmental Research, vol. 166, pp. 628-637 · DOI 10.1016/j.envres.2018.06.030
Language	English
Measurement context	Systematic review and meta-analysis of 143 studies (103 observational, 40 interventional) covering about a hundred health indicators.
Outcome described	Health: physiological markers of stress, chronic morbidity, pregnancy outcomes, mortality.
Results	Exposure to green spaces associated with: reduced salivary cortisol (-0.05, 95% CI -0.07 to -0.04), heart rate -2.57 bpm, diastolic pressure -1.97 mmHg, type 2 diabetes (OR 0.72), all-cause mortality (OR 0.69), cardiovascular mortality (OR 0.84), preterm birth (OR 0.87), good self-reported health (OR 1.12).
Web link	https://doi.org/10.1016/j.envres.2018.06.030
Level of evidence	Peer-reviewed meta-analysis: highest level of evidence in the corpus.
Gap with figures in circulation	Reference absent from the document collection, added as a reference synthesis to consolidate the earlier individual studies.
Secondary source	Added by this consolidation.

Record 10 · The health benefits of the great outdoors: a systematic review and meta-analysis of greenspace exposure and health outcomes. Verified online, September 2026.

4.2. Stress, mental health and well-being

These studies document recovery from stress, mood, rumination and reported well-being. They provide the "dose" benchmarks (from 5 minutes, 120 minutes per week) and explicitly link species richness to psychological benefit, which is of direct relevance to the BiodiverCity labels.

4.2.1. Record 11 · Jesper J. Alvarsson (2010)

Study title	Stress recovery during exposure to nature sound and environmental noise
Author(s)	Jesper J. Alvarsson, Stefan Wiens, Mats E. Nilsson (Stockholm University)
Year(s)	2010
Publication	International Journal of Environmental Research and Public Health, vol. 7, no. 3, pp. 1036-1046 · DOI 10.3390/ijerph7031036
Language	English
Measurement context	Laboratory (Sweden). 40 students subjected to an arithmetic stressor then exposed to a nature sound (50 dB) or to urban noise (40, 50 and 80 dB); measurement of skin conductance and heart rate variability.
Outcome described	Health: speed of physiological recovery after stress.
Results	Half-life of skin conductance recovery: 101 s (nature sound), 111 s (low noise), 121 s (ambient noise), 160 s (high noise); recovery 9 to 37% faster with nature sounds, the difference being significant only against the high noise ($p = 0.045$). No effect on heart rate variability.
Web link	https://doi.org/10.3390/ijerph7031036
Level of evidence	Peer-reviewed, controlled experiment, small sample, marginal effects: moderate to weak evidence.
Gap with figures in circulation	Terrapin's "up to 37% faster" is the upper bound; the range is 9 to 37%.
Secondary source	Terrapin, 14 Patterns of Biophilic Design (2014), pattern P2.

Record 11 · Stress recovery during exposure to nature sound and environmental noise. Verified online, September 2026.

4.2.2. Record 12 · Peter H. Kahn Jr. (2008)

Study title	A plasma display window? The shifting baseline problem in a technologically mediated natural world
Author(s)	Peter H. Kahn Jr., Batya Friedman, Brian Gill, Jennifer Hagman, Rachel L. Severson, Nathan G. Freier, Erika N. Feldman, Sybil Carrère, Anna Stolyar
Year(s)	2008
Publication	Journal of Environmental Psychology, vol. 28, no. 2, pp. 192-199 · DOI 10.1016/j.jenvp.2007.10.008
Language	English
Measurement context	University of Washington, Seattle. 90 students in three groups of 30: office facing a real window onto a natural scene, a high-definition plasma screen showing the same scene in real time, or a blank wall; measurement of heart rate after mild stress tasks.
Outcome described	Health: heart rate recovery; behaviour: looking time and attention.
Results	Heart rate falls faster facing the real window; the plasma screen has no more effect than the blank wall; recovery increases with time spent looking at the window, not at the screen. The factor "1.6 times faster" cited by Terrapin could not be verified in the accessible sources.
Web link	https://doi.org/10.1016/j.jenvp.2007.10.008

Level of evidence	Peer-reviewed, controlled experiment, modest student sample: moderate evidence.
Gap with figures in circulation	Sample size and protocol confirmed; the “1.6 times” remains to be sourced in the full text.
Secondary source	Terrapin, 14 Patterns (2014, pattern P1) and Economics of Biophilia (2015).

Record 12 · A plasma display window? The shifting baseline problem in a technologically mediated natural world. Verified online, September 2026.

4.2.3. Record 13 · Gregory N. Bratman (2015)

Study title	Nature experience reduces rumination and subgenual prefrontal cortex activation
Author(s)	Gregory N. Bratman, J. Paul Hamilton, Kevin S. Hahn, Gretchen C. Daily, James J. Gross (Stanford University)
Year(s)	2015
Publication	PNAS, vol. 112, no. 28, pp. 8567-8572 · DOI 10.1073/pnas.1510459112
Language	English
Measurement context	Stanford (California). 38 healthy young adults, randomised trial: 90-minute walk in a natural setting (grassland with trees) or in an urban setting (street with heavy traffic); rumination questionnaire and brain perfusion imaging before and after.
Outcome described	Mental health: rumination (a risk factor for depression) and activity of the subgenual prefrontal cortex.
Results	The “nature” group reports reduced rumination and shows decreased activity in the subgenual prefrontal cortex; neither of these effects in the “urban” group. The detailed numerical values are given in the full text (open access PMC4507237).
Web link	https://doi.org/10.1073/pnas.1510459112
Level of evidence	Peer-reviewed (PNAS), randomised, small sample (19 per arm).
Gap with figures in circulation	Consistent with the Terrapin mention (2015); Bratman et al. 2019 (Science Advances) cited by the WEF is a synthesis with no figures.
Secondary source	Terrapin, Economics of Biophilia (2015); WEF, BiodiverCities by 2030 (2022, Bratman 2019).

Record 13 · Nature experience reduces rumination and subgenual prefrontal cortex activation. Verified online, September 2026.

4.2.4. Record 14 · Ian Alcock (2014)

Study title	Longitudinal effects on mental health of moving to greener and less green urban areas
Author(s)	Ian Alcock, Mathew P. White, Benedict W. Wheeler, Lora E. Fleming, Michael H. Depledge (University of Exeter)
Year(s)	2014 (data 1991-2008)
Publication	Environmental Science & Technology, vol. 48, no. 2, pp. 1247-1255 · DOI 10.1021/es403688w
Language	English
Measurement context	England, British Household Panel Survey. 1,064 people who moved home (594 to a greener area, 470 to a less green area), followed for 2 years before and 3 years after; mental health measured by the GHQ; fixed-effects models.
Outcome described	Mental health and quality of life.
Results	Mental health significantly better in the three years following a move to a greener area ($p = 0.015$; 0.016; 0.008), a lasting improvement; people moving to a less green area show a deterioration in the year before the move then a return to the initial level.
Web link	https://doi.org/10.1021/es403688w

Level of evidence	National longitudinal cohort, robust within-person design, modest effect: good level.
Gap with figures in circulation	Cited without figures by Terrapin (14 Patterns); details added.
Secondary source	Terrapin, 14 Patterns (2014).

Record 14 · Longitudinal effects on mental health of moving to greener and less green urban areas. Verified online, September 2026.

4.2.5. Record 15 · Jo Barton (2010)

Study title	What is the best dose of nature and green exercise for improving mental health? A multi-study analysis
Author(s)	Jo Barton, Jules Pretty (University of Essex)
Year(s)	2010
Publication	Environmental Science & Technology, vol. 44, no. 10, pp. 3947-3955 · DOI 10.1021/es903183r
Language	English
Measurement context	United Kingdom. Meta-analysis of 10 studies by the same group, 1,252 participants; self-esteem (Rosenberg scale) and mood (POMS); dose-response analysis by duration, intensity, age, sex, health status and type of environment.
Outcome described	Mental health: self-esteem and mood.
Results	Overall effect size d = 0.46 for self-esteem and d = 0.54 for mood ($p < 0.00001$). Substantial gains from short exposures (from 5 minutes) then diminishing but positive returns; the presence of water increases the effect; people with mental disorders are among those who improve the most.
Web link	https://doi.org/10.1021/es903183r
Level of evidence	Peer-reviewed meta-analysis, but covering studies by the same group and with no control group for several source studies.
Gap with figures in circulation	Terrapin speaks of an effect “most significant in the first five minutes”; accurate wording: gains from 5 minutes then diminishing returns.
Secondary source	Terrapin, 14 Patterns (2014).

Record 15 · What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. Verified online, September 2026.

4.2.6. Record 16 · Mathew P. White (2019)

Study title	Spending at least 120 minutes a week in nature is associated with good health and wellbeing
Author(s)	Mathew P. White, Ian Alcock, James Grellier, Benedict W. Wheeler, Terry Hartig, Sara L. Warber, Angie Bone, Michael H. Depledge, Lora E. Fleming
Year(s)	2019 (surveys 2014-2016)
Publication	Scientific Reports, vol. 9, article 7730 · DOI 10.1038/s41598-019-44097-3
Language	English
Measurement context	England, MENE nationally representative survey (Natural England): 19,806 participants; cross-sectional analysis of weekly time spent in nature.
Outcome described	Self-reported health and well-being (quality of life).
Results	Likelihood of reporting good health or high well-being significantly greater from 120 minutes per week (120-179 min: OR health 1.59; OR well-being 1.23); plateau between 200 and 300 minutes; effect consistent among older people and people with chronic illness; unaffected by how the visits are split up.
Web link	https://doi.org/10.1038/s41598-019-44097-3

Level of evidence	Peer-reviewed, large sample, cross-sectional (association).
Gap with figures in circulation	Reference absent from the document collection, added as a “dose” benchmark complementing Barton and Pretty 2010.
Secondary source	Added by this consolidation.

Record 16 · Spending at least 120 minutes a week in nature is associated with good health and wellbeing. Verified online, September 2026.

4.2.7. Record 17 · Patrik Grahn (2003)

Study title	Landscape planning and stress (2003) and The relation between perceived sensory dimensions of urban green space and stress restoration (2010)
Author(s)	Patrik Grahn, Ulrika K. Stigsdotter (Swedish University of Agricultural Sciences)
Year(s)	2003 and 2010
Publication	Urban Forestry & Urban Greening, vol. 2, no. 1, pp. 1-18 · DOI 10.1078/1618-8667-00019; Landscape and Urban Planning, vol. 94, no. 3-4, pp. 264-275 · DOI 10.1016/j.landurbplan.2009.10.012
Language	English
Measurement context	Sweden, 9 cities; 953 randomly selected respondents (postal questionnaire). Variables: frequency of visits, weekly time, distance to green spaces, private garden; then analysis of eight perceived sensory dimensions (Serene, Space, Nature, Rich in species, Refuge, Culture, Prospect, Social).
Outcome described	Mental health: stress-related illnesses; quality of restorative green spaces.
Results	The more frequent the visits to green spaces, the fewer stress-related illnesses are reported, regardless of age, sex and social status; distance from home and access to a garden are decisive. The “Refuge” and “Nature” dimensions are the most strongly correlated with stress; the combination Refuge + Nature + Rich in species, with little of the “Social” dimension, makes up the most restorative environment.
Web link	https://doi.org/10.1078/1618-8667-00019 · https://doi.org/10.1016/j.landurbplan.2009.10.012
Level of evidence	Peer-reviewed articles, self-reported cross-sectional survey (correlation).
Gap with figures in circulation	Cited without a figure in 14 Patterns; species richness as a factor in restoration is a direct argument for the BiodiverCity labels.
Secondary source	Terrapin, 14 Patterns (2014) and Economics of Biophilia (2015).

