Good Health Grows on Trees
the research evidence

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Data → Information → Knowledge → Wisdom

meaning → value
Public Perceptions & Values for Trees

Public Perceptions

Health & Economic Values

Nature & Human Health Evidence
“The tree which moves some to tears of joy is in the eyes of others only a green thing that stands in the way. Some see nature all ridicule and deformity . . . and some scarce see nature at all. But to the eyes of the man of imagination, nature is imagination itself.”

WILLIAM BLAKE
trait distinctions:

- conifers & deciduous
- crown shape
- 2D crown size to trunk height ratio
- crown density
higher branching trunk
dense canopy
moderate length of leaves (about 4.5 in)
seasonal differences in response
Determining Public Values of Urban Forests Using a Sidewalk Interception Survey in Fredericton, Halifax, and Winnipeg, Canada

importance of urban forests, because:

- aesthetics
- air quality
- shade
- naturalness
- older people and women rated higher importance for trees
How do people perceive urban trees? Assessing likes and dislikes in relation to the trees of a city

- **Benefits:** oxygen supply, shade, aesthetics
- **Annoyances:** dropped leaves, tend to fall, infrastructure damage
- **Preferences:** larger trees, trees near houses, increase tree density, more needed in the city
How are urban trees associated with human health?
Health is...

A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity

(World Health Organization, 1946)
Green Cities: Good Health
www.greenhealth.washington.edu

Sponsors:
USDA Forest Service,
(U&CF Program + Pacific NW Research)
University of Washington
NGO partners

Thanks!
to U of WA students:
Katrina Flora
Mary Ann Rozance
Sarah Krueger

Research Reviews & Summaries
Local Economics

Trees in cities are not grown and managed for products that can be bought and sold on markets, but they do provide many intangible services and functions! This article serves two purposes. First, it introduces valuation methods that are used to convert intangible benefits to dollar sums. Then, it shows how nonmarket valuations can support local decision-making.

Fast Facts

- The presence of larger trees in yards and as street trees can add from 3% to 15% to home values throughout neighborhoods.
- Averaging the market effect of street trees on all house values across Portland, Oregon yields a total value of $1.35 billion, potentially increasing annual property tax revenues $15.3 million.
- A study found 7% higher rental rates for commercial offices having high quality landscapes.
- Shoppers claim that they will spend 9% to 12% more for goods and services in central business districts having high quality tree canopy.
- Shoppers indicate that they will travel greater distance and a longer time to visit a district having high quality trees, and spend more time there once they arrive.
Literature review of research about nearby nature & human health
Outside Our Doors

The benefits of cities where people and nature thrive.

design: milepost

coa-author

coa-author & printing:

The Nature Conservancy
Public Perceptions & Values for Trees

Public Perceptions

Health & Economic Values

Nature & Human Health Evidence
Urban Trees & Human Health: A Scoping Review

Purpose:
To carefully collect and synthesize the peer-reviewed evidence concerning urban trees and human health
Project Team

- Kathleen Wolf, Ph.D., University of Washington
- Sharon Lam, MSc, Ontario Climate Consortium
- Jennifer McKeen, MPH, Simon Fraser University
- Gregory Richardson, MUP, Health Canada
- Matilda Van Den Bosch, M.D, University of British Columbia
- Adrina Bardekjian, Ph.D., Tree Canada
Method

Keyword search (n = 2563)

Abstract review (n = 436)

Quality assessment (n = 215)

Final article set (n = 199) (201 studies)

Synthesize and present findings
What did we learn?

Publication Dates by Decade

- 1980-1989
- 1990-1999
- 2000-2009
- 2010-2018
What did we learn?

- single & park trees
- pollen
- tree canopy/NDVI
- immersion
- image/simulation

credit: Univ of Utah
What did we learn?

Health Outcomes Themes:

- Tree Pollen and VOCs
- Active Living/Weight Status
- Psychophysiological Stress
- Excess Heat and Thermal Comfort
- Cardiovascular Function
- Mental Health, Anxiety and Mood
- Air Pollutants and Respiratory Condition
- Other Restoring Capacities (e.g., Birth...)
- Cognition and Attention Restoration
- Other Reducing Harm (Crime, UVR)
- Clinical Outcomes
Urban Forests & Newborns
the natural environment may affect pregnancy outcomes . . .

