THE DELICATE BALANCE

OF BIODIVERSITY AND HUMAN HEALTH

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Outline

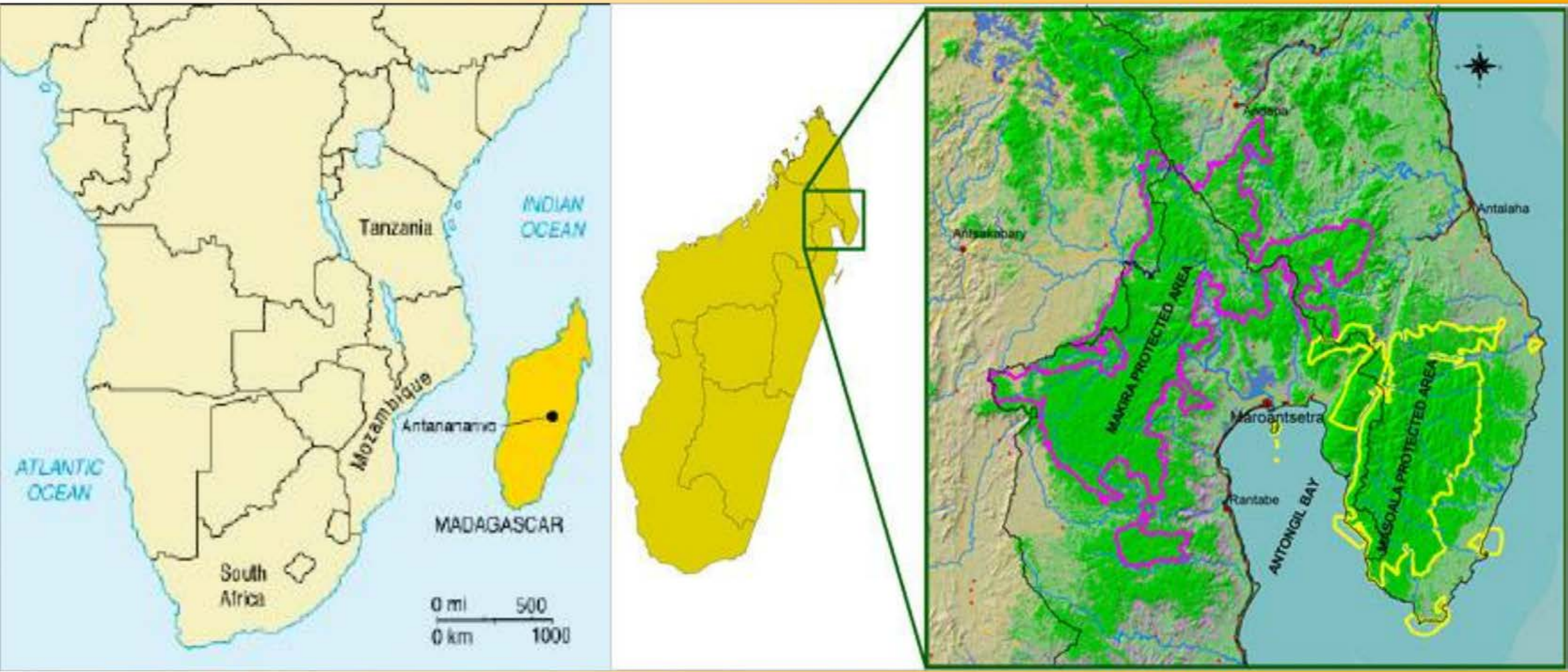
- Priorities for Development and Conservation
- Environmental Sustainability
- Human Health and the Environment
- Madagascar Case Study
- Ways Forward

Global Malnutrition

Biodiversity Loss

Disentangling environmental change and human health

Locating the Makira Watershed



- 85% of all flora and fauna in Madagascar is endemic to the country
- 50% of floral diversity is found in the Makira watershed
- Lemurs and all native carnivores are endemic only to Madagascar

Sustainability results

The International Journal of Conservation, Pages 1 to 7

Bushmeat hunting and use in the Makira Forest, north-eastern Madagascar: a conservation and livelihoods issue

CHRISTOPHER D. GOLDEN

What are Ecosystem Services?

- Regulatory services (i.e. pollination, pest control, water and air purification, etc.)
- Supporting services: (i.e. nutrient cycling, primary production, seed dispersal, etc.)
- Cultural services: (i.e. intellectual/spiritual inspiration, ecotourism, recreation etc.)
- Provisioning services: (i.e. food, water, pharmaceuticals, and energy).
- Estimated $16-54 trillion in value per year (Costanza et al. 1997)

