Value of Wetlands to Protect Biodiversity, Reduce Disaster Impacts, and Promote Human Health

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Coastal Ecosystem Services

Examples of benefits:

1. Protection from storms and erosion
2. Fisheries (recreational and commercial)
3. Recreation & tourism
4. Water filtration
5. Cultural services including supporting human health
6. Habitat for other species

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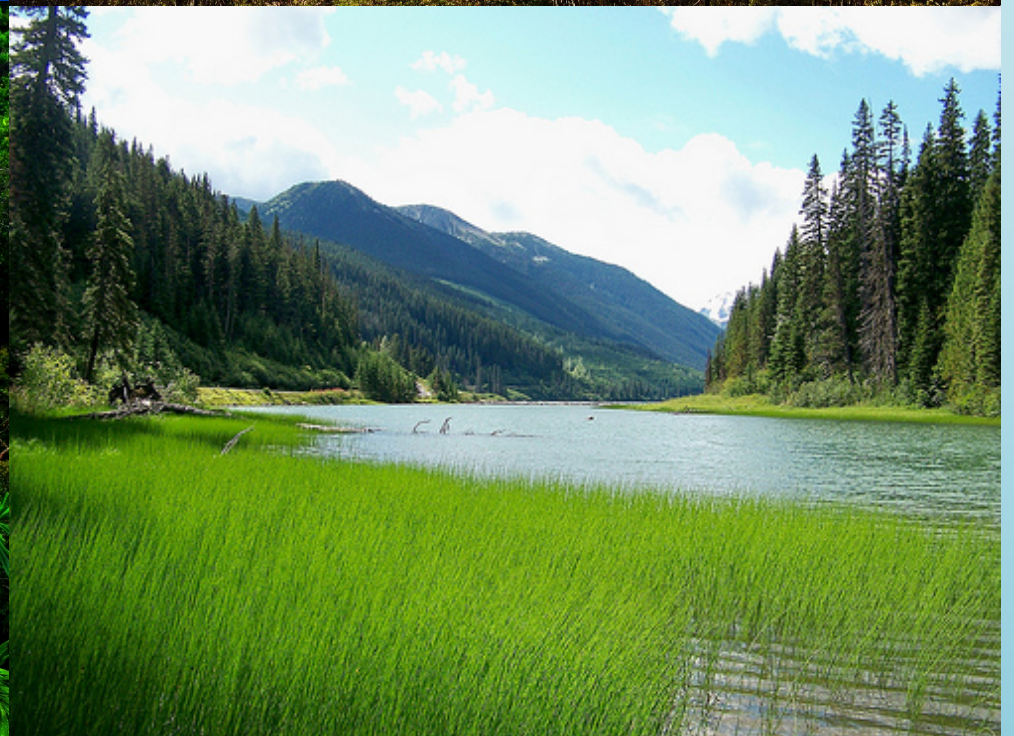


Why Conserve Nature and Biodiversity?

- Prior reasons to conserve biodiversity
  - Intrinsic value
  - Provisioning of food, medicines
  - Climate regulation

Nature/Biodiversity and Human Health

- New evidence suggests important connections between biodiversity and human health and well-being

Biodiversity
WE ARE ALL IN THIS TOGETHER

Human Health and Well-Being

- “…a state of physical, mental and social well-being and not merely the absence of disease or infirmity.”
  -World Health Organization (1946)

Questions

1. Can experiencing more natural settings can improve psychological and physical health?

   -YES!

2. Does exposure to biodiverse nature result in measurable health responses?

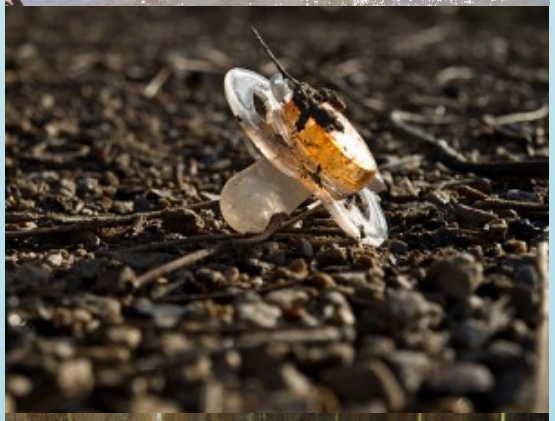
   -YES!

