



Ecosystems, Biodiversity and Human Health: Links to Green Infrastructure Planning

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Outline

- Background
- Interdisciplinary Approach
- Leading Research Questions
- Research Projects
- Anticipated Results, Links to Planning and Decision-Making



Green Infrastructure and Human Health

A strategically planned and managed network of natural lands, working landscapes, and other open spaces that conserves **ecosystem values and functions** (*disease regulation*) and provides associated **benefits** (*lower human risk of disease*) to human populations

Ecosystem Services

As provided by the diversity of life on earth

Provisioning Services

Food
Freshwater
Wood and fiber
Fuel
Clean Air
Medicines

Regulating Services

Climate regulation
Flood regulation
Disease regulation
Water purification

Cultural Services

Aesthetic
Cultural
Recreational
Spiritual

Supporting Services

Nutrient cycling
Primary production
Soil formation

Biodiversity loss is accelerating

Fig. 4: TERRESTRIAL LIVING PLANET INDEX, 1970-2003

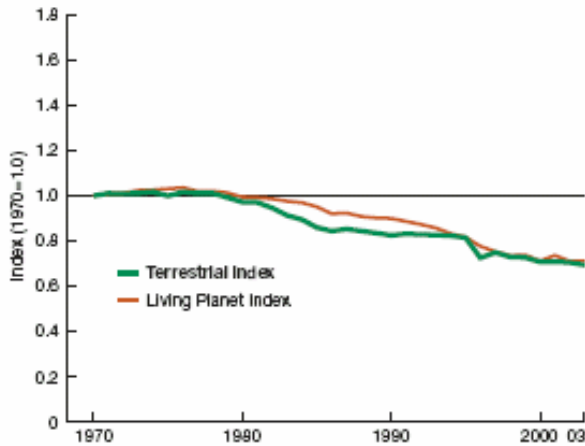


Fig. 5: MARINE LIVING PLANET INDEX, 1970-2003

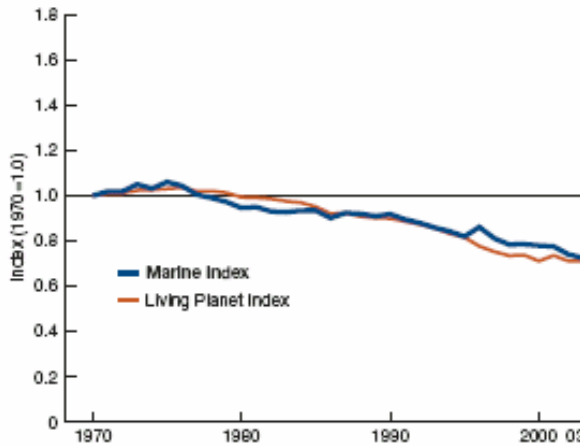
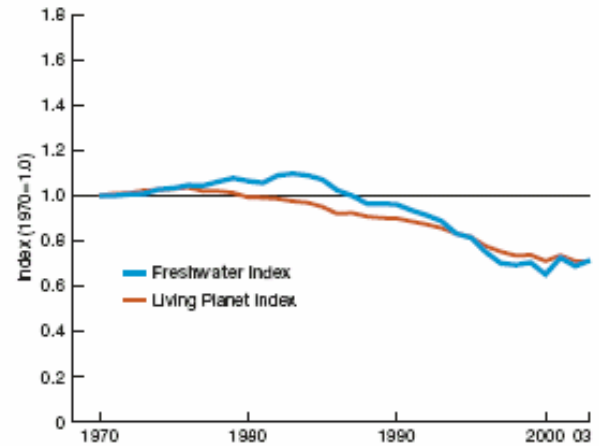


Fig. 6: FRESHWATER LIVING PLANET INDEX, 1970-2003



From WWF, "Living Planet Report," 2006.

BBC NEWS

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Health Education Entertainment Talking Point In Depth AudioVideo

Tuesday, 21 May, 2002, 13:48 GMT 14:48 UK

Quarter of mammals 'face extinction'

Siberian tigers may vanish within three decades

By Corinne Podger
BBC science correspondent

Almost a quarter of the world's mammals face extinction within 30 years, according to a United Nations report on the state of the global environment.

