


Knowing the Hazards: Extinction and Loss of Ecosystem Services II

Class 17



Critical Ecosystem Services


1. Climate and Biogeochemical Cycles
2. Regulation of Hydrologic Cycle
3. Soils and Erosion
4. Biodiversity and Ecosystem Functions
5. Mobile Links
6. Balance of Diseases Transmission

**MILLENNIUM ECOSYSTEM ASSESSMENT**

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- **Overall synthesis**
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- **Business & Industry**
- **Wetlands and Water**
- **Health**


Statement of the MA Board




The MA Board of Directors has developed an interpretation of the key messages to emerge from the assessment, entitled *Living Beyond Our Means: Natural Assets and Human Well-being*. [Learn more](#)

- **Download the Statement**
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A Framework for Assessment



In late 2003, the MA and Island Press published *Ecosystems and Human Well-being: A Framework for Assessment*. This volume lays out the assumptions, processes and parameters that were used in the MA. [Learn more](#)





About the Millennium Assessment

The Millennium Ecosystem Assessment assessed the consequences of ecosystem change for human well-being. From 2001 to 2005, the MA involved the work of more than 1,360 experts worldwide. Their findings provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably. [Read More](#)

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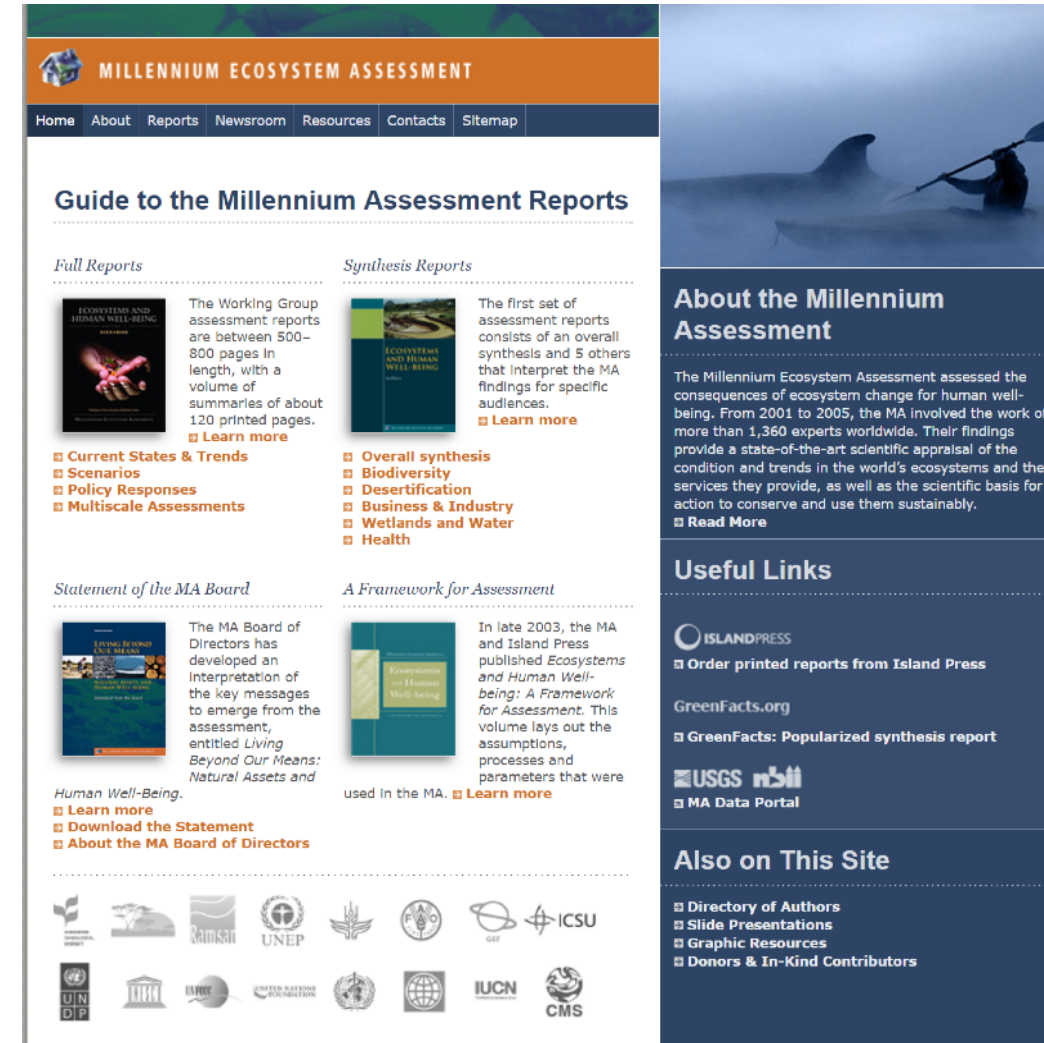
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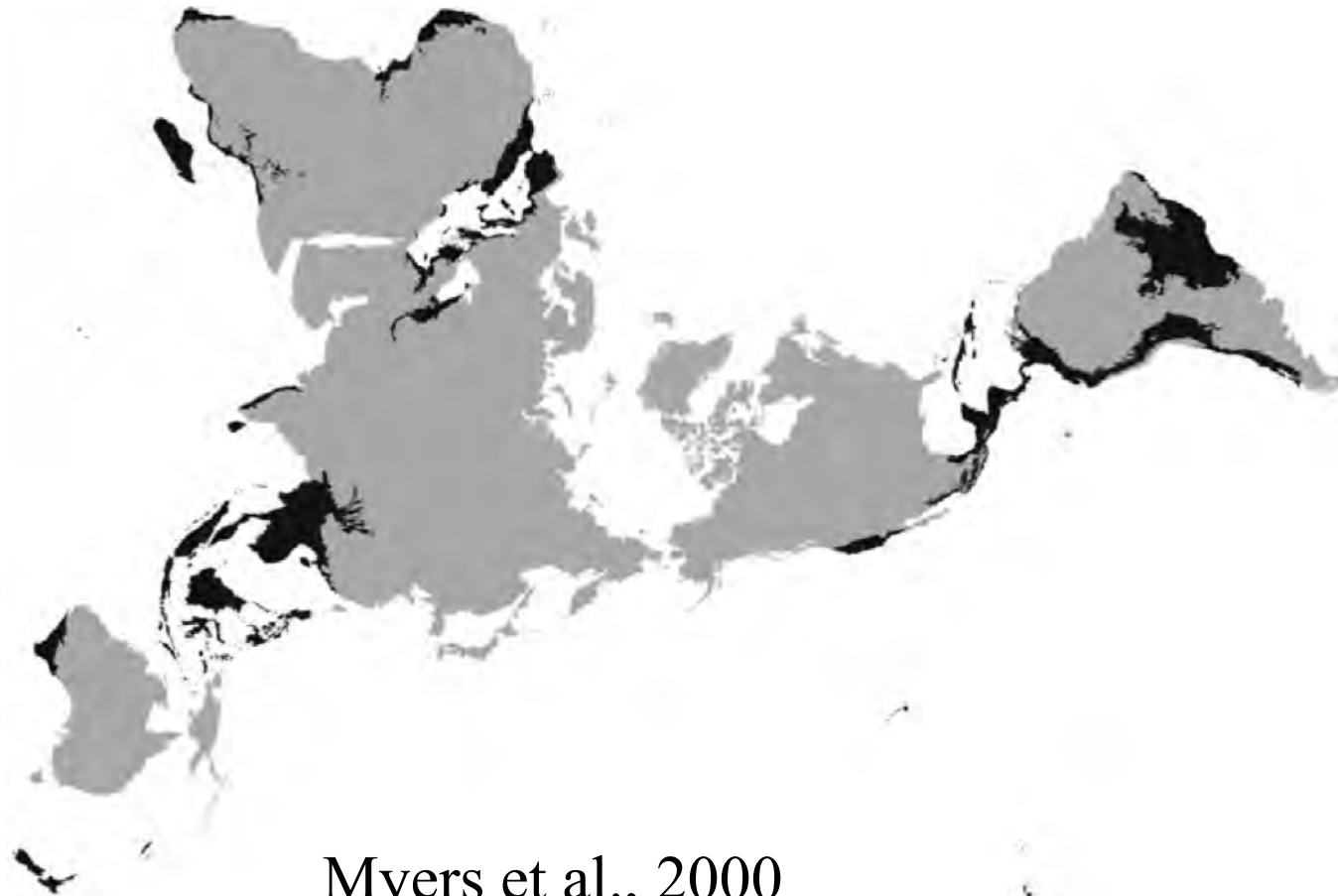
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Where are spp becoming extinct?