Record 17 · Landscape planning and stress (2003) and The relation between perceived sensory dimensions of urban green space and stress restoration (2010). Verified online, September 2026.

4.2.8. Record 18 · Richard A. Fuller (2007)

Study title	Psychological benefits of greenspace increase with biodiversity
Author(s)	Richard A. Fuller, Katherine N. Irvine, Patrick Devine-Wright, Philip H. Warren, Kevin J. Gaston (University of Sheffield)
Year(s)	2007 (survey July-October 2005)
Publication	Biology Letters, vol. 3, no. 4, pp. 390-394 · DOI 10.1098/rsbl.2007.0149
Language	English
Measurement context	Sheffield (United Kingdom). 312 users of 15 green spaces interviewed on site; inventories of plant, butterfly and bird richness and number of habitats; measures of psychological well-being (reflection, place attachment, identity, continuity).
Outcome described	Psychological well-being and quality of life.

Results	Psychological benefits increase with the species richness of green spaces: the capacity for reflection grows with plant richness and the size of the space, place attachment with bird diversity and the number of habitats; users correctly perceive richness in plants and in birds (not that of butterflies).
Web link	https://doi.org/10.1098/rsbl.2007.0149
Level of evidence	Highly cited seminal study, peer-reviewed, cross-sectional, a single city.
Gap with figures in circulation	Consistent with the Terrapin mention (14 Patterns). A key study for the IBPC: it explicitly links biodiversity (and not merely “greenery”) with human benefit.
Secondary source	Terrapin, 14 Patterns (2014).

Record 18 · Psychological benefits of greenspace increase with biodiversity. Verified online, September 2026.

4.2.9. Record 19 · Nancy M. Wells (2003)

Study title	Nearby nature: a buffer of life stress among rural children
Author(s)	Nancy M. Wells, Gary W. Evans (Cornell University)
Year(s)	2003
Publication	Environment and Behavior, vol. 35, no. 3, pp. 311-330 · DOI 10.1177/0013916503035003001
Language	English
Measurement context	Five rural communities in New York State. 337 children aged 8 to 11; naturalness scale for the home (view, plants, garden), psychological distress (maternal questionnaire), global self-worth, stressful life events. Cross-sectional study.
Outcome described	Child mental health and well-being: buffering effect of nature on stress.
Results	The impact of stressful events on psychological distress and self-worth is significantly lower among children with a great deal of nature nearby (stress x nature interaction: $p < 0.05$ for distress, $p < 0.001$ for self-worth). No effect percentage published.
Web link	https://doi.org/10.1177/0013916503035003001
Level of evidence	Peer-reviewed seminal study, cross-sectional, self-reported measures.
Gap with figures in circulation	Consistent; the “20 to 26%” associated with Wells and Evans in a Terrapin box in fact belongs to Heschong Mahone Group 1999.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 19 · Nearby nature: a buffer of life stress among rural children. Verified online, September 2026.

4.2.10. Record 20 · Clare Cooper Marcus (1995)

Study title	Gardens in healthcare facilities: uses, therapeutic benefits, and design recommendations
Author(s)	Clare Cooper Marcus, Marni Barnes (University of California, Berkeley)
Year(s)	1995 (survey 1994)
Publication	The Center for Health Design, Martinez (California), research report
Language	English
Measurement context	Four hospitals in the San Francisco Bay Area. Post-occupancy evaluation: visual analysis, behaviour mapping and interviews with 143 garden users (patients, families, staff).
Outcome described	Health and well-being: stress restoration, mood.
Results	90% of users report a positive change in mood after time spent in the garden; the most frequent answer to “what helps you feel better” is “more relaxed, calmer” (79%).
Web link	https://www.healthdesign.org/knowledge-repository/gardens-healthcare-facilities-uses-therapeutic-benefits-and-design

Level of evidence	Research report (grey literature), qualitative and descriptive, limited sample.
Gap with figures in circulation	Terrapin's “95%” was not found in the source; use 90% (mood) and 79% (relaxation).
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 20 · Gardens in healthcare facilities: uses, therapeutic benefits, and design recommendations. Verified online, Septem ber 2026.

4.3. Cognition, attention and education

This group draws on attention restoration theory (Kaplan 1995). The effects are measured by standardised cognitive tests (digit span, sustained attention) and by school results.

4.3.1. Record 21 · Marc G. Berman (2008)

Study title	The cognitive benefits of interacting with nature
Author(s)	Marc G. Berman, John Jonides, Stephen Kaplan (University of Michigan)
Year(s)	2008
Publication	Psychological Science, vol. 19, no. 12, pp. 1207-1212 · DOI 10.1111/j.1467-9280.2008.02225.x
Language	English
Measurement context	Ann Arbor (Michigan). Experiment 1: 38 students, walk of 50 to 55 minutes in an arboretum or in the city centre, crossover design; experiment 2: 12 students viewing photographs of nature or of the city. Measures: backward digit span, Attention Network Task.
Outcome described	Cognition: directed attention and working memory.
Results	Improvement in backward digit span of 1.5 digits after the nature walk (p_rep = 0.99) versus 0.5 digits after the urban walk, that is, about +20% in performance; effect independent of mood; effect replicated with simple photographs of nature.
Web link	https://doi.org/10.1111/j.1467-9280.2008.02225.x
Level of evidence	Seminal study for attention restoration theory, peer-reviewed, small samples.
Gap with figures in circulation	Study absent from the Terrapin documents; it probably corresponds to the reference “Taylor et al. 2008” in a piece of IBPC training material (recovery of attentional resources).
Secondary source	IBPC training material, 2022 (reference to be specified).

Record 21 · The cognitive benefits of interacting with nature. Verified online, September 2026.

4.3.2. Record 22 · Andrea Faber Taylor (2009)

Study title	Children with attention deficits concentrate better after walk in the park
Author(s)	Andrea Faber Taylor, Frances E. (Ming) Kuo (University of Illinois)
Year(s)	2009 (online 2008)
Publication	Journal of Attention Disorders, vol. 12, no. 5, pp. 402-409 · DOI 10.1177/1087054708323000
Language	English
Measurement context	Illinois. 17 children aged 7 to 12 diagnosed with ADHD; single-blind within-subjects design: three guided walks of 20 minutes (urban park, residential neighbourhood, city centre) one week apart, randomised order; backward digit span test.
Outcome described	Cognition: concentration and directed attention in children with ADHD.

Results	Concentration significantly better after the walk in the park than after the walk in the city centre (p = 0.023) or in the residential neighbourhood (p = 0.007); effect sizes d = 0.52 and 0.77, “comparable to those reported for recent formulations of methylphenidate”; 20 minutes are enough.
Web link	https://doi.org/10.1177/1087054708323000
Level of evidence	Peer-reviewed seminal study, controlled experiment, very small sample.
Gap with figures in circulation	Terrapin gives 16 children (publication: 17) and “+13.37%” on the test, a figure not found (Terrapin recalculation): prefer the published effect sizes.
Secondary source	Terrapin, Economics of Biophilia (2015), appendix D.

Record 22 · Children with attention deficits concentrate better after walk in the park. Verified online, September 2026.

4.3.3. Record 23 · Andrea Faber Taylor (2002)

Study title	Views of nature and self-discipline: evidence from inner city children
Author(s)	Andrea Faber Taylor, Frances E. Kuo, William C. Sullivan
Year(s)	2002
Publication	Journal of Environmental Psychology, vol. 22, no. 1-2, pp. 49-63 · DOI 10.1006/jevp.2001.0241
Language	English
Measurement context	Robert Taylor Homes, social housing in Chicago. 169 children (91 boys, 78 girls, 9.6 years old on average) randomly assigned to 12 identical buildings whose views are more or less green; tests of concentration, impulse inhibition and delay of gratification.
Outcome described	Cognition and behaviour: self-discipline in children.
Results	Among girls, the greenness of the view from the home explains 20% of the variance in the combined self-discipline index (R^2 = 0.20; p < 0.0001), 13% for concentration and 14% for delay of gratification; no relationship among boys.
Web link	https://doi.org/10.1006/jevp.2001.0241
Level of evidence	Peer-reviewed seminal study, quasi-experimental (random assignment to housing), correlational.
Gap with figures in circulation	To be corrected: Terrapin presents self-discipline as “20% higher”; it is 20% of variance explained, among girls only.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 23 · Views of nature and self-discipline: evidence from inner city children. Verified online, September 2026.

4.3.4. Record 24 · Kate E. Lee (2015)

Study title	40-second green roof views sustain attention: the role of micro-breaks in attention restoration
Author(s)	Kate E. Lee, Kathryn J.H. Williams, Leisa D. Sargent, Nicholas S.G. Williams, Katherine A. Johnson (University of Melbourne)
Year(s)	2015
Publication	Journal of Environmental Psychology, vol. 42, pp. 182-189 · DOI 10.1016/j.jenvp.2015.04.003
Language	English
Measurement context	Melbourne (Australia). 150 randomised students; sustained attention task (SART) in two blocks, separated by a micro-break of 40 seconds in front of an image of a flowering green roof or of a bare concrete roof.
Outcome described	Cognition: sustained attention at work (omission errors, consistency of responses).

Results	The “green roof” group makes significantly fewer omission errors and responds more consistently in the second block; less than one minute of a view of nature is enough to restore attention. The percentages circulating in the press (+6% / -8%) do not appear in the abstract.
Web link	https://doi.org/10.1016/j.jenvp.2015.04.003
Level of evidence	Peer-reviewed randomised trial, student sample, very short-term effect.
Gap with figures in circulation	Consistent with the Terrapin mention (2015). Direct application to green roofs visible from offices.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 24 · 40-second green roof views sustain attention: the role of micro-breaks in attention restoration. Verified online, September 2026.

