

Introduction

Ecosystems provide many nature-based goods and services that are beneficial to society. There is a large body of research linking these ecosystem services to improvements in human health. The ecosystem services that are most relevant to human health can be broadly categorized as: air filtration; biodiversity conservation; climate stabilization; habitat maintenance; natural hazard mitigation; food, fuel and fiber production; water filtration; water regulation; and the provision of aesthetic environments and recreational opportunities. A review article summarizing this work was recently published in *IJPH* (doi: 10.1007/s00038-013-0482-1).

Objectives

- (1) Identify literature focused on the relationship between ecosystem services and human health.
- (2) Design an interactive, web-based tool highlighting the weight of evidence.
- (3) Make the information accessible to a wide audience.

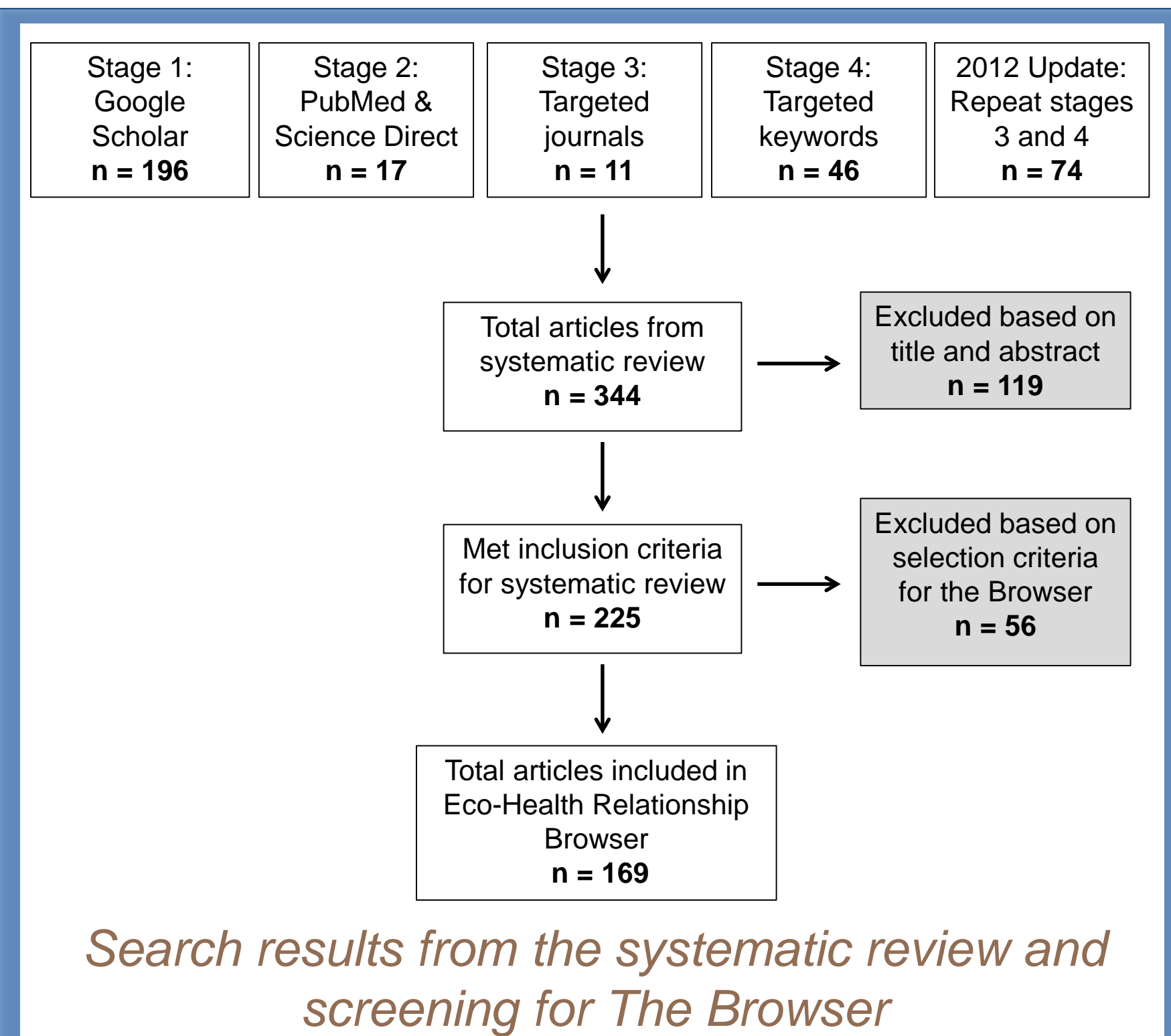
Methods

Stage 1: Google Scholar search terms Health terms Health Mental Health Wellbeing Well-being Social Physical Environment Terms Natural Environment Green space Ecosystem Services Open space Nature Park (s) Urban forest Greenness Wetlands	Stage 2: PubMed & Science Direct search terms a) Health + Green space; Greenness; Urban forest; Natural environment b) Mental Health + Ecosystem service; Greenness; Urban forest c) Wellbeing/Well-being + Greenness; Urban forest d) Physical + Parks; Green space