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Daily E-mail News Ticker

CNN.com / SCI-TECH

THE GREEN CENTURY

Scientists agree world faces mass extinction

August 23, 2002 Posted: 11:43 AM EDT (1543 GMT)

By Gary Stricker
CNN

Organ Pipe Cactus National Monument

(CNN) – The complex web of life on Earth, what scientists call "biodiversity," is in serious trouble.

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Study: Only 10 percent of big ocean fish remain

By Marsha Walton
CNN
Wednesday, May 14, 2003 Posted: 10:29 PM EDT (0229 GMT)

(CNN) – A new global study concludes that 90 percent of all large fishes have disappeared from the world's oceans in the past half century, the

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Lions 'close to extinction'

Lion populations have fallen by almost 90% in the past 20 years, leaving the animal close to extinction in Africa, a wildlife expert has warned.

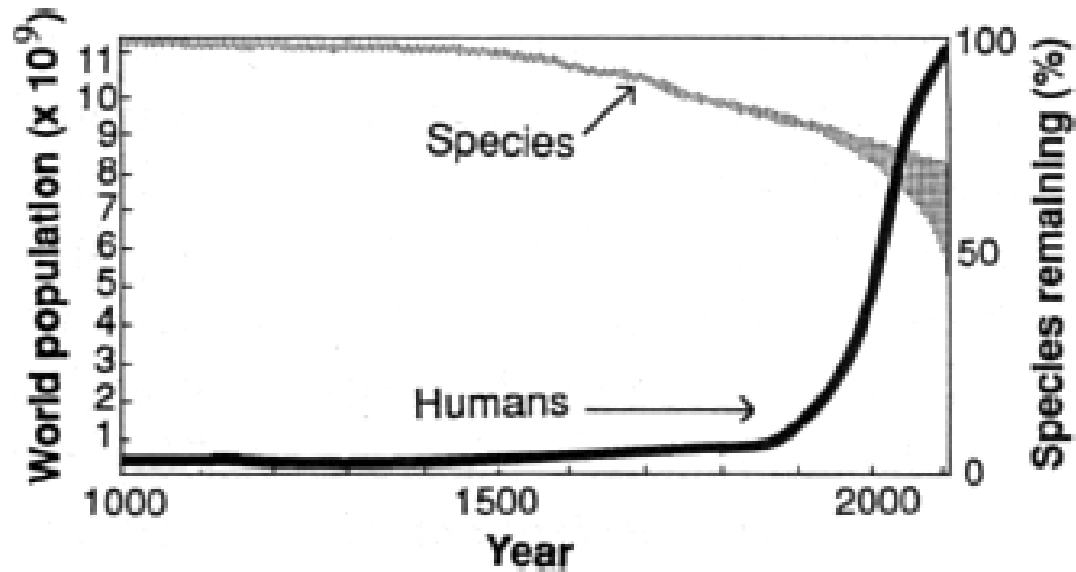
There are now only 23,000 left, compared to an estimated 200,000 two decades ago,