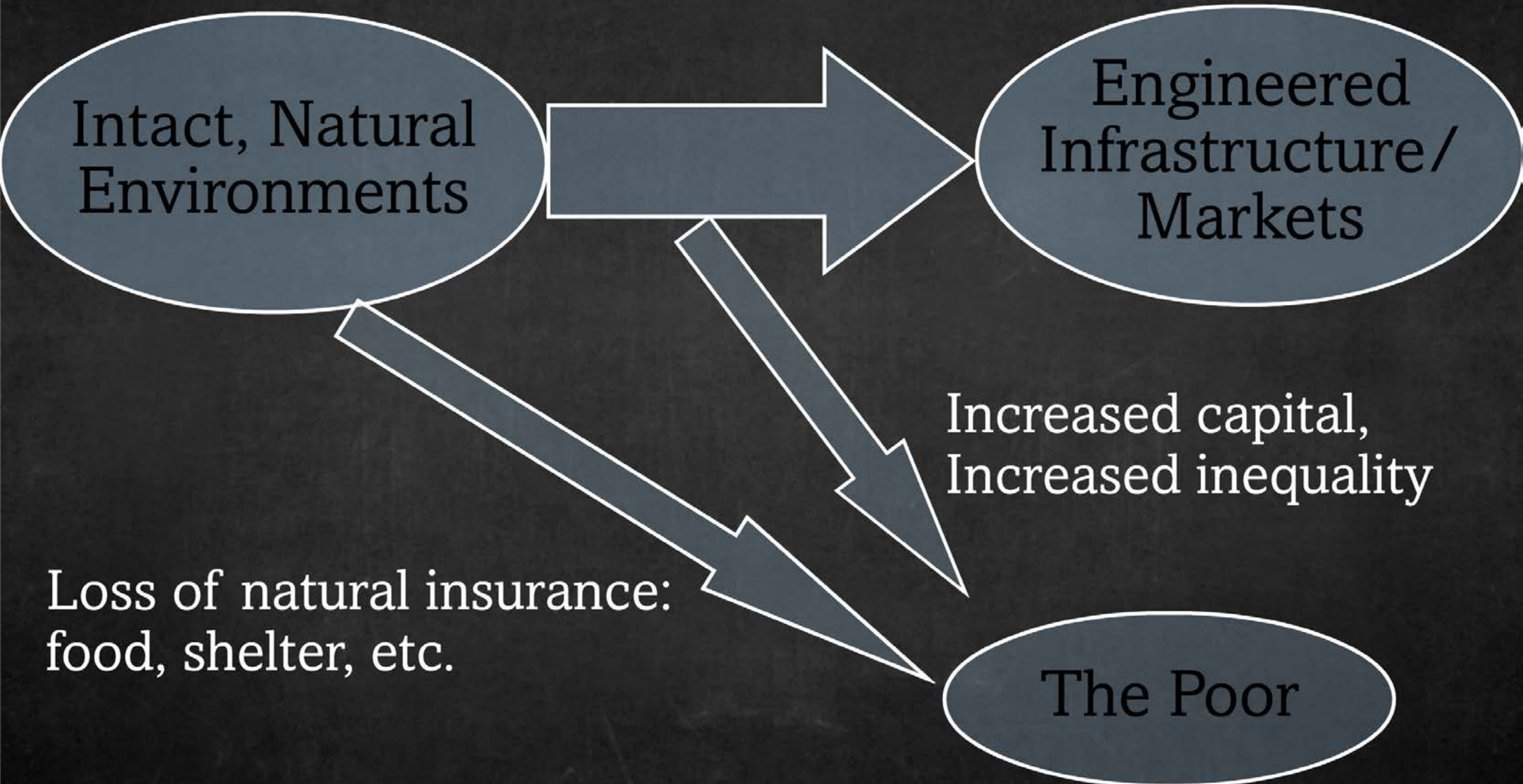
Provisioning services
Products obtained from ecosystems

Regulating services
Benefits obtained from regulation of ecosystem processes

Cultural services
Nonmaterial benefits obtained from ecosystems

Supporting services
Services necessary for the production of all other ecosystem services