Stage 3: Targeted journals Searched "health" and "green" within: Landscape and Urban Planning; Urban Forestry & Urban Greening; Health & Place; American Journal of Preventive Medicine; Environment and Behavior; Journal of Environmental Psychology; Journal of Epidemiology and Community Health	Stage 4: Targeted keywords Category 1 + Category 2 + Category 3 a) Ecosystem + Topic (T) + Human health b) Ecosystem + Service (S1) + Human health c) Ecosystem + Service (S2) + Human health

The four stages of the systematic review

Screening Articles for the Browser

- A four stage systematic review focused on ecosystem services and human health was conducted (see left)
- The literature search was limited to peer-reviewed journal articles published from 1 January 1990 to 31 December 2012
- Gathered articles were then screened for inclusion in the Browser
- Preference was given to articles that were published after 2000, with objectively measured variables, and quantitative results



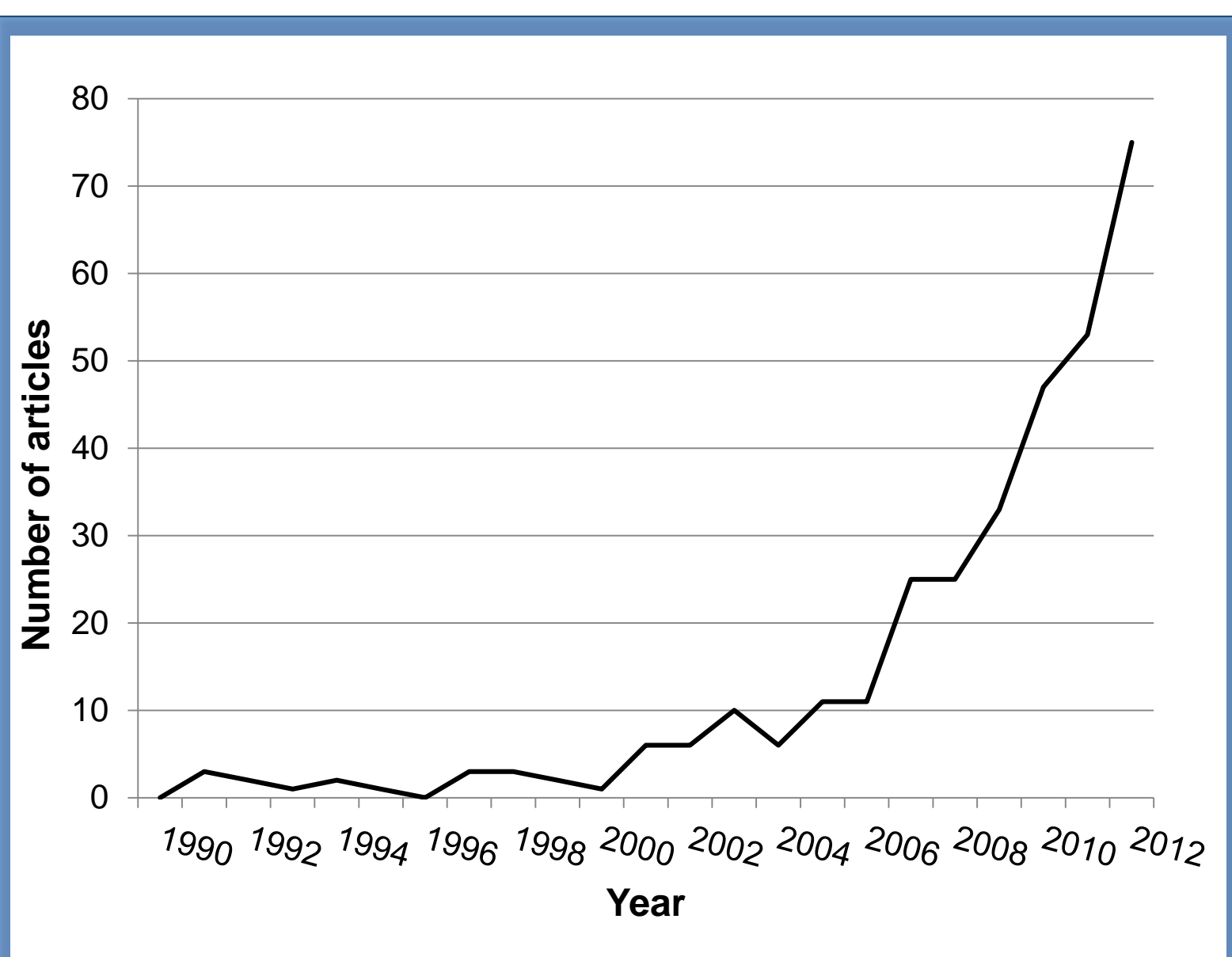
Search results from the systematic review and screening for The Browser

