Urban forest → Pro-environmental → Warm glow/ Helpers high
<table>
<thead>
<tr>
<th>WHAT?</th>
<th>WHERE?</th>
<th>FOR WHOM?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health mediator</td>
<td>Local conditions</td>
<td>Population</td>
</tr>
<tr>
<td>Stress relief</td>
<td>Climate</td>
<td>Adolescents</td>
</tr>
<tr>
<td>Physical activity</td>
<td>Native flora</td>
<td>Working population</td>
</tr>
<tr>
<td>Play</td>
<td>Built environment</td>
<td>Unemployed</td>
</tr>
<tr>
<td>Social interactions</td>
<td>Infrastructure &amp; transport</td>
<td>Disabled</td>
</tr>
<tr>
<td>Cooling</td>
<td>City size</td>
<td>Children</td>
</tr>
<tr>
<td>Reduced air pollution</td>
<td>Culture/traditions</td>
<td>Elderly</td>
</tr>
<tr>
<td>Reduced noise</td>
<td></td>
<td>Etc.</td>
</tr>
<tr>
<td>Etc.</td>
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</tbody>
</table>
URBAN FORESTS AND STRESS REDUCTION

January 31, 2017
OBJECTIVES

UNDERSTAND
- Why stress is a major risk factor for many diseases
- Why it is important to prevent stress

DESCRIBE
- What effects urban forests have on stress and give examples of scientific evidence

DISCUSS
- What elements and qualities of urban forests may provide stress relief

ARGUE FOR
- That urban forests shall be implemented more in healthy and sustainable urban planning
Non-communicable diseases (NCDs) —
Life-style related and depend on living environments

- Diabetes
- Cardiovascular diseases
- Obesity
- Chronic respiratory diseases
- Cancer
- Mental disorders
RISK FACTORS

➢ Stress
➢ Physical inactivity
➢ Loneliness
➢ Socioeconomic inequalities
Risk factor: stress
URBAN FORESTS – STRESS – MENTAL HEALTH
• The prevalence of mental disorders is lower in urban green areas (van den Berg et al. 2015)

• Exposure to nature significantly increases happiness (McMahan & Estes, 2015)
How Stress can be seen as a major public Health Problem

- Social Isolation
- Reduced access to Greenspace
- Social Inequalities leading to environmental injustice
- Physical inactivity and Obesity
- Anxiety and Depression
- Chronic Stress
- Raised Inflammatory Markers
- Diabetes
- Cancer
- Cardiovascular Disease
- Lung Disease

Slide courtesy of William Bird
Why might green spaces make us less stressed?

- **Biophilia**
  The direct effects of nature on the brain

- **Less bad things**
  Noise, pollution, excess heat, poor aesthetics

- **More good things**
  Physical activity, social interaction

Direct effects on the brain
Neural processing, fractal patterns
Place: Green Space moderates the effect of stressful events in children

Nearby Nature
A Buffer of Life
Stress among Rural Children
NM Wells, GW Evans
Environment and Behavior May 2003 vol. 35 no. 3 311-33
Beyer et al. 2014. IJERPH

Exposure to Neighbourhood Green Space and Mental Health: Evidence from the Survey of the Health of Wisconsin
“Higher levels of neighborhood green space were associated with significantly lower levels of symptomology for depression, anxiety and stress, after controlling for a wide range of confounding factors.”
Stress provocation

Trier Social Stress Test (TSST):
1. Presentation
Real TSST
Virtual TSST
Stress indicators

- Cortisol in saliva
- Heart Rate (HR)
- T-wave amplitude (TWA)
- Heart Rate Variability (HF-HRV)
Stress recovery in a virtual forest
Control
Parasympathetic activation

$F_{\text{linear}}=7.55; p=.003$

Annerstedt et al. 2013. *Inducing physiological stress recovery with sounds of nature in a virtual reality forest — Results from a pilot study*. Physiology and Behavior 118:240-50
Bratman et al. 2015. Nature experience reduces rumination and subgenual prefrontal cortex activation. *PNAS. 112(28):8567-8572*

