BIOPHILIC DESIGN

Improving Health & Well-Being in the Built Environment

Visual Connection with Nature, Thermal & Airflow Variability, Presence of Water, Prospect, Refuge.
Courtesy of COOKFOX Architects

THE EXPERIENCE OF LANDSCAPE
JAY APPLETON, 1975

BIOPHILIA
WHAT IS BIOPHILIA?

"Biophilia...

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

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

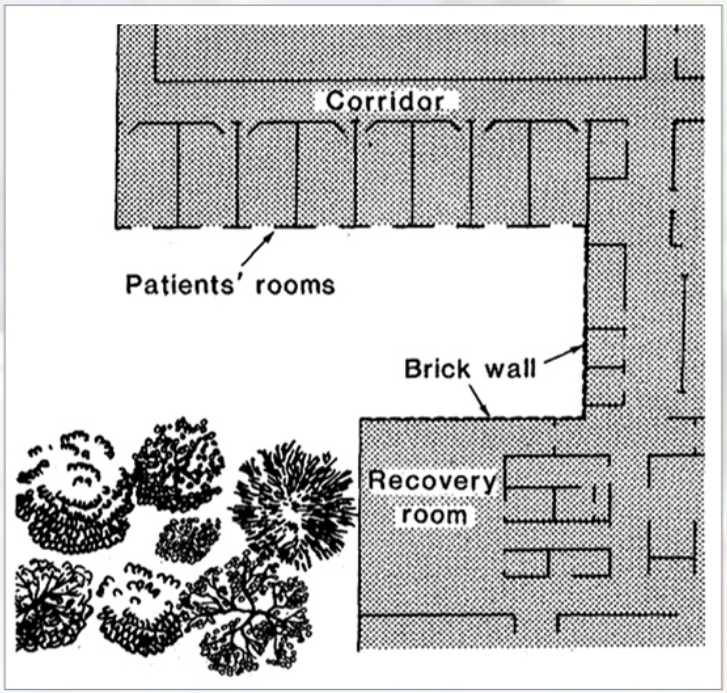
Edward O. Wilson
The Biophilia Hypothesis

SHEEP'S MEADOW, NEW YORK CITY © 2004 Stephen Doyle

GREEN HELPS PEOPLE HEAL
ULRICH STUDY, 1984

A view to nature equals...

- Shorter hospital stays
- Fewer negative comments
- Fewer strong analgesics



VISUAL RESPONSE
KAHN ET AL. STUDY, 2008

Kahn et al. found that...

- Views to nature through a glass window lowered blood pressure faster than a view to fake nature via a digital window (video/plasma) or no window at all.
- Views to fake nature (artwork) are more beneficial than no view.

Physiological benefits to viewing real nature are greater than the benefits of viewing simulated nature.

Courtesy of Peter Kahn

PHYSIOLOGICAL AND COGNITIVE PERFORMANCE
YIN ET AL., 2018

Physical and virtual exposure to biophilic vs. non-biophilic indoor environments

Significant Findings

- Lower blood pressure
- Lower skin conductance level
- Improved short-term memory
- Decreased negative emotions and increased positive emotions reported

Similar effects for both physical and virtual exposure

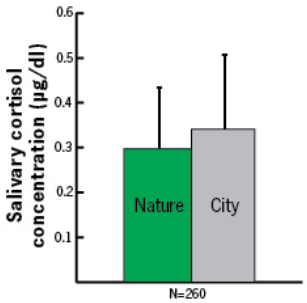
Figure. Test environments and physical vs. virtual exposure. A: biophilic environment with physical exposure; B: biophilic environment with virtual exposure; C: non-biophilic environment with physical exposure; D: non-biophilic environment with virtual exposure.

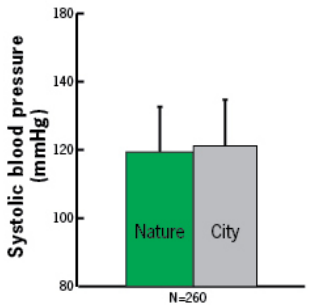
SHINRIN-YOKU "FOREST BATHING"

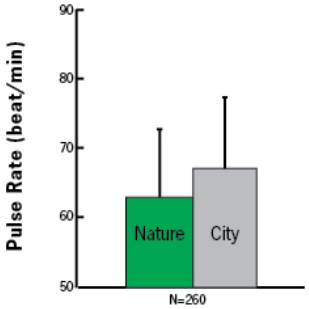
BUM PARK, 2010 & QING LI, 2010

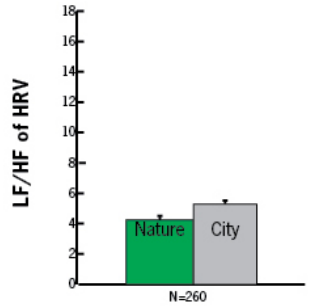
In natural environments compared to urban environments, subjects had...

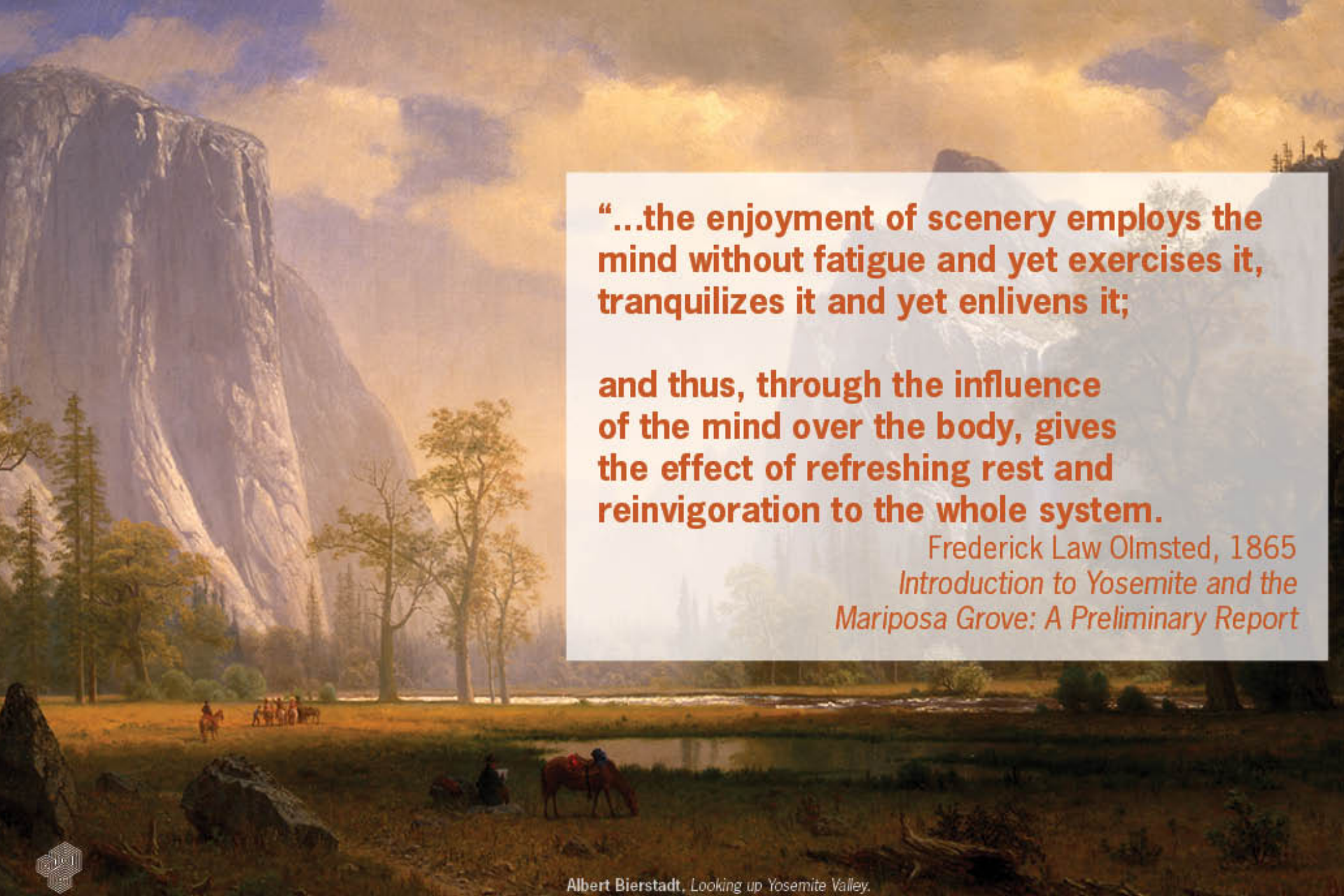
- reduced pulse rate
- reduced systolic blood pressure
- reduced cortisol levels
- increased immune function











"...the enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it;

and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system.