4.3.5. Record 25 · Heschong Mahone Group (1999)

Study title	Daylighting in schools: an investigation into the relationship between daylighting and human performance
Author(s)	Heschong Mahone Group (Lisa Heschong, director; analyses by RLW Analytics), for Pacific Gas and Electric Company
Year(s)	1999 (school year 1997-1998); re-analysis 2002
Publication	California Board for Energy Efficiency, Third Party Program; ERIC ED444337
Language	English
Measurement context	Three school districts (Capistrano in California, Seattle, Fort Collins); more than 21,000 pupils from second to fifth grade in more than 2,000 classrooms ranked by their level of daylight; multivariate regression with around fifty control variables.
Outcome described	Education: progress in mathematics and reading results.
Results	In Capistrano, pupils in the classrooms with the most daylight progress 20% faster in mathematics and 26% faster in reading; large windows: +15% and +23%; well-designed skylights: +19 to 20%. In Seattle and Fort Collins: scores 7 to 18% higher. Statistical significance at 99%.
Web link	https://eric.ed.gov/?id=ED444337
Level of evidence	Commissioned technical report of high statistical quality, not peer-reviewed, correlational.
Gap with figures in circulation	Figures confirmed (7 to 18%; 20 and 26%). Concerns daylight and views, not vegetation.
Secondary source	Terrapin, Economics of Biophilia (2015) and 14 Patterns (2014).

Record 25 · Daylighting in schools: an investigation into the relationship between daylighting and human performance. Verifie d online, September 2026.

4.3.6. Record 26 · Michael H. Nicklas (1996)

Study title	Analysis of the performance of students in daylit schools (Student performance in daylit schools)
Author(s)	Michael H. Nicklas, Gary B. Bailey (Innovative Design, Raleigh)
Year(s)	1996
Publication	Innovative Design for Johnston County Schools (North Carolina); ERIC ED458782
Language	English
Measurement context	Three daylit schools in Johnston County compared with the artificially lit schools in the same county; California Achievement Test scores; comparison of aggregates with no socio-economic control.
Outcome described	Education: school results and attendance.

Results	Results 5 to 14% higher in the daylit schools; a 17% drop in scores for pupils temporarily placed in windowless mobile classrooms. The attendance gain of 3.2 to 3.8 days per year cited by Terrapin could not be verified in the abstract.
Web link	https://eric.ed.gov/?id=ED458782
Level of evidence	Grey report by an architecture firm that designed the schools studied (potential conflict of interest), small sample.
Gap with figures in circulation	Figures of 5 to 14% and -17% confirmed; attendance not verified.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 26 · Analysis of the performance of students in daylit schools (Student performance in daylit schools). Verified online, September 2026.

4.4. Productivity and work

The results concern absenteeism, speed of execution, memory tests and job satisfaction. A large share comes from commissioned technical reports (California) and company case studies; the associated monetary amounts are most often extrapolations by Terrapin.

4.4.1. Record 27 · Ihab M.K. Elzeyadi (2011)

Study title	Daylighting-bias and biophilia: quantifying the impact of daylighting on occupants health
Author(s)	Ihab M.K. Elzeyadi (University of Oregon)
Year(s)	2011
Publication	Greenbuild 2011 Proceedings, USGBC Press, Toronto (conference paper, no DOI)
Language	English
Measurement context	Oregon Hall, an administrative building of the University of Oregon (Eugene). 175 responding employees; mixed method: ranking of views, physical measurements of lighting and glazed area, health survey, cross-referencing with sick leave records.
Outcome described	Productivity and health at work: absenteeism.
Results	Employees with the best views take about 57 hours of sick leave per year versus 68 hours for those with no view; better daylighting: 55 versus 71 hours; the two factors combined: 53 versus 71 hours, that is, 18 hours or more than two working days. Light and view explain 6.5% of the variance in sick leave, nearly 10% with the glazed area.
Web link	https://www.usgbc.org/sites/default/files/OR10_Daylighting%20Bias%20and%20Biophilia.pdf
Level of evidence	Professional conference paper, a single building, small but significant effect; widely quoted seminal study.
Gap with figures in circulation	57 h versus 68 h and “nearly 10%” confirmed. The statement “quality of view is the primary predictor” (Terrapin, CESE, Socotec) is to be qualified: light and view carry identical weight in the model.
Secondary source	Terrapin, Economics of Biophilia (2015); CESE opinion 2018, pp. 18-19; Socotec 2019, pp. 66-67.

Record 27 · Daylighting-bias and biophilia: quantifying the impact of daylighting on occupants health. Verified online, September 2026.

4.4.2. Record 28 · Heschong Mahone Group (2003)

Study title	Windows and offices: a study of office worker performance and the indoor environment
Author(s)	Heschong Mahone Group (Lisa Heschong, Mudit Saxena, Abhijeet Pande, Puja Manglani; analyses by Roger Wright, Don Aumann)

Year(s)	2003 (data 2002-2003)
Publication	California Energy Commission, PIER, technical report P500-03-082-A-9
Language	English
Measurement context	Sacramento Municipal Utility District (California). Call centre with around a hundred operators (handling time recorded continuously) and about 200 office workers (cognitive tests at the workstation); multivariate regressions controlling for individual and physical characteristics.
Outcome described	Productivity (call handling speed) and cognition (memory, attention).
Results	Operators with the best view handle calls 6 to 12% faster than those with no view; office workers score 10 to 25% higher on tests of mental function and memory with the best view. The physical variables explain 2 to 5% of the total variance.
Web link	https://filesnewbuilding.s3.amazonaws.com/wp-content/uploads/2015/11/A-9_Windows_Offices_2.6.101.pdf
Level of evidence	Commissioned technical report (good-quality grey literature), large sample, not peer-reviewed.
Gap with figures in circulation	Terrapin uses “6 to 7%” (lower bound); the report states 6 to 12%. The cost of $1,000 against a gain of $2,990 per employee and the return on investment in four months are Terrapin calculations, not results of the report.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 28 · Windows and offices: a study of office worker performance and the indoor environment. Verified online, September 2026.

4.4.3. Record 29 · Marlon Nieuwenhuis (2014)

Study title	The relative benefits of green versus lean office space: three field experiments
Author(s)	Marlon Nieuwenhuis, Craig Knight, Tom Postmes, S. Alexander Haslam (Cardiff, Exeter, Groningen, Queensland)
Year(s)	2014
Publication	Journal of Experimental Psychology: Applied, vol. 20, no. 3, pp. 199-214 · DOI 10.1037/xap0000024
Language	English
Measurement context	Three field experiments in large offices in the United Kingdom and the Netherlands; “lean” (bare office) and “green” (plants added) conditions; experiment 2: call centre, 81 participants followed up at 2 and 14 weeks; experiment 3: 33 participants on objective tasks.
Outcome described	Productivity, perceived air quality, concentration, job satisfaction.
Results	Improved results in offices enriched with plants; on an objective task (experiment 3), simply adding plants to a bare space increases productivity by 15%.
Web link	https://doi.org/10.1037/xap0000024
Level of evidence	Peer-reviewed (APA), field experiment, modest samples; seminal study on the productivity effect of plants.
Gap with figures in circulation	This is the primary source of the “+15% productivity in a planted open-plan office” attributed by Socotec to Arseg (2015).
Secondary source	Socotec, Livre blanc immobilier durable [White paper on sustainable real estate] (2019), p. 33.

Record 29 · The relative benefits of green versus lean office space: three field experiments. Verified online, September 2026.

4.4.4. Record 30 · Andrea Dravigne (2008)

Study title	The effect of live plants and window views of green spaces on employee perceptions of job satisfaction
Author(s)	Andrea Dravigne, Tina Marie Waliczek, R. Daniel Lineberger, Jayne M. Zajicek (Texas State University, Texas A&M)
Year(s)	2008
Publication	HortScience, vol. 43, no. 1, pp. 183-187 · DOI 10.21273/HORTSCI.43.1.183
Language	English
Measurement context	Online survey of office workers in Texas and the Midwest (United States); 449 usable responses; four groups (neither plants nor window, plants only, window only, plants and window); job satisfaction and quality of life scales.
Outcome described	Quality of working life: satisfaction and perceived well-being.
Results	Significant differences ($p \leq 0.05$); highest overall score for the plants and window group; 82% of this group say they are content or very happy, versus 69% with plants only and 60% with neither plants nor window.
Web link	https://doi.org/10.21273/HORTSCI.43.1.183
Level of evidence	Peer-reviewed, self-reported, self-selection of respondents.
Gap with figures in circulation	Present in the Terrapin bibliography (2015) without a figure; figures added.
Secondary source	Terrapin, Economics of Biophilia (2015), bibliography.

Record 30 · The effect of live plants and window views of green spaces on employee perceptions of job satisfaction. Verified online, September 2026.

4.4.5. Record 31 · Joseph J. Romm (1994)

Study title	Greening the building and the bottom line: increasing productivity through energy-efficient design
Author(s)	Joseph J. Romm (U.S. Department of Energy), William D. Browning (Rocky Mountain Institute)
Year(s)	1994
Publication	Rocky Mountain Institute, Snowmass (Colorado); short version in ACEEE Summer Study 1994
Language	English
Measurement context	Collection of eight company case studies (Lockheed, West Bend Mutual, Boeing, NMB/ING Bank headquarters in Amsterdam, etc.) based on reported internal data, with no experimental protocol.
Outcome described	Productivity and absenteeism; energy savings.
Results	ING/NMB headquarters, Amsterdam (daylight, vegetation, water): absenteeism 15% lower than in the former building, and sustained; energy savings estimated at $2.6 million per year for an additional cost of about $700,000. Lockheed: productivity +15%, absenteeism -15%.
Web link	https://www.aceee.org/files/proceedings/1994/data/papers/SS94_Panel9_Paper30.pdf
Level of evidence	Grey report, self-reported case studies, no peer review: to be cited as an illustration.
Gap with figures in circulation	The $2.6 million cited by Terrapin corresponds to energy savings, not to absenteeism.
Secondary source	Terrapin, Economics of Biophilia (2015) and 14 Patterns (2014).

Record 31 · Greening the building and the bottom line: increasing productivity through energy-efficient design. Verified online, September 2026.

4.5. Social behaviour and safety

Two sister studies conducted in Chicago's public housing link the vegetation around the buildings to aggression, violence and crime, with mediation by attentional fatigue.

4.5.1. Record 32 · Frances E. Kuo (2001)

Study title	Aggression and violence in the inner city: effects of environment via mental fatigue
Author(s)	Frances E. Kuo, William C. Sullivan (University of Illinois)
Year(s)	2001
Publication	Environment and Behavior, vol. 33, no. 4, pp. 543-571 · DOI 10.1177/00139160121973124
Language	English
Measurement context	Robert Taylor Homes, Chicago. 145 female public housing residents randomly assigned to more or less greened buildings; aggression measured with the Conflict Tactics Scale, attention with the backward digit span.
Outcome described	Mental health and behaviour: aggression, partner violence, attentional fatigue.
Results	The women living in the barren buildings report more aggression and violence than those in the green buildings; mean differences of one third to one half of a standard deviation (psychological aggression 1.47 versus 1.00; severe violence 0.48 versus 0.31); higher attention (5.0 versus 4.6); the nature-aggression relationship is fully mediated by attentional functioning.
Web link	https://doi.org/10.1177/00139160121973124
Level of evidence	Peer-reviewed seminal study, quasi-experimental, self-reported measures.
Gap with figures in circulation	The “-25% domestic violence” cited by Terrapin is not worded in this way by the authors; retain the mean differences and the mediation by attention.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 32 · Aggression and violence in the inner city: effects of environment via mental fatigue. Verified online, September 2026.