Article Exclusion

- Inappropriate article type (e.g., book, abstract)
- No reported consideration of ecosystem services/natural stimuli/nature as the exposure variable
- No mention of a health outcome
- Lack of adherence to Browser structure (e.g., review papers)

Results: Systematic Review

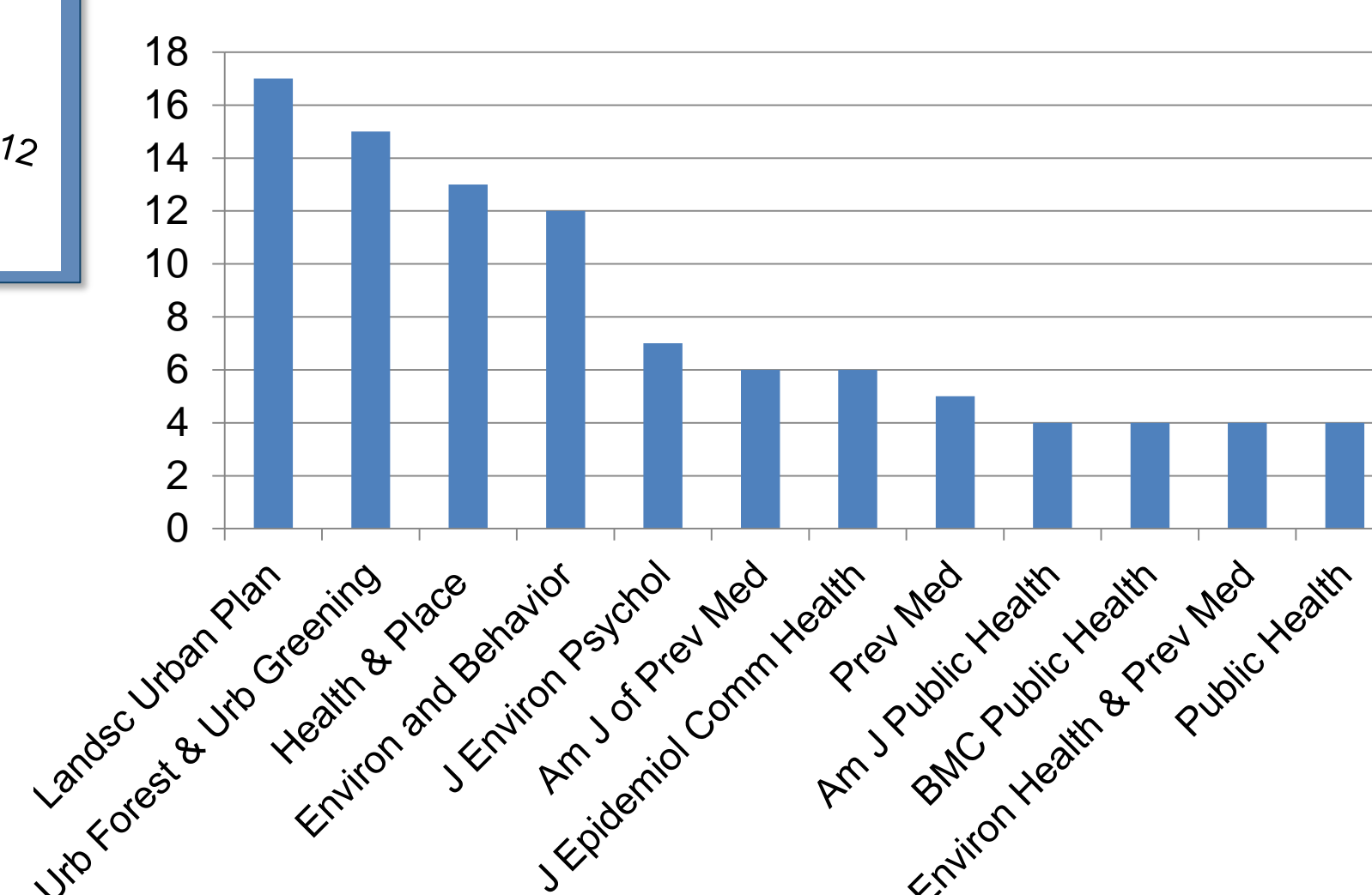
Number of relevant articles returned from the systematic review from 1990 to 2012