- **Myers' Hotspots** = 25 areas with 1,000 endemic plants (many spp with small ranges) and <30% of remaining natural vegetation

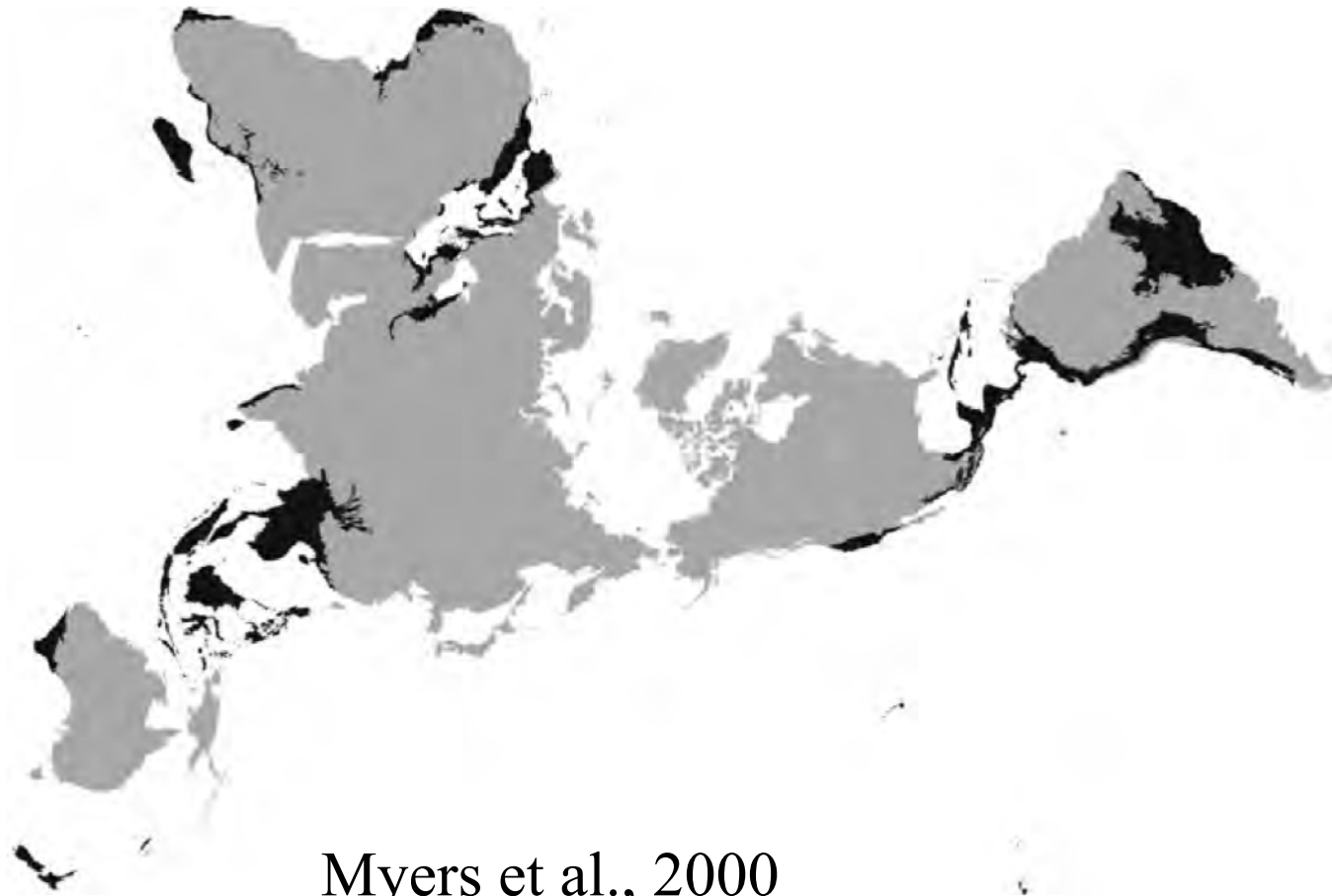


Myers et al., 2000

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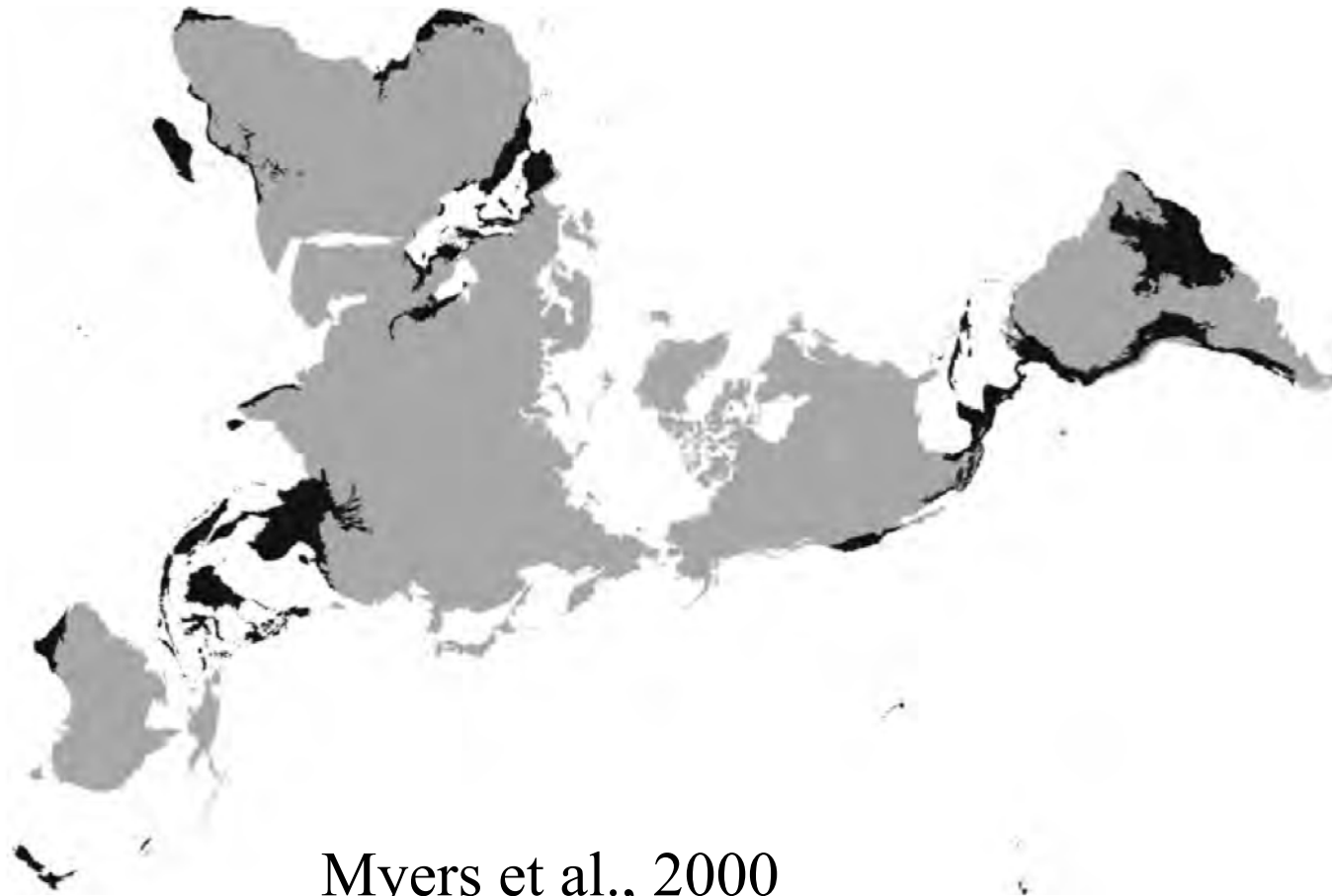
Hotspots have higher human population density and population growth rate (Cincotta et al., 2000)