Frederick Law Olmsted, 1865
Introduction to Yosemite and the Mariposa Grove: A Preliminary Report

Albert Bierstadt, *Looking up Yosemite Valley.*

THE RESTORATIVE BENEFITS OF NATURE: TOWARD AN INTEGRATIVE FRAMEWORK

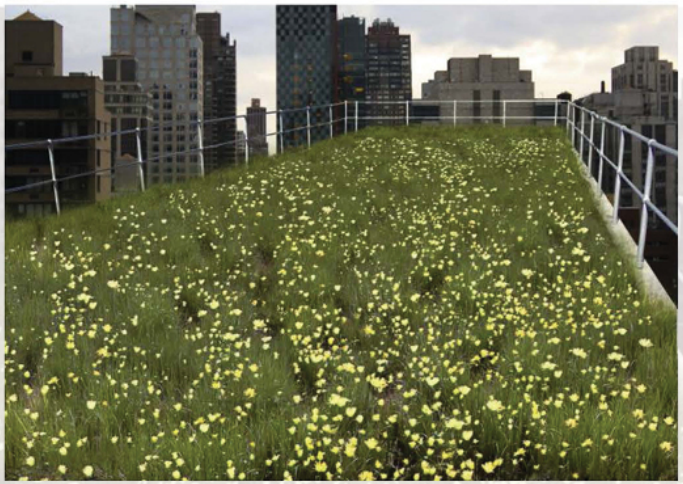
S. KAPLAN, 1995

"Directed attention fatigue" limits ability to focus on a task at hand.

Time spent viewing Nature can reduce mental fatigue and improve concentration.

MICRO-BREAKS & ATTENTION RESTORATION

LEE, WILLIAMS, SARGENT ET AL., 2015



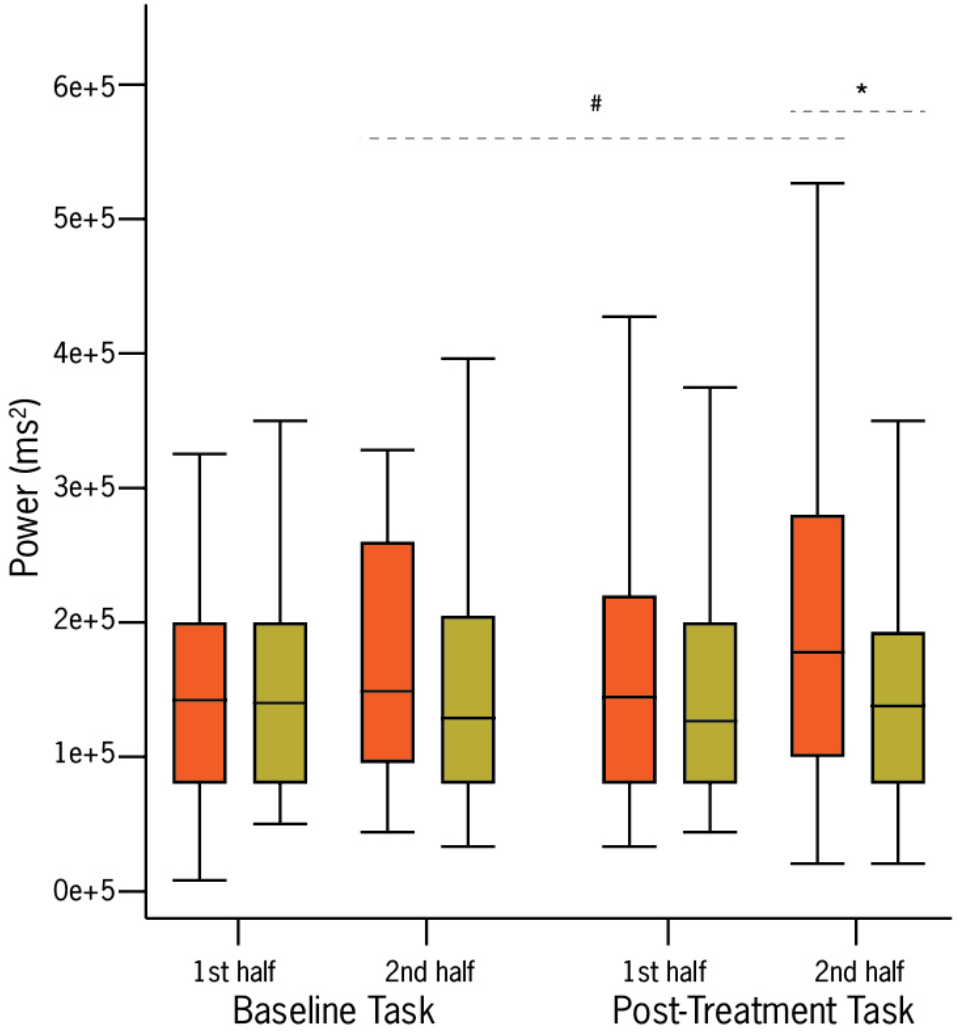
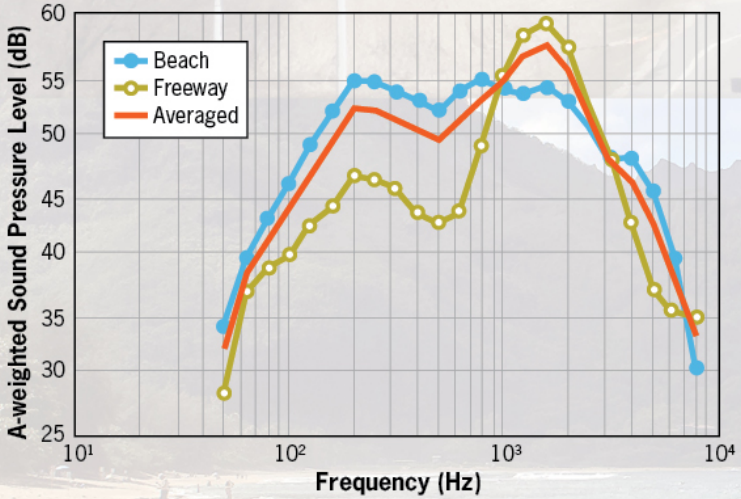


Figure. Boxplot of the median and variance of moment-to-moment response variability (reported as power). Participants viewed a concrete (orange boxes) or green (green boxes) roof. Data shown for the 1st and 2nd half baseline task, and the 1st and 2nds half post-treatment task indicates a significant difference between participants viewing a concrete and green roof. Source: Lee et al. 40-second green roof views sustain attention: The rolde of micro-breaks in attention restoration. *Journal of Environmental Psychology 42*(2015):182–189.