- 344 potentially relevant articles were collected for further review

- Results suggest an increase in attention to the subject area, as the annual publication of articles increased substantially from 0 to 75 from 1990 to 2012 (see left)

Journals publishing the most articles identified in review of ecosystem services and human health 1990-2012



- Several journals published multiple articles; between 4 and 17 articles were found in 12 journals (see right)

- The majority of articles focused on either buffering or health-promotional services

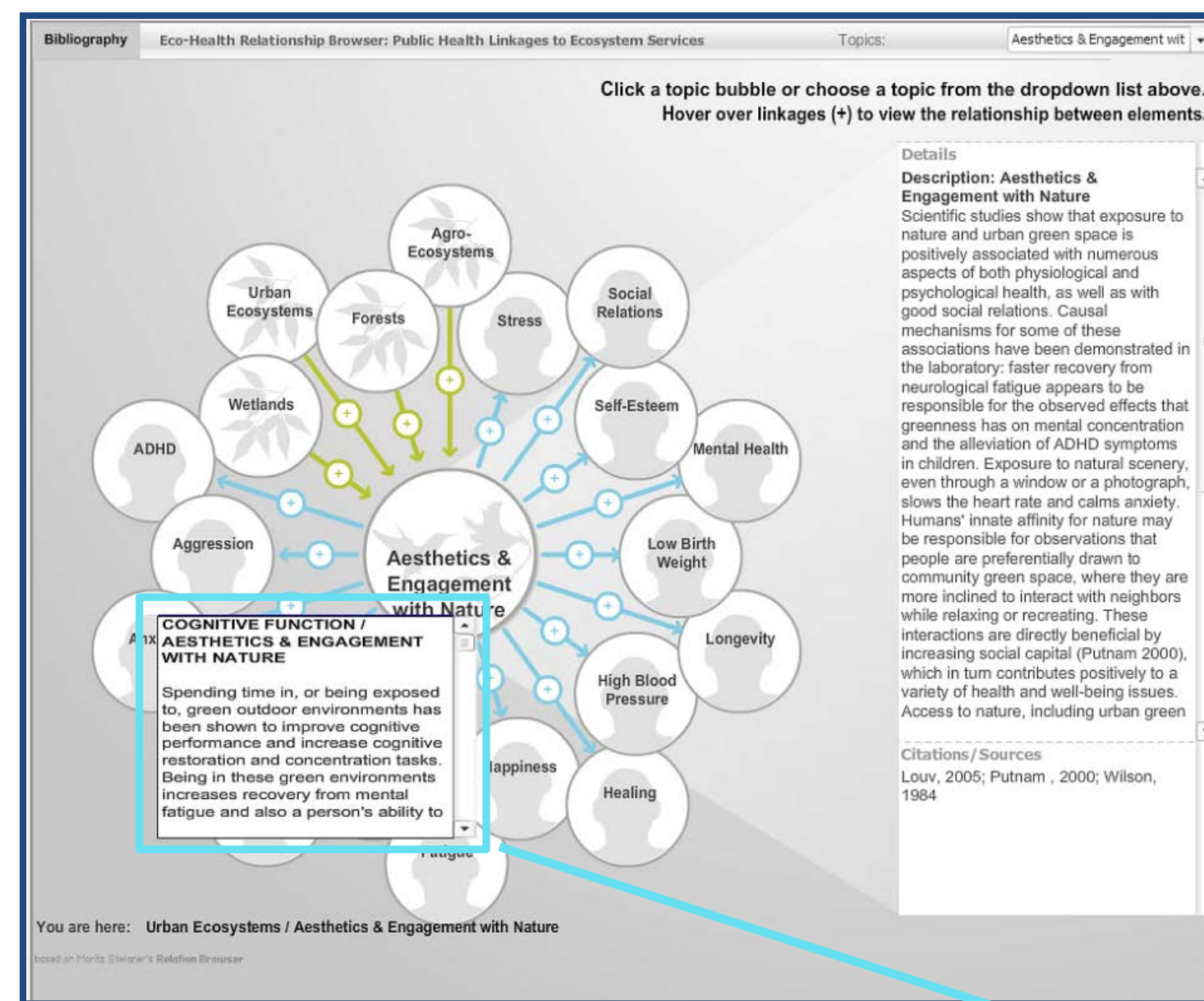
Results: The Eco-Health Browser

The Eco-Health Relationship Browser

www.epa.gov/enviroatlas/enviroatlas-eco-health-relationship-browser

There are four ecosystems in the Browser:

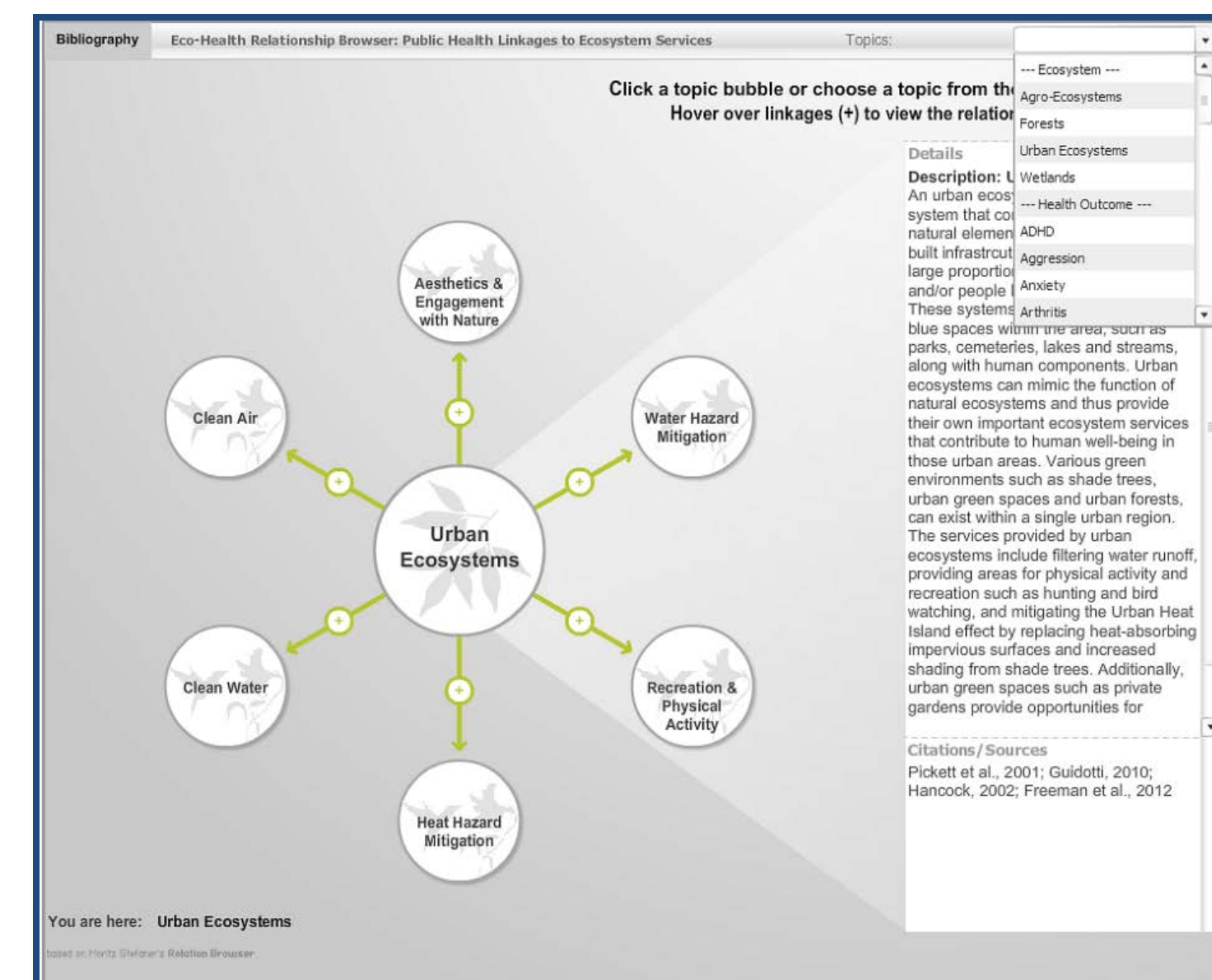
- Forests
- Urban Ecosystems
- Wetlands
- Agro-Ecosystems