Ecological Transition



GLOBAL COMMONS

GOVERNMENT/ NATIONAL INTERESTS

LOCAL COMMUNITIES

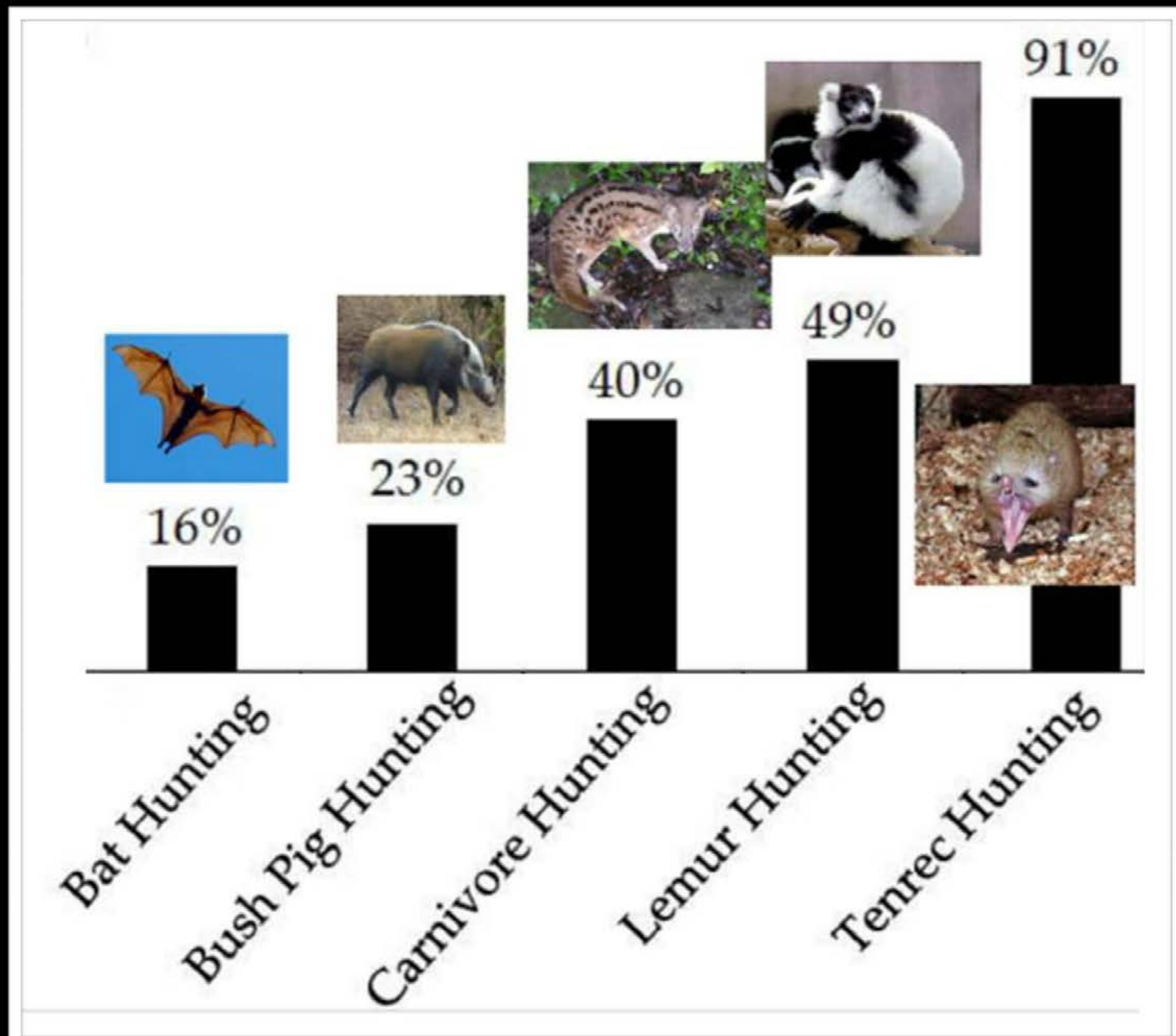
Exception to the Rule:

Provisioning services and issues of sustainability

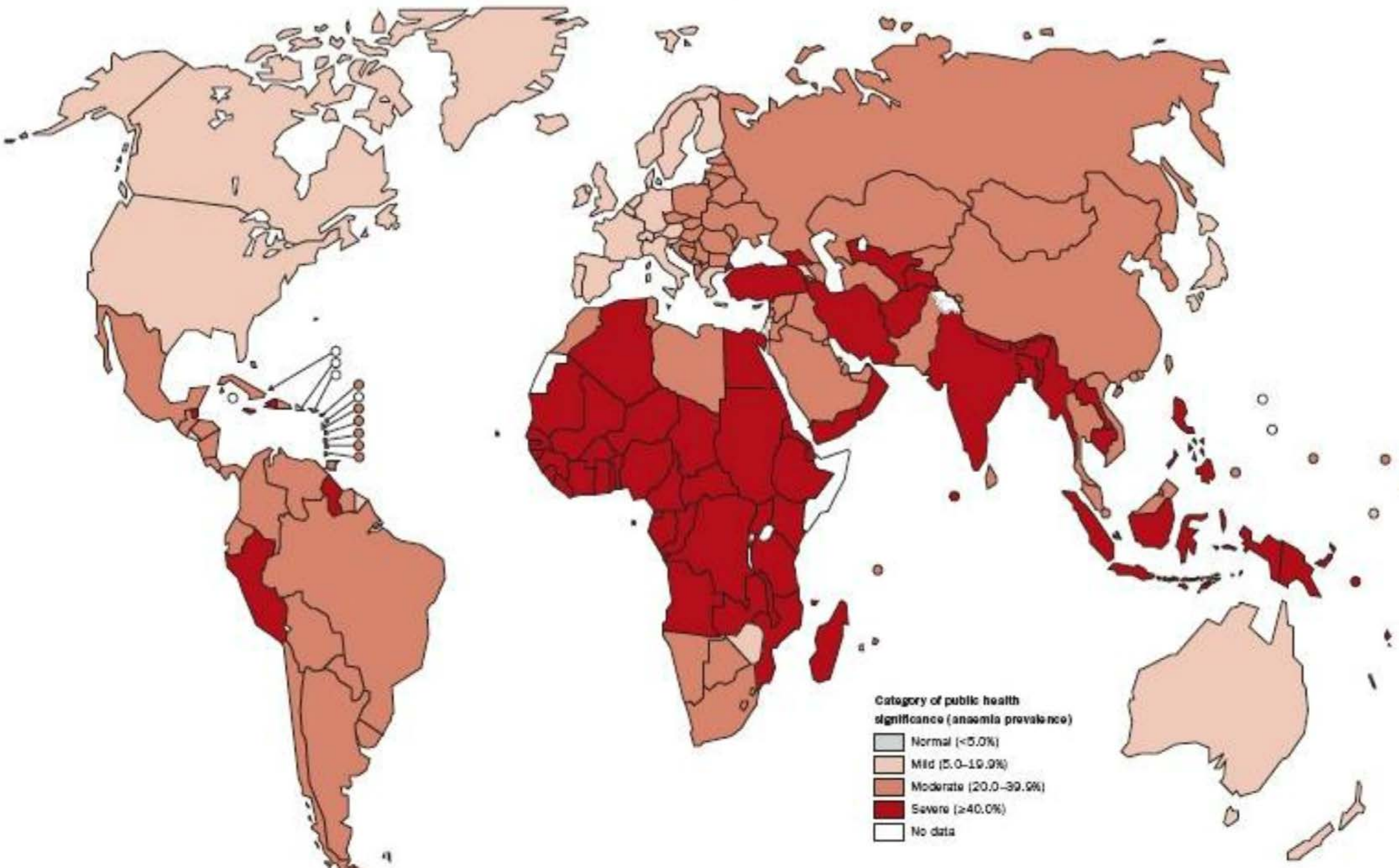
BUSHMEAT AND ECONOMIES

- The bushmeat trade is a local to global market that is valued at **billions** of dollars per year

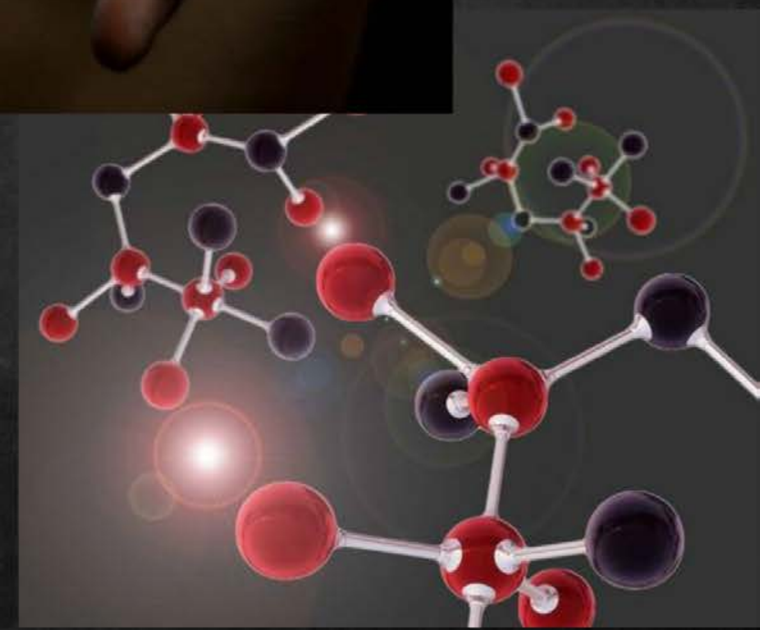
Biodiversity and Nutrition



Global Anemia Prevalence



Anthropometry & Clinical Work



Wildlife Conservation Society
WWF
The Nature Conservancy
Protecting nature. Preserving life.
Conservation International
natural capital PROJECT
World Resources Institute
School of Public Health
University of California, Berkeley
EcoHealth Alliance
University of Michigan
Harvard Medical School
The University of Wisconsin Madison
summit Institute of Development
James Cook University Australia
Massachusetts Institute of Technology

HEALTH & ECOSYSTEMS: ANALYSIS OF LINKAGES

Universitas Negeri Papua
Ministério da Ciência e Tecnologia
Instituto Nacional de Pesquisas Espaciais
Ministry of Agriculture and Forestry
Cambodian Ministry of Agriculture, Forestry & Fisheries, Fisheries Administration
National University of Laos
IFRI
Coastal Marine Ecology & Conservation Lab
SFU Simon Fraser University
Thinking of the World
Stanford University
Harvard University Center for the Environment
Harvard School of Public Health
Wetlands International
FIOCRUZ
Columbia University in the City of New York

Benefits of wildlife consumption to child nutrition in a biodiversity hotspot

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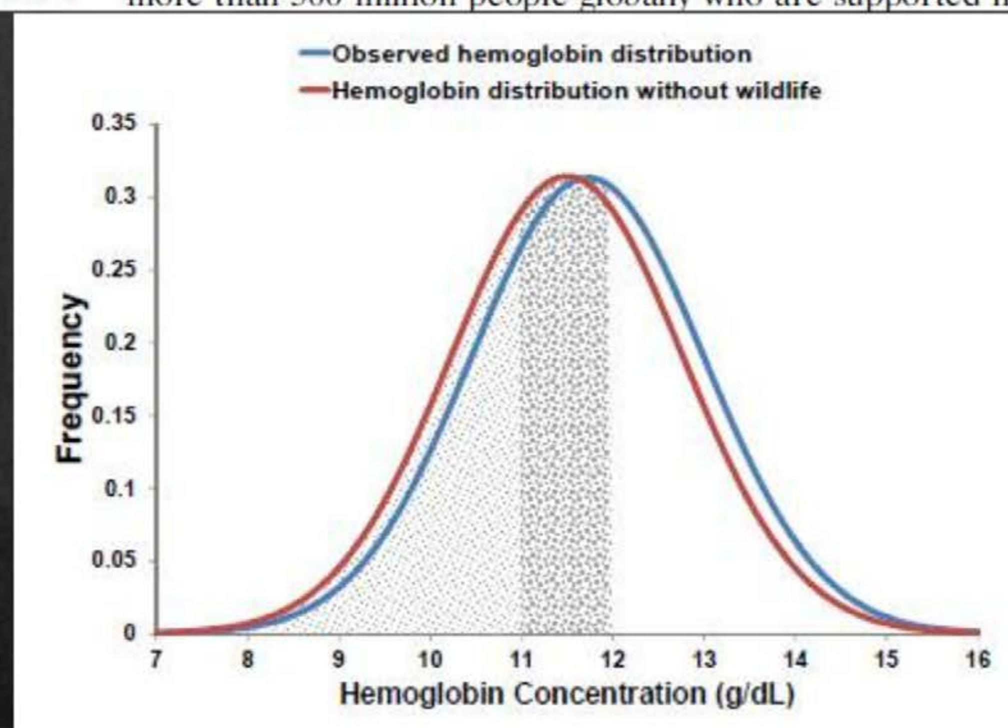
Terrestrial wildlife is the primary source of meat for hundreds of millions of people throughout the developing world. Despite widespread human reliance on wildlife for food, the impact of wildlife depletion on human health remains poorly understood. Here we studied a prospective longitudinal cohort of 77 preadolescent children (under 12 y of age) in rural northeastern Madagascar and show that consuming more wildlife was associated with significantly higher hemoglobin concentrations. Our empirical models demonstrate that removing access to wildlife would induce a 29% increase in the numbers of children suffering from anemia and a