CONTEXT & PERCEPTION

HUNTER ET AL., 2010

Freeway and Beach Frequency Spectra and Logarithmic Averages



Freeway and beach frequency spectra, and their logarithmic average. The averaged spectrum was employed in the experiment. Photographic inserts are stills from typical movies used in the behavioural and scanning studies.

Source: M.D. Hunter, et al. The state of tranquility: Subjective perception is shaped by contextual modulation of auditory connectivity. *NeuroImage 53* (2010) 611–618.

HIGHWAY 401, ONTARIO © Hal Jackey/Flickr
TUNNELS BEACH, KAUAI © Garden State Hiker/Flickr

MEASUREMENT AND SUBJECTIVE ASSESSMENT OF WATER GENERATED SOUNDS

WATTS ET AL., 2009

The perception of a water sound as natural was significantly correlated with improving tranquility.

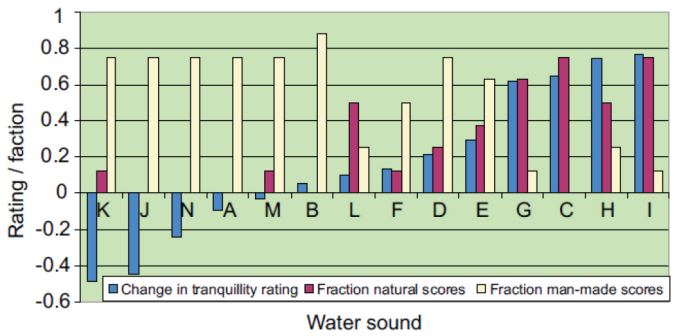


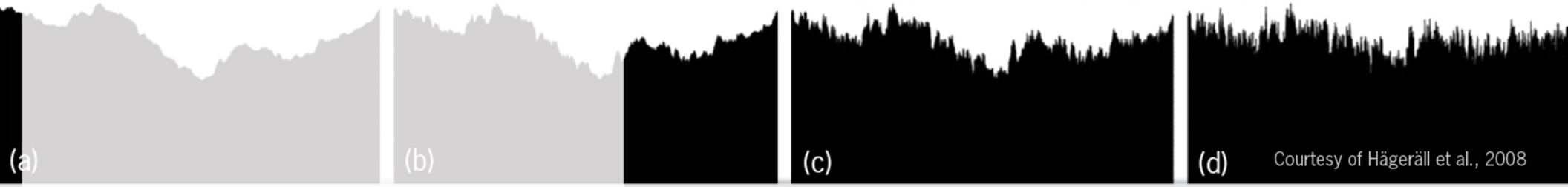
Figure. Average tranquility ratings based on all 4 experiments together with fraction categorised as natural and man-made.

FRACTALS & VISUAL RESPONSE

SALINGAROS, 2012; TAYLOR, 2006; HÄGERHÄLL ET AL., 2008; JOYE, 2005

Key takeaways...

- Fractal patterns encourage perceptual rather than cognitive thinking.
- Humans have a preference for patterns with a moderate fractal dimension like that found and processed in nature.
- Moderate fractal dimensions are perceived as are most restorative and relaxing.
- High fractal dimensions can engender stress in some people, or creativity in others.



Courtesy of Hägeräll et al., 2008

FRACTALS IN ARCHITECTURE: THE VISUAL INTEREST, PREFERENCE, & MOOD RESPONSE

ABBOUSHI ET AL., 2019

Fractal images were rated as significantly more visually interesting and visually prefered than non-fractal images

Visual interest peaked at higher complexity levels (D=1.5–1.7) than visual preference (D=1.5)

Distance from projected fractals did not affect visual interest or preference

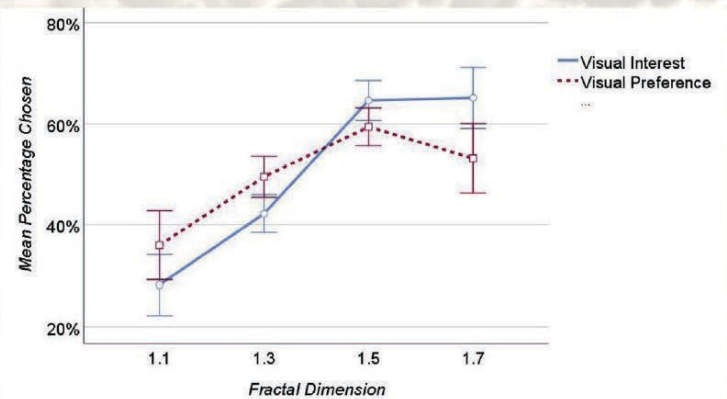


Figure. Mean percentage chosen for visual interest and preference by fractal complexity

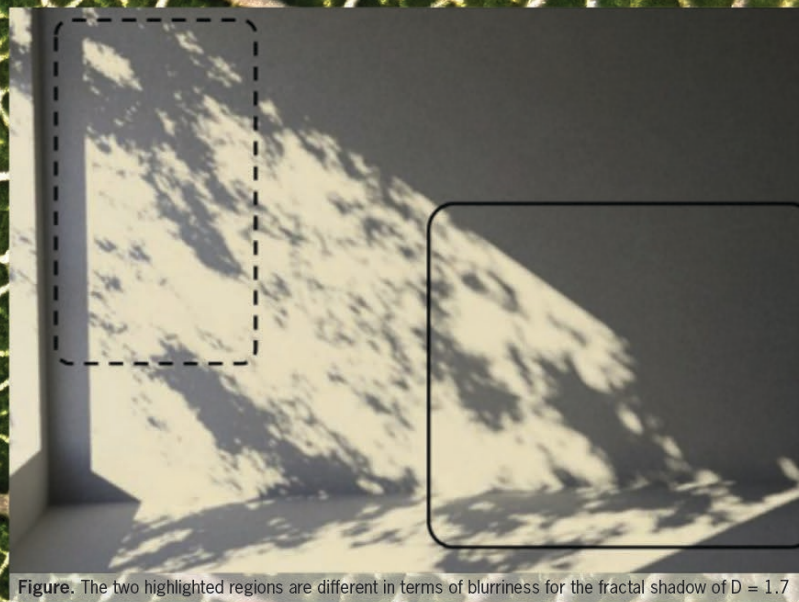


Figure. The two highlighted regions are different in terms of blurriness for the fractal shadow of D = 1.7

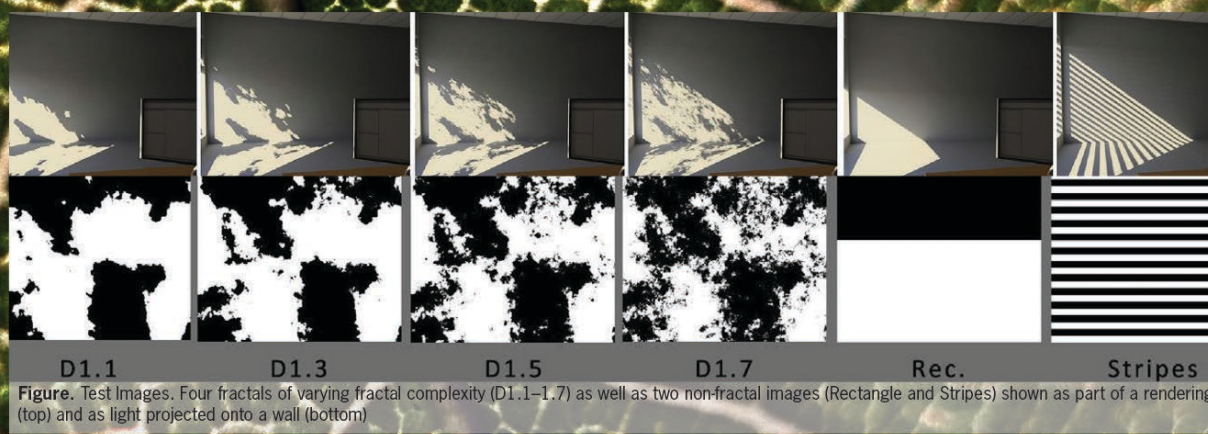


Figure. Test Images. Four fractals of varying fractal complexity (D1.1–1.7) as well as two non-fractal images (Rectangle and Stripes) shown as part of a rendering (top) and as light projected onto a wall (bottom)