4.5.2. Record 33 · Frances E. Kuo (2001)

Study title	Environment and crime in the inner city: does vegetation reduce crime?
Author(s)	Frances E. Kuo, William C. Sullivan (University of Illinois)
Year(s)	2001 (police reports over two years)
Publication	Environment and Behavior, vol. 33, no. 3, pp. 343-367 · DOI 10.1177/0013916501333002
Language	English
Measurement context	Ida B. Wells, Chicago public housing. 98 buildings with more or less greened surroundings; objective police data, controlling for the number of apartments, height and vacancy.
Outcome described	Safety and quality of life: property crimes and violent crimes.
Results	The greener the surroundings, the fewer crimes are reported: 52% fewer crimes in total between the most and the least greened buildings (48% for property crimes, 56% for violent crimes); vegetation explains 7 to 8% of the variance in the number of crimes.
Web link	https://doi.org/10.1177/0013916501333002
Level of evidence	Peer-reviewed seminal study, objective data, correlational, a single site.
Gap with figures in circulation	Figures confirmed; the -52% compares the extremes. The extrapolation to $1.7 billion for New York is specific to Terrapin.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 33 · Environment and crime in the inner city: does vegetation reduce crime?. Verified online, September 2026.

4.6. Economic and property value

These studies translate the presence of nature into turnover, rents, market value and avoided health expenditure. They call for a cautious reading: several widely circulated figures (sales +40%, prices +20 to 25%) do not correspond to the original publications.

4.6.1. Record 34 · Heschong Mahone Group (2003)

Study title	Daylight and retail sales
Author(s)	Heschong Mahone Group (led by Lisa Heschong; Ramona Peet, Roger Wright, Don Aumann)
Year(s)	2003 (sales 1999-2001); earlier study Skylighting and Retail Sales, 1999
Publication	California Energy Commission, PIER, technical report P500-03-082-A-5
Language	English
Measurement context	73 stores of a Californian chain, 24 of them daylit by skylights; multivariate regression with more than 50 control variables (floor area, age, parking, demographics, competition).
Outcome described	Economics: retail turnover.
Results	Average effect of daylight on sales of 0 to 6% depending on the model and the period (1 to 6% as a chain average), effect per store of +2 to +37%, maximum effect of about 40% in the most favourable stores. The 1999 study (another chain, 108 stores) had measured sales 40% higher (range 31 to 49%, 99% significance).
Web link	https://filesnewbuilding.s3.amazonaws.com/wp-content/uploads/2015/11/A-5_Daylgt_Retail_2.3.71.pdf
Level of evidence	Commissioned technical report, robust statistical analysis, not peer-reviewed.
Gap with figures in circulation	To be corrected: the “+40%” taken up by Terrapin belongs to the 1999 study; the 2003 study gives 0 to 6% on average. The “per square metre” values in the French edition appear to be unconverted per-square-foot values.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 34 · Daylight and retail sales. Verified online, September 2026.

4.6.2. Record 35 · Kathleen L. Wolf (2005)

Study title	Trees in the small city retail business district: comparing resident and visitor perceptions
Author(s)	Kathleen L. Wolf (University of Washington)
Year(s)	2005
Publication	Journal of Forestry, vol. 103, no. 8, pp. 390-395 · DOI 10.1093/jof/103.8.390 (companion article pp. 396-400)
Language	English
Measurement context	National mail survey (United States) of residents and visitors of small cities of 10,000 to 20,000 inhabitants; images of shopping streets with or without trees; stated preferences (visual quality, intention to visit, acceptable prices).
Outcome described	Economics: consumer behaviour and willingness to pay.
Results	Consumers state that they would accept paying 9% more in small cities and 12% more in large cities for goods and services sold in shopping streets with a quality tree canopy (“amenity margin”). The comparable study on out-of-town retail areas (Wolf 2009, Arboriculture & Urban Forestry) gives a premium of 8.8%.
Web link	https://doi.org/10.1093/jof/103.8.390
Level of evidence	Peer-reviewed, stated preferences, low response rates; a single author for this body of literature.

Gap with figures in circulation	Terrapin's “+20% / +25% / +15%” trio was not found in the 2005 articles; retain 9 to 12%.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 35 · Trees in the small city retail business district: comparing resident and visitor perceptions. Verified online, September 2026.

4.6.3. Record 36 · Robert J. Laverne (2003)

Study title	The influence of trees and landscaping on rental rates at office buildings
Author(s)	Robert J. Laverne, Kimberly Winson-Geideman
Year(s)	2003
Publication	Journal of Arboriculture, vol. 29, no. 5, pp. 281-290 · DOI 10.48044/jauf.2003.032
Language	English
Measurement context	Cleveland metropolitan area (Ohio). 85 office buildings, 270 leases; hedonic regression of rents per square foot (structural, lease, location and landscape variables).
Outcome described	Commercial property value: office rents.
Results	High-quality aesthetic landscaping adds about 7% to the average rent; shading of the building by large trees about 7%; conversely, a vegetation screen hiding the building reduces the rent by about 7.5%.
Web link	https://doi.org/10.48044/jauf.2003.032
Level of evidence	Peer-reviewed (International Society of Arboriculture).
Gap with figures in circulation	Terrapin's +7% is confirmed; the negative effect of the vegetation screen must be mentioned.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 36 · The influence of trees and landscaping on rental rates at office buildings. Verified online, September 2026.

4.6.4. Record 37 · Earl D. Benson (1998)

Study title	Pricing residential amenities: the value of a view
Author(s)	Earl D. Benson, Julia L. Hansen, Arthur L. Schwartz Jr., Greg T. Smersh
Year(s)	1998 (transactions 1984-1994)
Publication	Journal of Real Estate Finance and Economics, vol. 16, no. 1, pp. 55-73 · DOI 10.1023/A:1007785315925
Language	English
Measurement context	Bellingham (Washington State). 7,305 single-family home transactions; hedonic model with a test of functional form.
Outcome described	Residential property value: premium for a view of water, a lake or the mountains.
Results	Year 1993: full ocean view +58.8%, superior partial view +30.8%, poor view +8.2%; lakefront +126.7%, lake view +18.1%; mountain view +8.9% (not significant). The view premium decreases with distance from the water (68% at 0.1 mile, 31% at 2 miles).
Web link	https://doi.org/10.1023/A:1007785315925
Level of evidence	Peer-reviewed.
Gap with figures in circulation	Orders of magnitude consistent with Terrapin; these are views of water (landscape amenity), not urban green spaces.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 37 · Pricing residential amenities: the value of a view. Verified online, September 2026.

4.6.5. Record 38 · Peter Harnik (2009)

Study title	Measuring the economic value of a city park system
Author(s)	Peter Harnik, Ben Welle (with Linda S. Keenan), The Trust for Public Land
Year(s)	2009 (2007 data)
Publication	The Trust for Public Land, Center for City Park Excellence, Washington
Language	English
Measurement context	American cities (Washington, Sacramento, Philadelphia, etc.). Valuation framework with seven attributes (property value, tourism, direct use, health, social cohesion, water, air) based on GIS, surveys and Forest Service calculators.
Outcome described	Economic value of parks: property value uplift, health savings, social cohesion.
Results	Washington: conservative value of 5% added to the value of properties near parks ($6.95 million in annual tax revenue); Sacramento: $19.87 million in health expenditure savings in 2007 thanks to physical activity in parks ($250 per active adult under 65, $500 beyond that); Philadelphia: community cohesion value of $8.6 million.
Web link	https://www.tpl.org/wp-content/uploads/2014/03/ccpe-econvalueparks-rpt.pdf
Level of evidence	Grey report from an NGO, explicit method, not peer-reviewed.
Gap with figures in circulation	Figures confirmed; the 5% is a conservative assumption made by the authors, not a hedonic measurement.
Secondary source	Terrapin, Economics of Biophilia (2015).

Record 38 · Measuring the economic value of a city park system. Verified online, September 2026.

4.6.6. Record 39 · Asterès consultancy (2016)

Study title	Les espaces verts urbains : lieux de santé publique, vecteurs d'activité économique [Urban green spaces: places of public health, drivers of economic activity]
Author(s)	Asterès consultancy (led by Nicolas Bouzou), study commissioned by the Union nationale des entreprises du paysage (UNEP)
Year(s)	2016 (published on 24 May 2016)
Publication	UNEP / Asterès report (no DOI)
Language	French
Measurement context	France. Economic modelling based on the international epidemiological literature; scenario of a 10% increase in the area of urban green spaces.
Outcome described	Public health and national health insurance (Assurance maladie) expenditure; economic activity of the landscape sector.
Results	A 10% increase in green spaces would enable the national health insurance (Assurance maladie) to save €56 million per year through a reduction in the prevalence of asthma and €38 million per year through a reduction in hypertension, that is €94 million per year; a 10% increase in green spaces is associated with a reduction in reported symptoms equivalent to being five years younger.
Web link	https://www.actu-environnement.com/media/pdf/news-26850-espaces-verts-nicolas-bouzou.pdf
Level of evidence	Grey report commissioned by a trade organisation; extrapolation from foreign studies: to be presented as modelling.
Gap with figures in circulation	Figures consistent with the CESE opinion 2018 (statement by the UNAF group, p. 69). The only French source with figures in the corpus.
Secondary source	CESE opinion 2018, La nature en ville [Urban nature], p. 69.

Record 39 · Les espaces verts urbains : lieux de santé publique, vecteurs d'activité économique [Urban green spaces: places of public health, drivers of economic activity]. Verified online, September 2026.

4.6.7. Record 40 · Ibrahim Ahamada (2007)

Study title	Prix des logements et autocorrélation spatiale : une approche semi-paramétrique [Housing prices and spatial autocorrelation: a semi-parametric approach]
Author(s)	Ibrahim Ahamada, Emmanuel Flachaire, Marion Lubat
Year(s)	2007
Publication	Économie publique / Public economics, no. 20 (2007/1), pp. 131-145
Language	French
Measurement context	Hedonic model of housing prices with spatial autocorrelation (parametric then semi-parametric approach) on Paris data.
Outcome described	Residential property value: effect of proximity to a green space.
Results	According to the CESE opinion 2018 (note 28): “a flat in the immediate vicinity of an urban green space is worth 17% more than the dwelling located one hundred metres further away”. The figure could not be re-read in the online article (restricted access); it is retained subject to verification against the full text.
Web link	https://journals.openedition.org/economiepublique/7312
Level of evidence	Peer-reviewed article, primarily methodological in purpose.
Gap with figures in circulation	Not verified online; cite the CESE as the intermediate source until the article has been re-read.
Secondary source	CESE opinion 2018, La nature en ville [Urban nature], pp. 19 and 63.

Record 40 · Prix des logements et autocorrélation spatiale : une approche semi-paramétrique [Housing prices and spatial autocorrelation: a semi-parametric approach]. Verified online, September 2026.