Myers et al., 2000

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Similarly, large fraction of marine spp have small ranges (except corals) and they collide with high human impact

Myers et al., 2000

Major Causes of Biodiversity Loss

1. Habitat Change

- Habitat Loss
- Degradation
- Fragmentation

2. Pollution

3. Overharvesting (=overexploitation)

4. Invasive Species

5. Climate Change

Major Causes of Biodiversity Loss

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- $\frac{3}{4}$ of bird spp-- 1,250 spp-- in hotspots will go extinct this century (Pimm & Raven, 2000)
 - At current rates of deforestation, most of the Amazon will be gone by mid-century (Laurance et al., 2001)

Major Causes of Biodiversity Loss

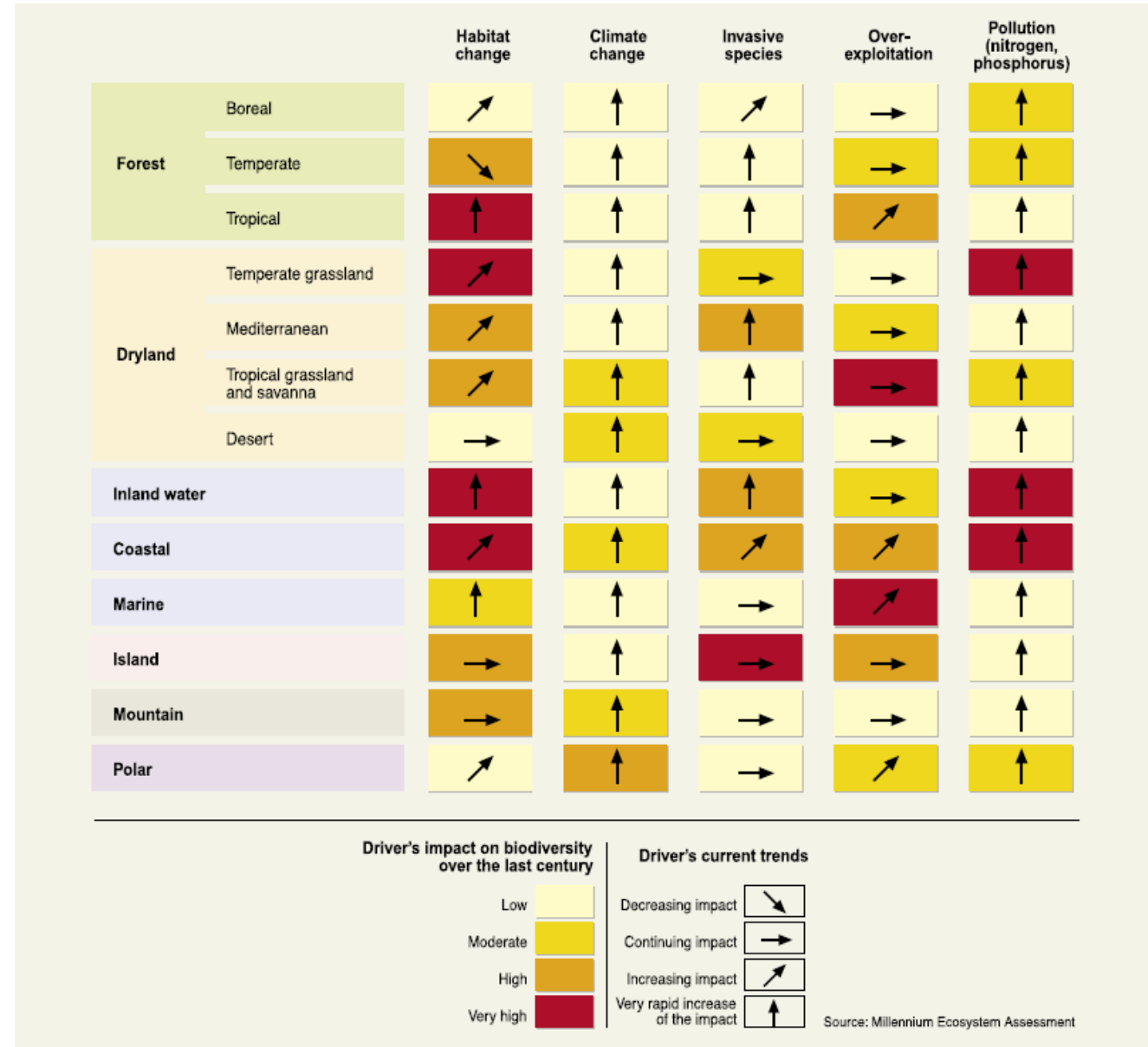
1. Habitat Change
 - Habitat Loss
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2. Pollution
3. Overharvesting
4. Invasive Species
5. Climate Change

Overall expectations of species moving poleward, to higher elevations, or to deeper depths to remain in their climate envelopes.

- Thomas et al., 2004 estimate 15-37% of spp are threatened by climate change within the next 50 years for a mid-range warming scenario
- 7-24% of plant spp will become extinct
- Lower rates in the ocean because of the greater freedom of movement

Main Drivers Impact on Biodiversity

Causes for biodiversity lost are changing



Climate Change impact on Biodiversity

- Climate change is projected to exacerbate the loss of biodiversity and increase the risk of extinction for many species, especially those already at risk due to factors such as low population numbers, restricted or patchy habitats, and limited climatic ranges (medium to high certainty).
- Water availability and quality are projected to decrease in many arid and semiarid regions (high certainty).
- The risk of floods and droughts is projected to increase (high certainty).
- The biomass production is projected to decrease in some regions (high certainty).
- Agricultural productivity is projected to decrease in the tropics and sub-tropics for almost any amount of warming (low to medium certainty), and there are projected adverse effects on fisheries.
- Projected changes in climate during XXI century are very likely to be without precedent during at least the past 10,000 years and, combined with land use change and the spread of exotic or alien species, are likely to limit both the capability of species to migrate and the ability of species to persist in fragmented habitats.

