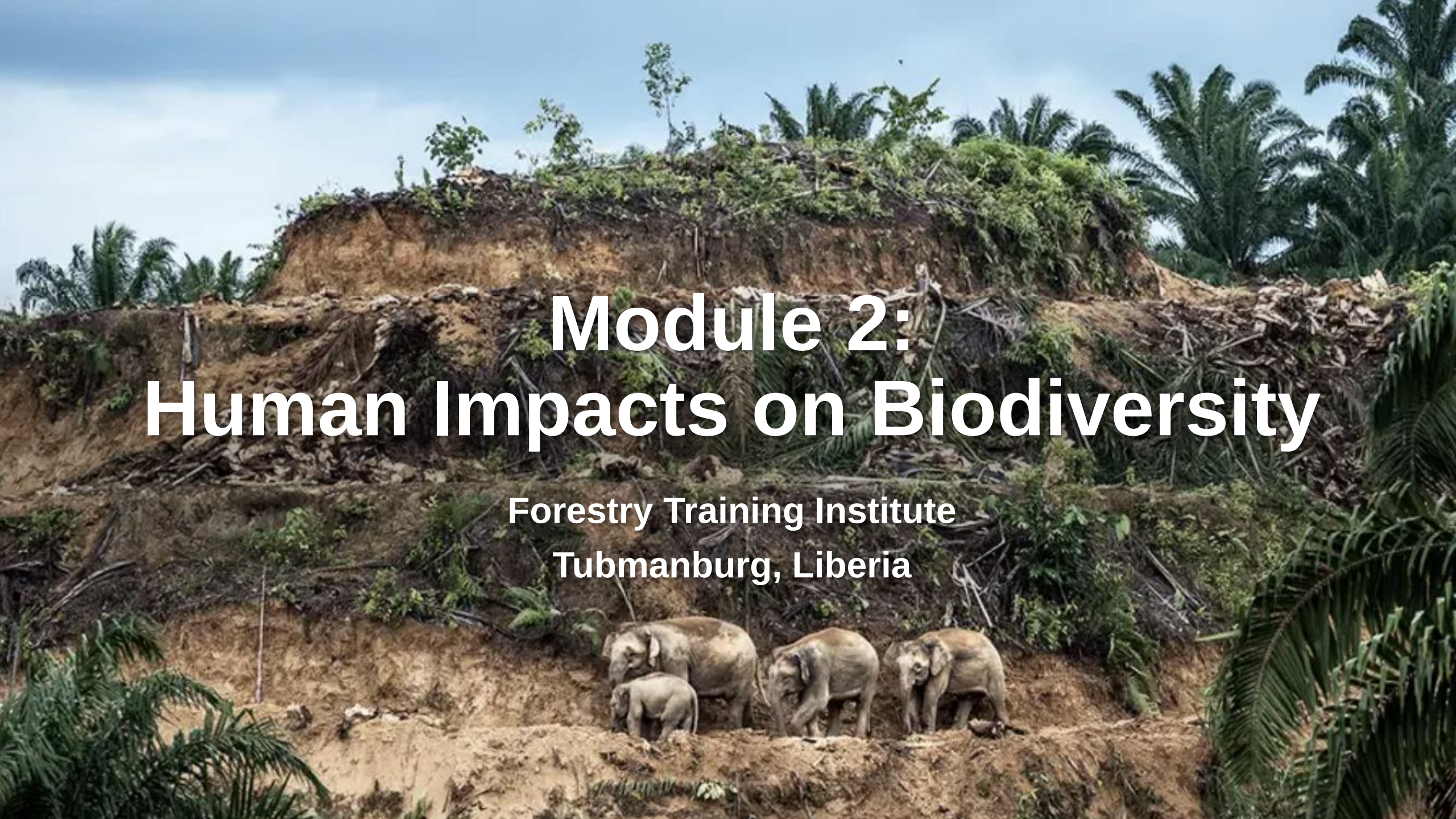


Module 2:
Human Impacts on Biodiversity

Forestry Training Institute

Tubmanburg, Liberia

Key Topics

- Human Impacts on Biodiversity
- Habitat destruction
- Hunting
- Overexploitation
- Invasive Species
- Wildlife Diseases
- Climate Change

Human Impacts on Biodiversity

30-50% of the planet's land surface has been substantially altered by human activity. Many species survive on a fraction of their former range and in increasingly fragmented landscapes.