3. Can biodiversity provide humans and animals protection from allergic & inflammatory diseases?

4. Is there evidence that exposure to coastal nature & biodiversity promotes health?

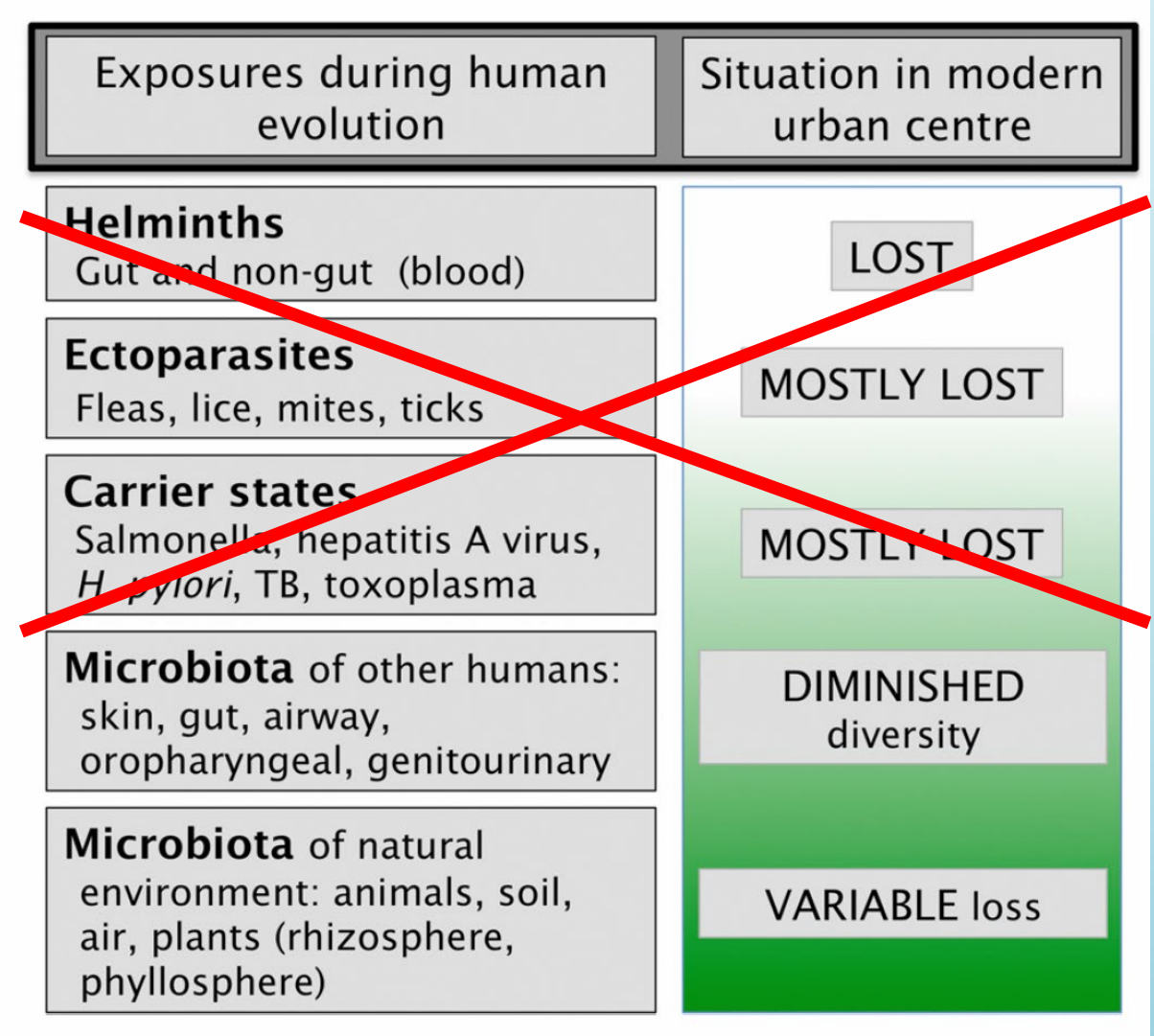
(Sandifer, Sutton-Grier and Ward Ecosystem Services 2015)

