Ecosystems, Biodiversity and Human Health: US EPA's Interdisciplinary Research Initiative

Montira Pongsiri, PhD MPH
U.S. Environmental Protection Agency
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Outline

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

Ecosystem Services

As provided by the diversity of life on earth

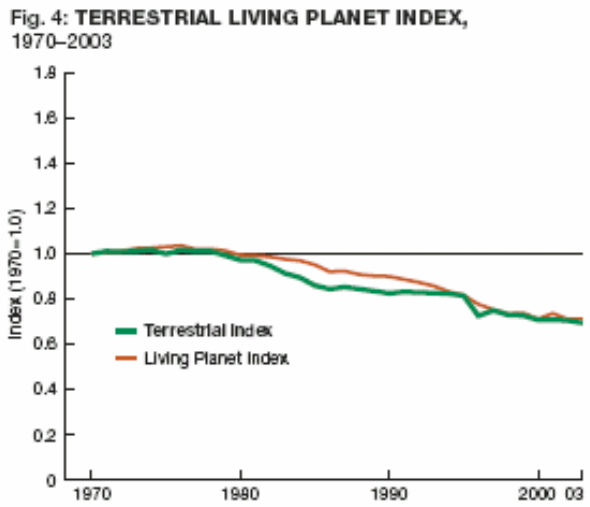
Provisioning Services	**Regulating Services**	**Cultural Services**
Food	Climate regulation	Aesthetic
Freshwater	Flood regulation	Cultural
Wood and fiber	**Disease regulation**	Recreational
Fuel	Water purification	Spiritual
Clean Air		
Medicines		

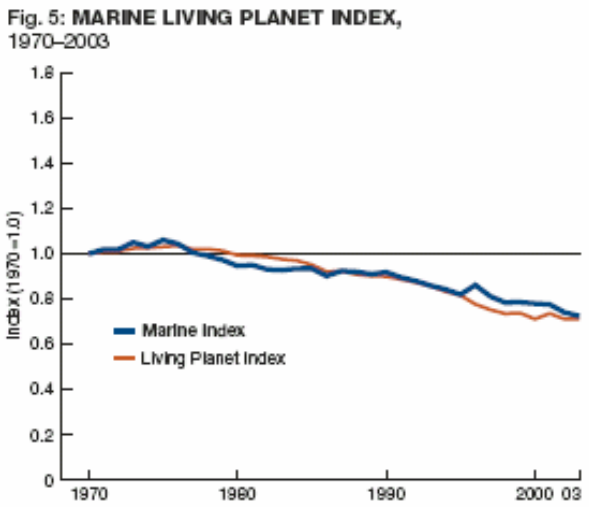
Supporting Services

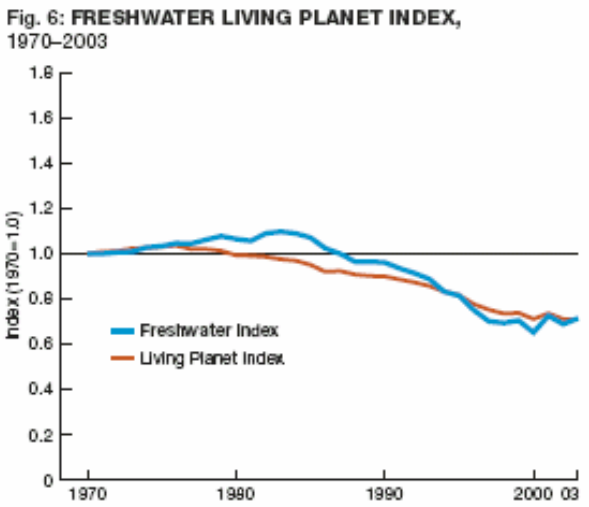
Nutrient cycling
Primary production
Soil formation

Adapted from the Millennium Ecosystem Assessment, 2005.