Bleaching

Fragmentation

Deforestation

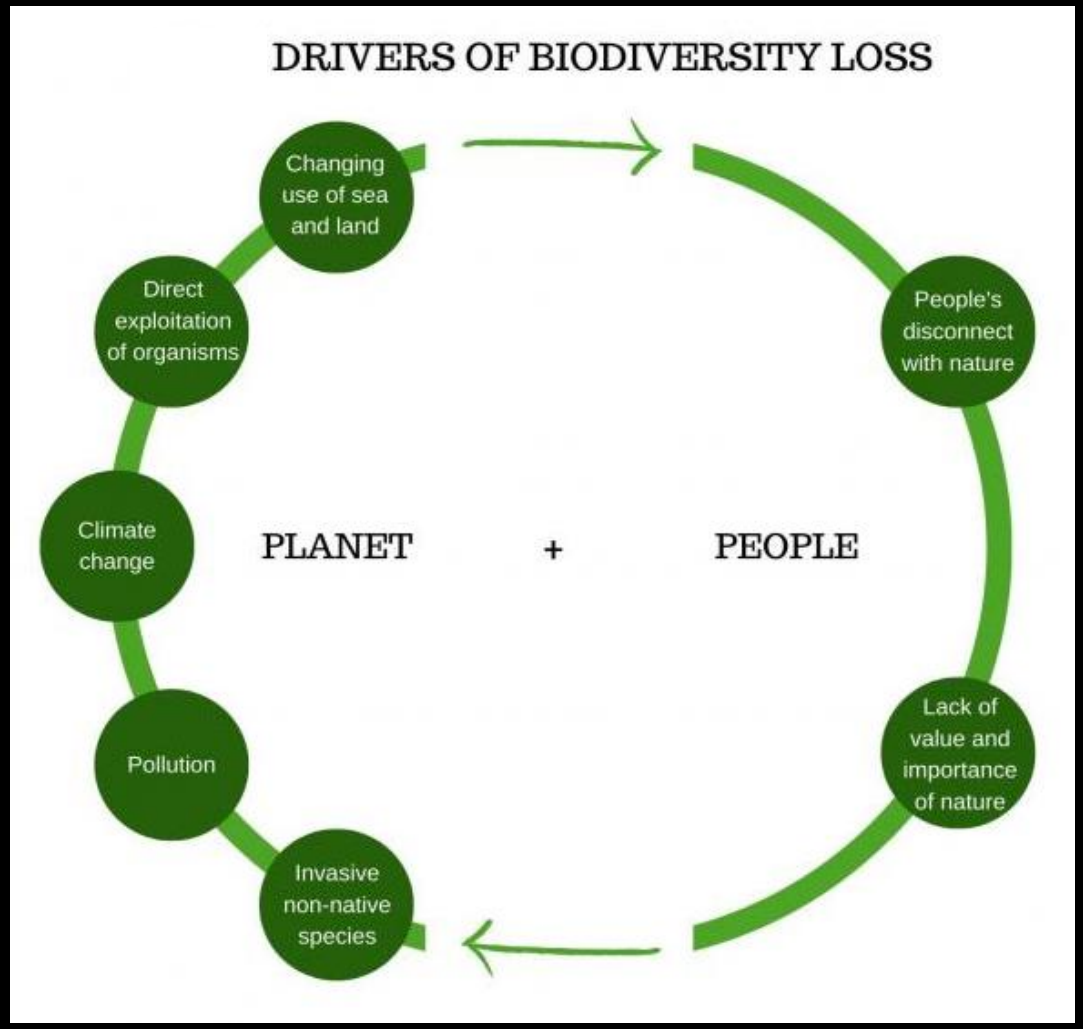
Overfishing

Air Pollution

Water Pollution

…and many more!