developing countries (18). IDA is caused by the inadequate intake of iron-rich foods or excessive blood loss because of bleeding or infectious diseases, such as malaria or parasitic infections.

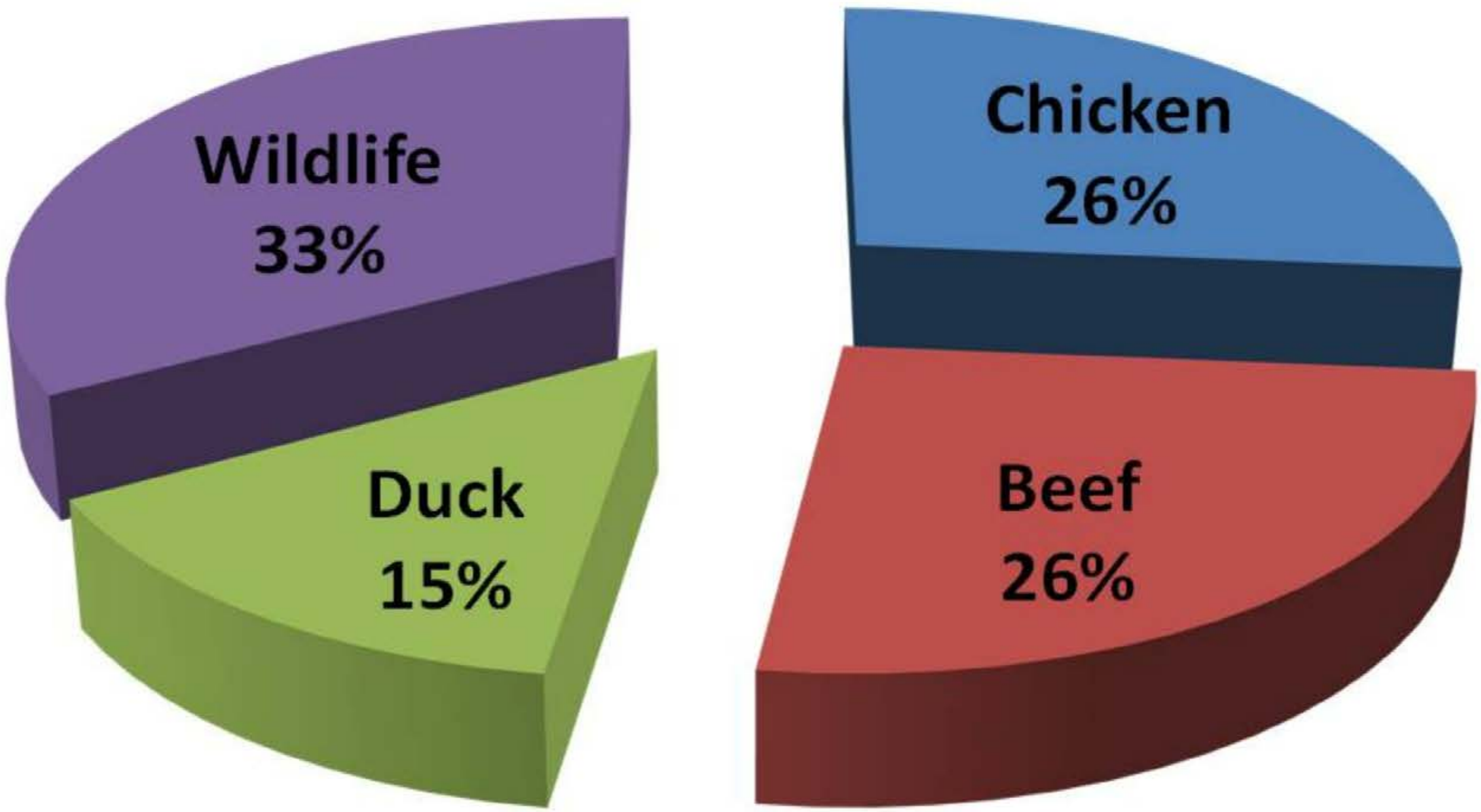
Our research examined how access to wildlife as a food source affected the risk of anemia for a longitudinal cohort of 77 children (Table S1) living in a remote area of the eastern rainforest in Madagascar (Fig. S1), who were measured monthly from March 2008 to February 2009. The rural community where the study was conducted relies heavily on local wildlife resources (Fig. S2), as do more than 300 million people globally who are supported nutri-