Critical Ecosystem Services

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Mobile Links

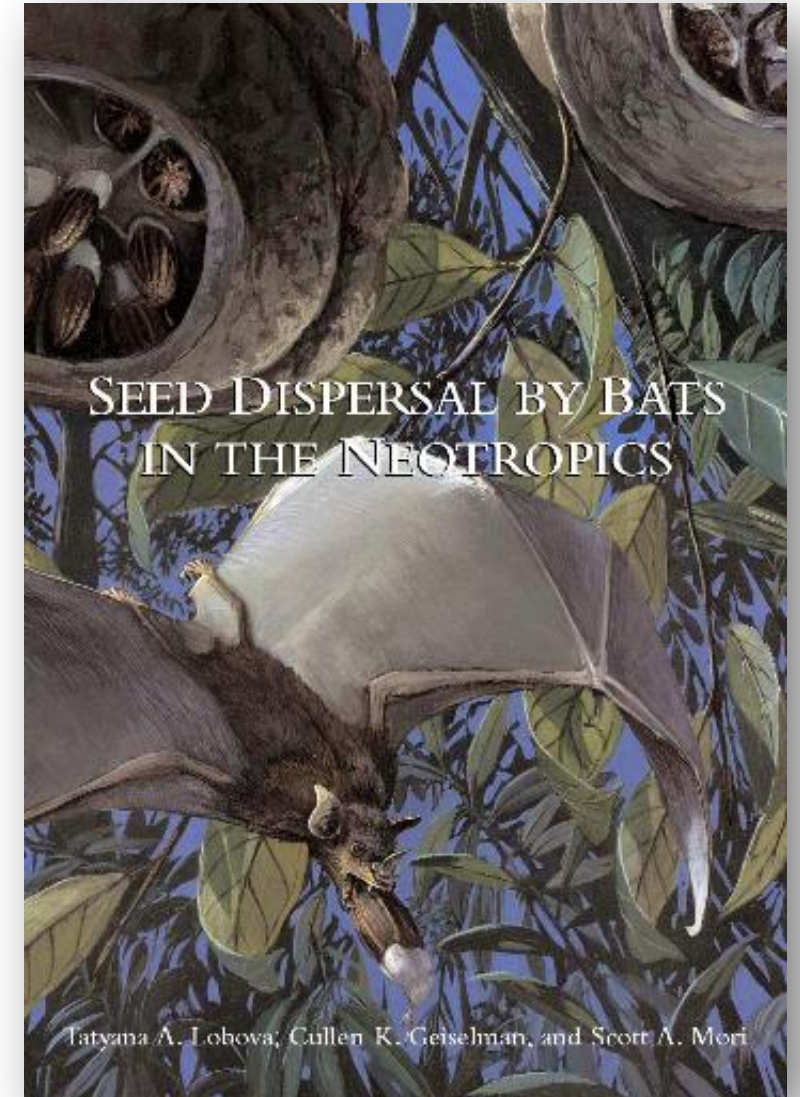
- “**Mobile links**” are animal species that provide critical ecosystem services and increase ecosystem resilience by connecting habitats and ecosystems as they move between them (Gilbert 1980; Lundberg and Moberg 2003)
- Ecosystems connections via:
 - 1) **Gene flow**
 - Pollinators and dispersers
 - 2) **Processes**
 - Trophic process: pray-predator, scavengers-infected carcasses
 - Nutrient process: nutrient in animals and birds droppings
 - Physical processes (ecosystem engineers): beavers, woodpeckers
 - 3) **Resource links**
 - Long-distance migration



Seed Dispersal

Seed dispersal is thought to benefit plants in three major ways (Howe and Smallwood 1982):

1. Escape from density-dependent mortality caused by pathogens, seed predators, competitors, and herbivores (Janzen-Connell escape hypothesis)
2. Chance colonization of favorable but unpredictable sites via wide dissemination of seeds.
3. Directed dispersal to specific sites that are particularly favorable for establishment and survival.



Missing Seed Dispersers

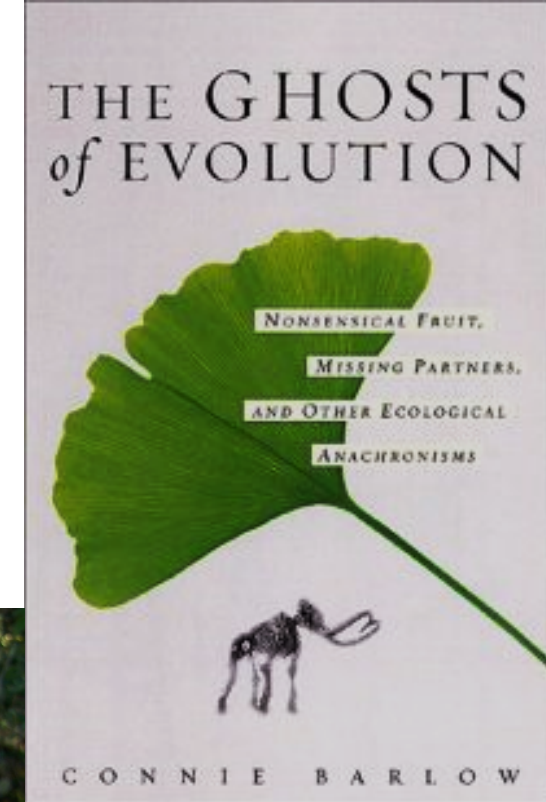
Overhunting
Loss of habitat
Habitat fragmentation