CALCULATING SLOPE!
CLEARING THE DENOM
2017/02/06


LOVE

THE IMPACT OF BIOPHILIC DESIGN ON STUDENT SUCCESS

GREEN STREET ACADEMY, BALTIMORE

Objective: to determine the contribution of biophilic design to 6th grade student's stress reduction and academic performance

Biophilic Classroom includes:

- Biomorphic Forms & Images
- Views to Nature
- Dynamic & Diffuse Light

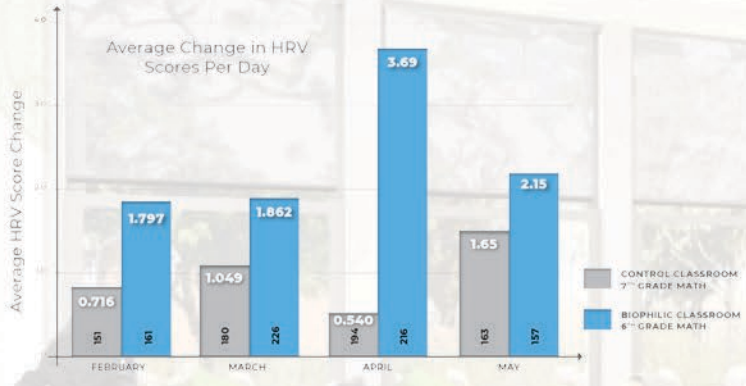
Measured:

- Stress
- Learning Outcomes
- Subjective Response

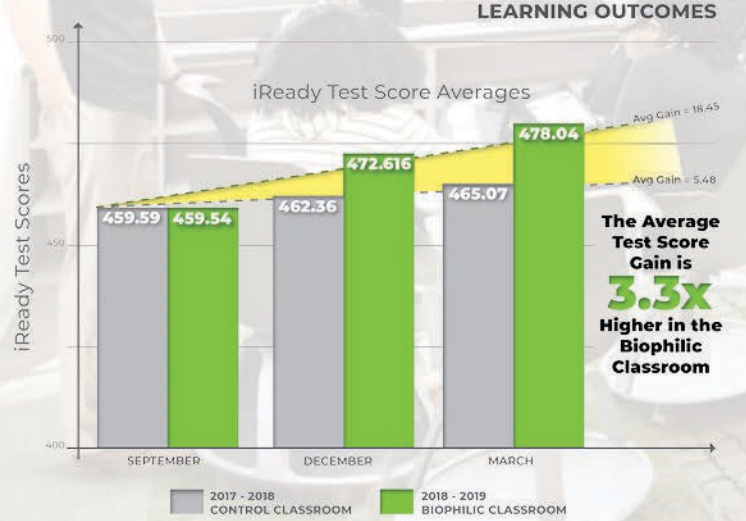
Control Classroom. GREEN STREET ACADEMY, BALTIMORE, MD © Craig Gaulden Davis Architects

THE IMPACT OF BIOPHILIC DESIGN ON STUDENT SUCCESS

GREEN STREET ACADEMY, BALTIMORE



LEARNING OUTCOMES



The Average Test Score Gain is

3.3x

Higher in the Biophilic Classroom

Biophilic Classroom. GREEN STREET ACADEMY, BALTIMORE, MD © Craig Gaulden Davis Architects

GREEN SPACES AND COGNITIVE DEVELOPMENT IN PRIMARY SCHOOLCHILDREN

DADVAND ET AL., 2015

- 2593 schoolchildren from 36 schools in grades 2-4
- Looked at greeness in surrounding home, community, and school
- Beneficial association of greenspace and cognitive development

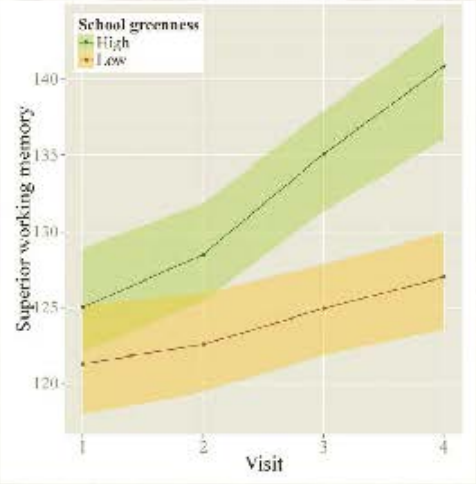
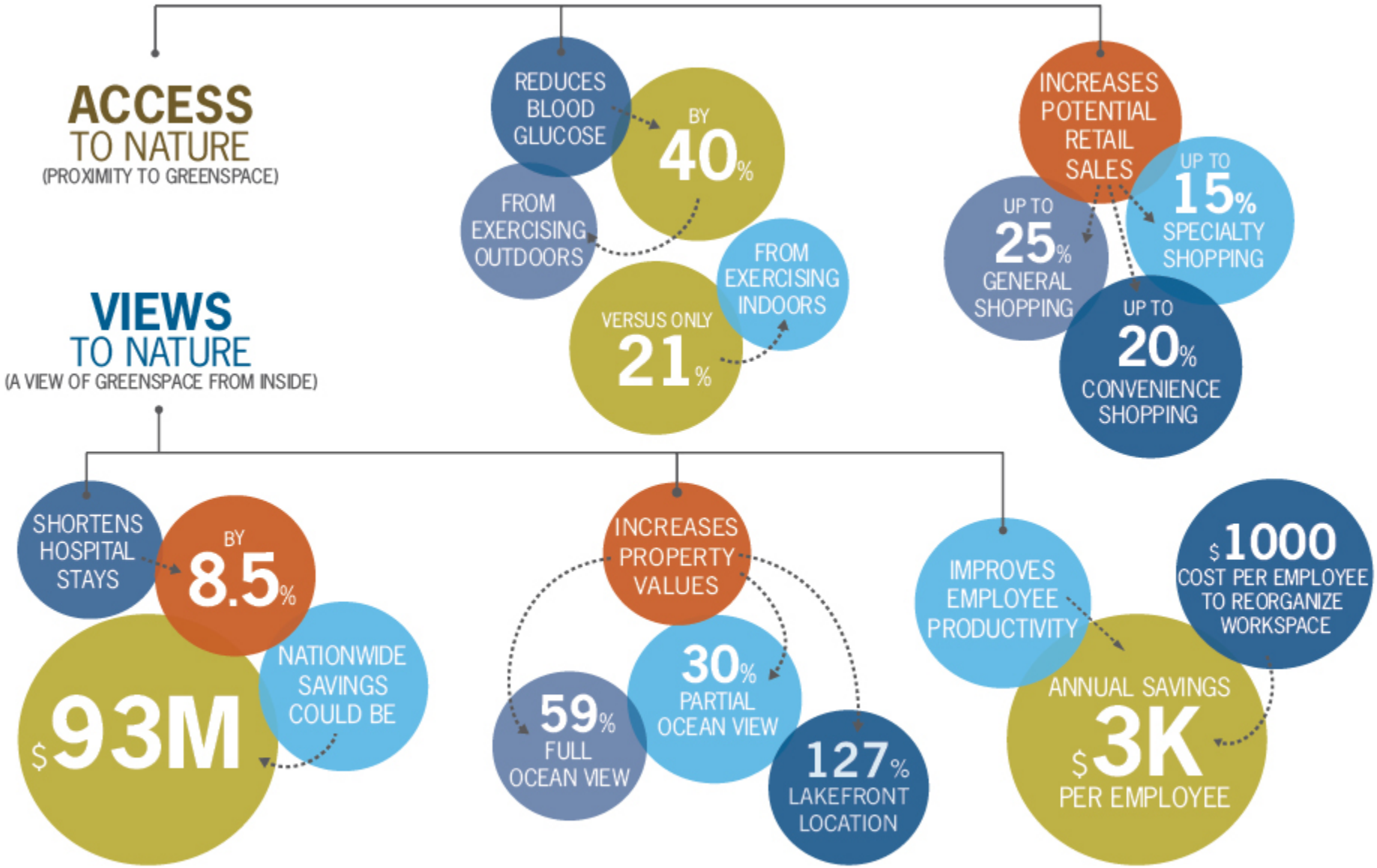