Biodiversity loss is accelerating

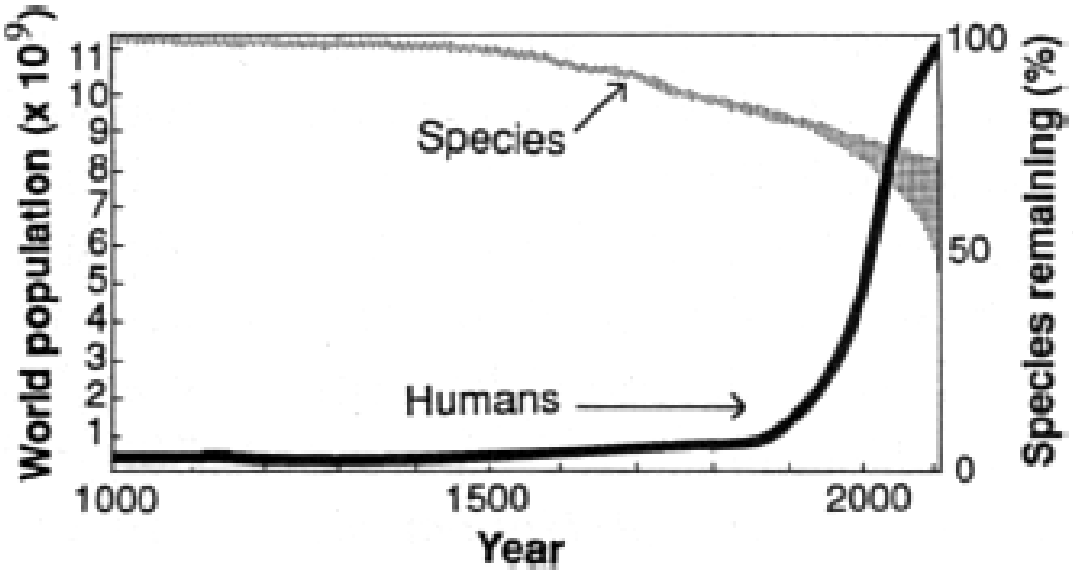






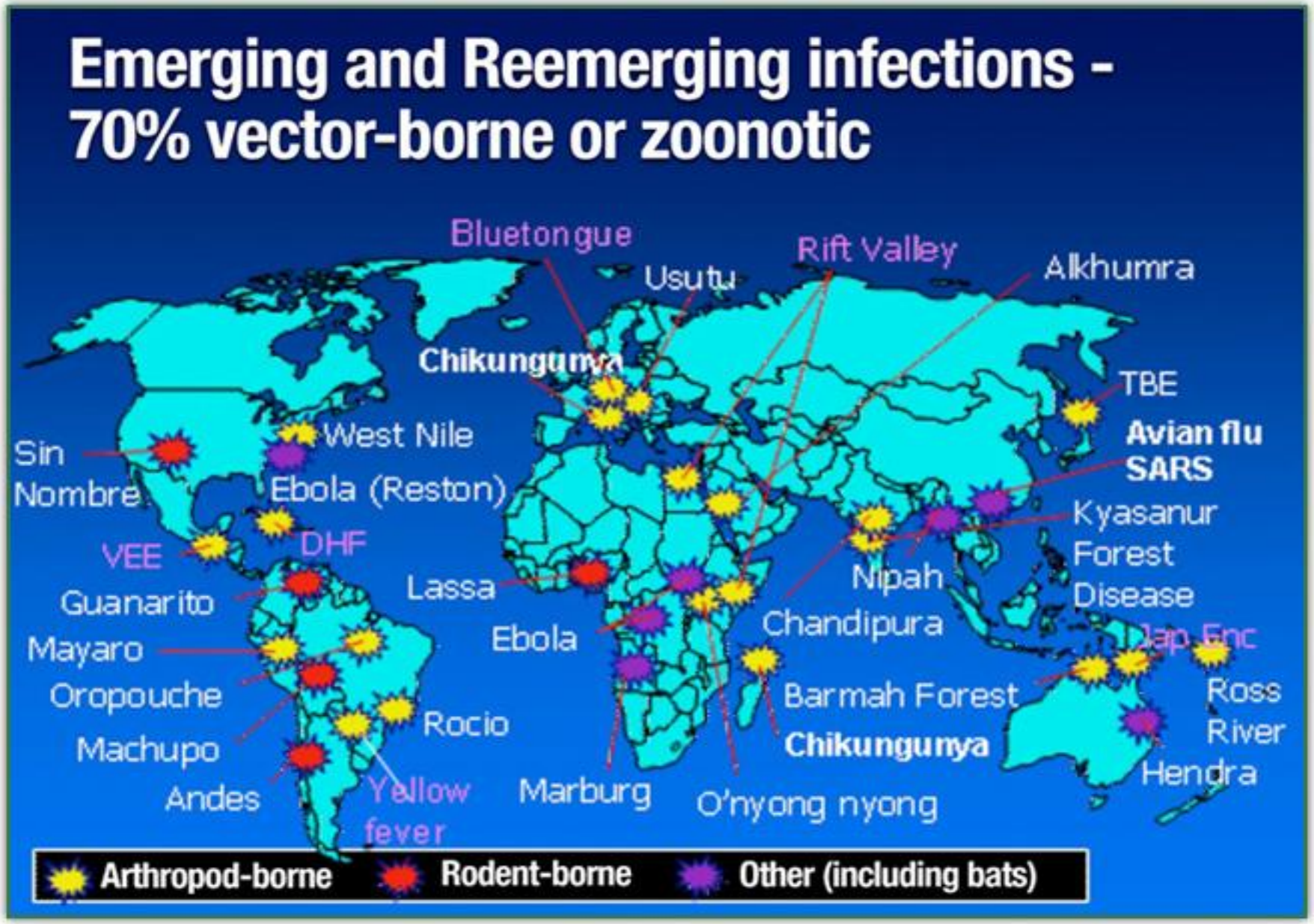
From WWF, "Living Planet Report," 2006.