**Fig. 1.** The impact of nature experience on self-reported rumination and blood perfusion to the sgPFC. (A) Change in self-reported rumination (postwalk minus prewalk) for participants randomly assigned to take a 90-min walk either in a natural setting or in an urban setting. (B) A time-by-environment interaction in blood perfusion was evident in the sgPFC. *(F)* map of significant interactions at a threshold of *P* < 0.05, FWE corrected for multiple comparisons. (C) Change in blood perfusion (postwalk minus prewalk) for participants randomly assigned to take a 90-min walk either in a natural setting or in an urban setting. Error bars represent SE within subjects: *P* < 0.05, ***P* < 0.001.
HOW DO WE DESIGN URBAN GREEN SPACES FOR THE MOST EFFICIENT STRESS RELIEF?
14 PATTERNS OF BIOPHILIC DESIGN
IMPROVING HEALTH & WELL-BEING IN THE BUILT ENVIRONMENT
Nature in the Space: seven biophilic design patterns

- **1. Visual Connection with Nature.** A view to elements of nature, living systems and natural processes.
- **2. Non-Visual Connection with Nature.** Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.
- **3. Non-Rhythmic Sensory Stimuli.** Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
- **4. Thermal & Airflow Variability.** Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.
- **5. Presence of Water.** A condition that enhances the experience of a place through seeing, hearing or touching water.
- **6. Dynamic & Diffuse Light.** Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
- **7. Connection with Natural Systems.** Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.
Nature in the space
Non-rhythmic stimuli:
Dockside Green Community, Vancouver Island
## Biophilic design patterns & Biological Responses

<table>
<thead>
<tr>
<th>14 PATTERNS</th>
<th>STRESS REDUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual Connection with Nature</strong></td>
<td>Lowered blood pressure and heart rate</td>
</tr>
<tr>
<td></td>
<td>(Brown, Barton &amp; Gladwell, 2013; van den Berg, Hartig, &amp; Staats, 2007; Tsunetsugu &amp; Miyazaki, 2005)</td>
</tr>
<tr>
<td><strong>Non-Visual Connection with Nature</strong></td>
<td>Reduced systolic blood pressure and stress hormones</td>
</tr>
<tr>
<td></td>
<td>(Park, Tsunetsugu, Kasetsani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mouwen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)</td>
</tr>
<tr>
<td><strong>Non-Rhythmic Sensory Stimuli</strong></td>
<td>Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity</td>
</tr>
<tr>
<td></td>
<td>(Li, 2009; Park et al., 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)</td>
</tr>
<tr>
<td><strong>Thermal &amp; Airflow Variability</strong></td>
<td>Positively impacted comfort, well-being and productivity</td>
</tr>
<tr>
<td></td>
<td>(Heerwagen, 2006; Tham &amp; Willem, 2005; Wigó, 2005)</td>
</tr>
<tr>
<td><strong>Presence of Water</strong></td>
<td>Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure</td>
</tr>
<tr>
<td></td>
<td>(Avarsson, Wiens, &amp; Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman &amp; Vessel, 2006)</td>
</tr>
<tr>
<td><strong>Dynamic &amp; Diffuse Light</strong></td>
<td>Positively impacted circadian system functioning</td>
</tr>
<tr>
<td></td>
<td>(Figueiro, Brons, Pitnick et al., 2011; Beckett &amp; Roden, 2009)</td>
</tr>
<tr>
<td><strong>Connection with Natural Systems</strong></td>
<td>Increased visual comfort</td>
</tr>
<tr>
<td></td>
<td>(Elyezadi, 2012; Kim &amp; Kim, 2007)</td>
</tr>
</tbody>
</table>
Natural Analogues: three patterns of biophilic design:

8. **Biomorphic Forms & Patterns.** Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.

9. **Material Connection with Nature.** Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

10. **Complexity & Order.** Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.
Natural analogue
NATURE OF THE SPACE: FOUR BIOPHILIC PATTERNS OF DESIGN

11. **Prospect.** An unimpeded view over a distance, for surveillance and planning.