10% increase in tree-canopy cover within 50m of a house
= lower number of low weight births
(1.42 per 1000 births)

Donovan et al., 2011. *Health & Place* 2011; Hystad et al., 2014. *Env Health Perspectives*
Healthy Microbiome

- control obesity & asthma
- boost immune function
- improve mental health

Bloomfield et al. 2016 Perspectives in Public Health

need contact with ‘Old Friends’

put aside the Hygiene Hypothesis
~10 to 100 trillion microbes in healthy gastrointestinal (GI) tract

intestine microbiome development

Arrieta et al. 2014. Frontiers in Immunology
Children & Nature Network

The Statistics on Children & Nature

Green Schoolyards Help Kids Feel:

- Calmer & Less Stressed: Views of green landscapes from classroom windows helped high school students recover more quickly from stressful events.
- Positive & Restored: Forest schools enhanced positive and decreased negative emotions.
- Resilient: Natural areas enhanced feelings of competence and increased supportive social relationships that help build resilience.

Green Schoolyards Promote Social-Emotional Skills

Practice Relationship Skills: Children demonstrated more cooperative play, civil behavior and positive social relationships in green schoolyards.

Develop Self-Awareness & Self-Management: Green schoolyards can reduce aggression and discipline problems. Gardening at school helped students feel proud, responsible & confident.
physically disabled & tree climbing!
Green High School Campuses

- cafeteria & classroom window views with greater quantities of trees and shrubs
- positively associated with:
  - standardized test scores,
  - graduation rates
  - %s of students planning to attend a four-year college
  - fewer occurrences of criminal behavior

Matsuoka. 2010. Landscape & Urban Planning

credit: NBC News
Public health officials moderate activity recommendations.
Encouraging Physical Activity

Review of studies of adults, natural environments vs indoors

Results of activity in natural environments:

- greater feelings of revitalization and positive engagement, increased energy
- decreases in tension, confusion, anger, and depression
- greater enjoyment and satisfaction, declared a greater intent to repeat the activity at a later date

Coon et al. 2011. *Environmental Science & Technology*
Improving Depression

20 adults with major depression walk in park setting or built setting

• 50-minute walks one week apart

• before-after testing:
  • Mood: Positive and Negative Affect
  • Cognition: Backward Digit Span

Berman et al. 2012. *Journal of Affective Disorders*

cognitive and affective improvements after walking in a nature setting
How Walking in Nature Changes the Brain

rumination: Maladaptive self-referential thoughts, heightened risk for depression and other mental illnesses

90-min walk in a natural setting decreased

- self-reported rumination
- neural activity in the subgenual prefrontal cortex
- no reduced effects from built environment walks

Bratman et al. 2015. *Proceedings of the National Academy of Sciences of the USA*
Group Walks Improve Mental Health

England, Walking for Health national program test Nature Group Walkers vs Non Group Walkers

results:
- lower depression, perceived stress, negative affect
- enhanced positive affect and mental well-being
- group walks synergize with physical activity to improve positive affect and mental well-being
Tree cover shows an inverse relationship with depressive symptoms in elderly residents living in U.S. nursing homes

Matthew H.E.M. Browning, Kangjae Lee, Kathleen L. Wolf
Forest Bathing & Therapy  *Shinrin yoku*

more than a decade of research – Japan, South Korea, northern Europe
Forest Bathing & Therapy
multiple wellness benefits

results for forest vs built environments:
- reduced stress & diabetes symptoms
- improved pulse rate, blood pressure, mood
- improved nervous system activity – less fight or flight
- one influence? phytoncides (wood essential oils)

Park et al., 2010. *Environmental Health and Preventive Medicine*
Li et al. 2006. *Immunopharmacology and Immunotoxicology*
The medicine of being in the forest

We are the leading global voice for forest bathing and forest therapy

Santa Rosa, California
City Trees & Human Health

- newborn & infant health
- increased physical activity for kids
- student therapy
- overall adult health
- social cohesion
- respiratory & cardiovascular health
- reduced depression
- elder care improvements
Story: Trees for Human Health Benefits Across the Life Cycle
Public Perceptions & Values for Trees

- Public Perceptions
- Health & Economic Values
- Nature & Human Health Evidence
Health Care Spending in U.S.