Health Outcomes

There are over 30 health outcomes in the Eco-Health Browser that relate to various ecosystem services. These include the following:

- Anxiety
- Stress
- Cognitive function
- Low birth weight
- ADHD
- Healing
- Confusion
- Fatigue
- Self-esteem
- Social relations
- Mental Health
- Birth Outcomes



Ecosystem Services

Health promotional services

- Aesthetics and Engagement with Nature
- Recreation and Physical Activity

Buffering Services

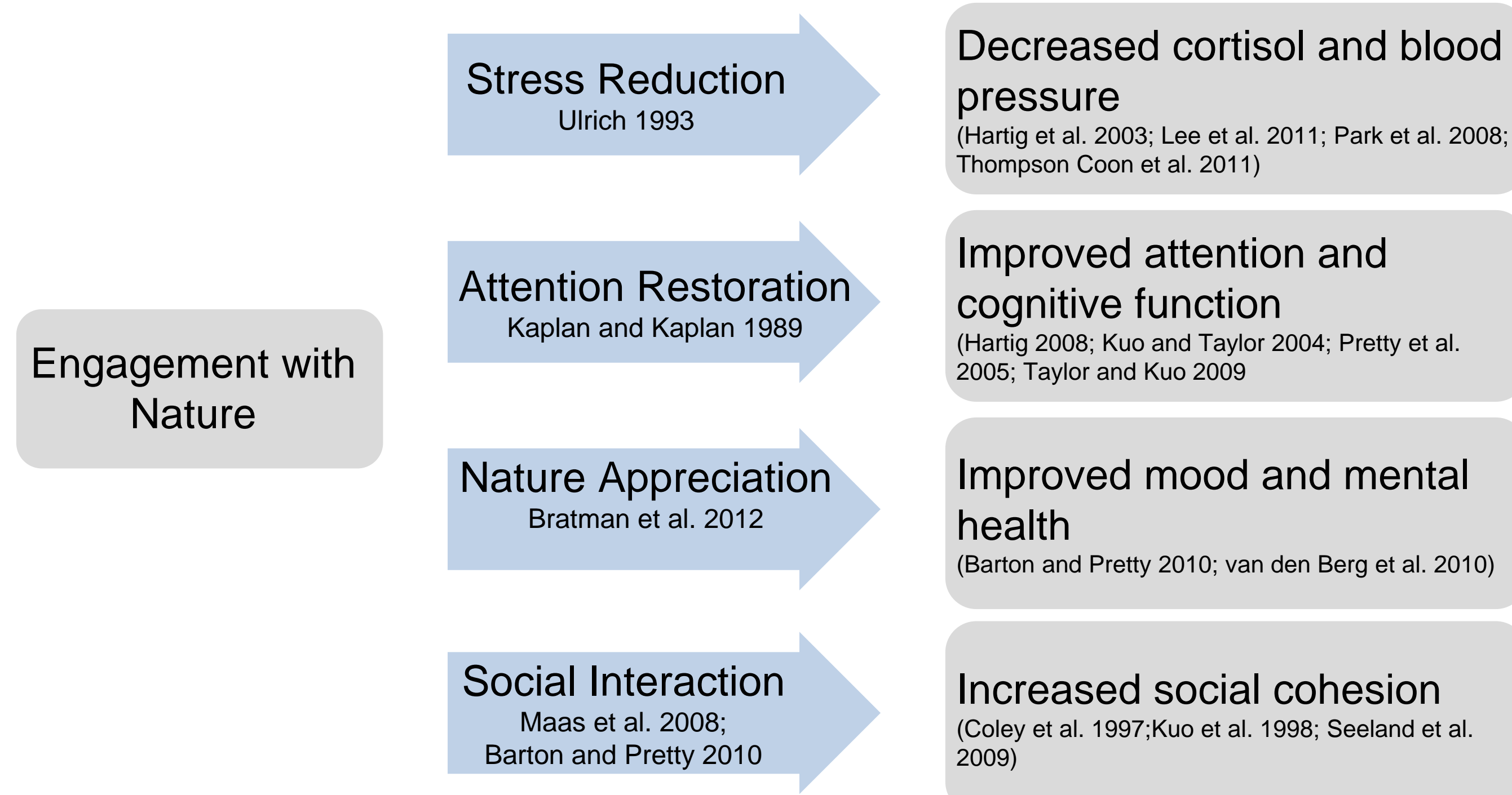
- Clean Air
- Clean Water
- Heat Hazard Mitigation
- Water Hazard Mitigation