Loss of Biodiversity
Poor Forest Regeneration

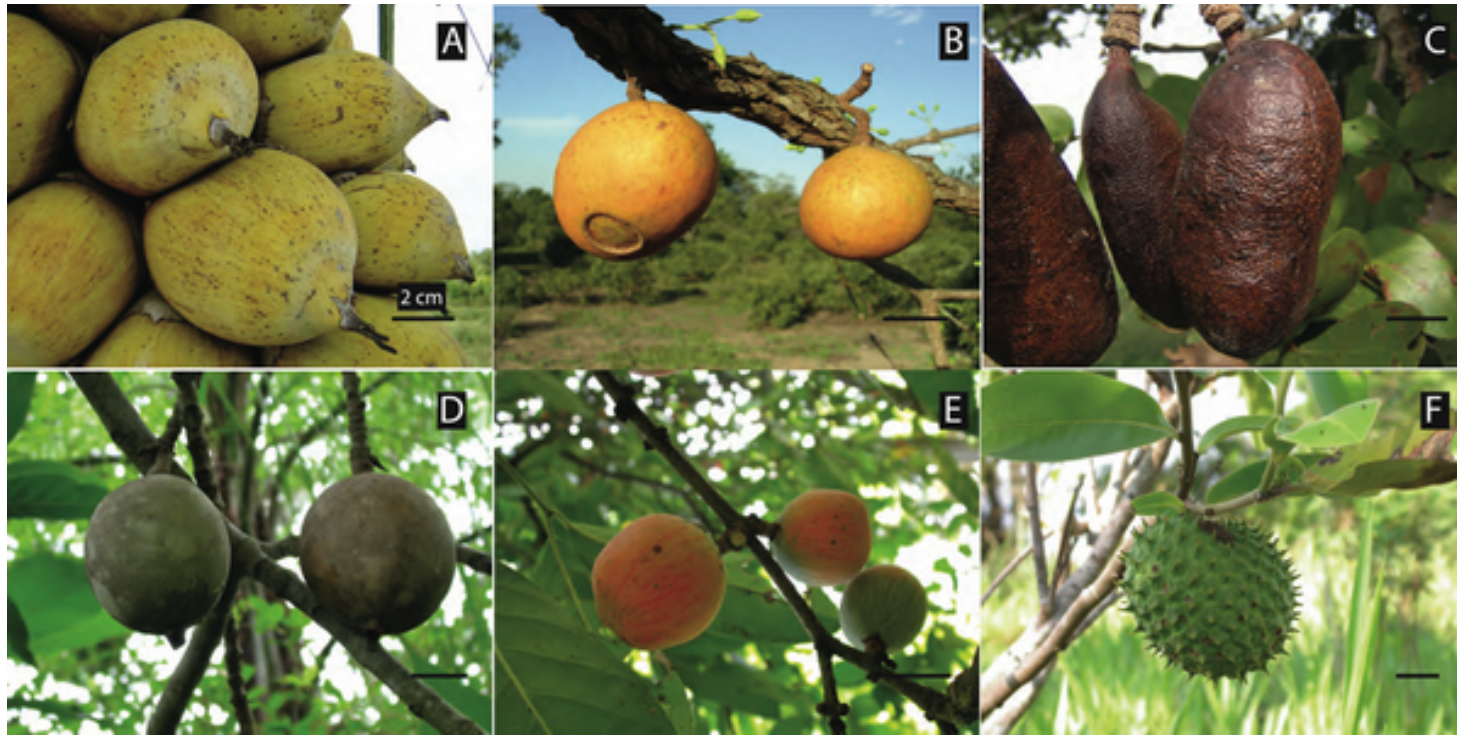


Osage-orange

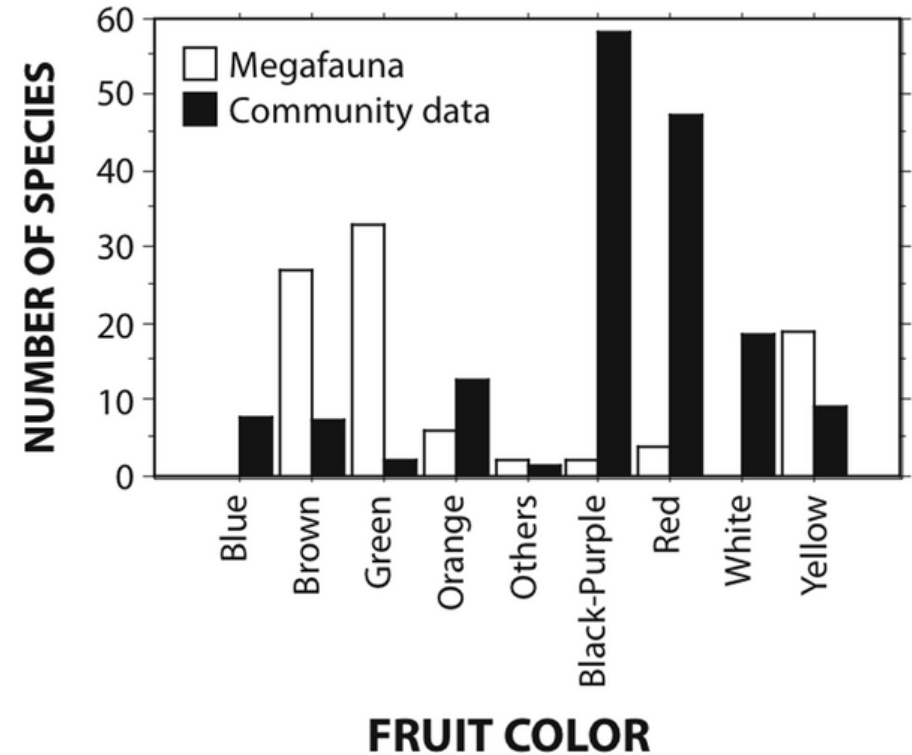


Missing Seed Dispersers

Fleshy fruited megafaunal-dependent species illustrating size, shape, and color variation.



Frequency of megafauna species with different fruit colors (blank bars) compared to the summed frequency in different communities (filled bars).



Guimarães PR Jr, Galetti M, Jordano P (2008) Seed Dispersal Anachronisms: Rethinking the Fruits Extinct Megafauna Ate. PLoS ONE 3(3): e1745. doi:10.1371/journal.pone.0001745
<http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0001745>

Pollination

- 98% of tropical trees are animal pollinated
- More than 1,200 vertebrate and about 289,000 invertebrate spp are involved in pollinating over 90% of flowering plant spp and 95% of food crops (Nabhan and Buchmann 1997).
- 75% of globally important crops rely on animal pollinators, providing up to 35% of crop production (Klein et al. 2007)



Missing Pollinators

Habitat Loss

Habitat modification

Pesticides



Extreme risk of relying on a single pollinator for crops



Bees pollinate $\frac{2}{3}$ of flowering plant spp and $\frac{3}{4}$ of food crops, that provide us with dietary diversity



Mobile Links

- “Mobile links” are animal species that provide critical ecosystem services and **increase ecosystem resilience** by connecting habitats and ecosystems as they move between them (Gilbert 1980; Lundberg and Moberg 2003)
- Protection of mobile links should be a top conservation priority to prevent collapses in ecosystem services:
 - Seed dispersers,
 - Pollinators,
 - Scavengers,
 - Predators,
 - Nutrient depositors

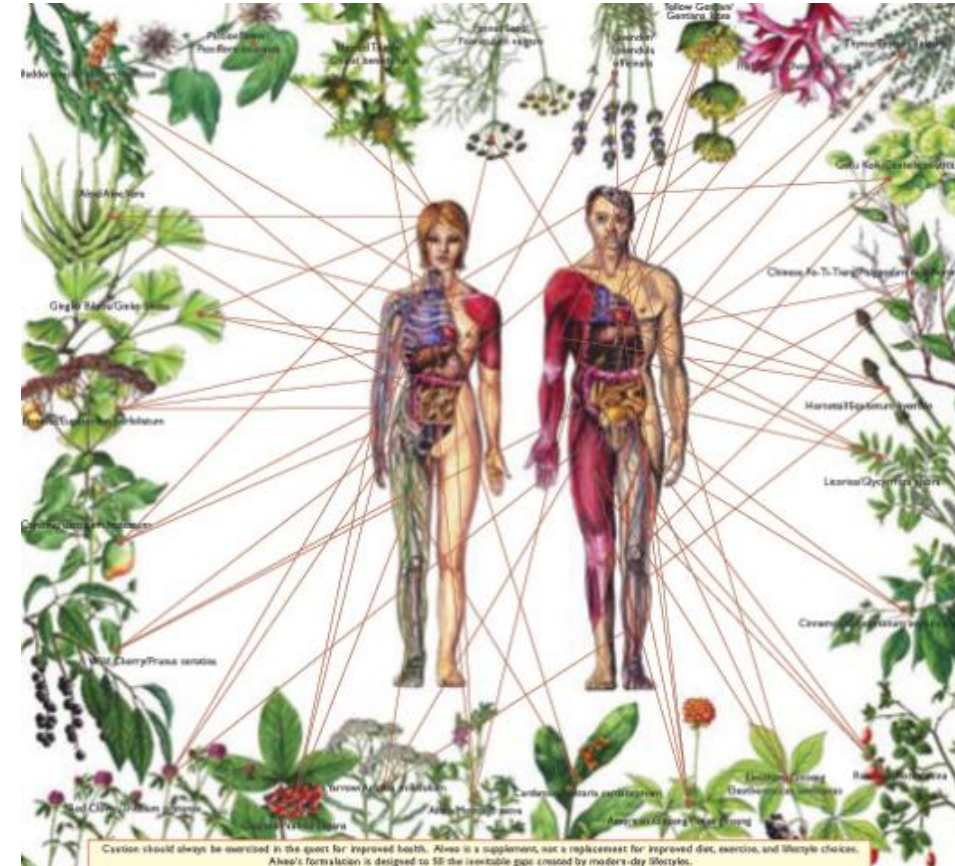


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Nature heals and hurts

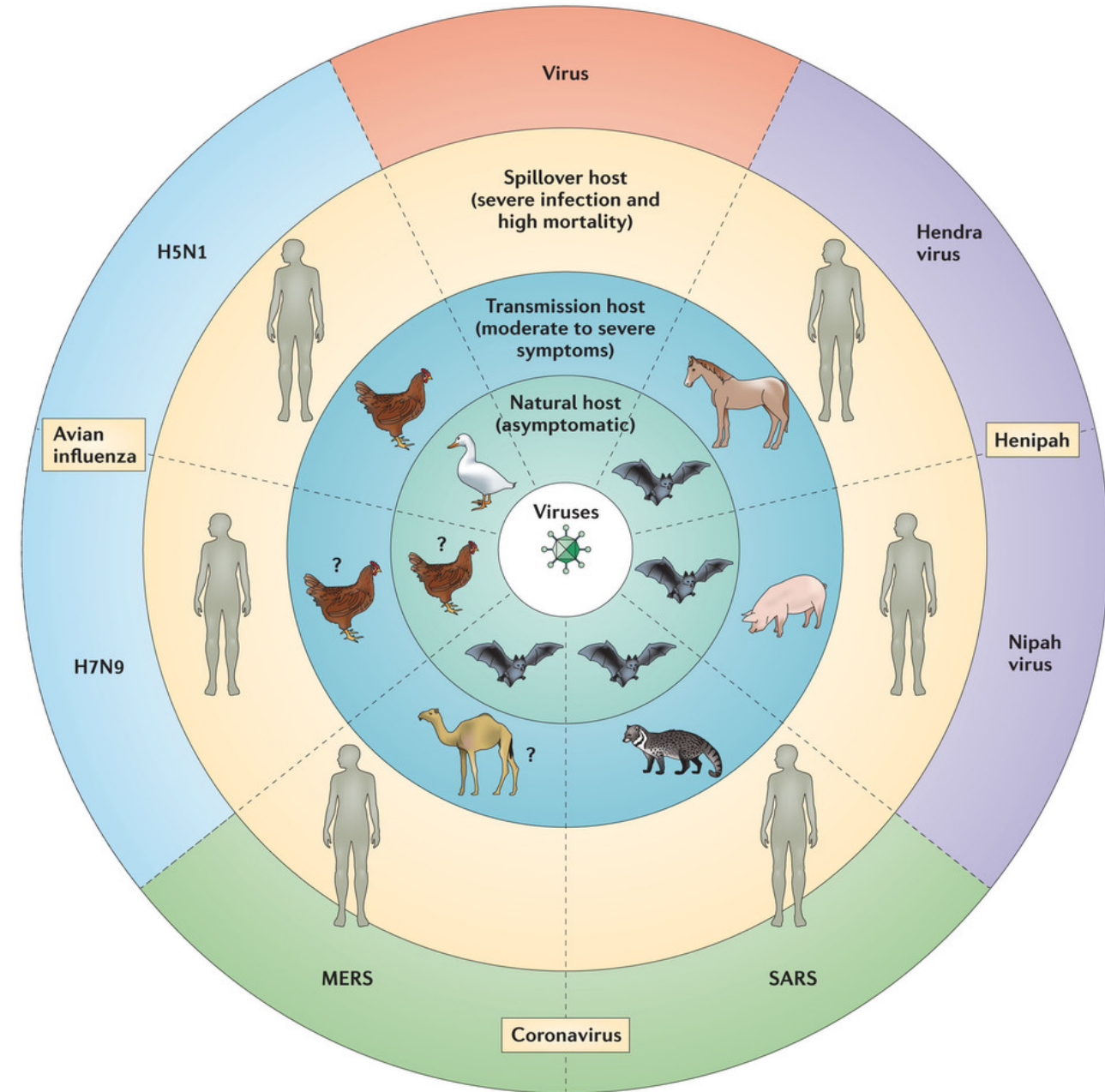
- 40% of our prescription medicine comes from plants
- Of the 3,000 plants identified by the US National Cancer Institute as active against cancer cells, 70% come from *rainforests*
- The planet's organisms also include countless diseases, many of which are making the *transition to humans* as people increasingly invade the habitats of the hosts of these diseases and consume the hosts themselves.
- $\frac{3}{4}$ of human diseases might have origin in *domestic or wild animals*
- Monkeypox, malaria, HIV and Ebola have come from African primates to people that killed, butchered and consumed them



