HUMAN HEALTH CONNECTIONS TO ECOSYSTEM SERVICES, NATURE, AND BIODIVERSITY

Paul A. Sandifer[1] and Ariana Sutton-Grier[2]

[1]NOAA/National Ocean Service

[2]University of Maryland and
NOAA/National Ocean Service

ACES Conference, Dec 8-12, 2014
Washington, DC




Prior Reasons to Preserve Biodiversity

- Biodiversity Important for:
  - Intrinsic value
  - Production of ecosystem services
    - Food and raw materials
    - New medicines & other products
    - Medical research and trials
    - Climate (and other system) regulation

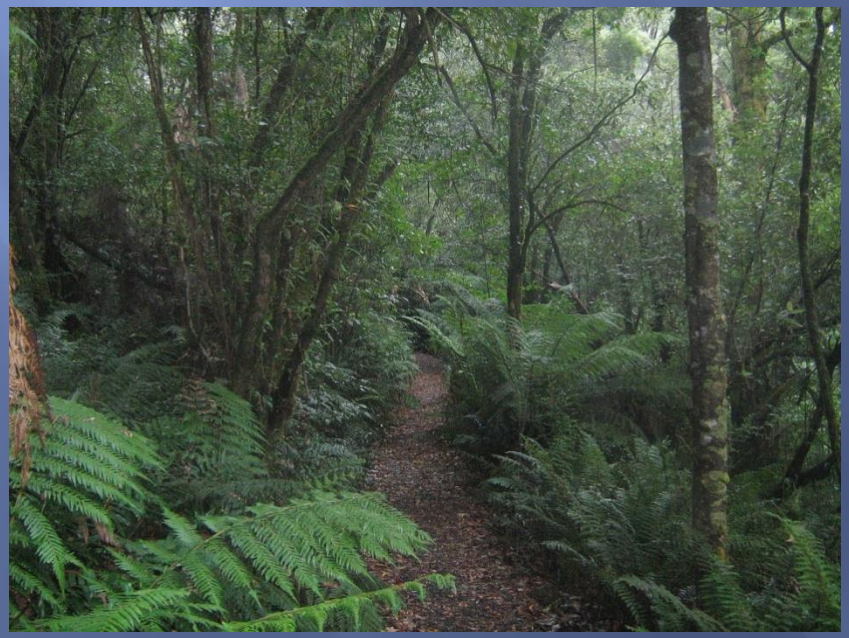
Nature, Biodiversity and Human Health

- New evidence suggests that there are additional reasons to preserve biodiversity
- Important connections to human health and well-being
- Human health is "ultimate ecosystem service"

Human Health and Well-Being

- "…a state of physical, mental and social well-being and not merely the absence of disease or infirmity." (WHO, 1946)
- Health also includes a supportive environment, personal security, freedom of choice, social relationships, adequate employment and income, access to educational resources, and cultural identity