Chronic Diseases and Biodiversity



- Allergy: response to exposure to too much bad stuff
- Allergy: *lack* of exposure to microbes→ hyper-responsiveness to bioparticles
- Microbe-rich environments confer health benefits especially to children
- "Biodiversity" or "Hygiene" hypothesis
  - Loss of macrodiversity → loss of microdiversity → changes in human microbiota and results in variety of disorders
    (Hanski et al. 2012, Rook 2010, Strachan 1989)

Biodiversity or Hygiene Hypothesis



(Rook 2013)

- Our bodies must learn not to attack:
  - Self
  - Harmless molecules in air (pollen)
  - Gut contents

Finland Adolescent Study

- Analyzed land-use types within 3km radius of homes
- Kids with allergies
  - Lower diversity of habitats
  - Fewer kinds of positive bacteria on their skin
    (Hanski et al. 2012)
- **Loss of contact with diverse natural world is making us sick**

Conservation Magazine

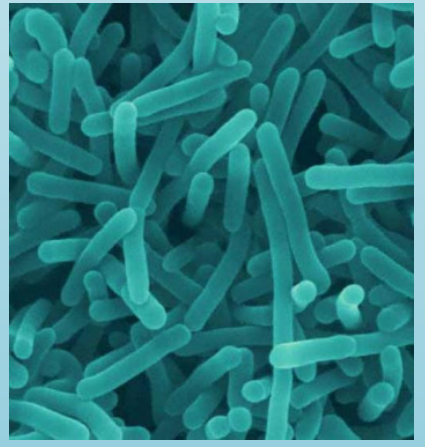
Wetlands and Human Health

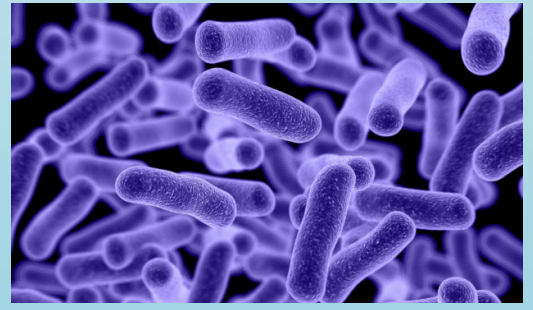
- Good respiratory health correlated with landscape biodiversity
  - Possible beneficial immunomodulatory effects from environmental microbiota in diverse areas as a potential mechanism
  - Wetlands and coasts were included → areas of high biodiversity they recommended should be investigated further

(Liddicoat et al. 2018)

Sutton-Grier and Sandifer 2018 Wetlands

Wetlands and Human Health





- Bacterial communities in anaerobic marsh soils of Sapelo Island, GA
  - Diversity similar to terrestrial soils but unique composition
  - Bacteria included representatives of Firmicutes and Bacteriodetes, two of the bacterial groups to which exposure was negatively associated with allergic reactions (Lasher et al. 2009)
- **Need to develop and test hypotheses about wetland biodiversity, particularly microbial diversity, and health protective benefits**