Figure. Twelve-month progress in superior working membory for partcipants with the first and third tertiles of greeness within the school boundaries.



Bottom Line Benefits of Biophilia.
NUMBERS ARE ROUNDED TO NEAREST WHOLE. © Bill Browning/GreenSource Magazine

Visual and Auditory Connection with Nature, Presence of Water, Prospect.
ART AQUA OFFICES, BIETIGHEIM, GERMANY © Bill Browning

CONSTRUCTS OF BIOPHILIC DESIGN

Nature in the Space

Plants, water, and animals in the built environment

UNDER AFRICAN SKIES © StormSignal/Flickr

Natural Analogues

Objects, materials, and patterns that evoke nature

Nature of the Space

Differing spatial configurations of the built environment

WORMSLOE PLANTATION, GEORGIA © Bruce Tuten/Flickr

14 PATTERNS OF BIOPHILIC DESIGN

Nature In The Space

1. Visual Connection with Nature
2. Non-Visual Connection with Nature
3. Non-Rhythmic Sensory Stimuli
4. Thermal & Airflow Variability
5. Presence of Water
6. Dynamic & Diffuse Light
7. Connection With Natural Systems

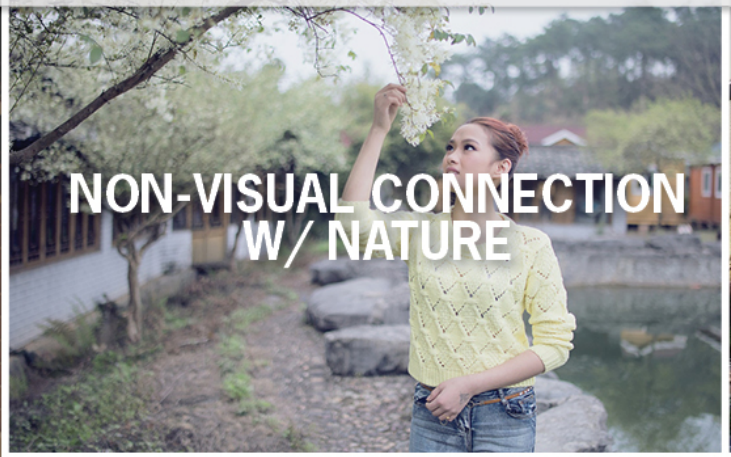
Natural Analogues

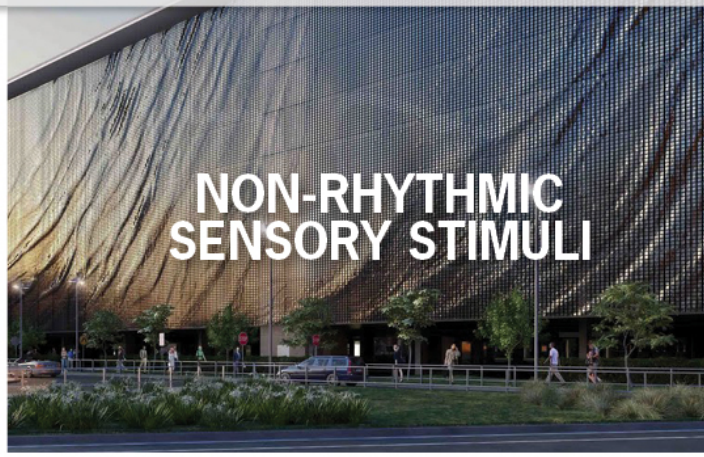
8. Biomorphic Forms & Patterns
9. Material Connection with Nature
10. Complexity & Order