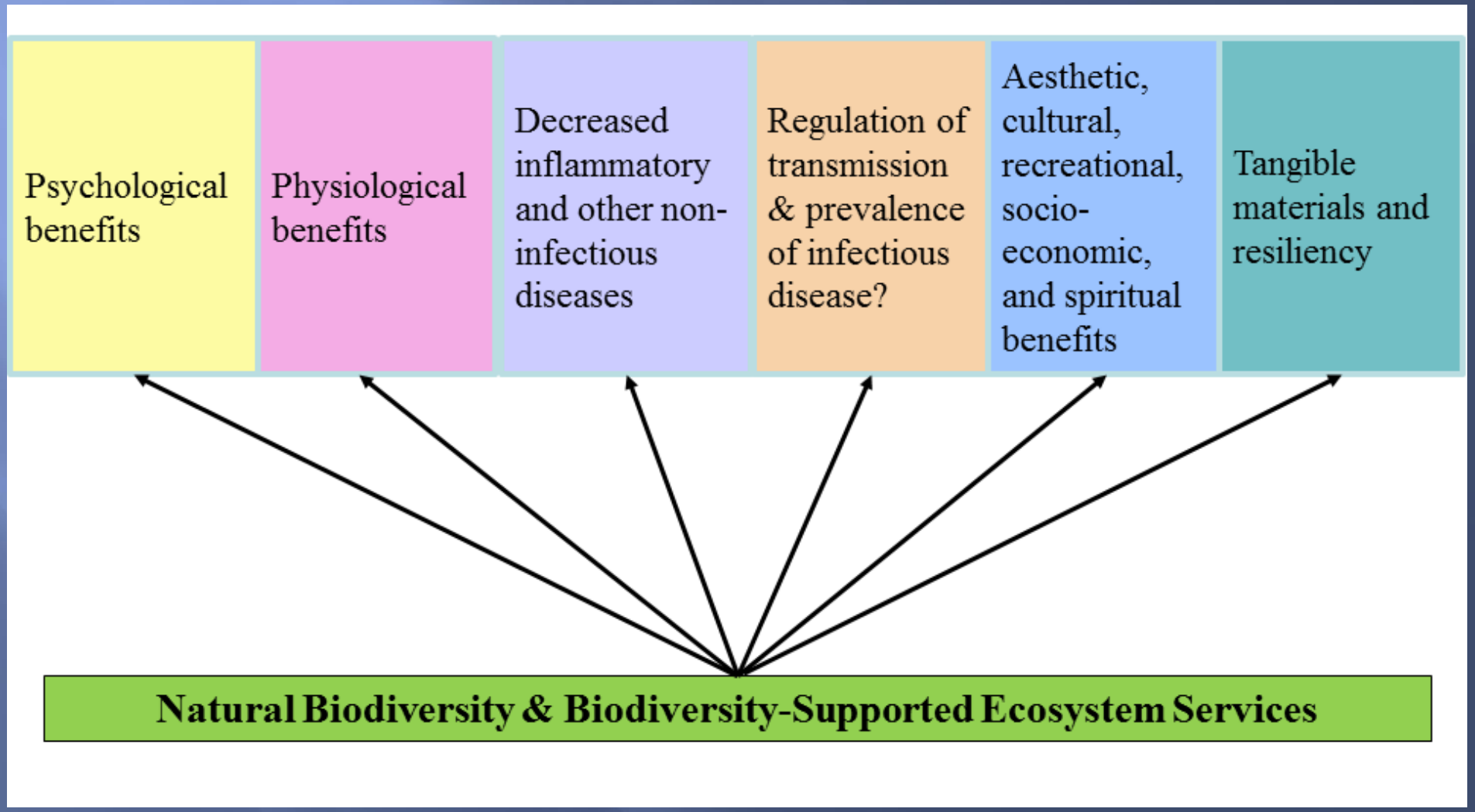
Our Research Questions



1. Is there convincing evidence that experiencing more natural settings, even briefly or vicariously, can improve psychological and physical health?
2. Does exposure to biodiverse nature result in measurable health responses?
3. Can biodiversity provide humans and animals protection from infectious and/or allergic and inflammatory diseases?

(Sandifer, Sutton-Grier and Ward, In Review)

Major Pathways By Which Nature and Biodiversity Provide Health Benefits to Humans



Typology and Examples of Reported Health Benefits of Interacting with Nature

Benefits	Description	Examples
Physiological	Positive effect on physical function and/or physical health	Better general health Perceived health/well-being Reduced illness/cough/sick leave/mortality Reduced stress/stress-related illness/improved physiological functioning Reduced cortisol levels (indicator of lower stress) Reduced blood pressure Reduced mortality from circulatory disease Reduced mortality from stroke Reduced headaches/pain Reduced mortality due to income deprivation

Benefits	Description	Examples
Physiological (cont'd)	Positive effect on physical function and/or physical health	Reduced COPD, upper respiratory tract infections, asthma, other inflammatory disorders, and infectious intestinal disease Faster healing/recovery from surgery/illness/trauma Improved addiction recovery Reduced cardiovascular and respiratory disease in men Reduced pulse/heart rate Decreased sympathetic nerve activity Increased parasympathetic nerve activity Increased levels of natural killer cells and anti-cancer proteins Decreased blood glucose levels in diabetes patients Increased physical activity Reduced exposure to pollution Increased longevity Better health of children General health/convalescence/better health near coasts

Benefits	Description	Examples
Psychological	Positive effect on mental processes and behavior	Psychological well-being Attention restoration/perceived restorativeness Decreased depression, dejection, anger, aggression, frustration, hostility, stress Increased self-esteem Positive/improved mood Reduced anxiety and tension Increased prosocial behavior/improved behavior Increased opportunities for reflection Increased vitality and vigor/decreased fatigue Increased creativity Increased happiness Increased calmness, comfort, and refreshment Improved body image for women Reduced ADHD in children Improved emotional, social life of children; self-worth Improved quality of life