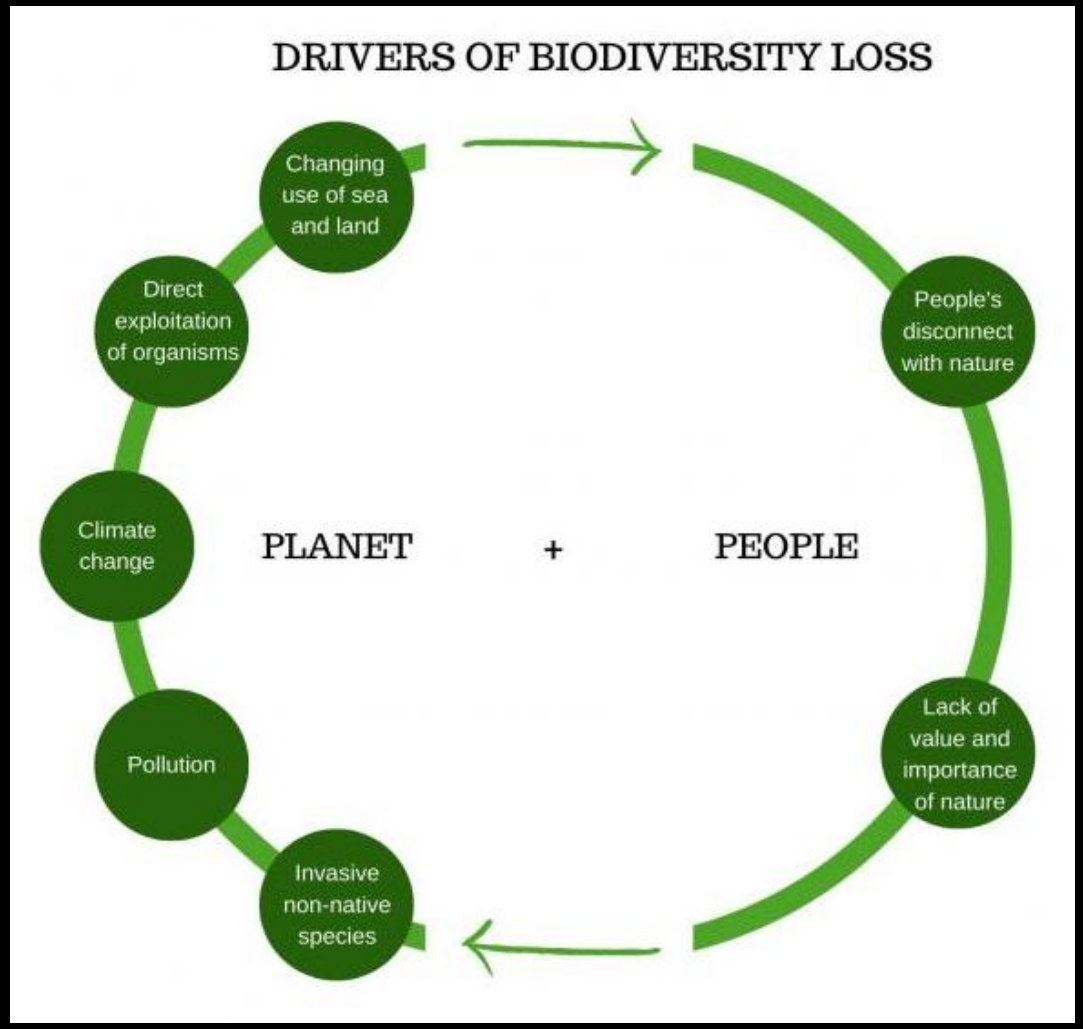
Drivers of Human Impacts on Biodiversity



A driver is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.

- A direct driver unequivocally influences ecosystem processes.
- An indirect driver operates more diffusely, by altering one or more direct drivers.

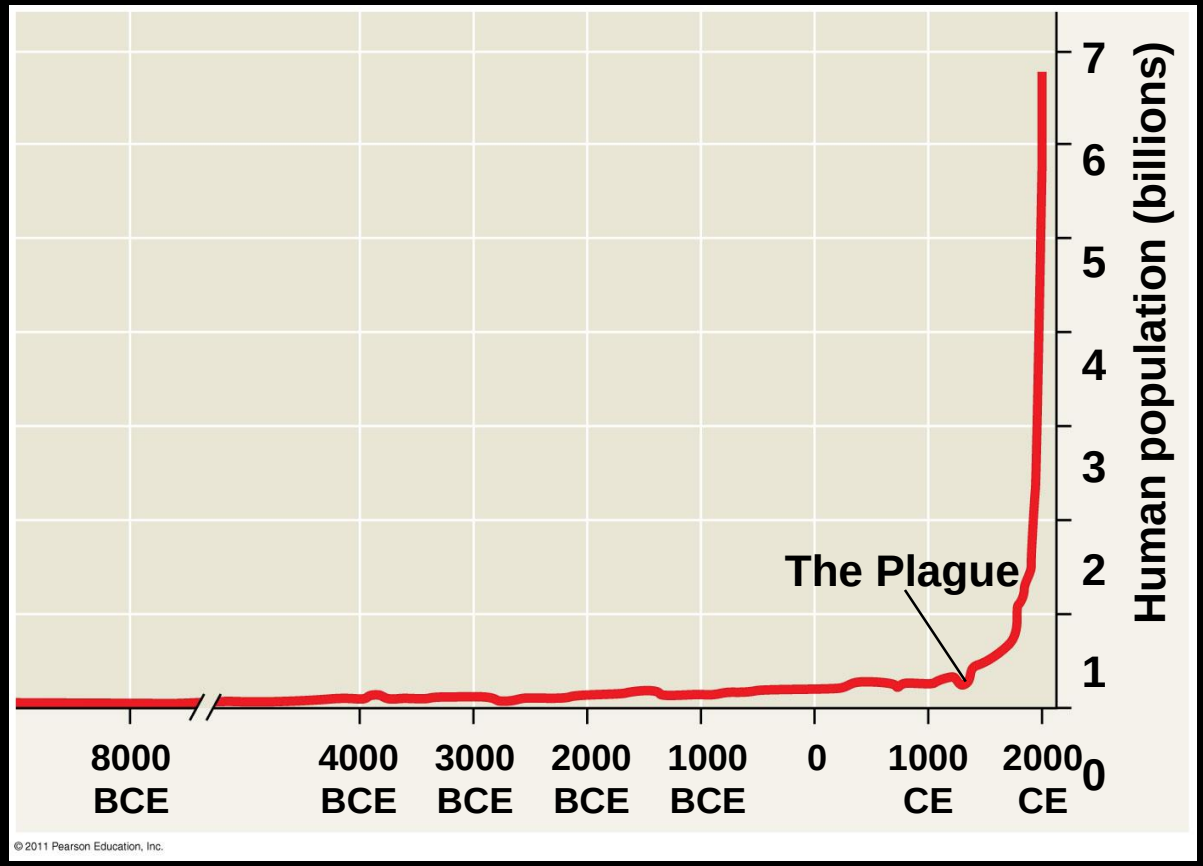
Drivers of Human Impacts on Biodiversity