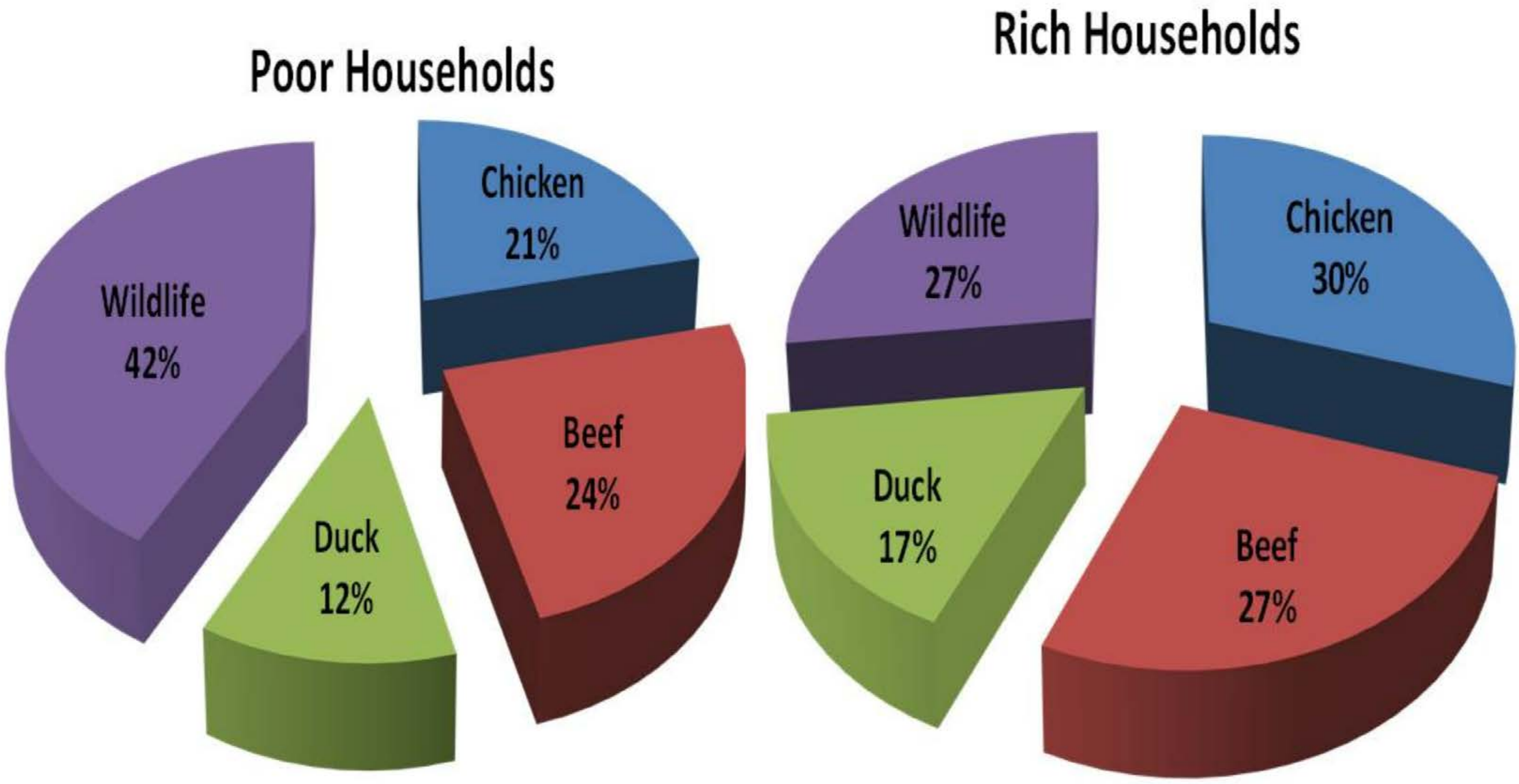
Consequences of Anemia

- 28% increase in moderate mental retardation
- Cognitive deficits have been shown to persist 20 years into the future
- 25% increase in maternal & perinatal mortality
- Anemic individuals transport 15% less O_2 - reduced physical activity