- $10,348 annual per capita (2016)
- $3.5 trillion total
- 17.9% of Gross Domestic Product

Wisconsin (2014): $8,702 per capita (+ 2-4% annual)
18.8% of GSP, (higher than U.S. average)
15 Leading Causes of Death in U.S., 2017

- Diseases of heart
- Cancer
- Accidents (unintentional injuries)
- Chronic lower respiratory diseases
- Cerebrovascular diseases
- Alzheimer's disease
- Diabetes mellitus
- Influenza and pneumonia
- Nephritis, nephrotic syndrome and nephrosis
- Intentional self-harm (suicide)
- Chronic liver disease and cirrhosis
- Septicemia
- Essential hypertension & renal hypertension
- Parkinson's disease
- Pneumonitis due to solids and liquids

source: U.S. Centers for Disease Control and Prevention
Costly chronic diseases
Nature & Health Economics Analysis Process

- human scale: individual to community
  - screen for benefits

- green condition
  - urban forestry
  - parks
  - gardens, etc.

- valuation strategy
  - market
  - non-market
## Nature & Health Annual Savings

Millions of U.S. Dollars (2012)

<table>
<thead>
<tr>
<th>Benefit (geographic scope)</th>
<th>Minimum ($)</th>
<th>Maximum ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn Health (U.S.)</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Attention Deficit Hyperactivity Disorder (U.S.)</td>
<td>383.5</td>
<td>1,917.7</td>
</tr>
<tr>
<td>Schools (U.S.)</td>
<td>20.4</td>
<td>1,262.9</td>
</tr>
<tr>
<td>Crime (U.S.)</td>
<td>340.6</td>
<td>899.4</td>
</tr>
<tr>
<td>Cardiovascular Disease (U.K., U.S.)</td>
<td>1,220.0</td>
<td>1,220.0</td>
</tr>
<tr>
<td>Alzheimer’s Disease (U.S.)</td>
<td>724.6</td>
<td>1,449.2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>2,694.4</strong></td>
<td><strong>6,754.5</strong></td>
</tr>
</tbody>
</table>

Nearby nature experiences are important across the entire life cycle, from cradle to grave.

INFANTS

BIRTH WEIGHT

ECONOMIC IMPACT
INCREASED PHYSICAL ACTIVITY, REDUCED ACTUAL (OR LEADING CAUSE OF DEATH) DEATHS, INCREASED QUALITY OF LIFE, AND REDUCTION OF BURDEN ON HEALTH SYSTEM.

OVERALL HEALTH AND WELL-BEING

ECONOMIC IMPACT
INCREASED PHYSICAL ACTIVITY, REDUCED ACTUAL (OR LEADING CAUSE OF DEATH) DEATHS, INCREASED QUALITY OF LIFE, AND REDUCTION OF BURDEN ON HEALTH SYSTEM.

IMMUNE FUNCTION

ECONOMIC IMPACT
STRENGTHENED IMMUNE SYSTEM LEADS TO REDUCED ILLNESS AND CHRONIC DISEASE ALONG A LIFETIME.

FAMILY DYNAMICS

ECONOMIC IMPACT
IMPROVED FAMILY DYNAMICS, ENSURING MENTAL HEALTH CARE TO MISS A DAY OF WORK.

ADHD

ECONOMIC IMPACT
$2200 IN SAVINGS ON MEDICATIONS PER YEAR.

FUTURE FINANCIAL SUCCESS

ECONOMIC IMPACT
$3.90 INCREASE IN HIGH SCHOOL GRADUATED LIFESpan ANNUAL INCOMES.

Note: All economic values are in 2018 U.S. dollars, and are potential annual savings across the entire U.S.

CHILDREN & TEENS

RESEARCH ON NATURE BENEFITS AND ECONOMIC VALUE IS FAIRLY NEW. SOME OF THE QUANTIFIED HEALTH BENEFITS OF NATURE IN CITIES ARE EASIER TO CONVERSION TO ECONOMIC VALUES THAN OTHERS. HERE ARE SOME PRELIMINARY VALUATIONS - ESTIMATED FOR THE ENTIRE U.S. ON AN ANNUAL BASIS.