READING

Nelson et al (2006), "Anthropogenic drivers of ecosystem change"

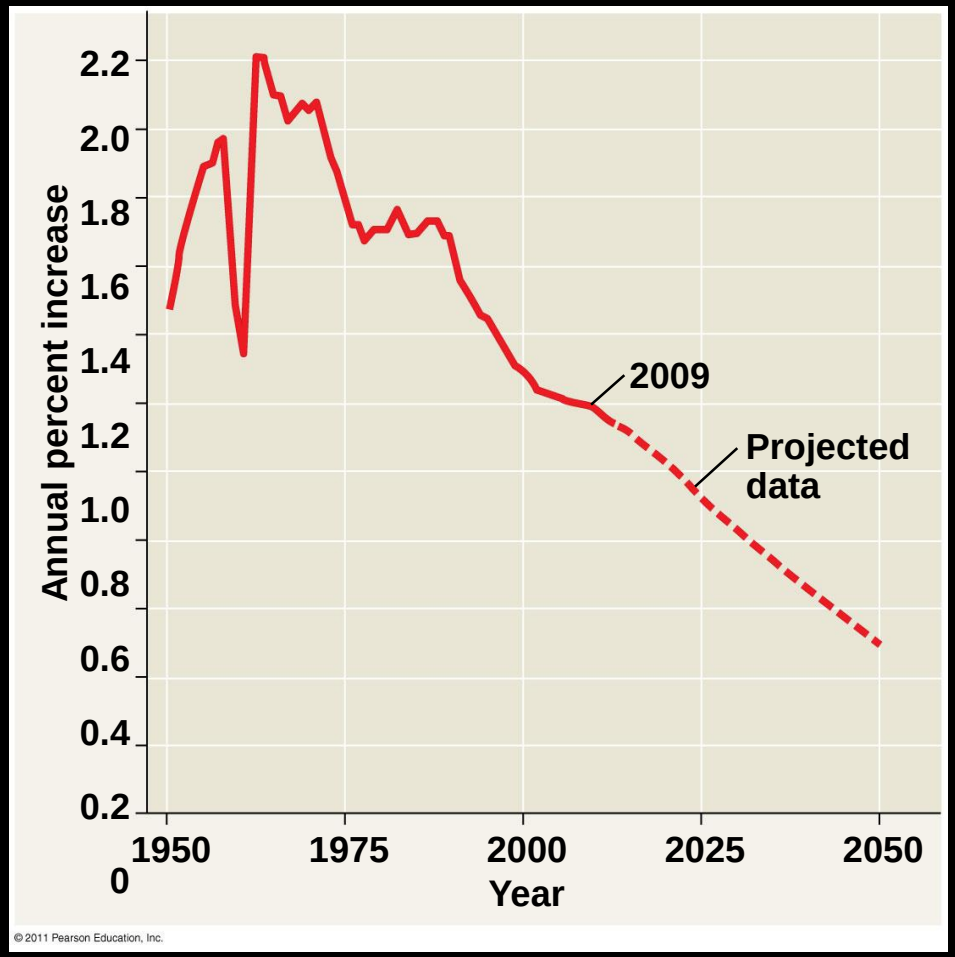
Drivers of Human Impacts: Population Growth



The human population increased relatively slowly until about 1650 and then began to grow exponentially.

Drivers of Human Impacts: Population Growth

Though the global population is still growing, the rate of growth began to slow during the 1960s. While the human population is no longer growing exponentially, it is still increasing rapidly.
The global population today is more than 7 billion people.



Human Impacts on Biodiversity

Habitat Destruction: population growth, industrialization, urbanization have all contributed to large-scale destruction of natural habitat of plants and animals.