Live with them or lose them

SEE ALSO:
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Malawi's killer lion shot dead
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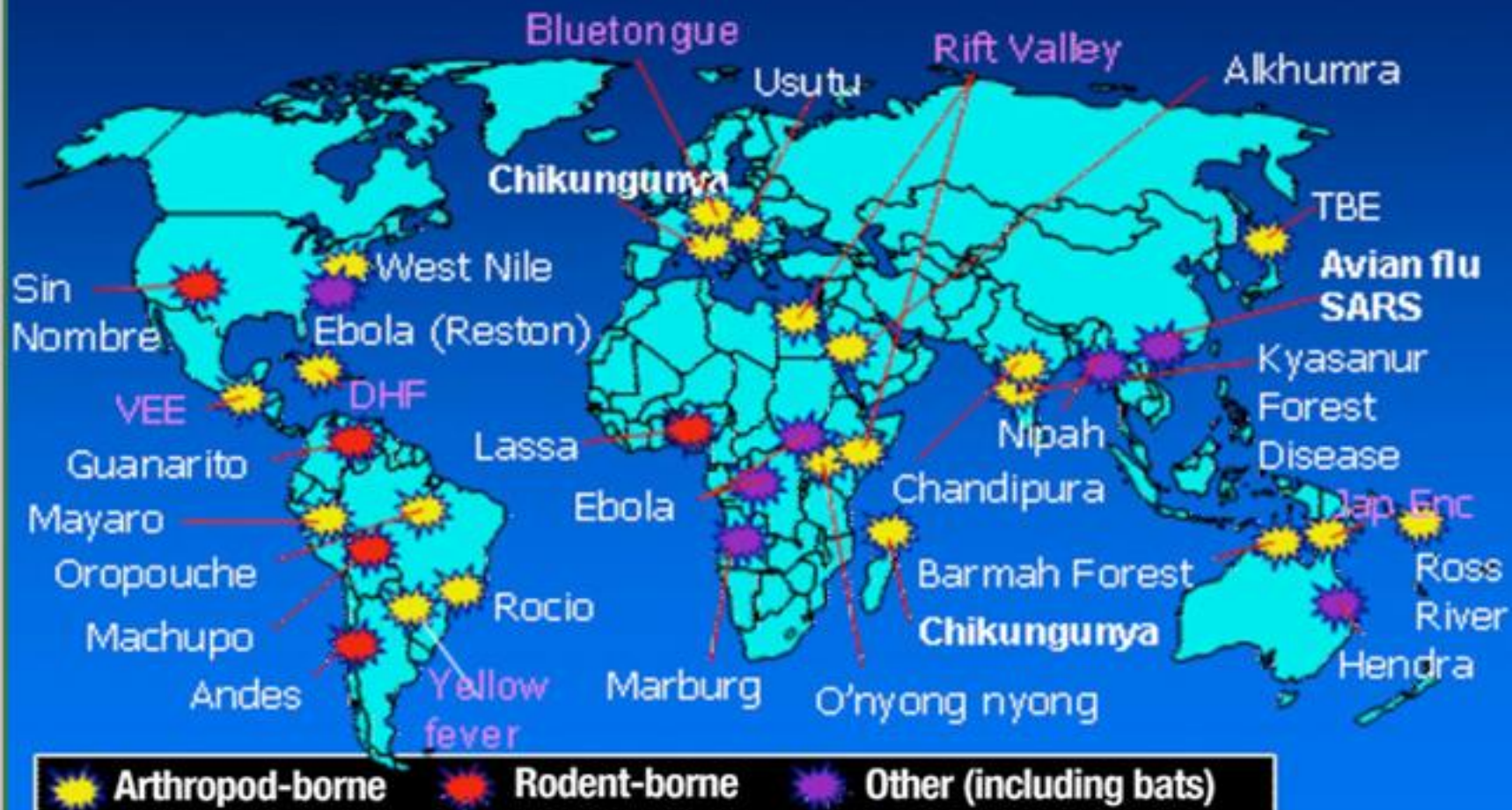
The Biodiversity Crisis



Human actions are causing a biodiversity crisis, with species extinctions up to 1000 times higher than background rates