The Biodiversity Crisis



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

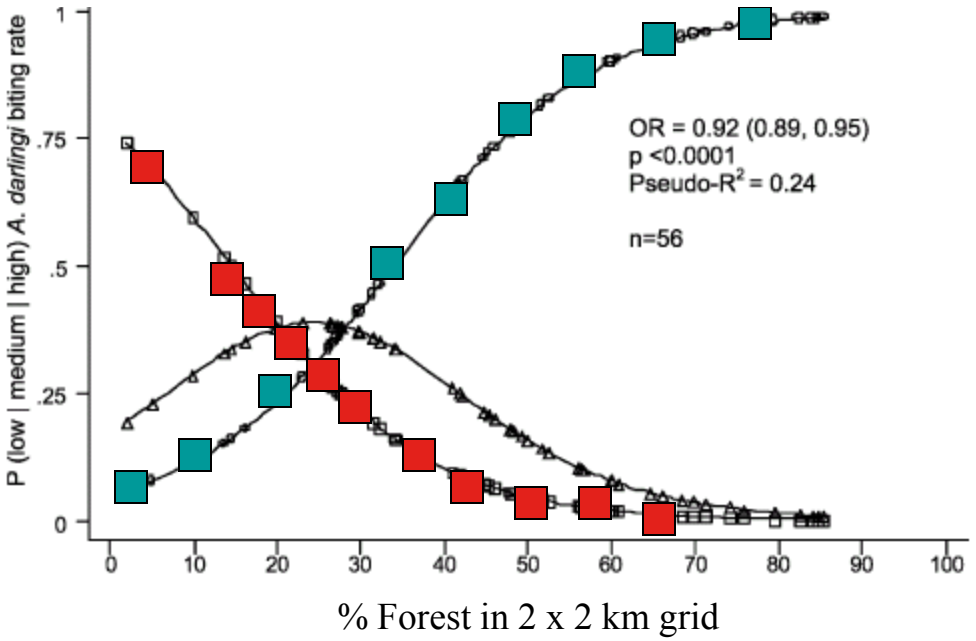
-Pimm et al. 1995


Emerging and Reemerging infections -
70% vector-borne or zoonotic
Bluetongue
Rift Valley
Alkhumra
Usutu
Chikungunya
TBE
Avian flu
SARS
West Nile
Sin
Nombre
Ebola (Reston)
Kyasanur
Forest
Disease
VEE
DHF
Lassa
Nipah
Guanarito
Ebola
Chandipura
Mayaro
Jap. Enc
Oropouche
Barmah Forest
Ross
River
Rocio
Chikungunya
Machupo
Hendra
Andes
Yellow
fever
Marburg
O'nyong nyong
Arthropod-borne
Rodent-borne
Other (including bats)