Sutton-Grier and Sandifer 2018 Wetlands

Wetlands and Human Health

- Health benefits from watching birds and other animals

Sutton-Grier and Sandifer 2018 Wetlands

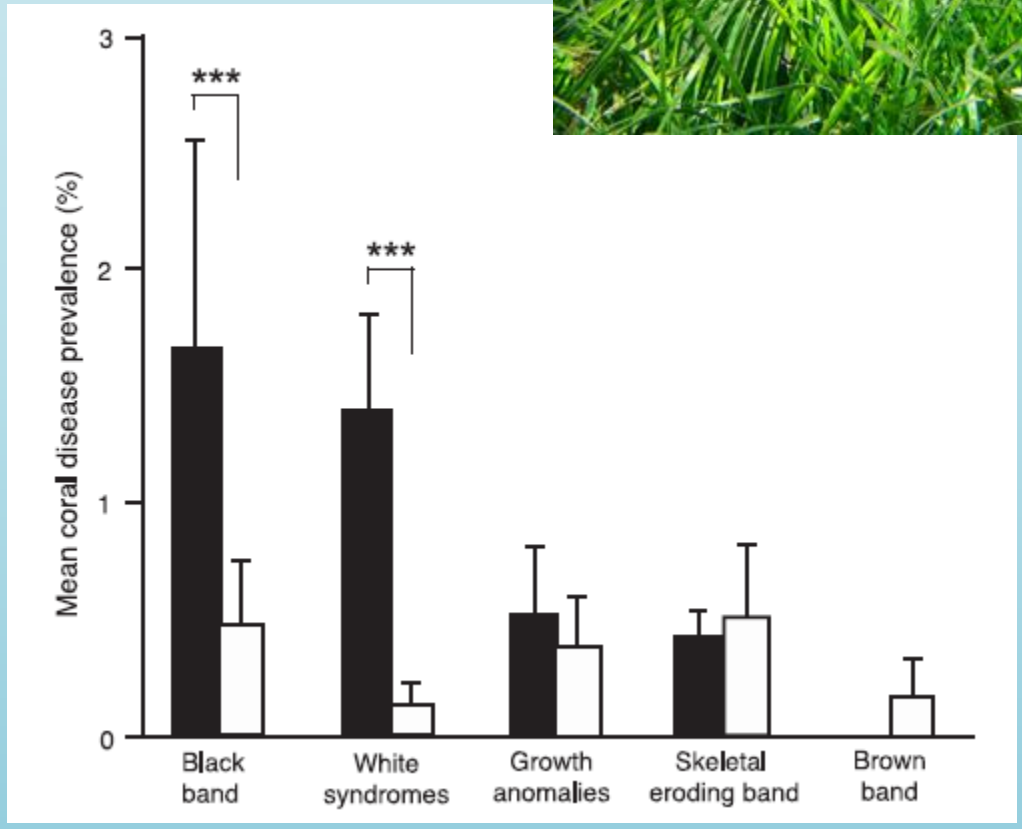
Wetlands and Human Health

- Wetlands can provide very relaxing, restorative experiences good for mental health

Sutton-Grier and Sandifer 2018

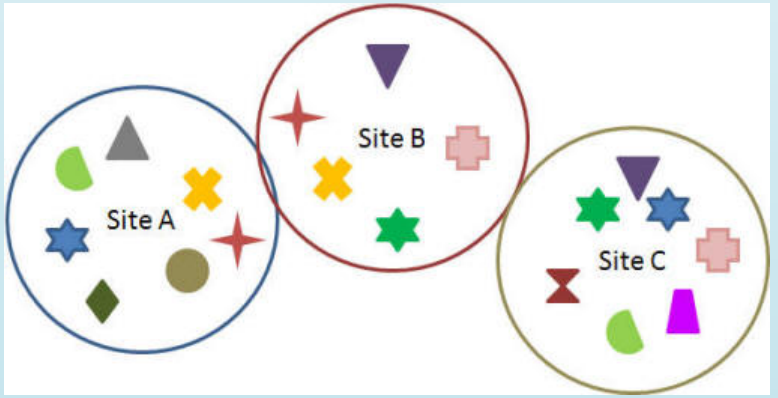
Wetlands and Disease Prevention: Seagrass

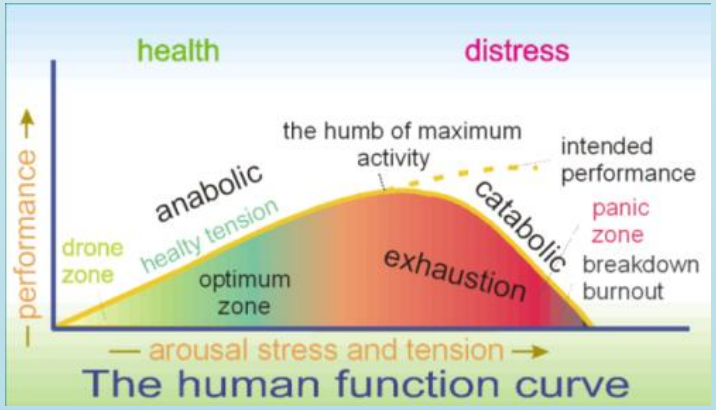
- 50% reduction in abundance of potential bacterial pathogens causing diseases in humans and marine organisms when seagrass present
- 2 of 5 global coral diseases significantly reduced in corals adjacent to seagrass (Lamb et al. Science 2017)
- Do other wetlands provide similar disease protection functions? (Sutton-Grier and Sandifer 2018)