Nature Of The Space

11. Prospect
12. Refuge
13. Mystery
14. Risk

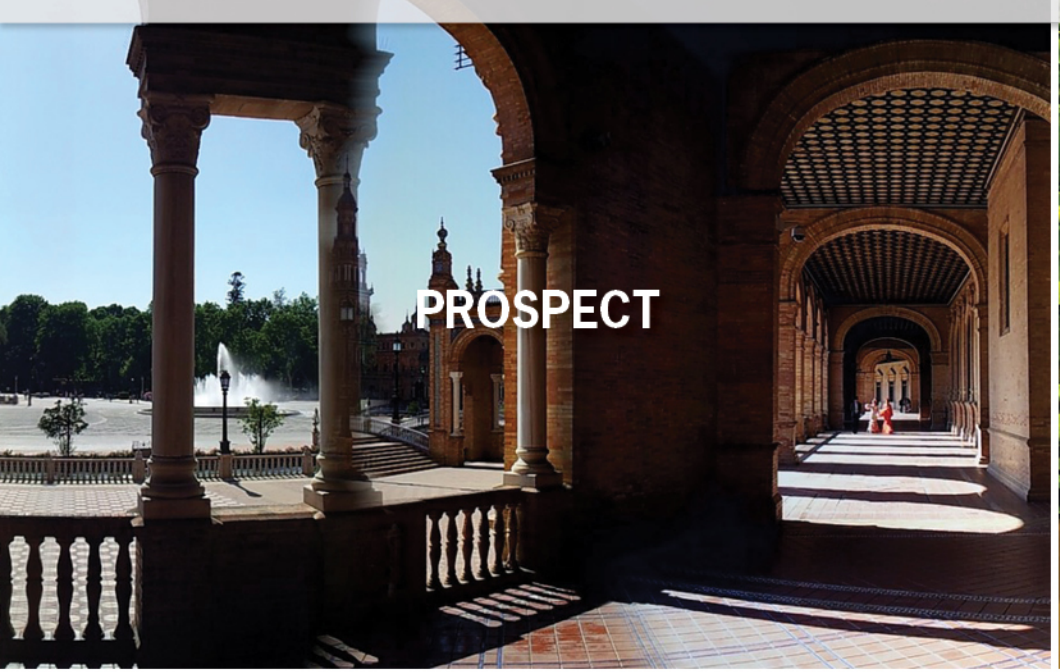
NY TIMES BIRCH GARDEN © Hubert J. Steed



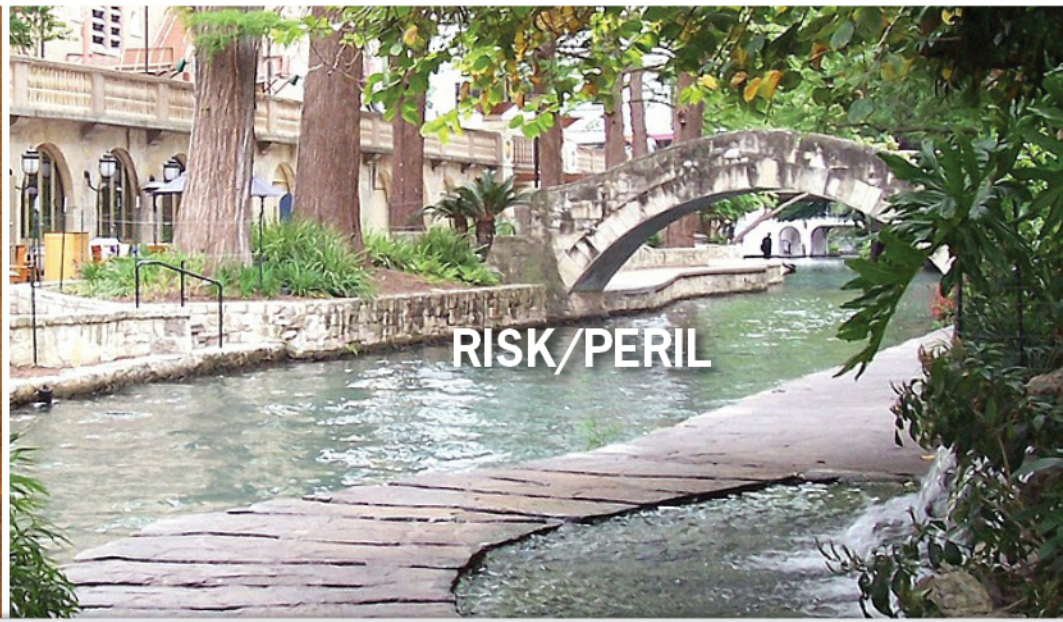


See "14 Patterns of Biophilic Design" publication for photo credits, unless otherwise noted.

FEDERAL CENTER SOUTH, BUILDING 1202, SEATTLE, WA, ZGF ARCHITECTS © ZGF Architects



ONE JACKSON SQUARE © Michael Moran Studio



BIOPHILIC DESIGN PATTERNS & BIOLOGICAL RESPONSES

	14 PATTERNS	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection w/ Nature	Lowered blood pressure and heart rate	Improved mental engagement/ attentiveness	Positively impacted attitude and overall happiness
	Non-Visual Connection w/ Nature	Reduced systolic blood pressure and stress hormones	Positively impacted cognitive performance	Perceived improvements in mental health and tranquility
	Non-Rhythmic Sensory Stimuli	Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity	Observed and quantified behavioral measures of attention and exploration	
	Thermal & Airflow Variability	Positively impacted comfort, well-being and productivity	Positively impacted concentration	Improved perception of temporal and spatial pleasure (alliesthesia)
	Presence of Water	Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure	Improved concentration and memory restoration; Enhanced perception and psychological responsiveness	Observed preferences and positive emotional responses
	Dynamic & Diffuse Light	Positively impacted circadian system functioning; Increased visual comfort		
	Connection w/ Natural Systems			Enhanced positive health responses; Shifted perception of environment
N. ANALOGUES	Biomorphic Forms & Patterns			Observed view preference
	Material Connection w/ Nature		Decreased diastolic blood pressure; Improved creative performance	Improved comfort
	Complexity & Order	Positively impacted perceptual and physiological stress responses		Observed view preference
NATURE OF THE SPACE	Prospect	Reduced stress	Reduced boredom, irritation, fatigue	Improved comfort and perceived safety
	Refuge		Improved concentration, attention and perception of safety	
	Mystery			Induced strong pleasure response
	Risk/Peril			Resulted in strong dopamine or pleasure responses

PATTERN PRIORITIZATION
& CONCEPTUALIZATION STRATEGIES

What are the main drivers?

- **Desired health outcomes** or health and wellbeing goals
- User type/group
- Space programming
- Local climate and ecosystem
- Local culture or heritage
- Environmental goals
- What's 'free' on site
- What's already measured

WINDHOVER MEDITATION CENTER, STANFORD UNIVERSITY © Aidlin Darling Design

COOKFOX STUDIO
CHELSEA, NEW YORK, NY

- **12,121** sf architecture office
- **3,600** sf greenroof
- Completed in 2006
- LEED Commercial Interior

Main Biophilic Patterns

- **[P1] Visual Connection w/ Nature**
- [P3] Non-Rhythmic Sensory Stimuli
- [P6] Biomorphic Forms & Patterns
- [P8] Prospect

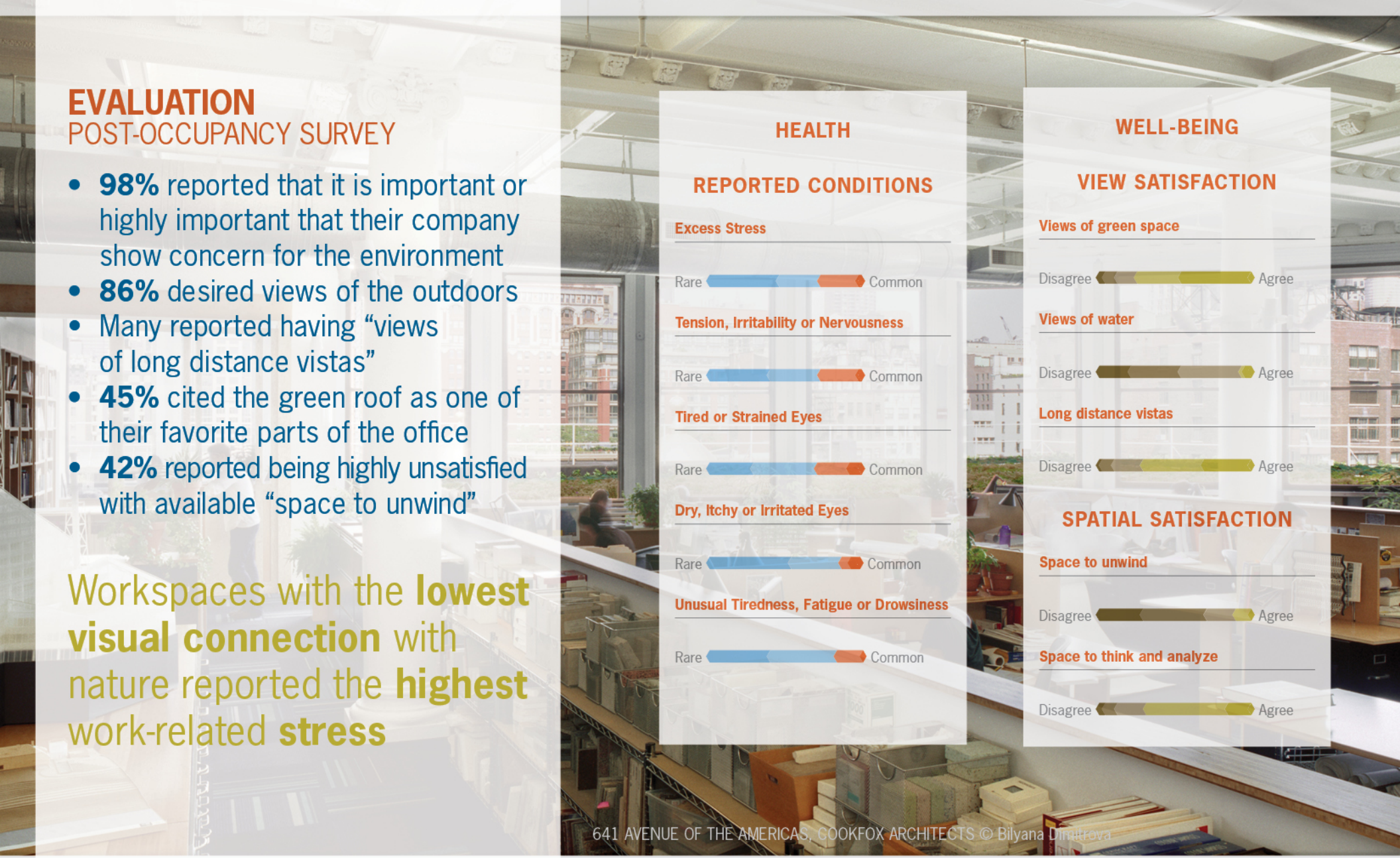
641 AVENUE OF THE AMERICAS, COOKFOX ARCHITECTS © COOKFOX

Visual Connection with Nature, Non-Rhythmic Sensory Stimuli, Connection with Natural Systems, Biomorphic Forms & Patterns, Material Connection with Nature, Complexity & Order, Prospect.
641 SIXTH AVENUE PENTHOUSE, NEW YORK, NEW YORK USA, COOKFOX ARCHITECTS