Human Interactions with Animals and the Environment

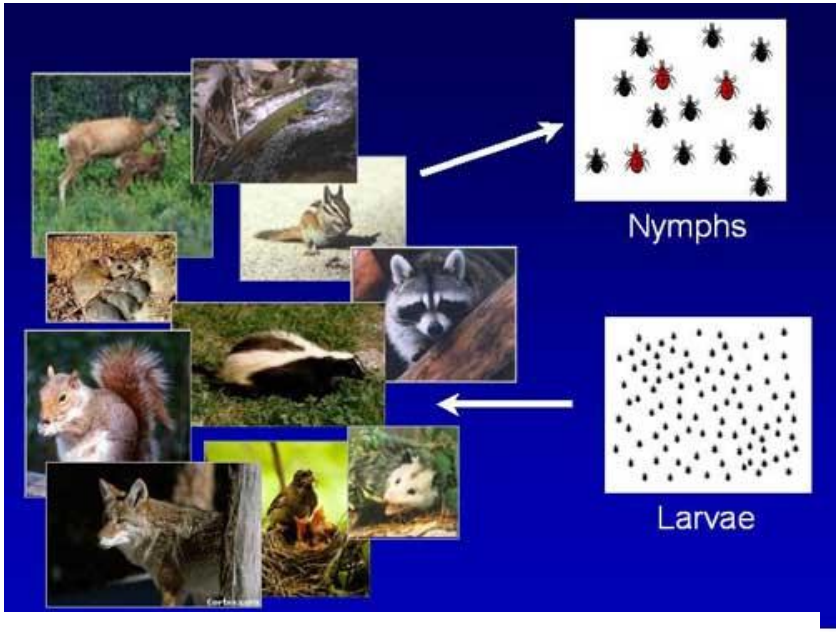
- More than half of all recognized human pathogens are zoonotic (Woolhouse 2005, Taylor et al. 2001)
- Nearly all of the most important human pathogens are either zoonotic or originated as zoonoses before adapting to humans (Wolfe et al. 2007)

Deforestation and Spread of Vector-Borne Diseases



- Vittor et al. 2006

Lyme Disease: Dilution Effect Hypothesis



- LoGiudice et al. 2003

Lyme Disease:

Host Diversity and Landscape Configuration

Allan et al. (2003)

- 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 was associated with a dramatic increase in the density of infected tick nymphs and LD 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?

This research is funded by
U.S. EPA - Science To Achieve Results (STAR) Program
Grant #

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
- Integration of earth observations and field data
- International and domestic projects

→ **Goal: develop sustainable, environmentally-based tools and strategies to prevent and reduce 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.)