Zoonotic Diseases

Zoonotic Diseases are diseases that can be passed between animals and humans.

- Viruses, bacteria, parasites, and fungi can cause zoonotic diseases.



Emerging Diseases: Nipah

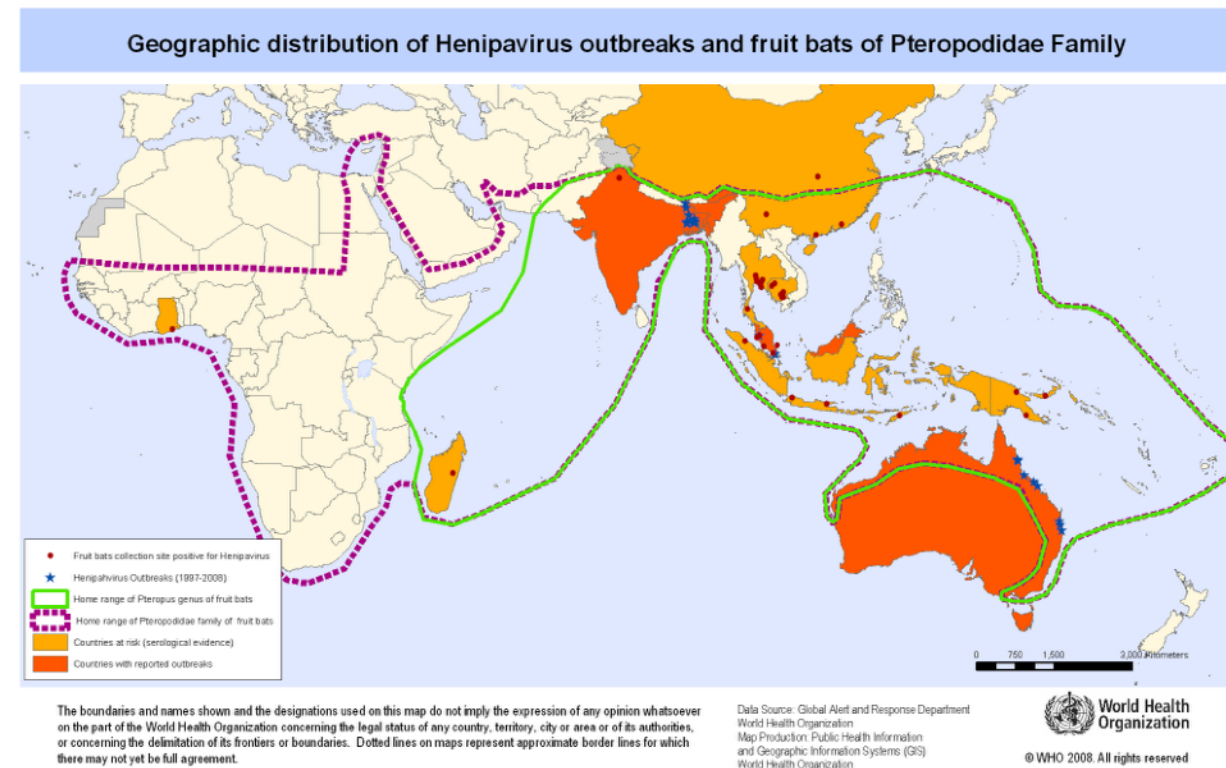
Nipah Virus, Malaysia 1998

- New, high fatality rate
- Misdiagnosed as Japanese encephalitis
- Aggressive control measures were unsuccessful
- Ethnic Chinese farmers sold pigs and spread disease
- Virus isolated after 6 months
- Farmers thought government indifferent to their welfare and health
- Ended with culling of >1M pigs, with devastating effects on farmers' livelihoods
- 265 cases, 105 fatal