Human Impacts on Biodiversity

Habitat Conversion: Ecosystems, such as tropical dry forests and grasslands, have been converted for agriculture. Dams disrupt freshwater ecosystems, while overfishing, pollution, and habitat destruction threaten the marine world.

Human Impacts on Biodiversity

Pollution: Natural habitats have been destroyed or damaged by the indiscriminate use of synthetic materials release of radiation and oil spills in the sea, generation of effluents and waste of various kinds and toxicity.

Human Impacts on Biodiversity

Invasive Species: Humans are transporting plants and animals around the globe both deliberately and unintentionally. These "invaders" threaten other species or change entire ecosystems.

Human Impacts on Biodiversity

Overexploitation: indiscriminate killing and poaching of wild animals food, horn, fur, tusk, pets, etc. has resulted in the reduction and extinction of many wild species.

Practicum: Threats to endangered Liberian species

Work together in small groups to create better understanding of the threats facing selected endangered species of Liberia.

Habitat Destruction

Habitat loss is the modification of an organism's environment to the extent that the qualities of the environment no longer support its survival.

Habitat loss usually begins as **habitat degradation**, the process by which the quality of a species' habitat declines.

Habitat Destruction

READING: MAXWELL ET AL (2016)

“THE RAVAGES OF GUNS, NETS, AND BULLDOZERS”

Habitat Destruction

Habitat degradation involves disturbing key habitat features, resulting in extensive erosion or adding toxins to the soil or water.

Habitat Destruction

Marine ecosystems such as mangroves, coral reefs, coastal wetlands are vulnerable to loss and fragmentation.

- e.g., when mangroves are removed, coastal areas are exposed to erosion and increased flooding.

Habitat Destruction: Fragmentation

Fragmentation is the division of a contiguous landscape into smaller units. Habitat fragmentation results from many processes including development, agricultural conversion, water diversion and logging. Fragmentation reduces continuity and interferes with wildlife dispersal and migration, thereby isolating populations and disrupting the flow of individual plants and animals (and their genetic material) across a landscape.

Habitat Destruction: Fragmentation

As fragmentation progresses in a landscape, negative consequences include:

- decreased patch size
- increased edge effects
- increased patch isolation

Habitat Destruction: Fragmentation

READING

Vijay et al, “Impacts of Oil Palm on Recent Deforestation and Biodiversity Loss”

Habitat Destruction: Fragmentation

“The end result of human settlement and resource extraction in a landscape is a patchwork of small, isolated natural areas in a sea of developed land.”
Gascon et al. 1999

Habitat Destruction: Fragmentation

Many of the effects of fragmentation are synergistic and can lead to increased fire risk, increased vulnerability to invasive species, or increased hunting pressure.

Habitat Destruction: Fragmentation

Species vulnerable to fragmentation

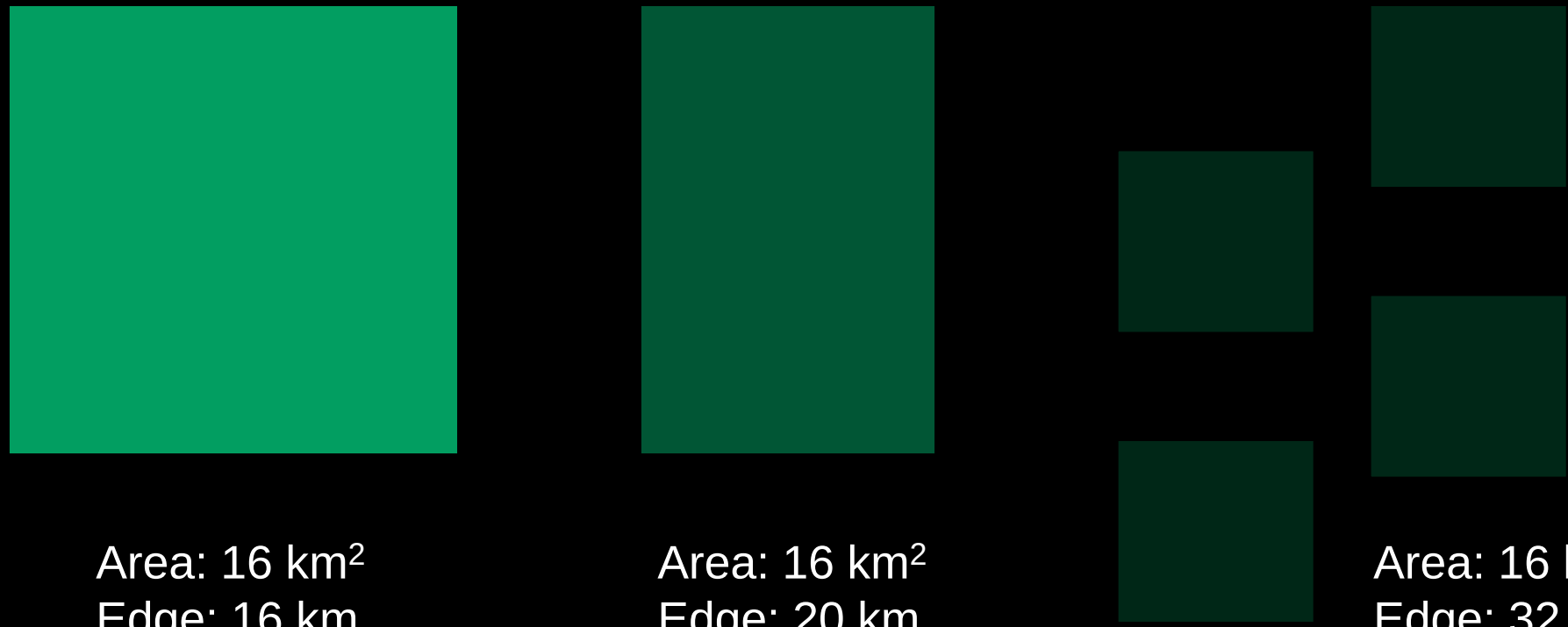
- Rare species with restricted distributions and small populations
- Species that require large and heterogeneous home ranges
- Species with very specialized habitat requirements
- Species with limited dispersal abilities and low birth rates