EVALUATION
POST-OCCUPANCY SURVEY

- **98%** reported that it is important or highly important that their company show concern for the environment
- **86%** desired views of the outdoors
- Many reported having “views of long distance vistas”
- **45%** cited the green roof as one of their favorite parts of the office
- **42%** reported being highly unsatisfied with available “space to unwind”

Workspaces with the **lowest visual connection** with nature reported the **highest** work-related **stress**



641 AVENUE OF THE AMERICAS, COOKFOX ARCHITECTS © Bilyana Dimitrova

FLOOR PLAN: 641 AVENUE OF THE AMERICAS © COOKFOX/Terrapin Bright Green

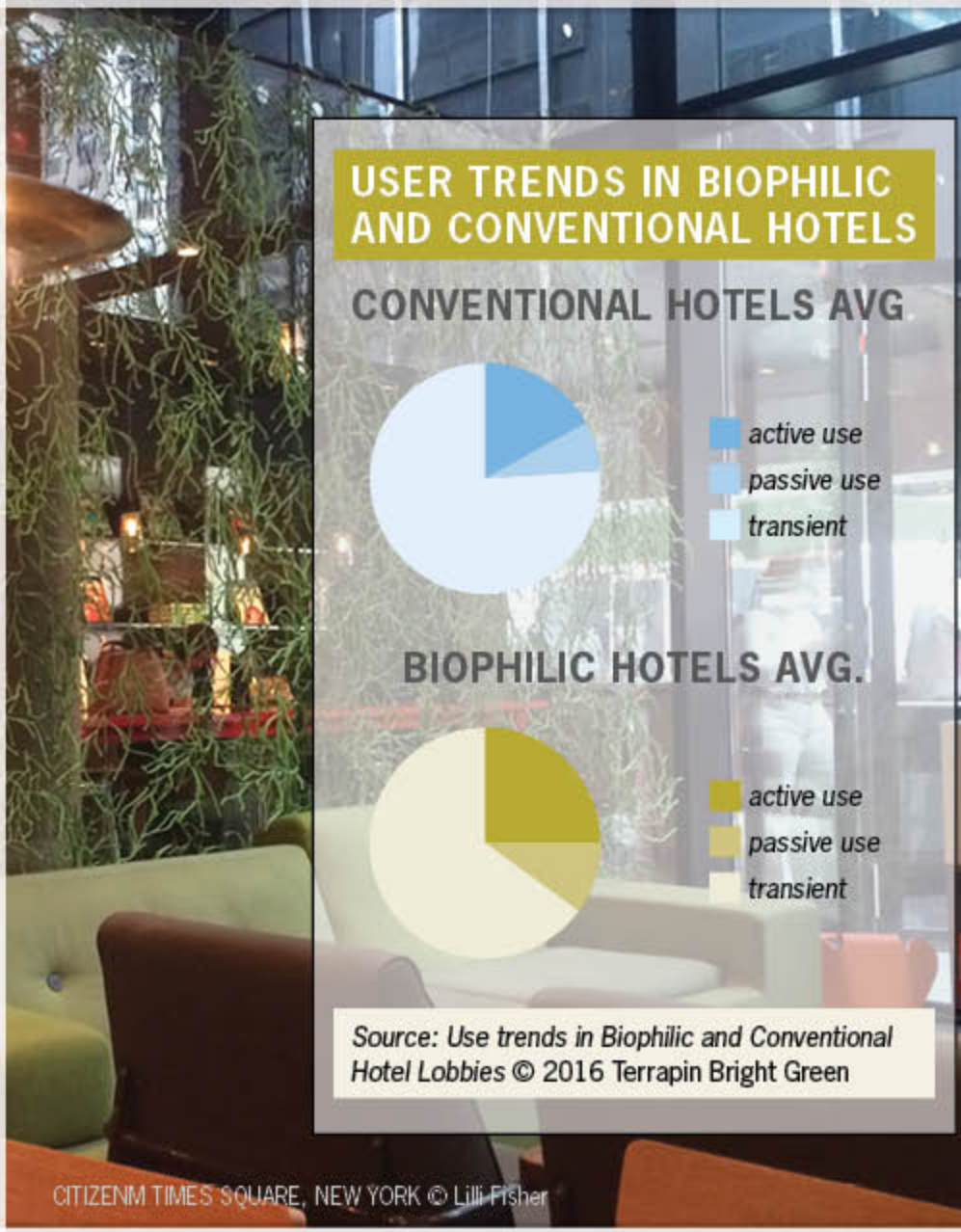
CitizenM Lobby. NEW YORK © Terrapin Bright Green

OBSERVATIONAL STUDY
USER TRENDS

Observational study of user trends in biophilic and comparable conventional hotel lobbies

- Sample of **6 hotels** in Midtown Manhattan
- All guests present were counted as either **active or passive users, or transient**
- All lobbies were observed at **morning, midday, and evening**

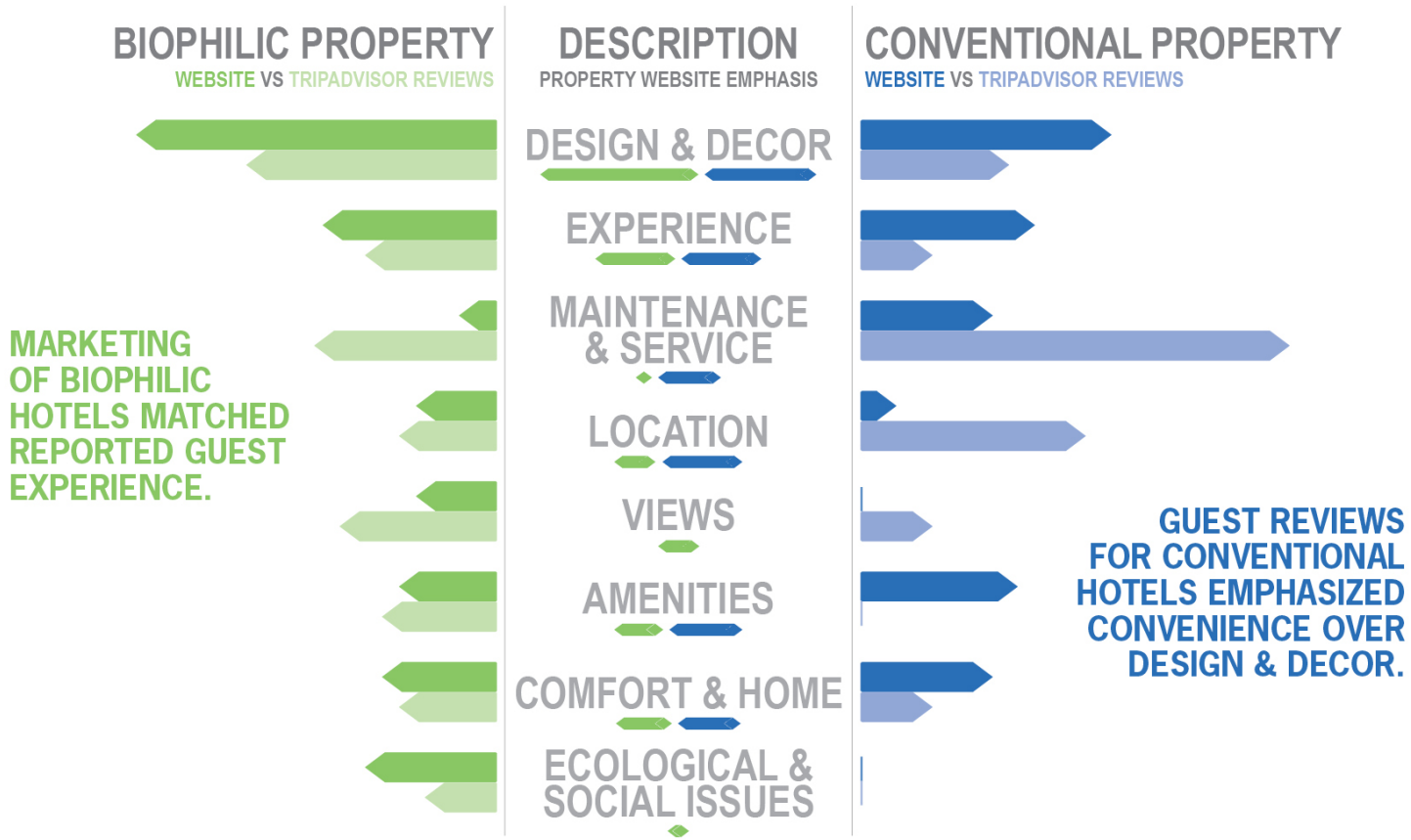
On average, biophilic lobbies saw a 36% use rate while conventional hotels saw only 25%