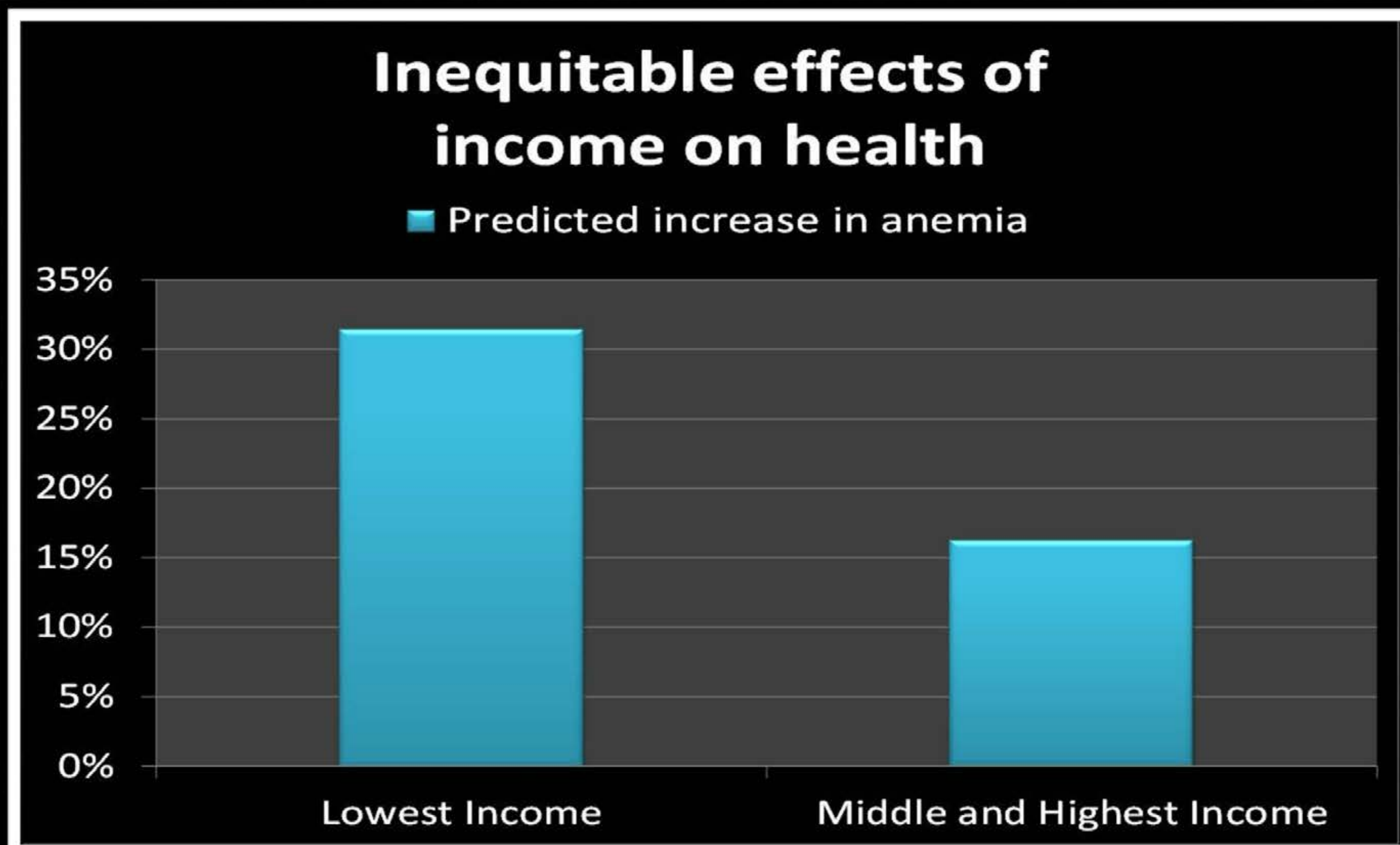
Nutritional Importance of Wildlife



Nutritional Importance of Wildlife



Those most vulnerable, are most affected

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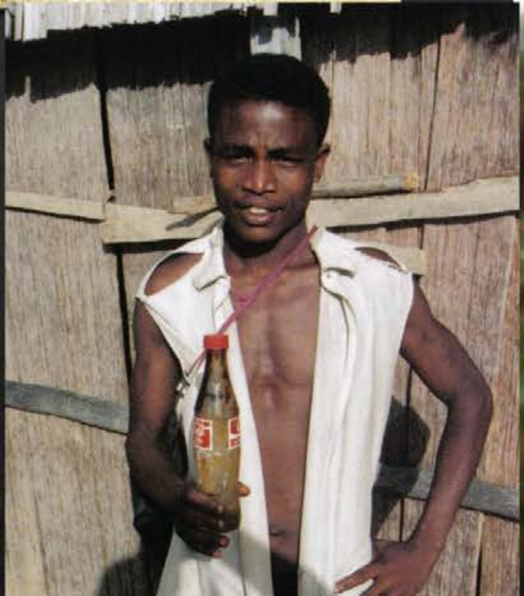
PENSACOLA
BEACH

Medicinal Value of Wildlife






LETTER FROM CAMEROON

THE DOOMSDAY STRAIN

Can Nathan Wolfe thwart the next AIDS before it spreads?

BY MICHAEL SPECTER

"Look up," Nathan Wolfe barked. I didn't respond immediately, so the next suggestion came with an elbow to the ribs: "Take your head out of that map." We were standing on the side of "the *road*," a dirt highway that passes through the center of Mindourou, a dusty logging village in southeastern Cameroon. Wolfe, the director of Global Viral Forecasting, and several colleagues were in the midst of a ten-hour drive from the capital, Yaoundé, to a town called Ngoila, one of the many sites that G.V.F. has established in the past decade to monitor the emergence of deadly viruses from the jungles of Central Africa. He nodded toward a couple who had just pulled up beside us on a Chinese motorcycle. The driver wore flip-flops and a red tracksuit. His passenger, dressed in a pale-blue shirt and a matching pillbox hat, looked as if she were on her way to church. But that wasn't where they were headed. Her right arm was wrapped around the driver's waist. In her left, she clutched the lengthy tail of a freshly killed agile mangabey, a mon-

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Wolfe's world consists of "bacteria, parasites, and viruses"; animals are "a tiny little addendum." Ph

Epidemic intelligence

Technology will help to spot and stop epidemics before they go global, predicts **Nathan Wolfe**, founder and director of the Global Viral Forecasting Initiative

In June 2011 public-health officials will mark the 30th anniversary of the first AIDS diagnosis. Much hand-wringing will ensue. Why do we not yet have an effective vaccine? How do HIV cases continue to grow?