Habitat Destruction: Fragmentation

- Ground nesters vulnerable to medium-sized predators at edges
- Species vulnerable to hunting
- Species that are arboreal (canopy dwellers)
- Co-evolved species (e.g., plants with specific pollinators)

Habitat Destruction: Fragmentation

Edge Effects in Conservation Reserves



Area: 16 km^2
Edge: 16 km

Reserve A

Area: 16 km^2
Edge: 20 km

Reserve B

Area: 16 km^2
Edge: 32 km

Reserve C

Habitat Destruction: Deforestation

Causes

- Agricultural conversion
- Human settlement
- Resource extraction
- Industrial development

Results

- Small isolated patches
- Many too small to support a diverse mix of species

Habitat Destruction: Deforestation

Causes: Competition between humans and other species for the remaining ecological niches on land and in coastal regions, e.g., the conversion of forestland to other uses such as agriculture, infrastructure for transportation and utilities, urban development, industry.

Habitat Destruction: Deforestation

READING

Vijay et al, “Impacts of Oil palm deforestation on biodiversity loss”

Habitat Destruction: Deforestation

Logging has serious effects on primates, including a decrease in biomass, direct mortality, decreases in recruitment, and high levels of infant malnutrition, abandonment and mortality. Primate species are typically constrained in space after logging due to their historical territorial affinity; others are unable to move to new areas due to either …

a) isolation in forest patches surrounded by inhospitable terrain,

b) excessive canopy gaps requiring ground travel between trees (this is particularly problematic for arboreal species), or

c) competitive exclusion and territorial aggression from conspecifics.

Habitat Destruction: Deforestation

Timber extraction and fragmentation affect bird species by modifying their physical environment, such as nest sites, cover, home range needs, etc. Larger-scale fragmentation influences population characteristics such as demography and dispersal processes because it reduces effective population sizes. This, in turn, affects reproductive rates, recruitment, and demographic ratios.

Habitat Destruction: Deforestation

Amphibians reach their highest diversity in the tropical forests of the world, and represent a significant portion of the vertebrate fauna of tropical forests. They are important components of tropical food webs, where they are the principal terrestrial insectivores. Tropical forest amphibians are in dramatic global decline due to a range of factors including habitat loss, climate change and disease.

Habitat Destruction: Deforestation

Logging poses serious threats to tropical freshwater fish species …

1. Many fish species are dependent on animals and plant material falling into water from overhanging vegetation and other material being washed into the water. Clearing of streamside vegetation reduces food for fish.
2. Water temperature rises with decreased shading. This leads to decreased oxygen levels in the water, while warmer water raises the metabolic rate of fish and thereby their oxygen demand.

Habitat Destruction: Deforestation

Increased turbidity can directly kill fish, as the silt can accumulate in the gills, resulting in suffocation. When the flow in a river slows, silt settles and can smother food resources, eggs and spawning grounds, as well as reduce the depth and the width of the channel.

Habitat Destruction: Roads

Roads result in over-harvesting and greatly depleted wildlife populations by:

- Facilitating increased immigration;
- Increased forest clearance along road sides, thereby reducing and fragmenting habitats and increasing human population density in the remaining forest;
- Loss of inaccessible and undisturbed ‘source’ areas to replenish populations.