12. **Refuge.** A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

13. **Mystery.** The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

14. **Risk/Peril.** An identifiable threat coupled with a reliable safeguard.
Nature of the space
Risk, peril
<table>
<thead>
<tr>
<th>NATURAL ANALOGUES</th>
<th>Stress reduction</th>
<th>Cognitive performance</th>
<th>Emotion, mood, preference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biomorphic Forms &amp; Patterns</strong></td>
<td>*</td>
<td></td>
<td><strong>Observed view preference</strong> (Vessel, 2012; Joyce, 2007)</td>
</tr>
<tr>
<td><strong>Material Connection with Nature</strong></td>
<td></td>
<td><strong>Decreased diastolic blood pressure</strong> (Tsunetsugu, Miyazaki &amp; Sato, 2007)</td>
<td><strong>Improved comfort</strong> (Tsunetsugu, Miyazaki &amp; Sato 2007)</td>
</tr>
<tr>
<td><strong>Prospect</strong></td>
<td>* <strong>Reduced stress</strong> (Grahn &amp; Stigsdotter, 2010)</td>
<td><strong>Reduced boredom, irritation, fatigue</strong> (Clearwater &amp; Coss, 1991)</td>
<td><strong>Improved comfort and perceived safety</strong> (Herzog &amp; Bryce, 2007; Wang &amp; Taylor, 2006; Pethrick, 2000)</td>
</tr>
<tr>
<td><strong>Refuge</strong></td>
<td>*</td>
<td></td>
<td><strong>Induced strong pleasure response</strong> (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood &amp; Zatorre, 2001)</td>
</tr>
<tr>
<td><strong>Mystery</strong></td>
<td>*</td>
<td></td>
<td><strong>Resulted in strong dopamine or pleasure responses</strong> (Kohno et al., 2013; Wang &amp; Tsien, 2011; Zald et al., 2008)</td>
</tr>
<tr>
<td><strong>Risk/Peril</strong></td>
<td>*</td>
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</tbody>
</table>
ART, Stress reduction theory, Prospect-Refuge theory

• Openness and presence of water
• Nature-based components and hardscape components.
• Presence/absence of people
OUTCOMES

Stress,
Attentional level
Perceived restorativeness
1. Open, 50-80 m sight distance

2. Open with people 50-80 m sight distance
3. Open, 50-60 m sight distance

4. Open with people 50-60 m sight distance
5. Water, 40-90 m sight distance

6. Semi-enclosed 2-5 m sight distance
7. Open, 50-80 m sight distance.

Many pedestrians, View from many people’s homes.
Table 3
Means and standard deviations for overall Perceived Restorativeness Scale (PRS) value and the four subscales of sites in urban parks.

<table>
<thead>
<tr>
<th>Videotaped scenes</th>
<th>Overall PRS (perceived restorativeness)</th>
<th>Subscales</th>
<th>Subscales</th>
<th>Subscales</th>
<th>Subscales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
</tr>
<tr>
<td>Lawn w/people</td>
<td>4.63 (0.76)</td>
<td>5.34 (0.95)</td>
<td>4.81 (0.99)</td>
<td>4.21 (1.37)</td>
<td>4.15 (1.12)</td>
</tr>
<tr>
<td>Lawn w/o people</td>
<td>4.96 (0.75)</td>
<td>5.52 (0.77)</td>
<td>4.30 (1.06)</td>
<td>5.34 (0.96)</td>
<td>4.67 (1.12)</td>
</tr>
<tr>
<td>Plaza w/people</td>
<td>3.95 (0.83)</td>
<td>4.58 (1.02)</td>
<td>3.56 (1.02)</td>
<td>4.50 (1.32)</td>
<td>3.17 (1.09)</td>
</tr>
<tr>
<td>Plaza w/o people</td>
<td>3.96 (0.83)</td>
<td>4.19 (1.20)</td>
<td>3.61 (0.90)</td>
<td>4.74 (1.02)</td>
<td>3.29 (1.10)</td>
</tr>
<tr>
<td>Small Lake</td>
<td>4.95 (0.66)</td>
<td>5.47 (0.76)</td>
<td>4.59 (0.94)</td>
<td>5.09 (1.07)</td>
<td>4.64 (1.01)</td>
</tr>
<tr>
<td>Walkway</td>
<td>4.49 (0.64)</td>
<td>5.03 (1.13)</td>
<td>4.09 (0.97)</td>
<td>4.84 (0.92)</td>
<td>3.99 (0.93)</td>
</tr>
<tr>
<td>Urban Roadway</td>
<td>2.07 (0.52)</td>
<td>1.83 (0.87)</td>
<td>2.20 (0.92)</td>
<td>2.62 (0.95)</td>
<td>1.65 (0.74)</td>
</tr>
</tbody>
</table>

PRS based on 7-point scale, where lower values indicate lower levels of restorative experience. \(N=20\) for each scene.
Fig. 9. Mean differences and standard deviations of the changes in state anxiety using the state part of the State-Trait Anxiety Inventory (STAI-S), where the values indicate the extent to which different videos relieved anxiety. *p*-Values show pairwise comparisons of each site condition, contrasted with Urban Roadway (N = 20): *** *p* < 0.001.
More nature-based
Less hardscape
Water
Reduced crowding

“The findings can also help landscape architects design more effective landscape components in urban parks.”
OBJECTIVES

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- Why stress is a major risk factor for many **diseases**
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DISCUSS
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