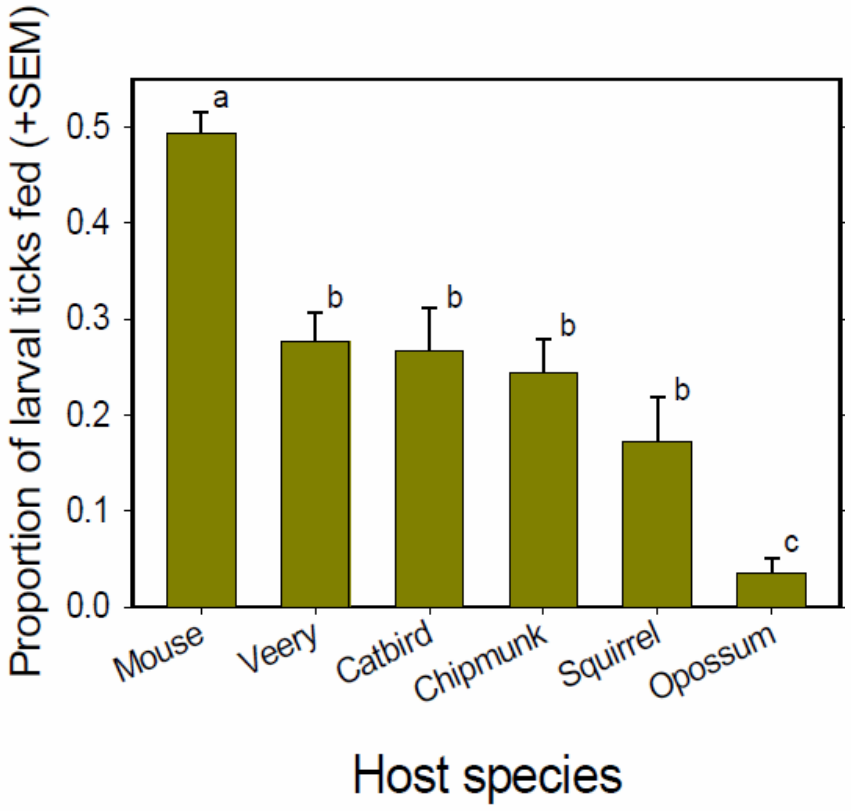
Cary Institute of Ecosystem Studies

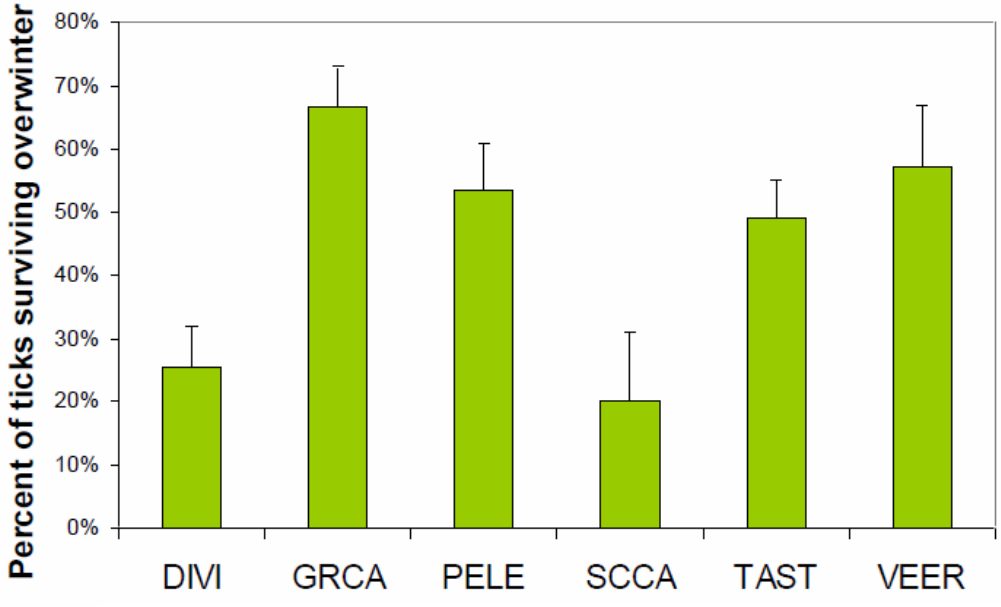
- Characterize the ecological mechanisms underlying Lyme disease (LD) risk
- Manipulate host diversity and community composition by removing and translocating two competent mammalian reservoirs and one incompetent reservoir in forest fragments while monitoring abundances of other hosts