Habitat Destruction: Roads

Roads increase access to markets. This allows local people to sell wild meat, and buy technology such as shotguns, cartridges, snare wires, batteries, vehicles and fuel. These technologies facilitate indiscriminate and excessive hunting while obscuring permitted subsistence hunting, raising the catch to unsustainable levels

Hunting

Hunting poses a greater threat to large forest fauna than timber harvesting in many areas of the humid tropics; it is even sometimes a greater threat to wildlife than habitat loss.

Overhunting alters wildlife population densities, distributions, and demography, which can then lead to shifts in seed dispersal, browsing, competition, predation, and other community dynamics.

Hunting

Traditional hunting is often non-selective, using traps or snares; animals are often killed irrespective of their condition and hunting is sometimes wasteful, with only part of the animal taken.

Hunting

Factors that increase the impacts of hunting on wildlife:

- increased forest accessibility
- improved transport with cars, motor bikes, motorized canoes, and light planes
- guns and ammunition
- the erosion of traditional prohibitions on killing and eating certain animals
- increased immigration by non-indigenous people to interior areas
- Increasing market for wildlife products either as food, trophies, or medicine.

Hunting

Concentration: Some species have aggregation behaviors that make them vulnerable to disturbance or hunting.

- e.g., bats may congregate in large numbers to have their young, making significant portions of their total population susceptible when their habitat is disturbed by human visitation.

Hunting

Concentration: Various species of groupers often come together to spawn on a few nights of each year based on the phases of the moon. Fishermen who know these sites and the timing of spawning can devastate large populations of these species by concentrating their efforts during this most vulnerable time in the fish’s life cycle.

Poaching

Poaching is the illegal hunting, killing or capturing of animals contrary to national and international conservation and wildlife management laws and regulations. A distinction is made between subsistence and commercial poaching.

Subsistence poaching is hunting and gathering for the sole purpose of providing for yourself and your family, in other words hunting for survival.

Commercial hunting is hunting for profit with the sole purpose of economic and/or material gain.

- Highly prized species for hunting in Liberia include zebra duiker, water chevrotain, western bongo and dwarf buffalo.

READING

WCF and FDA, “Wildlife & Anthropogenic threats in Grebo-Sapo Corridor”

Wildlife Trade

TRAFFIC International defines wildlife trade as any sale or exchange of wild animal and plant resources by people. This can involve live animals and plants or a diverse range of products needed or prized by humans—including skins, medicinal ingredients, tourist curios, timber, fish and other food products.

Wildlife Trade

READING

KUHL ET AL (2017)
“CRITICALLY ENDANGERED WESTERN CHIMPANZEE POPULATION DECLINES BY 80%”

Wildlife Trade

International Wildlife Trade

- Estimated by Interpol to be $12 Billion annually
- Second only to drugs in global value

Domestic Consumption (Liberia)

- Much (maybe most) domestically consumed
- Magnitude is unknown

Overexploitation

Overharvesting means hunting, fishing or collecting so many individuals from a species that it can no longer reproduce enough to withstand the harvest.

Over harvesting has caused the extinction of many species worldwide, including the Passenger Pigeon in North America, the Great Auk throughout the North Atlantic, the Tasmanian wolf in Australia, the Moa in New Zealand, and the Dodo of Mauritius.

Overexploitation

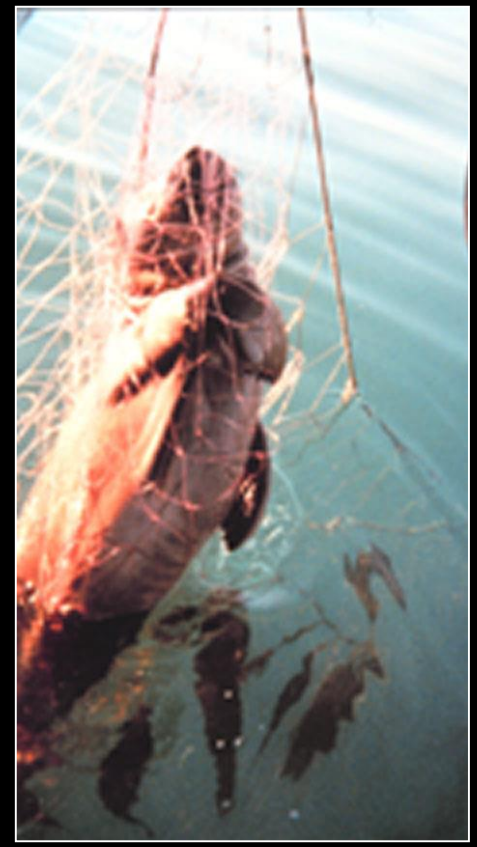
Unsustainable levels of consumption, harvest or loss result from direct and indirect pressures …