ADULTS

DEPRESSION & STRESS

ECONOMIC IMPACT
REDUCTION IN MENTAL HEALTH COSTS, DECREASED PREMATURE DEATHS, AND INCREASED QUALITY OF LIFE.

CARDIOVASCULAR DISEASE

ECONOMIC IMPACT
$5.7-$6.48 SAVINGS ON HEART CARE COSTS FROM FALLS PER YEAR.

MOBILITY & QUALITY OF LIFE

ECONOMIC IMPACT
$5.7-$6.48 SAVINGS ON HEART CARE COSTS FROM FALLS PER YEAR.

HYPERTENSION

ECONOMIC IMPACT
$5.7-$6.48 SAVINGS ON HEART CARE COSTS FROM FALLS PER YEAR.

COGNITIVE DISORDERS

ECONOMIC IMPACT
$5.7-$6.48 SAVINGS ON HEART CARE COSTS FROM FALLS PER YEAR.

CONTRIBUTING ANALYSTS:
Dr. Stephen Grado & Marcus Measells, MSU; Dr. Alicia Robbins, Weyerhaeuser
Urban Forests for Human Health: A Focused Economic Valuation

Healthy trees are rooted in research!
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**Strength of Evidence**

<table>
<thead>
<tr>
<th>Demonstrates a Rationale</th>
<th>well-specified logic model or modeling of conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promising</td>
<td>correlational study with statistical controls for bias</td>
</tr>
<tr>
<td>Moderate</td>
<td>quasi-experimental study a ‘natural experiment’</td>
</tr>
<tr>
<td>Strong</td>
<td>experimental study e.g. randomized control trial</td>
</tr>
</tbody>
</table>
Trees & Health Valuation Potential

- cancer
- diabetes, respiratory illness, asthma, healing/recovery
- cardiovascular disease, mental disease, ADHD

strength of evidence
clinical illness &
disease incidence
# Health Care Costs

<table>
<thead>
<tr>
<th>Illness or Disease</th>
<th>Annual Costs (U.S.)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>hospital stay/recovery</td>
<td>$1.1 trillion (2017)</td>
<td><a href="https://debt.org">debt.org</a></td>
</tr>
<tr>
<td>diabetes</td>
<td>$327 billion (2017)</td>
<td><a href="https://www.diabetes.org">American Diabetes Association</a></td>
</tr>
<tr>
<td>mental disease</td>
<td>$201 billion (2013)</td>
<td><a href="https://www.healthaffairs.org">Health Affairs Journal</a></td>
</tr>
<tr>
<td>cardiovascular disease</td>
<td>$200 billion (2015)</td>
<td><a href="https://www.cdc.gov">Centers for Disease Control &amp; Prevention</a></td>
</tr>
<tr>
<td>ADHD</td>
<td>$143 billion (2013)</td>
<td><a href="https://www.aap.org">American Academy of Child and Adolescent Psychiatry</a></td>
</tr>
<tr>
<td>asthma</td>
<td>$82 billion (2013)</td>
<td><a href="https://www.thoracic.org">American Thoracic Society</a></td>
</tr>
<tr>
<td>respiratory illness</td>
<td>$36 billion (2010)</td>
<td><a href="https://www.chest.org">American College of Chest Physicians</a></td>
</tr>
</tbody>
</table>
Trees & Health Valuation Potential

- Physical activity, weight control, UV screen, better sleep

- Birth outcomes, pain relief, crime reduction, thermal comfort, social cohesion

- Stress, anxiety, mental function, immune function

Strength of evidence:

Health & wellness: ‘protection’
Conclusions!

- Public Perceptions
- Health & Economic Values
- Nature & Human Health Evidence
Build Knowledge Into Practice

• nearly 40 years of research about health: city trees, nearby nature
• evidence to counter negative messages
• knowledge to inform allies & advocates
• possible identity messaging
healthy trees.
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Good Health Grows on Trees: The Research Evidence
Kathleen Wolf

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