Browser Pop-Up Box

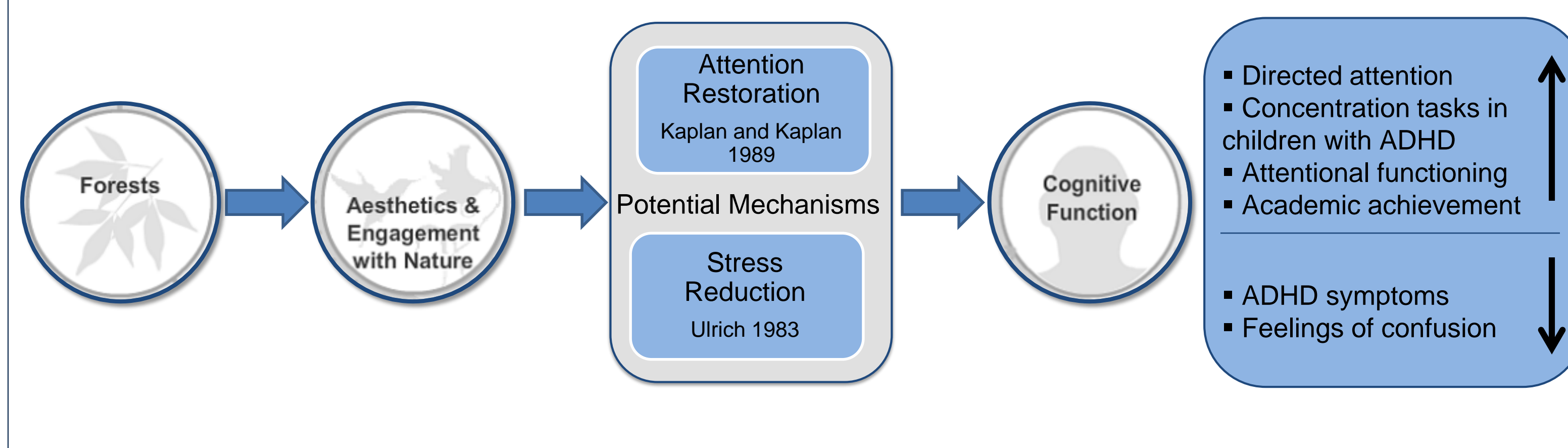
- Pop-up appears when user hovers over "+".
- Article summaries capture the state of the science on the selected link.
- Includes citations, sample sizes, and study locations.
- Summaries allow reader to distinguish between speculative and more well-established results.

Discussion: Mechanisms for Observed Health Outcomes

Prevailing Mechanistic Theories



An Example of Integrating Mechanistic Theories into the Browser



Acknowledgements and Disclaimer

This work was supported by US EPA Contracts EP-10-D-000808, EP-11-D-000186, and EP-11-D-000529; and Cooperative Agreement Number X3-83388101 between the US Environmental Protection Agency and the Association of the Schools of Public Health. Findings and conclusions do not necessarily represent the official views of EPA or ASPH. We would like to recognize the contribution of several individuals who reviewed the Browser during the beta-testing stage of development.