4.7. Supplementary references from the Busan Housing Forum presentation (October 2026)

The presentation given at the Busan Housing Forum on 28 October 2026 drew, in its preparatory work, on fourteen additional references. They are analysed here in the same format, distinguishing peer-reviewed scientific studies, summary reports and site or market data.

4.7.1. Record 41 · Kaida Chen (2022)

Study title	Review of the impact of urban parks and green spaces on residence prices in the environmental health context
Author(s)	Kaida Chen, Huimin Lin, Shuying You, Yan Han
Year(s)	2022 (review of about 59 studies published from 1990 to 2021)
Publication	Frontiers in Public Health, vol. 10, article 993801 · DOI 10.3389/fpubh.2022.993801
Language	English
Measurement context	Narrative review of the literature (non-systematic, without meta-analysis) on the capitalisation of parks and green spaces into housing prices: methods (hedonic pricing, geographically weighted regression), variability of effects according to the type, size and accessibility of the spaces.
Outcome described	Residential property value: price premium linked to proximity to, or a view of, a green space.
Results	The review draws on primary studies: “urban green space within 100 m of a flat raises the cost of a home by 3.4-4.6%” (Trojanek et al.), “a community park has a 16.88% price increase potential” (Jim and Chen), “the park increases the property values in the area by 20%” (Crompton), “parklands can have a 0.5-14.1% value-added effect” (Zhang et al.).

Web link	https://doi.org/10.3389/fpubh.2022.993801
Level of evidence	Peer-reviewed narrative review, with no weighting of the studies: low to moderate level; the evidential value lies in the primary studies (following records).
Gap with figures in circulation	The three figures from the review are faithfully reproduced in the preparatory work for the Busan presentation. The “about +20%” comes from Crompton (order of magnitude of the “proximate principle”, not a measurement) and the review is not a systematic review.
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 41 · Review of the impact of urban parks and green spaces on residence prices in the environmental health context. Verified online, September 2026.

4.7.2. Record 42 · Radosław Trojanek (2018)

Study title	The effect of urban green spaces on house prices in Warsaw
Author(s)	Radosław Trojanek, Michał Głuszak, Justyna Tanaś
Year(s)	2018 (transactions 2010-2015)
Publication	International Journal of Strategic Property Management, vol. 22, no. 5, pp. 358-371 · DOI 10.3846/ijspm.2018.5220
Language	English
Measurement context	Warsaw (Poland). 43,075 geocoded apartment transactions; hedonic models (ordinary and weighted least squares, quantile regression).
Outcome described	Property value: effect of the presence of a park or forest within 100 m of the home.
Results	“On an average presence of a green area within 100 meters from an apartment increases the price of a dwelling by 2,8% to 3,1%”; for new buildings (built after 1989): “close vicinity (less than 100 m distance) to an urban green increased the sales prices of apartments by 8,0-8,6%, depending on a model”.
Web link	https://doi.org/10.3846/ijspm.2018.5220
Level of evidence	Peer-reviewed, large sample, multiple models; a single market.
Gap with figures in circulation	The figure “+3.4 to +4.6% within 100 m” circulates on the basis of the Frontiers review; the abstract of the primary study gives +2.8 to +3.1% on average and +8.0 to +8.6% for new buildings. Retain the primary source.
Secondary source	Preparatory work for the Busan presentation (via Chen et al. 2022).

Record 42 · The effect of urban green spaces on house prices in Warsaw. Verified online, September 2026.

4.7.3. Record 43 · C.Y. Jim (2010)

Study title	External effects of neighbourhood parks and landscape elements on high-rise residential value
Author(s)	C.Y. Jim, Wendy Y. Chen (University of Hong Kong)
Year(s)	2010
Publication	Land Use Policy, vol. 27, no. 2, pp. 662-670 · DOI 10.1016/j.landusepol.2009.08.027
Language	English
Measurement context	Hong Kong, a district of private high-rise housing. 1,471 transactions; hedonic model including availability and view of neighbourhood parks, and view of the harbour, the mountain and the street.
Outcome described	Property value in dense high-rise housing: premium linked to neighbourhood parks.
Results	“Neighbourhood parks could lift price by 16.88%, including 14.93% for availability and 1.95% for view”; harbour view +5.1%; the mountain view is not valued. The authors stress that the scarcity of parks in an ultra-dense city amplifies the premium.

Web link	https://doi.org/10.1016/j.landusepol.2009.08.027
Level of evidence	Peer-reviewed, one district, very specific context: moderate level.
Gap with figures in circulation	Figure in circulation (+16.9%) confirmed; specify “neighbourhood park” and date it 2010. The most relevant reference for a Korean audience (high-rise multi-unit housing).
Secondary source	Preparatory work for the Busan presentation (via Chen et al. 2022).

Record 43 · External effects of neighbourhood parks and landscape elements on high-rise residential value. Verified online, September 2026.

4.7.4. Record 44 · Diana E. Bowler (2010)

Study title	Urban greening to cool towns and cities: a systematic review of the empirical evidence
Author(s)	Diana E. Bowler, Lisette Buyung-Ali, Teri M. Knight, Andrew S. Pullin (Bangor University)
Year(s)	2010 (primary studies prior to 2009)
Publication	Landscape and Urban Planning, vol. 97, no. 3, pp. 147-155 · DOI 10.1016/j.landurbplan.2010.05.006
Language	English
Measurement context	Systematic review (Collaboration for Environmental Evidence protocol) of 47 empirical studies of air temperature; meta-analysis of 16 studies (26 effect sizes) by day and 7 studies (12 effect sizes) by night.
Outcome described	Thermal comfort and health: difference in air temperature between an urban park and the built-up fabric.
Results	“On average, a park was 0.94 °C cooler in the day”; mean night-time effect of 1.15 °C; parks larger than 3 ha and parks with trees are cooler; the temperature under trees is lower than in open areas, with no aggregate value published.
Web link	https://doi.org/10.1016/j.landurbplan.2010.05.006
Level of evidence	Systematic review with meta-analysis: high level for the order of magnitude; observational data, effect at city scale not demonstrated.
Gap with figures in circulation	The -0.94 °C is confirmed; the “-0.8 °C” and the “more than -1.5 °C under dense tree canopy”, sometimes cited with it, do not appear in Bowler and must be sourced elsewhere or removed. Add the night-time effect (-1.15 °C), which is more relevant to health during heatwaves.
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 44 · Urban greening to cool towns and cities: a systematic review of the empirical evidence. Verified online, September 2026.

4.7.5. Record 45 · G. Darrel Jenerette (2023)

Study title	A global synthesis of reported urban tree carbon production rates and approaches
Author(s)	G. Darrel Jenerette, Dustin L. Herrmann (University of California, Riverside)
Year(s)	2023 (online December 2023; corpus up to July 2021)
Publication	Frontiers in Ecology and Evolution, vol. 11, article 1244418 · DOI 10.3389/fevo.2023.1244418
Language	English
Measurement context	Global quantitative synthesis: 128 articles, 277 estimates, 154 cities; values converted into tonnes of carbon per hectare per year; acknowledged bias towards temperate biomes and North America.
Outcome described	Climate service of urban trees: carbon sequestration and storage (not a direct human benefit).

Results	Reported productivity from less than 0.1 to nearly 10 t C/ha/yr; mean of 1.1 t C/ha/yr in the urban fabric and 3.0 t C/ha/yr in urban woodland; median storage of 25.7 t C/ha. Conversion to CO2 (x 3.67): about 4 to 11 t CO2/ha/yr and 94 t CO2/ha stored. The authors conclude that the contribution to reducing atmospheric CO2 is limited at current emission rates.
Web link	https://doi.org/10.3389/fevo.2023.1244418
Level of evidence	Peer-reviewed global synthesis, strong methodological heterogeneity.
Gap with figures in circulation	Figures in circulation (4 to 11 t CO2/ha/yr; 94 t CO2/ha) confirmed after carbon-CO2 conversion; specify that 4 t corresponds to the ordinary urban fabric and 11 t to woodland, and mention the authors' cautious conclusion.
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 45 · A global synthesis of reported urban tree carbon production rates and approaches. Verified online, September 2026.

4.7.6. Record 46 · Omid Kardan (2015)

Study title	Neighborhood greenspace and health in a large urban center
Author(s)	Omid Kardan, Peter Gozdyra, Bratislav Mišić, Faisal Moola, Lyle J. Palmer, Tomáš Paus, Marc G. Berman
Year(s)	2015 (data 2010-2013)
Publication	Scientific Reports, vol. 5, article 11610 · DOI 10.1038/srep11610
Language	English
Measurement context	Toronto (Canada). 31,109 respondents to the Ontario Health Study; tree density (street tree inventory and remote sensing of the tree canopy) by dissemination area; multiple regressions and canonical correlations controlling for income, age and education. Cross-sectional study.
Outcome described	Self-rated health and prevalence of cardio-metabolic conditions according to street tree density.
Results	“Having 10 more trees in a city block, on average, improves health perception in ways comparable to an increase in annual personal income of $10,000 and moving to a neighborhood with $10,000 higher median income or being 7 years younger”; “having 11 more trees in a city block, on average, decreases cardio-metabolic conditions in ways comparable to an increase in annual personal income of $20,000 […] or being 1.4 years younger”; ten additional trees represent about 4% of street tree density.
Web link	https://doi.org/10.1038/srep11610
Level of evidence	Large sample, peer-reviewed, but cross-sectional and self-reported health: associations, not causation.
Gap with figures in circulation	The figure “+$10,200” is in circulation; the article gives $10,000 (Canadian dollars). Specify “street trees” and “comparable to” (statistical equivalence). Add the cardio-metabolic result (+11 trees, $20,000, 1.4 years).
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 46 · Neighborhood greenspace and health in a large urban center. Verified online, September 2026.

4.7.7. Record 47 · World Green Building Council (2014)

Study title	Health, Wellbeing & Productivity in Offices: the next chapter for green building
Author(s)	World Green Building Council (collective report, more than 50 contributors; sponsors JLL, Lend Lease, Skanska)
Year(s)	2014 (September)
Publication	World Green Building Council, report (no DOI)
Language	English

Measurement context	Narrative literature review and framework of indicators for companies; no measurement of its own.
Outcome described	Structure of a company's operating costs and effects of office quality (air, thermal comfort, light, noise, biophilia) on productivity.
Results	“Staff costs, including salaries and benefits, typically account for about 90% of business operating costs”; diagram o staff, 9% rent, 1% energy, attributed to Browning (Terrapin, Economics of Biophilia, 2012); productivity gains of 8 to 11 with better air quality; decision-making impaired by 11 to 23% at 1,000 ppm of CO2; 46 minutes more sleep per night employees near windows (Cheung 2013).
Web link	https://worldgbc.org/wp-content/uploads/2022/03/compressed_WorldGBC_Health_Wellbeing__Productivity_Full_Report_Dbl_Med_Res_Feb_1.pdf
Level of evidence	Sector advocacy report: low to moderate level; heterogeneous figures taken from secondary sources.
Gap with figures in circulation	The 90 / 9 / 1 rule is confirmed (secondary source Terrapin 2012). However, “productivity +18% with daylight”, “sales +40%” and “cognition +10 to +25%”, often attributed to this report, do not appear in it: the 18% corresponds to the sc scores of Heschong Mahone 1999, the 15 to 40% to the sales of Heschong Mahone 1999 (brought down to 0 to 6% in 2 and the 10 to 25% to the office tests of Heschong Mahone 2003. To be reattributed.
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 47 · Health, Wellbeing & Productivity in Offices: the next chapter for green building. Verified online, September 2026 .