Benefits	Description	Examples
Cognitive	Positive effect on cognitive ability or function	Attional restoration Reduced mental fatigue Reduced confusion Improved academic performance/education/learning opportunities Improved cognitive function Improved cognitive function in children Improved productivity/ability to perform taks/positive workplace attitude
Disease exposure and regulation	Potential to reduce incidence of infectious disease	Reduction in spread/amplification of some infectious diseases including some zoonotic diseases
Social	Positive effect at individual, community, or national scale	Increased/facilitated social interaction Enables social empowerment Reduced aggression, crime rates, violence, fear Enables interracial interaction Enhances social cohesion and social support

Benefits	Description	Examples
Aesthetic, cultural, recreational, spiritual	Positive effect on cultural and spiritual well-being	Aethetic appreciation Increased inspiration Enhanced spiritual well-being Increased recreational satisfaction
Tangible materials	Material goods, services, benefits	Supply of food, raw materials, medicines, and other values Contribution to biomedical advances Increased value of property/housing; money Increased economic value of recreation
Increased resiliency	Personal and community ability to withstand impacts and remain healthy	Sustainability/pro-environmentawareness and behavior Supply of ecosystem services critical for human health and well-being Supply of ecosystem services that support/protect communities and enable community resilience

Results: Nature and Human Health

Range of positive health responses to environments that are more natural

Reduces stress, blood pressure

Improves mood, self-esteem, energy, pleasure

Improves recovery from surgery

Decreases prevalence of asthma, anxiety

Biodiversity and Human Health

- Limited but growing evidence that not just exposure to nature, but contact with diverse natural habitats and many different species has positive effects on human health

Greater decrease in heart rate and more improvement in mood with fish diversity Cracknell 2013

Reflection, sense of identity, and sense of place increased with plant and bird diversity Fuller et al 2007

Preference for outdoor activity in biodiverse environments Dallimer 2012

Chronic Diseases and Biodiversity

- Allergy results from a *lack* of exposure to microbes which leads to hyper-responsiveness to bioparticles→ microbe-rich environments confer health benefits especially to children
- "Biodiversity," "Old Friends" or "Hygiene" hypothesis: loss of macrodiversity leads to loss of microdiversity which leads to changes in human microbiota and results in variety of disorders (Hanski et al. 2012, Rook 2010, 2013)

Finland Adolescent Study

- Loss of contact with diverse natural world is making us sick
- Analyzed land-use types within 3km radius of homes
- Kids with allergies had lower environment diversity and fewer kinds of Gram-negative gammaproteo-bacteria on their skin
- Hanski et al. (2012)

http://conservationmagazine.org/2012/09/biodiversity-under-our-skin-2/

For related information see also Debarry et al. 2007, 2010, Round and Mazmanian 2009, 2010, Rook 2010, 2013, Ege et al. 2011 , Haahtela et al. 2013, Bernstein 2014, Hough 2014, Fyhrquist et al. 2014, Lynch et al. 2014

Microbial Biodiversity and Human Health

1) Environmental microbiological diversity may profoundly affect the human microbiome and through these effects influence the operation of the human immune system. There appears to be a powerful association between the diversity of habitats (and associated microbiota) experienced, the diversity of microbiota on and in the human system, and certain important health outcomes.

Microbial Biodiversity and Human Health

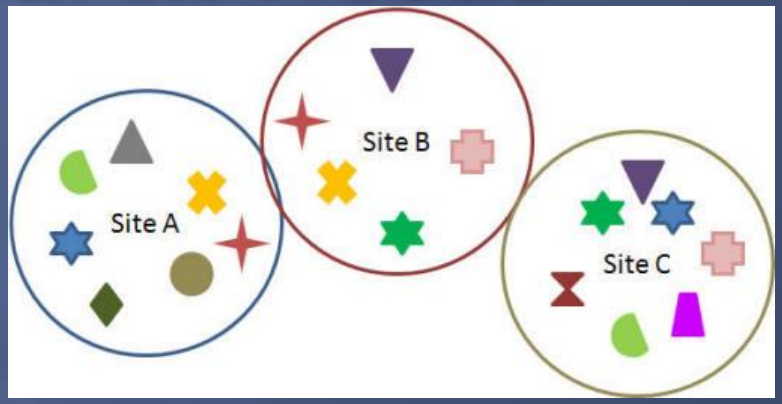
2) Rook (2013) concluded that:

"the requirement for microbial input from the environment to drive immunoregulation is… a neglected ecosystem service that is essential for our well-being."