Ongoing Research Needs

- Specific mechanisms for biodiversity affects human health
- Best ways to measure biodiversity to determine human exposure?
- Which metrics of health would be the best indicators of biodiversity-human health impacts?
- Better monitor biodiversity and integrate info into public health and natural resource management and policy
- Need for large, community-wide health datasets and over longer periods of time





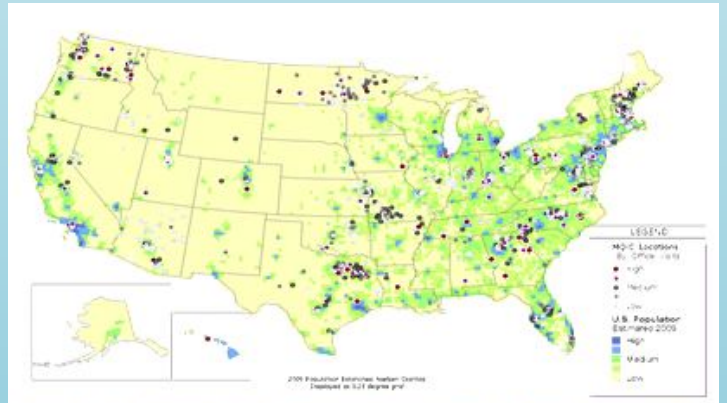


Figure 2. The Medical Quality Improvement Consortium (MQIC) comprises 35 million de-identified patient records from participating CPS and Centricity EMR practices.

(Sandifer, Sutton-Grier and Ward Ecosystem Services 2015)

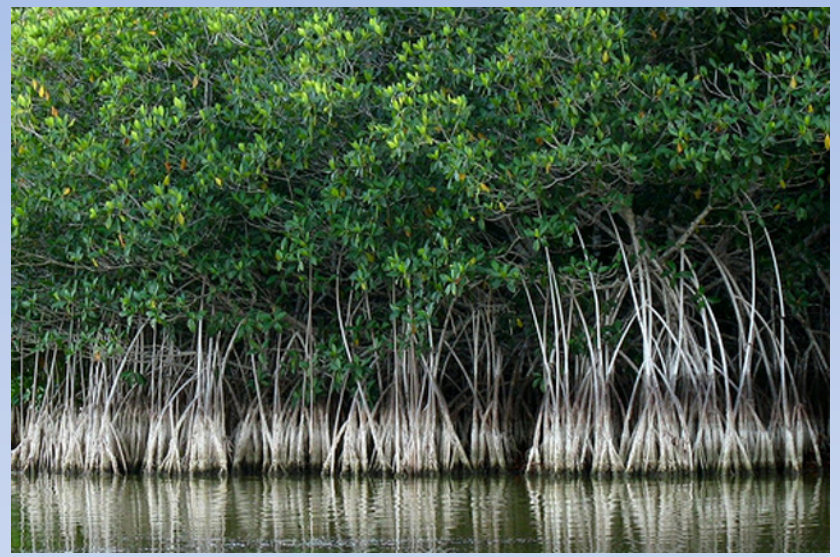
Nature/Biodiversity Conclusions

- Exposure to nature has direct, positive heath effects and exposure to biodiversity seems to have direct, positive impacts human health
- Potential to implement these findings to enhance human well-being ***and*** develop increased public support for green & blue space protection and restoration
- More research needed on wetlands and human health

So, what can we do?