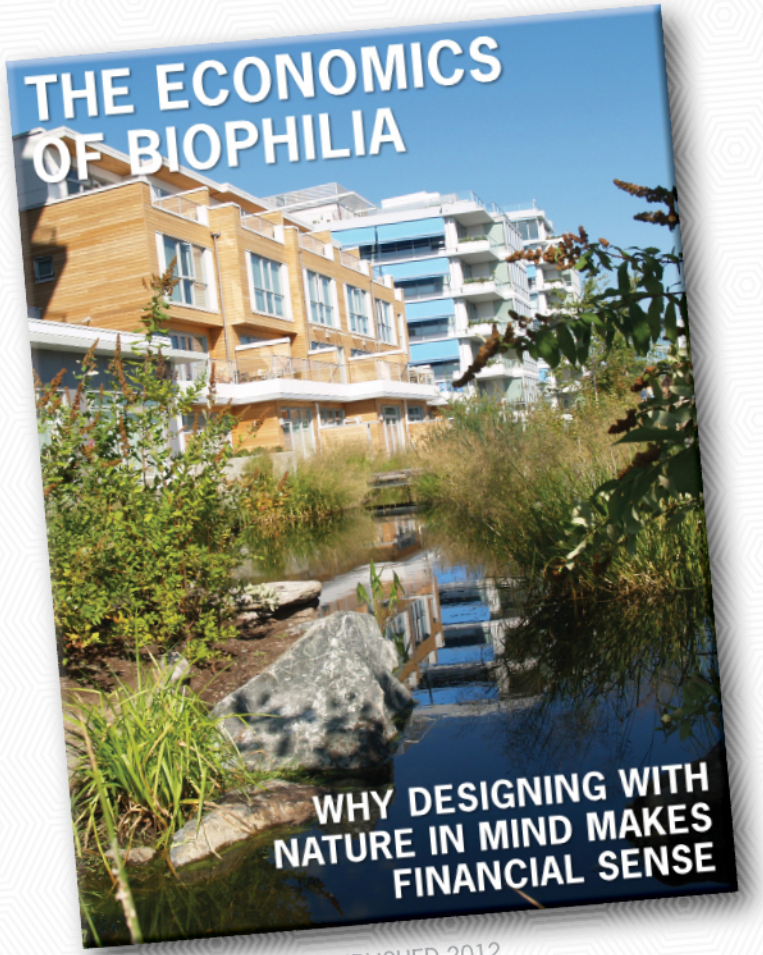
CITIZENM TIMES SQUARE, NEW YORK © Lilli Fisher

GUEST EXPERIENCE OBSERVATIONAL STUDIES

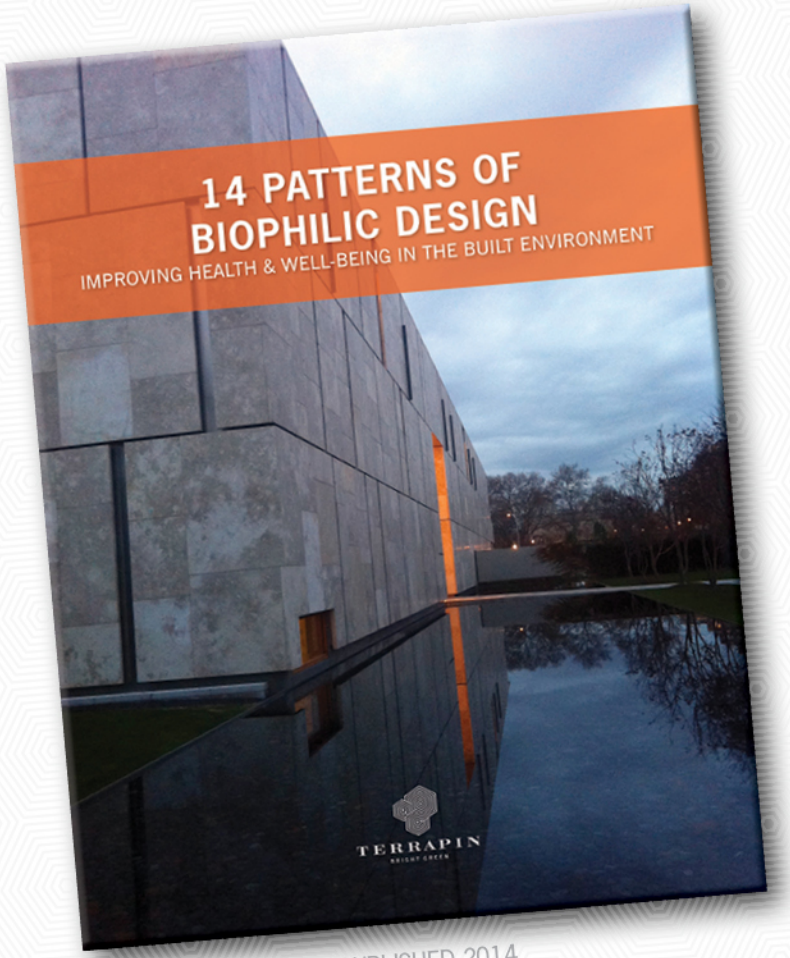
DATA BASED ON PROPERTY DESCRIPTIONS FROM 6 HOTELS WEBSITES AND 10 MOST RECENT TRIPADVISOR REVIEWS FOR EACH HOTEL



SOURCE: HUMAN SPACES 2.0: BIOPHILIC DESIGN IN HOSPITALITY (2017)



PUBLISHED 2012



PUBLISHED 2014

TERRAPIN BRIGHT GREEN

BIOMIMICRY@TERRAPINBG.COM
646-460-8400 / @TERRAPINBG

**"...life is more like a verb.
It repairs, maintains,
re-creates, and outdoes itself."**

– Lynn Margulis and Dorion Sagan, 1995

Blue Morpho Butterfly Wing © Thanushi Eagelle/Flickr