3) But, we don't know much about the characteristics of environments that provide "good" microbial biodiversity exposure vs those that do not, with the exception that farms tend to be "good" and urban environments not so good.

Conclusions: Research Needs

- Specific mechanisms for how biodiversity affects human health
- Best ways to measure biodiversity to determine human exposure
- Best metrics of health to evaluate biodiversity-human health linkages
- Better methods to monitor biodiversity and integrate information into public health and natural resource management and policy
- Need for large, community-wide health datasets over longer periods of time available to researchers



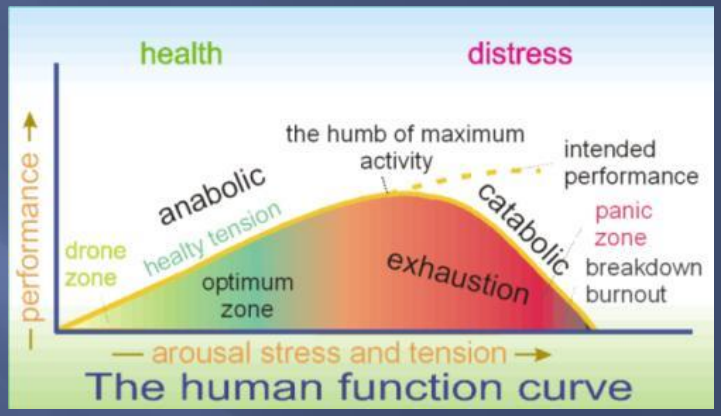
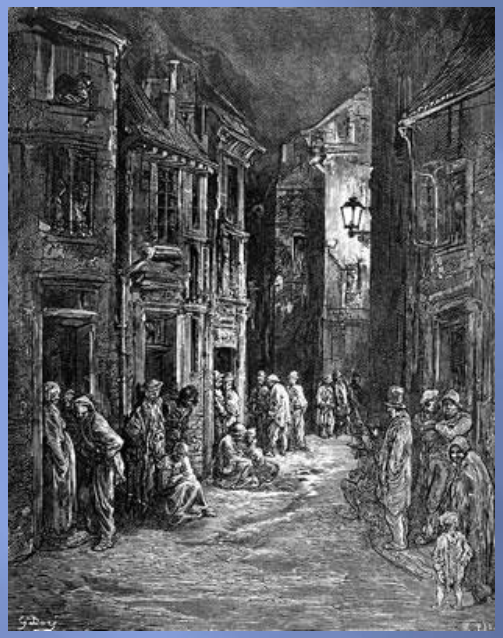


Figure 2. The Medical Quality Improvement Consortium (MQIC) comprises 35 million de-identified patient records from participating CPS and Centricity EMR practices.

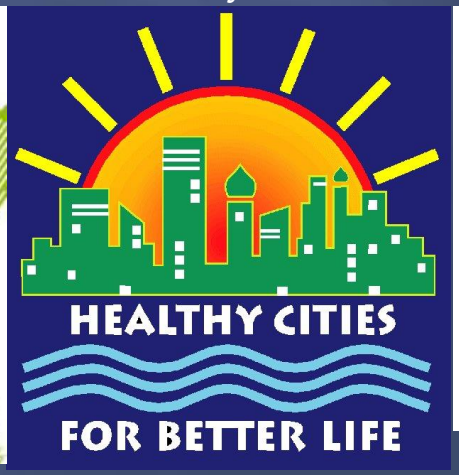
Conclusions: Policy and Planning



19th century poor conditions led to urban improvements

Ideally, want to place human health and well-being as the *central purpose* of urban planning

WHO Healthy Cities and Healthy Urban Planning Initiatives



Big Take Homes

- Human health is a neglected but hugely important ecosystem service.
- Biodiversity may have direct, positive impacts on human health. These need to be investigated and exploited.
- Potential to use these findings to enhance human well-being *and* develop increased public support for biodiversity conservation & restoration.
- Progress will require concerted effort across multiple disciplines of natural, social, and biomedical sciences as well as urban, land and coastal planners and policy makers.

Now is the time!

- Capitalize on the growing interest in ES, green building and natural infrastructure!
- Include projected health benefits in cost analyses
- Use health effects to support biodiversity conservation
- Reach out to involve other disciplines & organizations

Graphic: Rebuild By Design

Questions?

Contact information:
Paul Sandifer (paul.sandifer@noaa.gov or pasandifer@att.net)
Ariana Sutton-Grier (Ariana.sutton-grier@noaa.gov)

Photo: B. Ba