→ **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

Tick Regulation by Certain Mammal Hosts

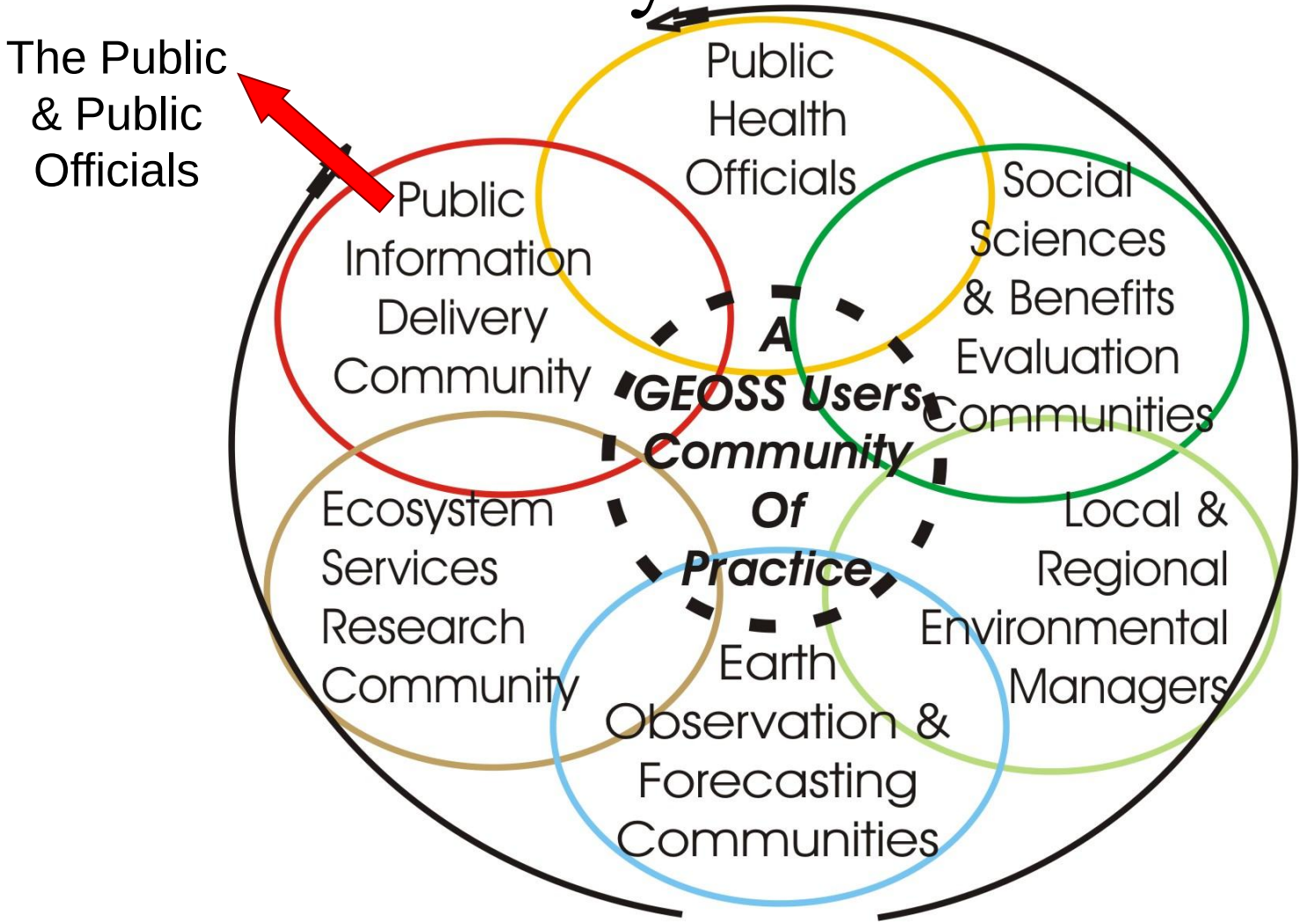




Providing better information for decision-making tools and analysis

- Environmental-health policy strategies from research results
  - Guidance on individual protection
  - Best practices on land use
  - Ecological indicators of human disease risk
  - Integrated pest management (IPM)

A Biodiversity & Health Community of Practice



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**

Opportunities for Collaboration

- Advance **Community of Practice** "Biodiversity, Landscape Change, and Human Health" in follow-up international workshop
- Connect researchers on mosquito-borne and tick-borne disease projects with decision-makers in at-risk areas to share state of the science and plan for implementation
  - New methodologies
  - Generalizability of study results
- Learn about other successful community-based models bringing together scientists and decision-makers/users of knowledge/tools

Protecting Biodiversity, Protecting Human Health

- Environmental factors contribute to emerging diseases and environmental strategies can reduce their burden
- Development of new tools to monitor and forecast risks
- Information that can be used to value biodiversity in public health terms
- Improved communication and outreach
- Improved analysis of land use planning
- Better communication and coordination among environmental and health managers

Partners

- US Centers for Disease Control and Prevention (CDC)
- Cary Institute of Ecosystem Studies
- Rutgers University
- UCLA
- Washington University
- University of Rhode Island
- Center for Health Applications of Aerospace Related Technologies (CHAART) at NASA Ames Research Center
- Gorgas Institute (Panama)
- Yale Center for EcoEpidemiology
- Smithsonian Institution
- US Group on Earth Observations (GEO)

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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 infections 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).

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

Research Project Search

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

pongsiri.montira@epa.gov

This presentation was written by Montira J. Pongsiri, Environmental Health Scientist, of the U.S. Environmental Protection Agency.
The views expressed are her own and do not necessarily reflect the policy positions of the EPA.