-Pimm et al. 1995

Emerging and Reemerging infections - 70% vector-borne or zoonotic



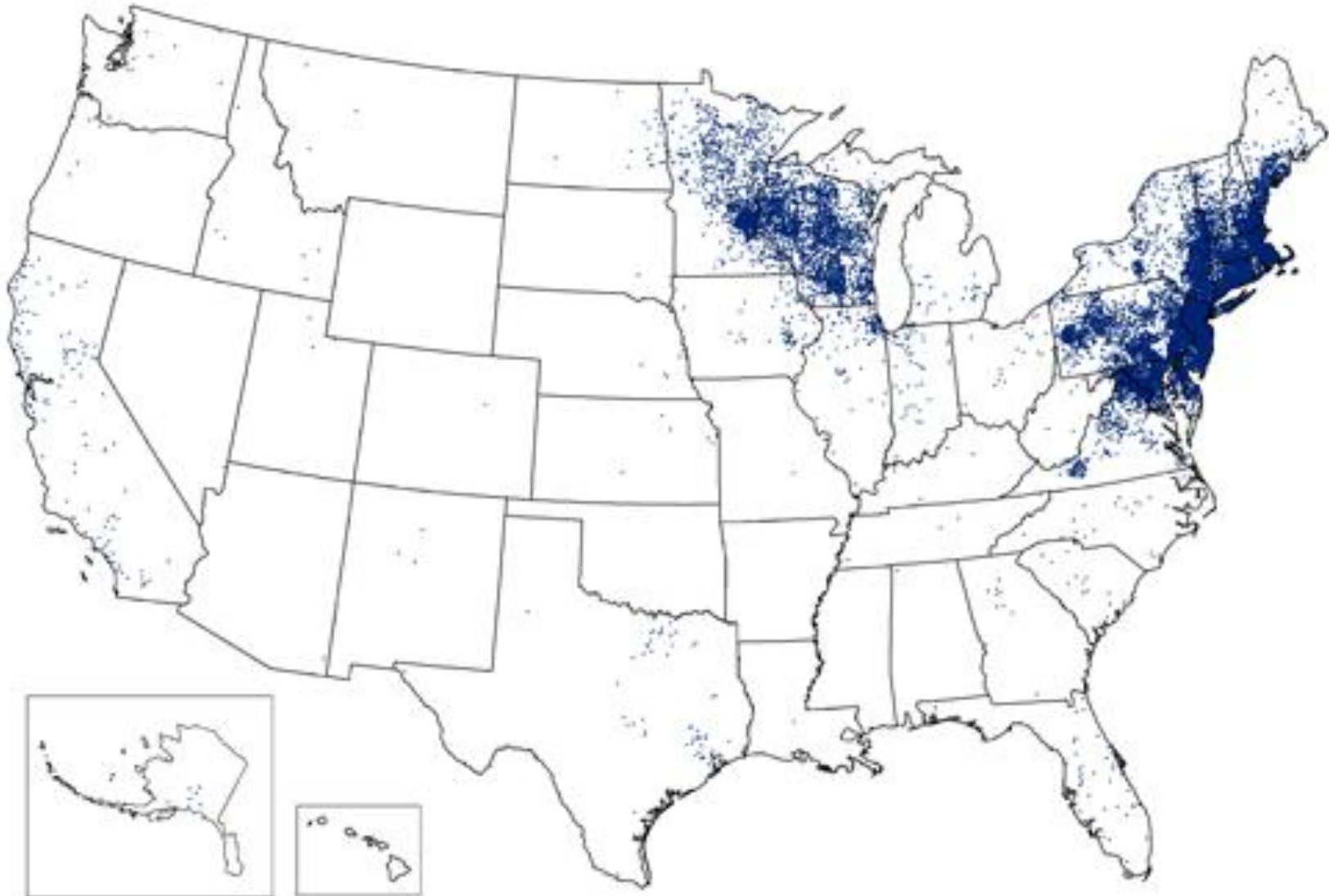
Case Study: Lyme Disease

Lyme Disease



A tick-transmitted inflammatory disorder that typically begins with a characteristic skin rash, and neurologic, cardiac, or joint abnormalities weeks/months later if not treated.

Reported Cases of Lyme Disease -- United States, 2010



1 dot placed randomly within county of residence for each confirmed case

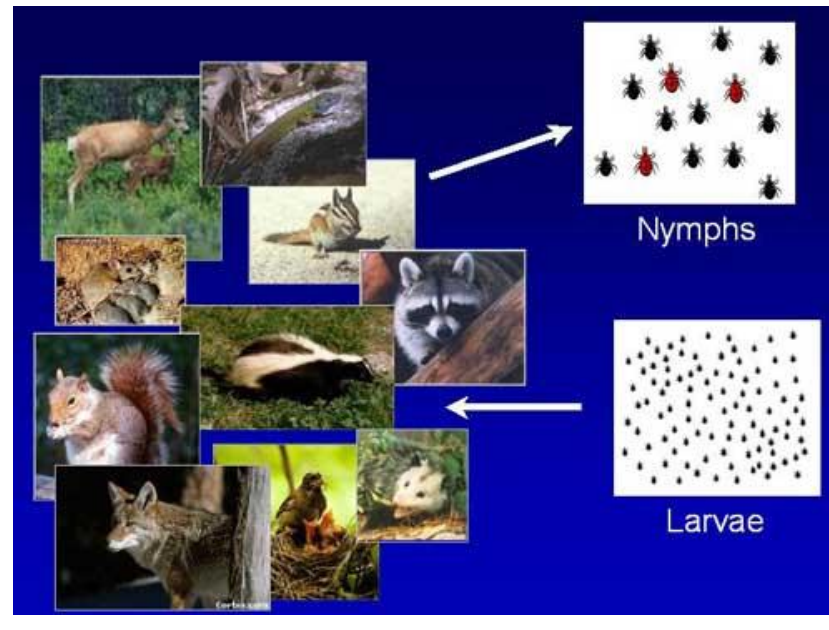


Ixodes scapularis is a tick that spreads Lyme disease from animals to people.