4.7.8. Record 48 · Greg Kats (2003)

Study title	The Costs and Financial Benefits of Green Buildings: a report to California's Sustainable Building Task Force
Author(s)	Greg Kats (Capital E), with Leon Alevantis, Adam Berman, Evan Mills (LBNL), Jeff Perlman
Year(s)	2003 (October; buildings completed 1995-2004)
Publication	California Sustainable Building Task Force, report (no DOI)
Language	English
Measurement context	United States. Cost premium established on 33 LEED-certified projects (25 offices, 8 schools); benefits modelled as net present value over 20 years (5% real rate) per square foot; productivity and health gains estimated from assumptions applied to payroll.
Outcome described	Financial balance of a certified building compared with a conventional building, including the productivity and health share.
Results	Per square foot over 20 years: energy $5.79, emissions $1.18, water $0.51, operations and commissioning $8.47, productivity and health $36.89 (Certified and Silver levels) or $55.33 (Gold and Platinum); net total $48.87 to $67.31 after an average green cost premium of about 2% ($3 to $5 per square foot); “an upfront investment of less than two percent of construction costs yields life cycle savings of over ten times the initial investment”.
Web link	https://archive.epa.gov/region09/waste/archive/web/pdf/docs1992.pdf
Level of evidence	Commissioned report, limited sample, productivity and health benefits derived from assumptions: low to moderate level, widely cited but dated.
Gap with figures in circulation	Components confirmed (36.90 to 55.30; 5.80; 8.50; 0.50); the total “$50 to $65”, often cited, is approximate ($48.87 to $67.31 net); not to be confused with the report Greening America's Schools (Kats 2006).
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 48 · The Costs and Financial Benefits of Green Buildings: a report to California's Sustainable Building Task Force. Verified online, September 2026.

4.7.9. Record 49 · Agence régionale de la biodiversité en Île-de-France (Data)

Study title	Écologie des toitures végétalisées : synthèse de l'étude GROOVES (Green ROOfs Verified Ecosystem Services) [Ecology of green roofs: summary of the GROOVES study]; derived article: Origins and drivers of roof plant assemblages: designing green roofs for biodiversity conservation
Author(s)	Agence régionale de la biodiversité en Île-de-France (Marc Barra, Hemminki Johan) with iEES Paris, MNHN, INRAE, Cerema, Opie, ODBU 93, Adivet; article: Audrey Muratet, Marc Barra, Laurent Hardion, François Chiron
Year(s)	Data 2017-2019; summary May 2021; article 2024
Publication	ARB îdF / L'Institut Paris Region (summary); Urban Forestry & Urban Greening, 2024 · DOI 10.1016/j.ufug.2024.128247
Language	French (summary) and English (article)
Measurement context	36 green roofs in Paris and its inner suburbs (extensive, semi-intensive, intensive); inventories of vascular flora, arthropods including pollinators, bryophytes, mycorrhizae and soil bacteria; measurements of water retention and cooling; comparison with open-ground green spaces.
Outcome described	Biodiversity hosted by the roofs and design factors (ecological data, not a direct human benefit).
Results	More than 400 plant species observed on the 36 roofs, including 292 in the plots, 70% spontaneous; 611 invertebrate species; substrate from 3 cm to more than one metre; water retention from 6 l/m^2 (3.5 cm) to 532 l/m^2 (100 cm); the roofs host on average fewer pollinators than open ground, except semi-intensive and intensive roofs; substrate design is the first factor of floristic richness (threshold of about 12.6 cm), surface area having no effect.
Web link	https://www.arb-idf.fr/nos-travaux/publications/ecologie-des-toitures-vegetalisees-2021/ · https://doi.org/10.1016/j.ufug.2024.128247
Level of evidence	Institutional field study supplemented by a peer-reviewed article.
Gap with figures in circulation	Figures in circulation confirmed (36 roofs, 400 plant species, 292 vascular, 70% spontaneous, 611 animal species to be specified as “invertebrates”). Plante & Cité does not appear among the partners; “native species” and “strata” are not formulated as factors in the sources.
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 49 · Écologie des toitures végétalisées : synthèse de l'étude GROOVES (Green ROOfs Verified Ecosystem Services) [Ecology of green roofs: summary of the GROOVES study]; derived article: Origins and drivers of roof plant assemblages: designing green roofs for biodiversity conservation. Verified online, September 2026.

4.7.10. Record 50 · Union nationale des entreprises du paysage (2013)

Study title	Jardins et espaces verts : l'exception culturelle française ? [Gardens and green spaces: the French cultural exception?] (Unep-Ipsos survey)
Author(s)	Union nationale des entreprises du paysage (Unep) with Ipsos
Year(s)	2013 (fieldwork from 11 to 18 January 2013)
Publication	Unep press kit; relayed by Batiactu and Maison à part (no DOI)
Language	French
Measurement context	Nationally representative samples of about 1,000 people aged 16 and over in Great Britain, Spain and Germany, compared with earlier French Unep-Ipsos data.
Outcome described	Self-reported quality of life: importance of proximity to a green space when choosing a home.

Results	"More than 70% of Europeans consider this criterion very important when choosing a home"; taken up by the CESE (2018, p. 18): "a key criterion for seven out of ten Europeans, who consider their proximity important or very important when choosing where to live".
Web link	https://www.batiactu.com/edito/francais-profitent-plus-leur-jardin-que-leurs-voisins-34834.php
Level of evidence	Opinion survey commissioned by a professional organisation.
Gap with figures in circulation	The "7 out of 10 Europeans" is confirmed in its order of magnitude; the accurate wording concerns the importance of the criterion, not the fact of "choosing one's home for"; scope: three European countries plus France, not the whole of Europe. Source document not consulted.
Secondary source	Preparatory work for the Busan presentation; CESE opinion 2018, p. 18.

Record 50 · Jardins et espaces verts : l'exception culturelle française ? [Gardens and green spaces: the French cultural exception?] (Unep-Ipsos survey). Verified online, September 2026.

4.7.11. Record 51 · City of Paris (2021)

Study title	Îlot de chaleur urbain parisien : L'adaptation aux vagues de chaleur à Paris [The Paris urban heat island: adapting to heatwaves in Paris] (City of Paris, based on Météo-France, APUR and the EPICEA project); measurements from the Evergreen campus
Author(s)	City of Paris, APUR, Météo-France; ARP-Astrance and Crédit Agricole Immobilier for the Evergreen campus (Montrouge)
Year(s)	2021 (City of Paris report); BiodiverCity Life label for the Evergreen campus in January 2020
Publication	City of Paris institutional report (no DOI); Crédit Agricole press release (June 2020); REX sheet no. 8, Biodiversity Impulsion Group / OID (November 2023)
Language	French
Measurement context	Measurements and modelling of the urban heat island in Paris (Météo-France network, EPICEA project); Evergreen campus: 8 ha including 16,300 m^2 of green spaces, 170,000 m^2 of offices, ecological inventories in 2020 and 2023.
Outcome described	Heat exposure: temperature difference between dense Paris, its woods and the surrounding countryside.
Results	City of Paris 2021: heat island "of the order of 2.5 °C compared with the surrounding rural areas"; the Bois de Boulogne and the Bois de Vincennes "2 °C to 4 °C" cooler than the neighbouring arrondissements; up to nearly 8 °C of difference during the 2003 heatwave. Evergreen campus: 73 species of spontaneous flora and 12 bird species (2020), more than 90 plant species, 18 birds, 9 butterflies and 2 bats (2023); no temperature measurement published.
Web link	https://cdn.paris.fr/paris/2021/05/12/92b8f55c368b25f126cd870d2343210b.pdf · https://biodiversity-impulsion-group.fr/wp-content/uploads/2023/11/231120-REX8-Campus-Evergreen-_CA-Immobilier.pdf
Level of evidence	Institutional report based on measurements (urban heat island); corporate communication and feedback report (Evergreen).
Gap with figures in circulation	The "+2 °C in Paris minimum temperatures compared with the neighbouring woods" attributed to "ARP-Astrance, Evergreen Campus, 2018" was not found; it is consistent with the APUR and Météo-France orders of magnitude. Reattribute to the City of Paris / APUR or present as unpublished internal data; date the Evergreen label to 2020.
Secondary source	Preparatory work for the Busan Housing Forum presentation, October 2026.

Record 51 · Îlot de chaleur urbain parisien : L'adaptation aux vagues de chaleur à Paris [The Paris urban heat island: adapting to heatwaves in Paris] (City of Paris, based on Météo-France, APUR and the EPICEA project); measurements from the Evergreen campus. Verified online, September 2026.

4.7.12. Record 52 · IBPC (Challenger)

Study title	Data from BiodiverCity-labelled sites published by the IBPC: Challenger (Bouygues Construction, Guyancourt), Cap 3000 (Altarea, Saint-Laurent-du-Var), Bolloré Logistics Nantes
Author(s)	IBPC (project sheets); Bouygues Construction; Altarea Cogedim; Bolloré (CSR report 2015)
Year(s)	Challenger: label 2014-2015, Biotope inventory 2013; Cap 3000: label March 2018; Bolloré Nantes: label 2015 (Performant level)
Publication	cibi-biodivercity.com website (project sheets); Bolloré corporate social responsibility report 2015 (no DOI)
Language	French and English
Measurement context	Challenger: 36 ha headquarters including 24 ha of landscaped park, 18 beehives; Cap 3000: first labelled shopping centre, 17,760 m^2 of gardens; Bolloré Logistics Nantes-Saint-Aignan-de-Grandlieu: 2,652 m^2 of offices resulting from a 2013 competition.
Outcome described	Site data: species richness, soil unsealing, occupant satisfaction.
Results	Challenger: 139 plant species and 50 bird species (IBPC sheet). Cap 3000: 4,282 m^2 unsealed, 4,450 m^2 of green roofs, 1,238 m^2 of accessible roof gardens (IBPC sheet). Bolloré Nantes: BiodiverCity label at Performant level confirmed by the 2015 CSR report; the employee survey (overall quality 97%, functionality 93%, visual atmosphere 91%, acoustic comfort 88%) was not found in public sources.
Web link	https://cibi-biodivercity.com/projet/challenger/ · http://cibi-biodivercity.com/en/projet/cap-3000/ · https://www.bollore.com/wp-content/uploads/2018/01/1603122_bollore_rse_2015.compressed_mel_2__24_05_16.pdf
Level of evidence	Self-reported site data (label sheets, CSR report); the employee survey comes from an internal document yet to be identified.
Gap with figures in circulation	Challenger and Cap 3000 confirmed; Bolloré Nantes employee survey not verified online: to be sourced from the labelling file before any reuse.
Secondary source	IBPC project sheets; preparatory work for the Busan presentation.