1. Protect and Restore Coastal Wetlands

2. Use “Natural Infrastructure” in our Coastal Resilience Efforts



3. Incorporate wetlands into disaster risk planning

- Wetlands mitigate extreme events like floods and heavy precipitation
- Slow release of water also recharges groundwater and provides more consistent water supply reducing risks of extreme droughts and fires

Endter-Wada, Kettenring, and Sutton-Grier Frontiers in Ecology and the Environment, October 2018

Sustaining wetlands to mitigate disasters and protect people

Hurricanes, flooding, droughts. Weather-related disasters are dominating news cycles and causing widespread destruction, most recently with Typhoon Mangkhut and Hurricane Florence. The US had the most catastrophic hurricane season on record in 2017, with hundreds of billions of dollars in estimated damages. California is experiencing unprecedented tragedies from widespread wildfires and increased vulnerability to storms. Disasters that were once uncommon appear to be the new norm globally, and evidence suggests the frequency and impacts of extreme events will increase further with climate change.

Wetlands can help protect people and property from some of the impacts of such disasters. These ecosystems play a crucial hydrologic role in relation to growing cities, many of which are situated on coasts, adjacent to rivers, downstream from large dams, or in arid locales. By storing and slowly releasing water downstream, wetlands help to recharge groundwater, decrease flood risks during extreme precipitation events, and delay the onset of drought. Wetlands also buffer wave energy, reducing the increasing extent and impacts of storms in coastal regions.

Society at large has yet to recognize and fully incorporate these disaster-risk reductions or "protective" services of wetlands into natural resource policies and land-use planning. Due in part to the fragmented nature of existing wetland management, the full range of environmental and societal values provided by wetlands, as well as the diversity of wetland types critical in different landscape settings, remain unprotected by current federal and state policies. The US Clean Water Act, which focuses on the water-quality benefits of wetlands, provides insufficient regulatory protection for all wetlands, particularly with the constantly shifting definitions of "Waters of the United States".

Additionally, wetland mitigation and compensation strategies imply inevitable impacts or loss, and fail to replicate critical watershed and ecosystem functions in landscape locations that make wetlands so valuable. Many wetlands are threatened due to human competition for land and water, which is highest in the very places where the protective services of wetlands are most needed – upstream from, surrounding, and within human communities. For millennia, humans have confined wetlands both spatially and temporally through extensive channelization, levees, dams, dikes, and pipes, or simply drained or filled wetlands, thereby completely removing them from the landscape. More recently, we continue to destroy and degrade wetlands, particularly small and temporary wetlands, which are presumed not to serve much of an ecological role but, in fact, are essential to landscape functioning. These losses have resulted in greater costs to society from disasters. Citizens pay the mounting costs for wetland loss and poor land-use decisions, which may be driven by short-term profits for a few people.

A more comprehensive, proactive, and integrated approach to wetland policy formulation and implementation – one that strategically incorporates wetlands into infrastructure investments and disaster planning, response, and recovery efforts – is needed in the US now. This approach will require coordination between federal, state, tribal, and local agencies that are responsible for, or impact, wetlands. At the federal level, this includes, but is not limited to, the Federal Emergency Management Agency, the Department of Transportation, the Department of Housing and Urban Development, the Department of the Interior (and its Bureau of Reclamation and Bureau of Indian Affairs), the Department of Agriculture, the Army Corps of Engineers, the Environmental Protection Agency, and the National Oceanic and Atmospheric Administration. Through these national-level bodies, extensive networks and working relationships with other governmental entities, non-profits, and private organizations can be mobilized. We believe that a National Interagency Wetlands Commission (NIWC) must be established to serve as a coordinating body among these various entities for large-scale wetland protection, management, and restoration. This commission would be modeled after joint river and lake commissions that have successfully managed trans-

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Better Disaster Relief Planning?

- Can we mitigate the stress of disasters by strategically using green and blue space exposure?
- “Blue health”, promoting healthy coastal and ocean ecosystems and human health via exposure to those ecosystems

Thank you!