White-footed mouse.
abundant in forests, a good host for ticks to feed on and become infected with the Lyme disease pathogen.

Lyme Disease: Dilution Effect Hypothesis



- LoGiudice et al. 2003

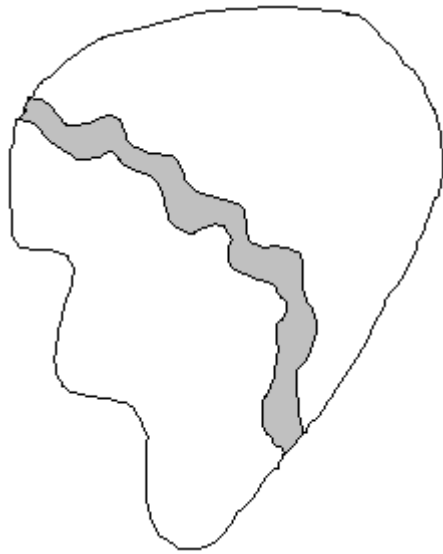
- generalist vector
- variation in transmission efficiency among animal hosts
- horizontal transfer of the pathogen

Lyme Disease: Host Diversity and Landscape Configuration

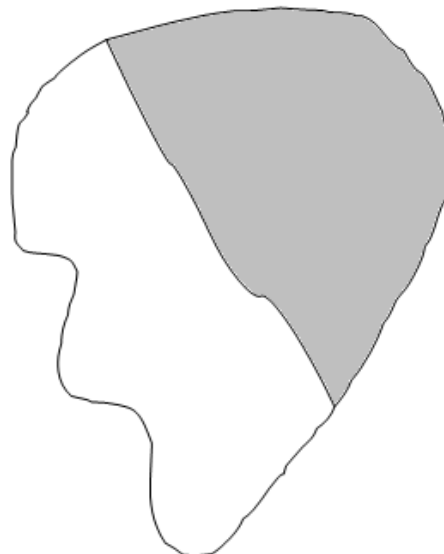
Allan et al. (2003)

- **Animal host diversity is linked to how intact (lack of fragmentation) the forest is**
- **With increasing forest patch area:**
 - **significant linear decline in nymphal infection prevalence**
 - **significant exponential decline in nymphal density**
- **Decreasing forest patch size, dramatic increase in density of infected nymphs and LD risk**

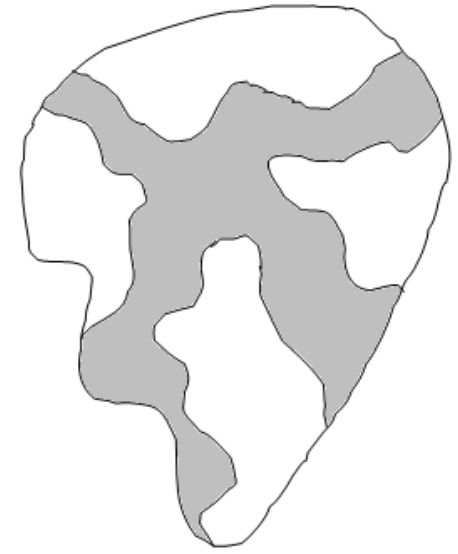
Quantifying Land-Cover Pattern that Relates to High Lyme Disease Incidence Rates in Maryland



high edge contrast index,
low forest/high herbaceous:
low Lyme disease



low edge contrast index,
50% forest/50% herbaceous:
low Lyme disease



high edge contrast index,
50% forest/50% herbaceous:
high Lyme disease

Jackson et al. 2006

Landscape, Biodiversity, and Human Disease Risk

- **Are there underlying causal mechanisms linking biodiversity change and disease transmission to humans?**
- **How is biodiversity change linked to landscape change?**
 - **Can we better manage the landscape and ecosystems and the biodiversity they contain, and indirectly, reduce human disease risk?**

Biodiversity and Infectious Diseases: What We Don't Know

- What are the mechanisms by which changes in biodiversity affect health? What are the interactions?
- How do animals (including humans) and disease vectors involved in the disease life cycle move through the environment as a result of land use change?
- At which taxonomic level does biodiversity affect human health? What ecological scale?
- When do we expect ecological risk to be correlated with human disease risk?
- What are the feedbacks between human behavior, biodiversity change, and human disease?
- How can global drivers like climate change and migration affect the link between the biodiversity and human health?