Record 52 · Data from BiodiverCity-labelled sites published by the IBPC: Challenger (Bouygues Construction, Guyancourt), Cap 3000 (Altarea, Saint-Laurent-du-Var), Bolloré Logistics Nantes. Verified online, September 2026.

4.7.13. Record 53 · IBPC; Batiactu; Le Moniteur; Business Immo; UPGE (2017)

Study title	Spread of the BiodiverCity label: labelled projects, committed projects, members (Batiactu 2020; IBPC ten-year review 2023; UPGE overview 2022; IBPC website)
Author(s)	IBPC; Batiactu; Le Moniteur; Business Immo; UPGE
Year(s)	2017 to 2023 (no public source for 2024-2026 with quantified results)
Publication	Trade press and institutional communication (no DOI)
Language	French
Measurement context	Self-reported counts from the association: labelled projects, committed projects, members, assessors, countries.
Outcome described	Trajectory of the label's spread (market data, not a scientific result).
Results	24 labelled projects at the end of 2017 (Business Immo); 50 in March 2018; 67 in June 2020 (Batiactu) and 200 operations assessed since the end of 2013 (Le Moniteur, December 2020); March 2022: Construction 131 labelled out of 318 committed, Ready 2 out of 17, Life 3 out of 10, about 120 assessors, projects in Italy, Switzerland, Poland, Singapore, Cuba and East Timor (UPGE); November 2023: more than 250 labelled projects out of 500 submitted, 90 members, scientific council of 10 members (IBPC).

Web link	https://www.batiactu.com/edito/biodivercity-un-label-59703.php · https://cibi10ans.wordpress.com/ · https://www.genie-ecologique.fr/wp-content/uploads/2022/11/UPGE_Panorama-Labels-biodiversite_immobilier_V22.04.25.pdf
Level of evidence	Institutional communication and trade press.
Gap with figures in circulation	Confirmed online: 67 (2020), more than 250 out of about 500 (2023), 90 members, scientific council of 10 experts. The more recent counts (labelled and committed projects, municipalities, operations, presence outside France) have not been verified online: take them from an IBPC document.
Secondary source	IBPC communication; trade press.

Record 53 · Spread of the BiodiverCity label: labelled projects, committed projects, members (Batiactu 2020; IBPC ten-year review 2023; UPGE overview 2022; IBPC website). Verified online, September 2026.

4.7.14. Record 54 · Terrapin Bright Green (2012)

Study title	The Economics of Biophilia: why designing with nature in mind makes financial sense (first edition)
Author(s)	Terrapin Bright Green (Bill Browning, Chris Garvin, Bob Fox, Rick Cook and team; reviewed by Judith Heerwagen, Vivian Loftness, Susan Painter)
Year(s)	2012 (12 June); French translation 2015; second edition 2023
Publication	Terrapin Bright Green, New York, report (no DOI)
Language	English (French translation 2015)
Measurement context	Literature review (Ulrich 1984, Elzeyadi 2011, Heschong Mahone Group 1999-2003, Kuo and Sullivan 2001, Wolf 2005) and economic modelling (absenteeism, hospital stays, sales, school results).
Outcome described	Productivity, absenteeism, length of hospital stay, sales in daylit retail, school results.
Results	“Patients whose windows overlooked a scene of nature were released after 7.96 days, compared with the 8.71 days [...] a decrease of 8.5%”; “10% of employee absences can be attributed to architectural elements that did not connect with nature”; “those with views of nature handled calls 6-7% faster”; “non-skylit stores experienced a 40% increase in gross sales after the installation of skylights” and “15-20% increase in sales” (unpublished estimate); school scores “5-18%” and progress “20-26% faster”.
Web link	https://www.terrapinbrightgreen.com/wp-content/uploads/2012/06/The-Economics-of-Biophilia_Terrapin-Bright-Green-2012e.pdf
Level of evidence	Summary report (grey literature) based on peer-reviewed studies and unpublished estimates.
Gap with figures in circulation	“Productivity +18%” and “cognition +10 to +25%”, often attributed to Terrapin 2012, are absent from the report (the 18% is a school score, the productivity cited is +6 to 7%). Stay -8.5%, absence 10% and sales +15 to 40% are indeed in the report, the last of these being contradicted by the Heschong Mahone 2003 study.
Secondary source	Preparatory work for the Busan presentation; 2015 French edition in the document collection.

Record 54 · The Economics of Biophilia: why designing with nature in mind makes financial sense (first edition). Verified online, September 2026.

4.8. References from a supplementary inventory (version 1.2)

An inventory of references received in September 2026 cites about twenty references, most of them second-hand. Four studies absent from the document collection were verified at source on 20 November 2026 and are added here: three quantified studies and one review. In all four cases,

the citation in the inventory (authors, journal or year) did not match the publication; the records give the exact reference. The other references in the inventory are mentioned in Annex B.

4.8.1. Record 55 · Gina S. Lovasi (2008)

Study title	Children living in areas with more street trees have lower prevalence of asthma
Author(s)	G.S. Lovasi, J.W. Quinn, K.M. Neckerman, M.S. Perzanowski, A. Rundle (Columbia University, New York)
Year(s)	2008 (school screening in 1999, hospitalisations in 1997, tree census in 1995)
Publication	Journal of Epidemiology and Community Health, vol. 62, no. 7, pp. 647-649 · DOI 10.1136/jech.2007.071894
Language	English
Measurement context	New York (United States). Ecological study of the city's 42 health areas (United Hospital Fund areas, from 3 to 67 km^2). Prevalence of asthma among children aged 4 and 5 (school screening in 1999) and hospitalisations for asthma among under-15s (1997), related to the street tree density of the 1995 municipal census. Poisson regression, adjusted for population density, poverty, population composition and proximity to pollution sources.
Outcome described	Health: prevalence of asthma in young children and hospitalisations for asthma.
Results	An increase of one standard deviation in street tree density (343 trees per km^2) is associated with a lower prevalence of asthma: relative risk 0.71 (95% CI: 0.64 to 0.79), that is about -29%. The association with hospitalisations is no longer significant after adjustment (RR 0.89; 95% CI: 0.75 to 1.06). The authors state: “This study does not permit inference that trees are causally related to asthma at the individual level.”
Web link	https://doi.org/10.1136/jech.2007.071894 · authors' manuscript in open access: PMC3415223
Level of evidence	Peer-reviewed, brief report. Ecological study of 42 units, with no individual measurement: association at area level, moderate to low level.
Gap with figures in circulation	Reference absent from the document collection. The supplementary inventory presents it as a study “published in 2008 in Environmental Health Perspectives”: it appeared in the Journal of Epidemiology and Community Health. The figure of 29% is confirmed (RR 0.71); the inventory mentions neither the non-significant result on hospitalisations nor the authors' reservation about causality.
Secondary source	Inventory of references received in September 2026.

Record 55 · Children living in areas with more street trees have lower prevalence of asthma. Verified online, November 2026.

4.8.2. Record 56 · Kathryn Gilstad-Hayden (2015)

Study title	Research note: Greater tree canopy cover is associated with lower rates of both violent and property crime in New Haven, CT
Author(s)	Kathryn Gilstad-Hayden, Lori R. Wallace, Amy Carroll-Scott, Spencer R. Meyer, Sarah Barbo, Colleen Murphy-Dunning, Jeannette R. Ickovics
Year(s)	2015 (crimes from 2008 to 2012)
Publication	Landscape and Urban Planning, vol. 143, pp. 248-253 · DOI 10.1016/j.landurbplan.2015.08.005
Language	English
Measurement context	New Haven (Connecticut, United States), a medium-sized city with a high crime rate. Spatial analysis by census block groups: tree canopy cover measured by high-resolution aerial imagery, set against the rates of violent crime, property crime and total crime (FBI Uniform Crime Report data, annual average 2008-2012 per 1,000 inhabitants); spatial lag models.
Outcome described	Safety: crime rate according to the tree cover of the neighbourhood.

Results	A more extensive canopy is associated with lower rates of violent crime, property crime and total crime, independently of educational level, median income, population composition, density, vacancy, share of tenants and spatial autocorrelation. According to the summary published by the authors, 10% more canopy corresponds to a violent crime rate 15% lower and a property crime rate 14% lower. The authors state that they did not establish a causal relationship.
Web link	https://doi.org/10.1016/j.landurbplan.2015.08.005 · authors' summary: https://blogs.lse.ac.uk/usappblog/2015/11/20/trees-a-new-partner-in-the-fight-against-urban-crime
Level of evidence	Peer-reviewed research note, cross-sectional, a single city: association, not causation. Verified on the abstract and on the authors' summary; the full text could not be consulted, and the number of block groups was not noted.
Gap with figures in circulation	Reference absent from the document collection. The supplementary inventory attributes it to “McPhearson, T., Byrne, J., et al. (2016)”: the authors are Gilstad-Hayden et al. and the article dates from 2015. The title and the journal are correct. Study to be compared with record 33 (Kuo and Sullivan 2001).
Secondary source	Inventory of references received in September 2026.

Record 56 · Research note: Greater tree canopy cover is associated with lower rates of both violent and property crime in New Haven, CT. Verified online, November 2026.

4.8.3. Record 57 · Geoffrey H. Donovan (2012)

Study title	The effect of trees on crime in Portland, Oregon
Author(s)	Geoffrey H. Donovan, Jeffrey P. Prestemon (USDA Forest Service)
Year(s)	2012 (online 2010; crimes from 2005 to 2007)
Publication	Environment and Behavior, vol. 44, no. 1, pp. 3-30 · DOI 10.1177/0013916510383238
Language	English
Measurement context	Portland (Oregon, United States). 2,813 single-family houses; 431 crimes reported from 2005 to 2007 (394 property crimes, 37 violent crimes). Three aggregates (all crimes, violent crimes, property crimes) and two offences (burglary, vandalism), related to trees in the public right-of-way and trees on the lot (number, canopy size).
Outcome described	Safety: crime according to the presence, size and position of trees.
Results	Trees in the public right-of-way are associated with lower crime. For trees on the lot, the relationship is mixed: small trees that obstruct the view are associated with more crime, large trees with less crime. The abstract gives no percentage. The authors suggest that a tree may signal a better-maintained house.
Web link	https://doi.org/10.1177/0013916510383238 · open-access text: https://research.fs.usda.gov/treesearch/42374
Level of evidence	Peer-reviewed, observational, a single city; effects not quantified in the abstract: moderate level. Verified on the abstract and on the USDA Forest Service press release; full text not read.
Gap with figures in circulation	Reference absent from the document collection. The supplementary inventory cites “Troy, A., Cadenas, A., et al. (2012), Some city trees may discourage 'shady' behavior, Landscape and Urban Planning”: this title is that of the USDA Forest Service press release of 2 November 2010 presenting the present study, which appeared in Environment and Behavior. The study by Troy et al. on Baltimore was not verified.
Secondary source	Inventory of references received in September 2026.