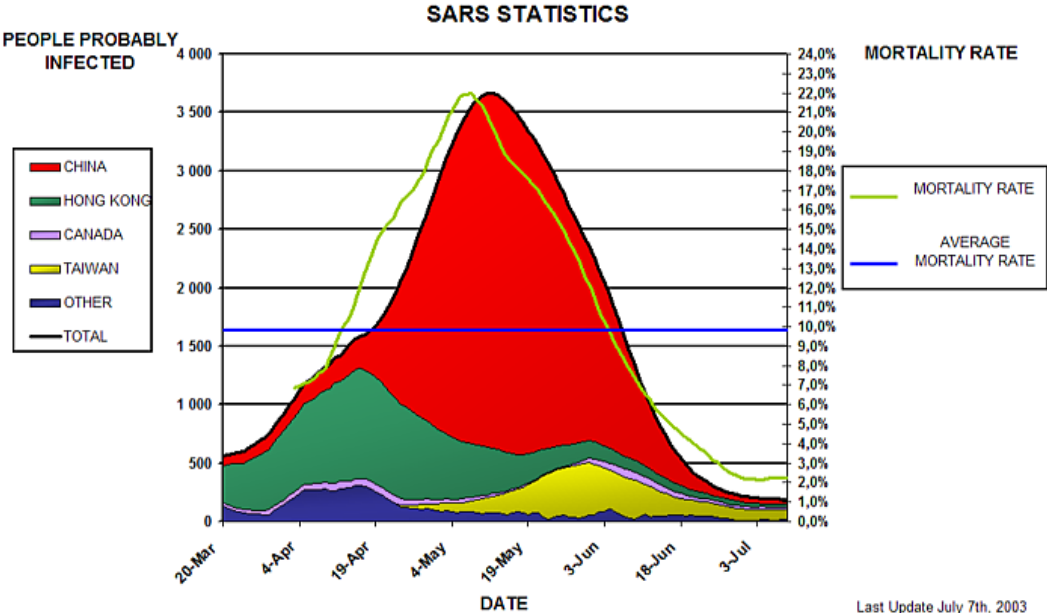
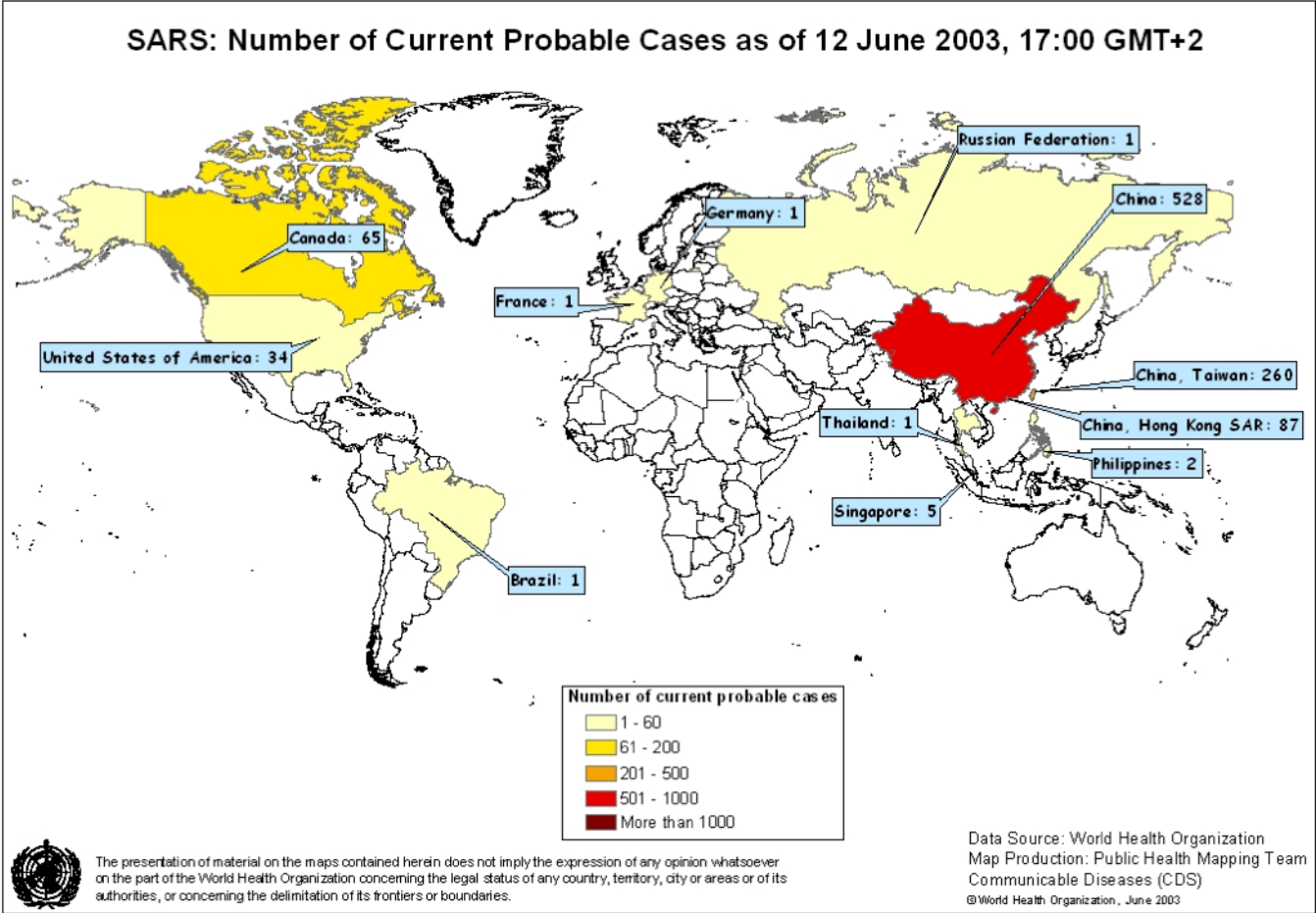


Emerging Diseases: Nipah

- Massive forest fires in 1997-1998 in SE Asia → forest destruction and smoke → forced fruit bats to feed on fruiting orchards, mainly mangoes → pigs were farmed among the fruiting trees and ate mangoes from the ground → bats are hosts to Nipah virus → passed to pigs → passed to people (Chivian, 2002)



Emerging Diseases: SARS



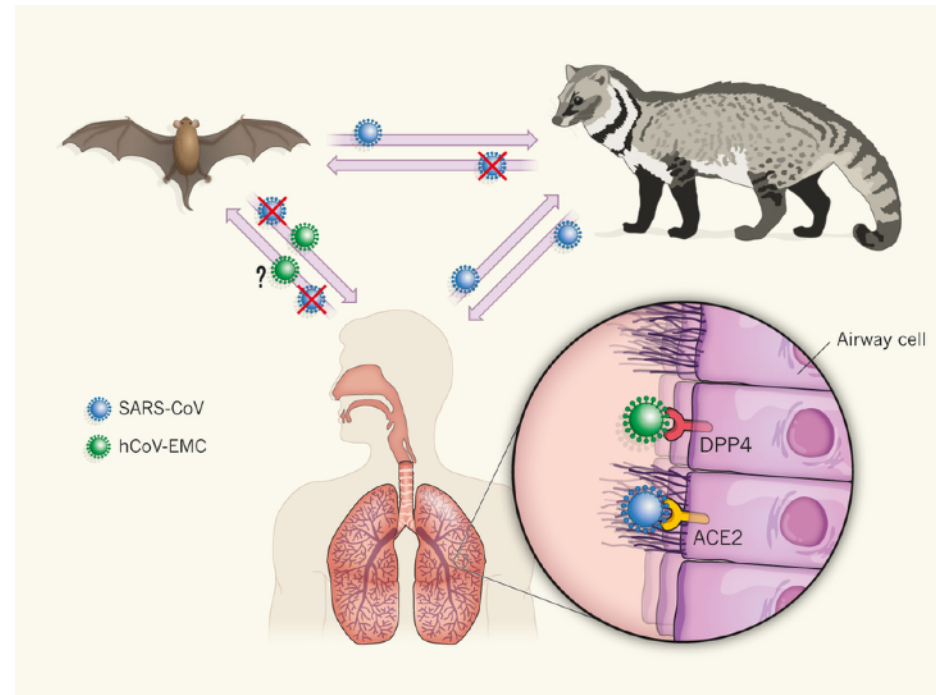
Emerging Diseases: SARS

Fruit bats are native hosts → partially eaten fruits → wild frugivorous animals, like civets and raccoon dogs → passed to other animals in wildlife market → people eat wild animals