Biodiversity-Health Research Initiative

U.S. EPA

- Qualitative and quantitative: *how do anthropogenic drivers of changes in biodiversity affect the transmission of human infectious disease?*
 - Transdisciplinary research approach, including decision-makers
- **Goal: develop sustainable, environmentally-based tools and strategies to reduce and prevent disease**

Why New Transdisciplinary Science is Needed

- Root causes of disease emergence and spread should be explored to assist in prevention and mitigation
- Lack of integrated tools and approaches that link ecology to human health
- Environmental and social factors contribute to these diseases – and environmentally-based and behavioral approaches can help reduce the disease burden

Mechanisms Linking Animal Host Biodiversity to Lyme disease Risk

(New York, U.S.)



- Characterize the ecological mechanisms underlying Lyme disease (LD) risk
 - Manipulate host diversity and community composition by removing and translocating two competent mammalian reservoirs and one incompetent reservoir in forest fragments while monitoring abundances of other hosts
- **Effect on tick abundance and infection rates?**
- Mechanisms by which high host diversity might reduce disease risk:
 - reducing encounter rates between ticks and the white-footed mouse
 - regulating abundance of the mouse host
 - regulating abundance of the tick

Providing better information for decision-making and analysis

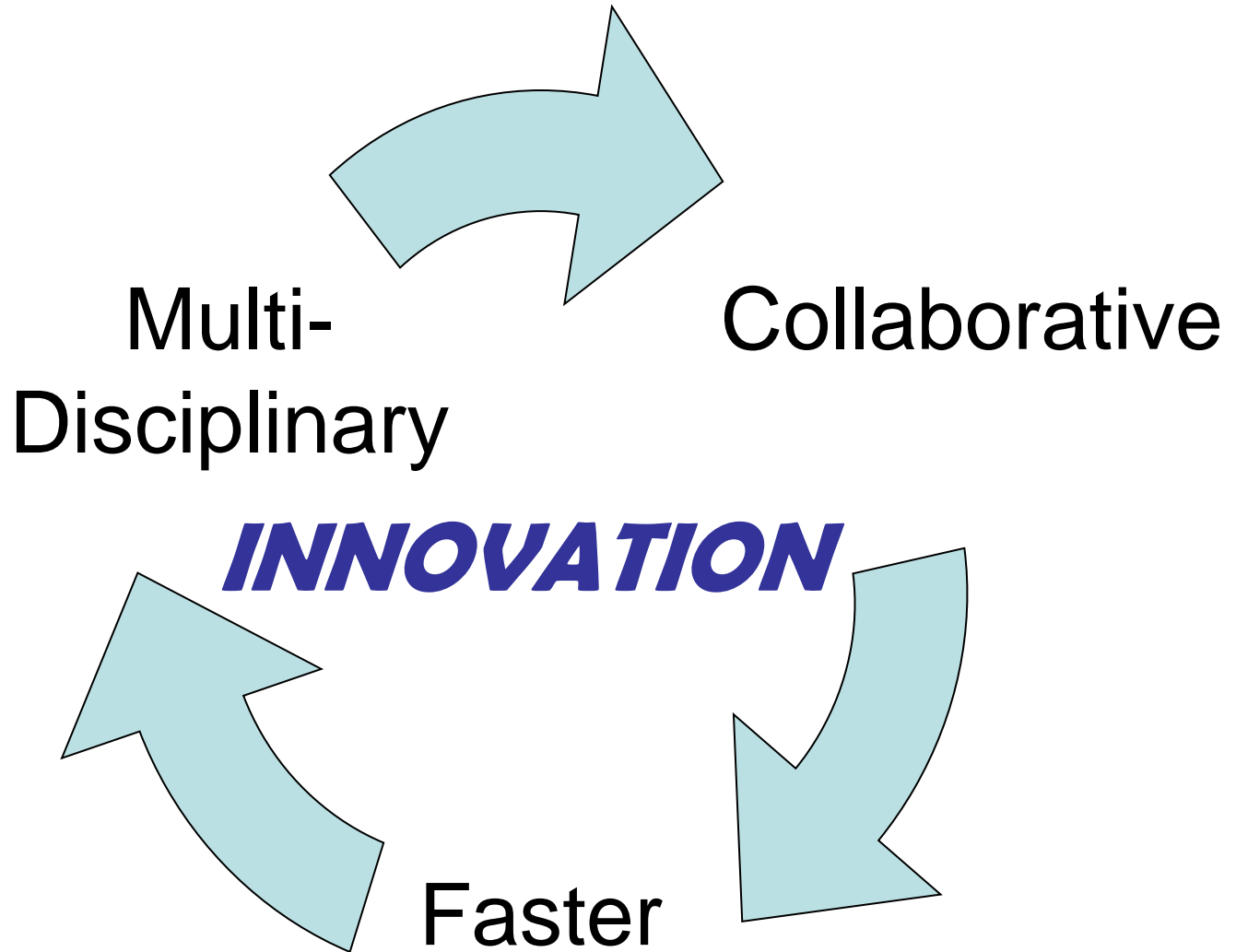
- Guidance on individual protection
- Best practices on land use
- Predictive models of disease risk based on ecological conditions
- Ecological indicators of human disease risk
- Integrated pest management (IPM)