At the same time, a small but growing number of scientists will mark the anniversary in a different way. We will instead ask: "Why is June 2011 the 30-year anniversary of AIDS's discovery rather than its 40-, 50- or 60-year one?"

The event that sparked the AIDS pandemic occurred around 100 years ago when a chimpanzee virus jumped into a person who had exposure to an infected animal, probably because he'd hunted or butchered it. Why did it take us some 80 years to discover it? Could we have stopped it before it spread globally?

During 2011 there will be viral outbreaks in Africa and Asia. These outbreaks will flare up after viruses "spill over" from animals into people with occupations such as hunting, farming or working in live-animal markets. At least one of these outbreaks will spread beyond the town it starts in, creating alarm among residents, jitters in stockmarkets and a flurry of media attention.

As outbreaks continue in 2011, public-health officials will begin to think of them in a different way. The idea that we must not only respond to pandemics, but work to predict and prevent them will move beyond a small group of advocates and become a mainstay of some of the world's largest governments and foundations. The world will increasingly recognise that in the case of pandemics, as with heart disease and cancer, an ounce of prevention is worth a pound of cure.

The march of globalisation will create a single mega-population of people on the planet in which more and more viruses have the potential to survive and thrive. Distant will be the days when the isolation of remote villages imposed a natural quarantine on a nascent outbreak. From a virus's perspective, there will be a single mass of humans, tightly connected by air travel, with plenty of susceptible people to fuel the fire of new plagues, whether natural, accidental or deliberate.

The growing field of digital epidemiology will attract more students, health officials and resources than ever before

Fortunately, globalisation will also speed the flow of health data. In 2011 the growing field of digital epidemiology will attract more students, health officials and resources than ever before. People in viral hotspots around the world will report suspicious human and animal deaths (often a warning sign of a coming plague) by mobile phones. These data will be posted to the web, instantly enriching the data that came from traditional surveillance systems and electronic medical records. Organisations like Google.org will scour search patterns around the world, expanding their search-based predictions of influenza to other infectious diseases. Still more creative early-detection systems will begin to pull together illness information present in social-networking sites like Facebook and Twitter, allowing us to see changing disease patterns before they make the morning news.

Novel laboratory approaches to the discovery of new viruses will emerge. The long-awaited era of single-molecule DNA sequencing will begin in earnest with new machines from companies like Pacific Biosciences, and with a bit of luck this will improve the speed at which we can recognise unknown bugs. At the cutting edge, new studies of virus evolution and chips housing tiny cell cultures will improve our capacity to sort through the viral chatter and determine if a newly identified outbreak has the potential to spread globally or is likely to fade away. The discovery of new viruses will make the move from universities to laboratories around the world, helping to facilitate international scientific collaboration and decrease fears of biopiracy.

Towards a global immune system

In 2011 you may be among those who will watch a new blockbuster movie on a frightening fictional pandemic. But whether you are a head of state wary of the political and economic costs of a disease catastrophe, a CEO concerned by supply-chain and staff disruption associated with the next pandemic, or a citizen worried about your family, in 2011 you will have access to better, more accurate and rapidly available data on actual outbreaks. In the increasingly popular Silicon Valley model, organisations will mash up multiple data sources—combining lab results in far-flung viral listening-posts with international news feeds, text messages, social-networking and search patterns to create a new form of epidemic intelligence.

The past ten years have seen noteworthy progress in the development of truly global systems. In the world of outbreaks, 2011 will mark the beginning of the development of a worldwide immune system that will detect and respond to biological threats before they go global. Although this will take years to build fully, if successful it could make pandemic anniversaries a thing of the past. ■

Zoonotic Disease Sampling


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mbato.

Type of taboo	Prevalence of Taboo
Hornless zebu	55.30%
Hedgehod tenrec	45.30%
Domesticated cat	31.80%
Octopus	27.80%
Blue coua	23.20%
Indri	23.10%
Eels	21.80%
Crested drongo	19.90%
Bush pig	18.70%
Insectivorous bats	18.20%
Madagascar blue pigeon	17.50%
Flying fox	15.80%
Taro leaves	14.30%
Madagascar magpie robin	13.90%
Eastern woolly lemur	12.80%
Madagascan rousette	12.50%
Malagasy coucal	11.10%
Aye-aye	11.10%
Sea turtle	10.00%
White-fronted brown lemur	8.60%
Ringtailed mongoose	7.80%
Fosa	7.70%
Eastern bamboo lemur	7.70%
Red-bellied lemur	7.10%

Successes

- Culture
- Religion
- Gender Equity
- Economics

Ny teny toy ny atody; ka fo, manan-kelatra

Acknowledgments

- Drs. Sam Myers, Claire Kremen, Lia Fernald, Justin Brashares, Kirk Smith, Art Reingold, and Alan Hubbard
- Rasolofoniaina Be Jean Rodolph
- Dr. Nicolas Lilien and Madame Florine
- Evelin Jean Gasta Anjaranirina
- Rivo, Emilien, and Rija