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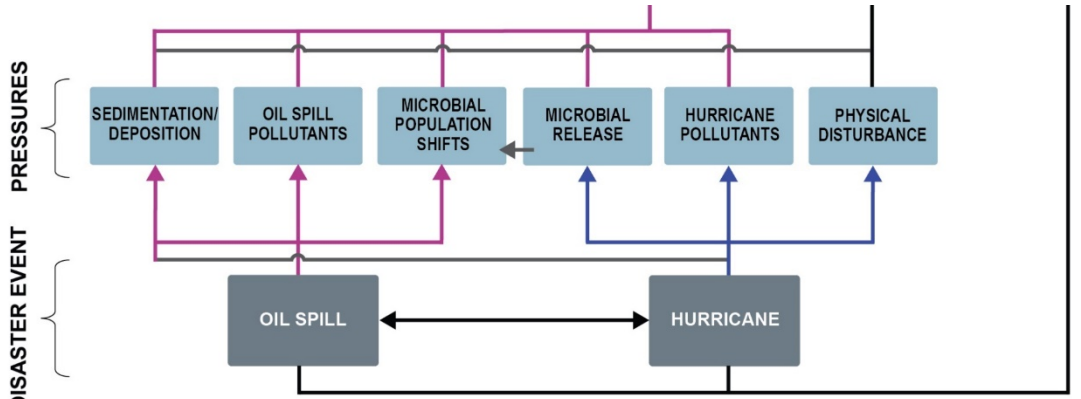
Modeling stress-associated health effects of multiple impacted ecosystem services

- Disasters impact ecosystem services with impacts to human health
- We don’t account for these human health impacts in disaster mitigation or planning

(Sandifer et al. 2017)



Publications

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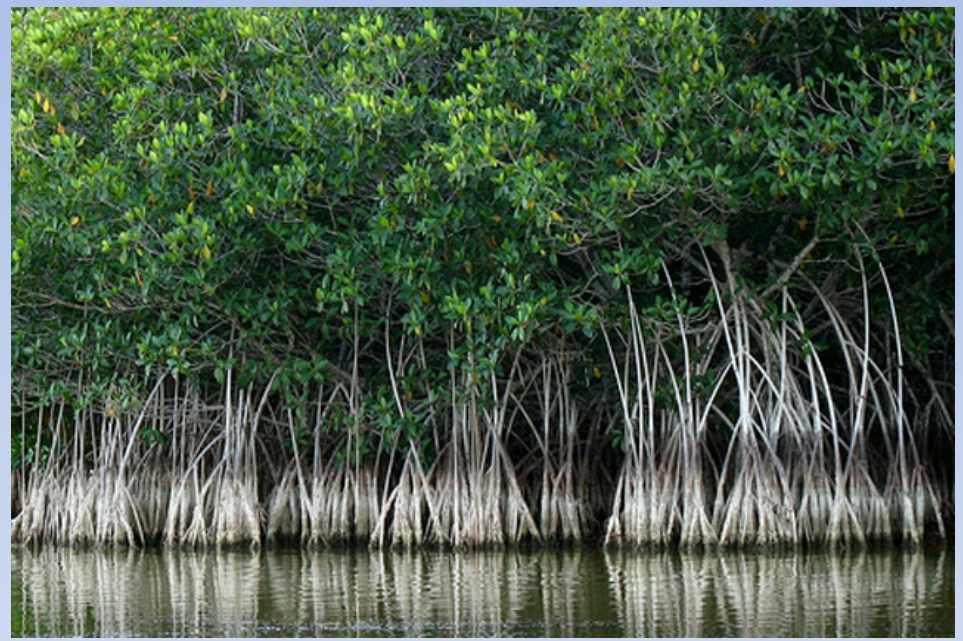
Many Factors Influence the Amount of Coastal Protection Provided by Natural infrastructure



Sutton-Grier et al. 2015

People value the natural solutions more than built solutions

Respondents were willing to pay 3.3 to 4.7 more for living shorelines

Coastal Protection Option	Turnbull Estimates (Lower Bound)	Estimates Derived from Statistical Analysis
Living Shorelines	$109.91 per household per year	$278 per household per year
Shoreline Armoring	$33.38 per household per year	$59 per household per year
Ratio	3.3	4.7

Nadeau. 2016. Hurricane Sandy and the Value of Trade-Offs in Coastal Restoration and Protection. Eastern Research Group.