A Biodiversity & Health Community of Practice

The Public
& Public
Officials



**From the
Global
Innovation
Outlook,
2004**



Landscape/Biodiversity Change and Lyme Disease: Science and Application



Science and Decision-making Needs

Science needs

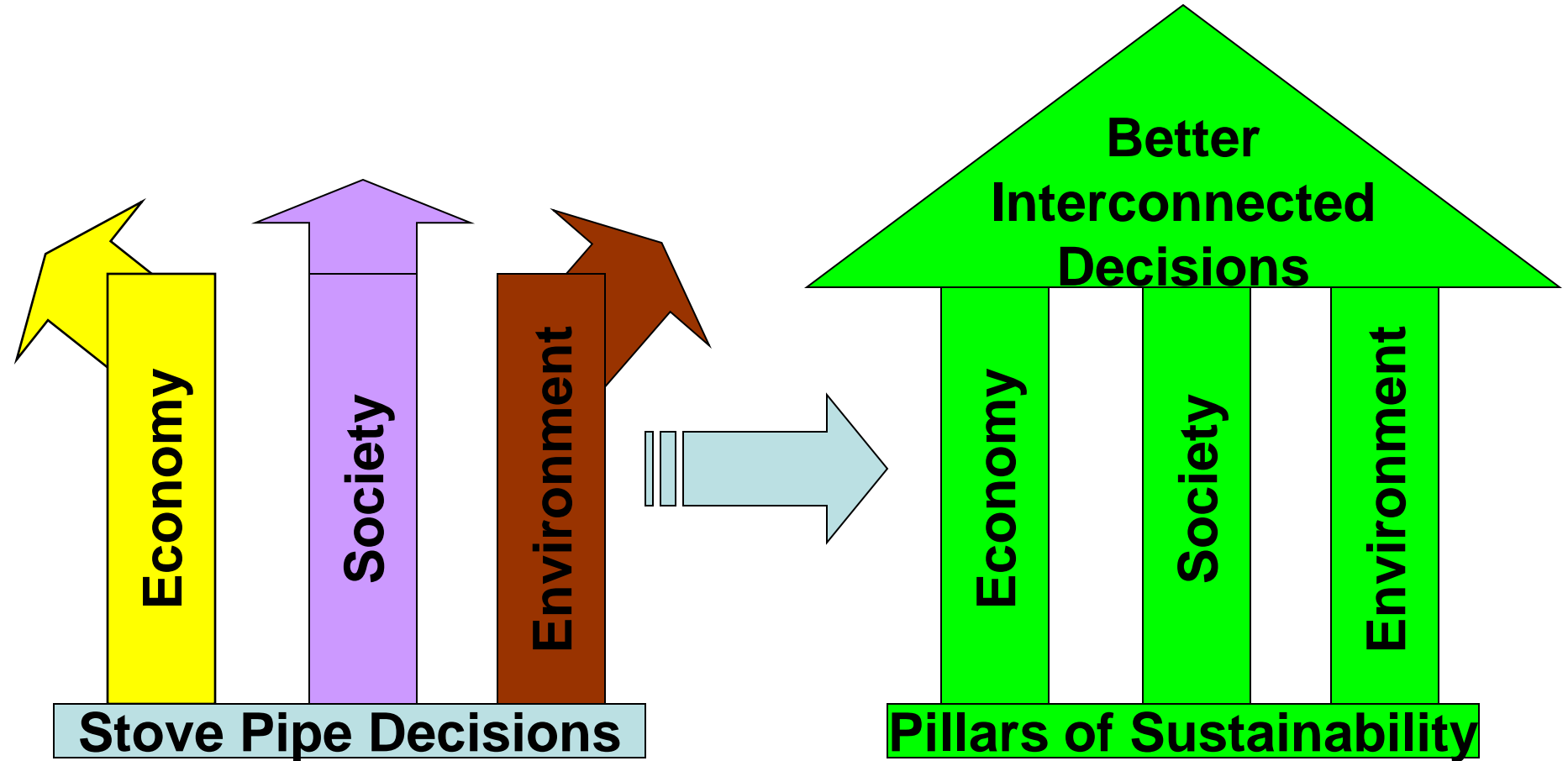
- **Transdisciplinary research at appropriate public health and ecological scales**
- **Increase understanding of how landcover configuration and connectedness (landscape pattern) affect LD risk**
- **Better understanding of how animals (including humans) and disease vectors involved in the LD life cycle move through the environment as a result of land use change**
- **Post-implementation monitoring with scientific evaluation to assess the effectiveness of disease mitigation research applications**