SARS originated from China

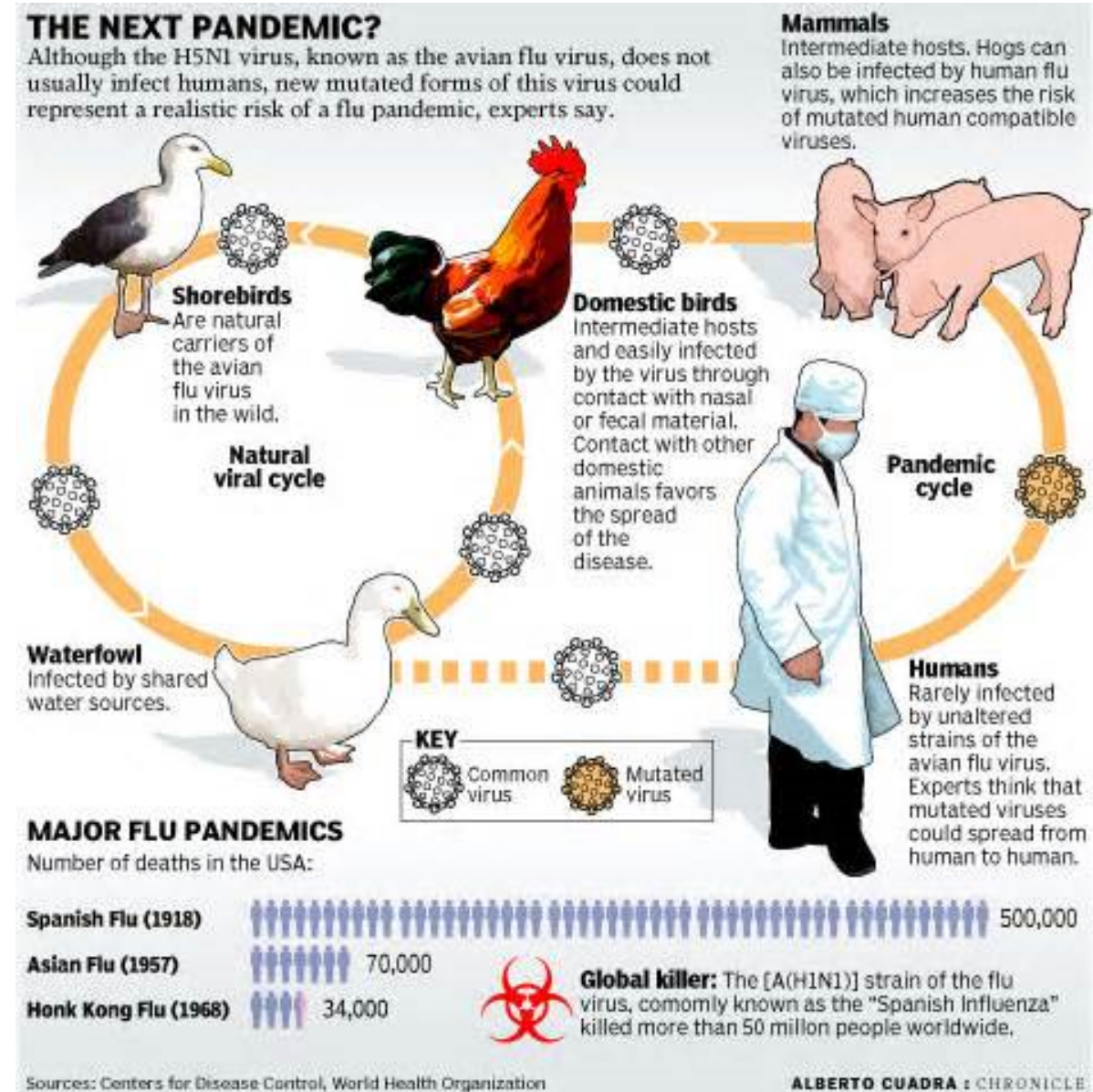


Avoid Traveling to: China, HongKong



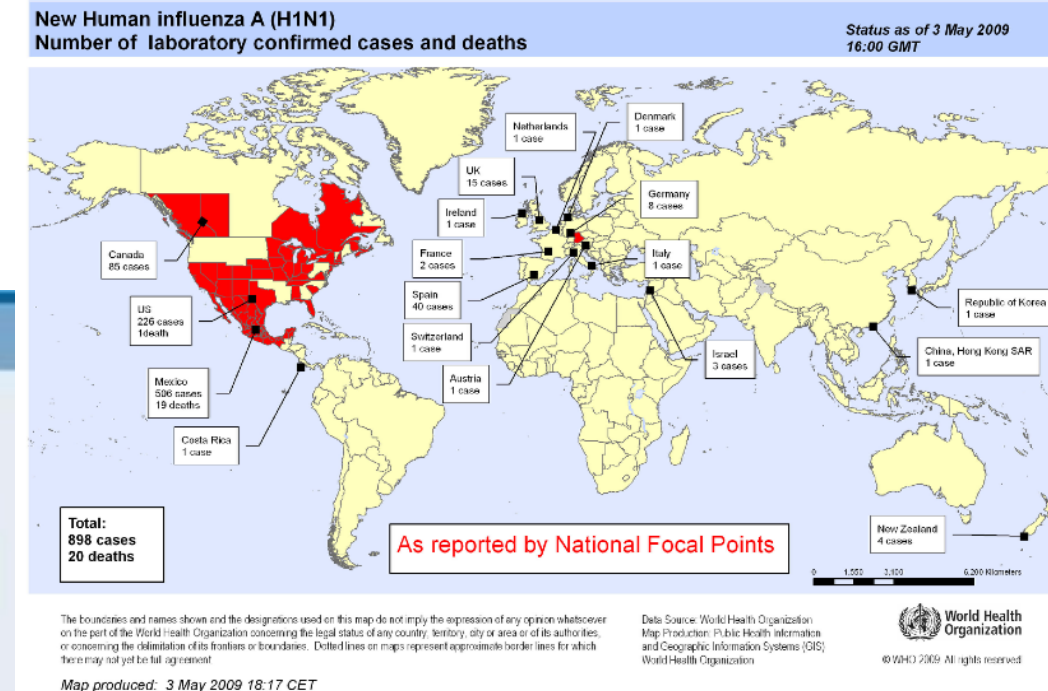
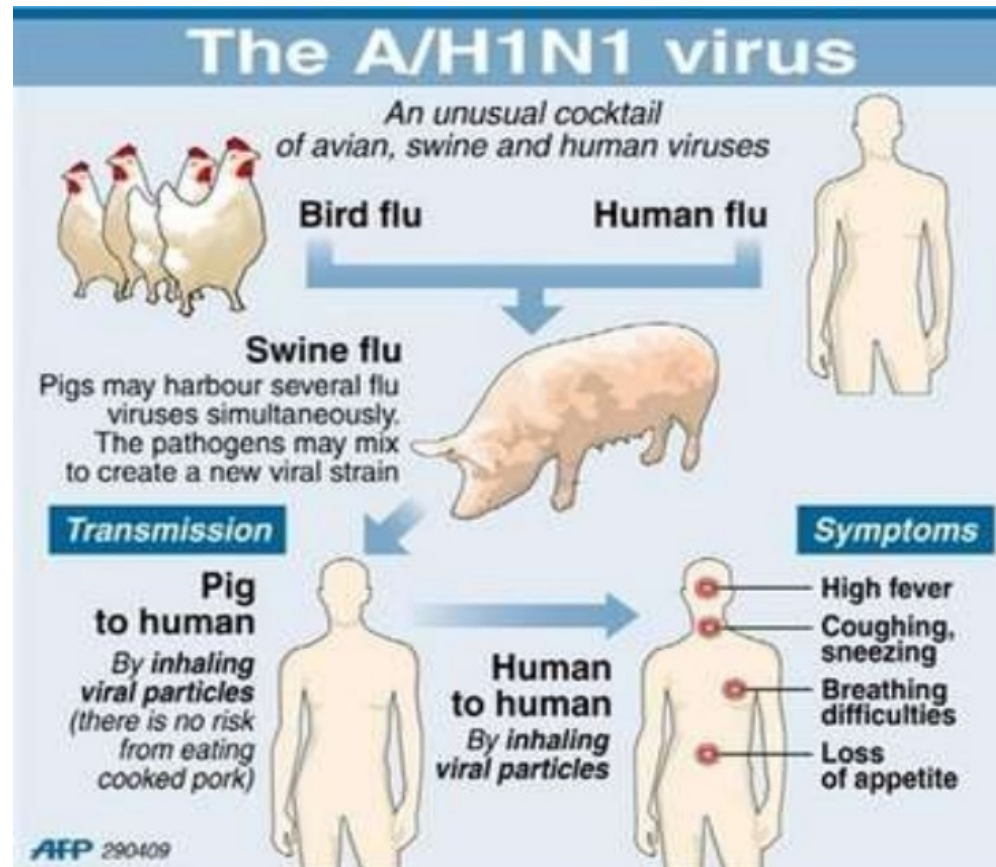
Emerging Diseases: Avian Flu

WHO data indicate 60% of cases classified as H5N1 resulted in death



Emerging Diseases: Swine Flu

Declared a pandemic in 2009 → May 30, 2010
more than 214 countries and overseas territories
have confirmed cases and over 18,138 deaths
(WHO) → vaccination in 2010



Zoonotic Diseases

- Tropical deforestation, combined with climate change, human migration, agricultural intensification, and animal trafficking create the **perfect storm** for the emergence of new diseases as well as the resurgence of old ones.
- In the face of rapid global change, **ecologically intact and relatively stable communities** may be our best weapon against the emergence of new diseases.