Record 57 · The effect of trees on crime in Portland, Oregon. Verified online, November 2026.

4.8.4. Record 58 · Theodore S. Eisenman (2019)

Study title	Urban trees, air quality, and asthma: An interdisciplinary review

Author(s)	Theodore S. Eisenman, Galina Churkina, Sunit P. Jariwala, Prashant Kumar, Gina S. Lovasi, Diane E. Pataki, Kate R. Weinberger, Thomas H. Whitlow
Year(s)	2019
Publication	Landscape and Urban Planning, vol. 187, pp. 47-59 · DOI 10.1016/j.landurbplan.2019.02.010
Language	English
Measurement context	Interdisciplinary review (planning and landscape, natural sciences, public health) of peer-reviewed review articles and empirical studies; examination of the biophysical processes and of the models that infer effects on asthma from them. No pooled estimate.
Outcome described	Health: link between urban trees, air quality and asthma.
Results	“This review finds no scientific consensus that urban trees reduce asthma by improving air quality.”; “In some circumstances, urban trees can degrade air quality and increase asthma.” The causal chains are described as highly complex and the approaches of the natural sciences and of epidemiology as divergent; the authors call for interdisciplinary work.
Web link	https://doi.org/10.1016/j.landurbplan.2019.02.010
Level of evidence	Peer-reviewed interdisciplinary narrative review, with no meta-analysis: useful for setting the limits of the argument, not for quantifying an effect. Verified on the abstract. The lead author of record 55 is a co-author.
Gap with figures in circulation	Reference absent from the document collection. The supplementary inventory attributes it to “Cohen, J.T., et al. (2019), Environmental Research, 178, 108707”: the authors are Eisenman et al. and the journal is Landscape and Urban Planning. The inventory takes from it a protective effect in the leaf season and a harmful effect in the pollen season; these details do not appear in the abstract, which rules out any consensus. Not to be used to claim that trees reduce asthma.
Secondary source	Inventory of references received in September 2026.

Record 58 · Urban trees, air quality, and asthma: An interdisciplinary review. Verified online, November 2026.

5. Critical reading: eighteen figures corrected or qualified

Verification at source leads to correcting or qualifying eighteen figures in circulation in summary reports and professional materials. None of these corrections calls into question the general direction of the results, but several significantly change the orders of magnitude.

Study	Finding	Action
Park et al. 2010	Cortisol -13.4 to -15.8%; +56.1% parasympathetic activity when viewing, +102% when walking	Consistent, specify the phase
Ohtsuka et al. 1998	108 mg (not 109); comparison of -21.2% indoors not found	Qualify
Li 2010	Distinction of 30 days for men / 7 days for women taken from Li et al. 2008	Re-source
Beauchemin and Hays 1996	16.9 days (not 16.7); sample size of 174 not verified	Correct
Alvarsson et al. 2010	9 to 37% faster, significant only against loud noise	Qualify
Kahn et al. 2008	Factor of “1.6 times” not verified	Re-source
Cooper Marcus and Barnes 1995	90% (mood) and 79% (relaxation), not 95%	Correct

Study	Finding	Action
Faber Taylor and Kuo 2009	17 children (not 16); "+13.37%" is a Terrapin recalculation	Correct
Faber Taylor et al. 2002	20% of variance explained among girls, not "+20% self-discipline"	Correct
Kuo and Sullivan 2001a	"-25% domestic violence" not stated by the authors	Rephrase
Heschong Mahone Group 2003 (retail)	Average effect 0 to 6%; the +40% belongs to the 1999 study	Correct
Heschong Mahone Group 2003 (offices)	6 to 12% (not 6 to 7%); costs and return on investment = Terrapin calculation	Correct
Wolf 2005	9 to 12%; the trio 20 / 25 / 15% not found	Correct
Romm and Browning 1994	$2.6 million = energy savings	Rephrase
Elzeyadi 2011	Light and view of equal weight; "first predictor" to be qualified	Qualify
Nicklas and Bailey 1996	Attendance +3.2 to 3.8 days not verified	Re-source
WHO Europe 2016	No threshold of "12 m^2 per inhabitant" in the WHO report; use 1 ha within 300 m or 5 min	Correct
Ahamada et al. 2007	+17% to be re-read in the article	Check

Table 2 · Corrections and qualifications to be made in any material using these figures.

5.1. Hierarchy of evidence

The corpus mixes peer-reviewed publications, commissioned technical reports (Heschong Mahone Group for the California Energy Commission, Asterès for the UNEP, the Union nationale des entreprises du paysage), reports from organisations (Trust for Public Land, Center for Health Design) and company case studies (Rocky Mountain Institute). Commissioned reports may be of good statistical quality, but they have not been peer-reviewed and some serve a direct interest of their sponsor. It is recommended to distinguish these three levels in any sales argument.

5.2. Extrapolations by Terrapin Bright Green

Économie de la biophilie [The Economics of Biophilia] converts study results into annual amounts on the scale of the United States or of New York City ($93 million in hospital savings, $470 million in recovered productivity, $1.7 billion in avoided crime, $228 million in medication). These amounts, repeated in other professional publications, are projections built by the authors of the report from cost assumptions; they do not appear in any primary study and must be presented as such.

5.3. Daylight and vegetation

Some of the most cited studies (Heschong Mahone Group, Walch, Beauchemin, Benedetti, Nicklas and Bailey) measure the effect of daylight or of a view through the window, not that of vegetation or biodiversity. They fall under "connection with nature" in the broad sense of the 14 Patterns, but cannot be used to demonstrate a benefit specific to biodiversity. The studies that isolate species richness (Fuller 2007; Grahn and Stigsdotter 2010) or the vegetation of the surroundings (Kuo and Sullivan 2001; James 2016) are those that best serve the BiodiverCity labels.

5.4. French data

The CESE (opinion 2018-21, note 39) acknowledges that “most of the studies on the impacts of nature on health cited in this opinion are of American origin, few French studies being available on the subject”. The corpus contains only two quantified French sources (Asterès 2016; Ahamada et al. 2007), both to be handled with caution. The Plante & Cité fact sheets (Meyer-Grandbastien 2021-2022), the thesis by Bastien Vajou (2021) and the Nature et Santé summary (Plante & Cité, 2021), present in the document collection but not analysed here, are the first resources to draw on to complete the French section.

6. Recommendations for use

Five rules make it possible to use these results in a sales argument, a brochure or a standard without betraying the studies.

- Cite the primary source: the original publication, its year, its sample size and its nature (peer-reviewed, commissioned report, company case study), rather than a summary report.
- Correct the eighteen figures of Table 2 in any material that uses them.
- In an argument about biodiversity, favour the studies that isolate it (Fuller 2007, Grahn and Stigsdotter 2010, James 2016, Twohig-Bennett and Jones 2018) and keep the daylight studies for the “biophilic design” section.
- Distinguish explicitly between the published result and the extrapolation: the national amounts in dollars are projections, not study results.
- Complete the French section by drawing on the Plante & Cité resources and by re-reading in full the article by Ahamada, Flachaire and Lubat (2007).

6.1. Points to be validated by a competent professional

Medical or therapeutic uses of the results (therapeutic gardens, nature prescription) are a matter for health professionals. The use of figures in a commercial communication or in a label standard must be validated against the rules on claims (misleading commercial practices, French Consumer Code). The links and content cited are those observed in September 2026; paywalled publications were verified only on their abstract when the full text was not freely accessible.

7. Annexes

7.1. Annex A · Documents of the IBPC collection analysed

Document	Type of document
Terrapin Bright Green, 14 Patterns of Biophilic Design (2014)	Summary report

Document	Type of document
Terrapin Bright Green, The Economics of Biophilia, French edition (2015)	Summary report
IBPC assessor training material, “Végétal et santé” [Plants and health], 7 October 2022	Training material
Plante & Cité, Concevoir la nature en ville pour la santé [Designing urban nature for health], IBPC assessor training material, 8 September 2022	Training material
CESE, La nature en ville : comment accélérer la dynamique ? [Urban nature: how to speed up the momentum?] (opinion 2018-21)	Institutional opinion
World Economic Forum, BiodiverCities by 2030 (2022)	Report
Socotec, Livre blanc immobilier durable [White paper on sustainable real estate] (December 2019)	White paper
Work of the IBPC Scientific Council, 6 February 2024 (work of Roger Ulrich)	IBPC document
BiodiverCity Ready kit 2022-2023 (descriptive guide, technical manual) and BiodiverCity Construction technical manual V1	IBPC standards
Documents of the collection not analysed: Plante & Cité, Synthèse des recherches Nature et Santé [Summary of research on nature and health] (2021); Bienfaits du végétal en ville [Benefits of plants in the city] (2013); Espaces verts urbains, un plaidoyer pour agir [Urban green spaces, a call to action]; webinar Homme Nature Santé [People, nature, health] of 15 October 2020; BiodiverCity scientific review 2021	Not analysed
Busan Housing Forum presentation, 28 October 2026: preparatory work	EXIMIUS REA presentation
Inventory of references received in September 2026, used in version 1.2 (records 55 to 58)	Second-hand inventory

Table 3 · Source documents of the IBPC collection (survey of 27 September 2026), Busan presentation and supplementary inventory.

7.2. Annex B · References cited without a quantified result

The following references are cited in the documents of the collection in support of a mechanism or a framework, without a usable figure: Wilson 1984 and Kellert and Wilson 1993 (biophilia); Kaplan and Kaplan 1989, Kaplan 1995 (attention restoration); Ulrich et al. 1991 (stress recovery); Hartig et al. 1991, 1996, 2003 (restoration in natural settings); Bauer et al. 2003 (determinants of health); Taylor et al. 2008 (attentional recovery, reference to be specified); Lorimier and Galopin 2022 (therapeutic garden); Dutcher et al. 2007, Mayer and Frantz 2004 (connectedness to nature); Berman et al. 2012, Beyer et al. 2014 (green spaces and mental health); James et al. 2015 (Harvard review of the benefits of greenness); Bratman et al. 2019, Shanahan et al. 2019, WHO Europe 2021 (summaries); Wolf et al. 2016 (urban tree canopy and health); Vajou 2021, Meyer-Grandbastien 2021-2022 (Plante & Cité). The World Health Organization (Regional Office for Europe, Urban green spaces and health, 2016) recommends a green space of at least one hectare within 300 metres or five minutes' walk of the home; the threshold of “12 m^2 per inhabitant” sometimes attributed to the WHO does not appear in this report. The supplementary inventory of September 2026 also cites

references that have not been verified and are not retained at this stage: Sullivan and Kuo 1996 (trees and domestic violence); Kuzma et al. 2016 and Clancy et al. 2013 (dilution effect); Thackeray et al. 2011 and Rook 2013 (hygiene and biodiversity hypotheses); the books by Jacques Tassin (Penser comme un arbre) and Stefano Mancuso (La Cité des vivants); the critical care garden project at King's College Hospital in London.

> *“The question is no longer whether urban nature is beneficial, but to cite accurately: the right study, the right figure, the right level of evidence.”*

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