Policy needs

- **Clear and consistent communication on risk prevention and management**
- **Effective, targeted communication pathways and products**
- **Co-benefits (outcomes) and resource efficiencies can be the basis of incentives to working across disciplines and sectors**

Sustainability

Making the Interconnections

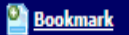


Opportunities for Collaboration

- Advance **Community of Practice** “Biodiversity, Landscape Change, and Human Health” in follow-up workshops
- Learn about existing community planning models (e.g. Community Viz) that could incorporate data from tick-borne disease projects to inform planning and development scenarios at local and regional scales
- Connect researchers on tick-borne disease projects with decision-makers and planners in at-risk areas to share state of the science and plan for implementation
 - New methodologies
 - Generalizability of study results



Biodiversity and Human Health



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Biodiversity and Human Health:



Special Announcements

- **Photos from the Field**

Check out four slide shows highlighting images taken from a joint EPA-Yale field study exploring the links between biodiversity, habitat change, and Lyme disease risk.

- **Could Preserving Biodiversity Reduce Disease? EPA Funds \$2.25 Million to Research Connections**

EPA has awarded three grants, totaling \$2.25 million, to support research programs working to better understand and characterize the mechanisms that link environmental stressors, such as deforestation and climate change, to the loss of biodiversity and the transmission of infectious diseases to people. [\[Read More\]](#)

EPA recognizes the importance of healthy ecosystems for our health and well-being, and conserving biodiversity is a primary way to sustain healthy ecosystems and the services they provide to us. One ecosystem service EPA is trying to better characterize is disease regulation – that is, maintaining biodiversity may protect us against emerging diseases like Lyme disease and West Nile virus.

The biodiversity-human health project complements existing domestic and international priorities to assess and manage emerging human diseases and ecosystem health hazards. But the research program is unique in its plans to link earth observations to the societal benefits outlined in the [Global Earth Observation System of Systems \(GEOSS\) 10-Year Implementation Plan](#) [EXIT Disclaimer]: (1) understanding the environmental factors affecting human health and well-being, and (2) understanding, monitoring, and conserving biodiversity (GEOSS 2005).

<http://www.epa.gov/ncer/biodiversity>

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Green Scene



Biodiversity and Human Health scientist Montira Pongsiri discusses biodiversity-human health connections in the research sponsored by the EPA STAR Research Program.

[Watch Video](#)

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