Direct

- Commercial pressures

Indirect

- Unintentional use, e.g. bycatch of sea turtles in fishery operations



Overexploitation

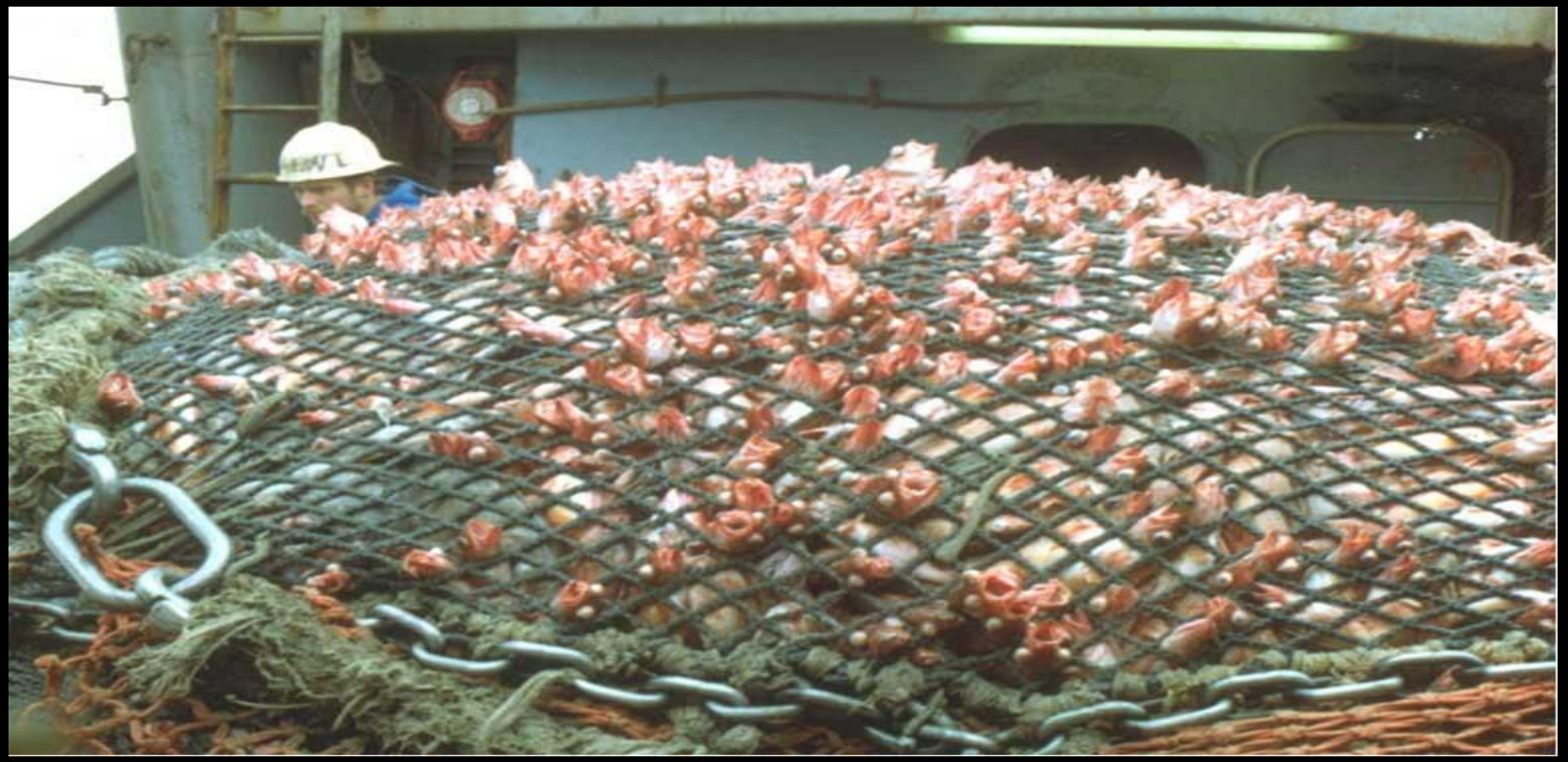
Global Fisheries

- 7% depleted
- 17% are overused
- 52% are fully used

- Total catch and average size declining
- Increases in demand and improvements in technology increase the speed of the decline
- Result is “fishing down the web”

Overexploitation

Tragedy of the Commons: When resources are treated as a public property that are available equally for all, they will be overused.



Overexploitation

<u>Responses to the Tragedy of the Commons</u>

- Quotas and governance zones (200-mile limit)
- Restrictions on types of gear and number of boats
- Marine Protected Areas (MPA)

Overexploitation

Fisheries By-Catch

Estimated at 16-40 million tons annually

- 5lbs by-catch for every 1lb shrimp harvested

Wildlife Trade

- Deaths in transit for legal transport require larger numbers caught.
- Birds 60 - 70% mortality
- Aquarium Trade reef fish 80-90% mortality

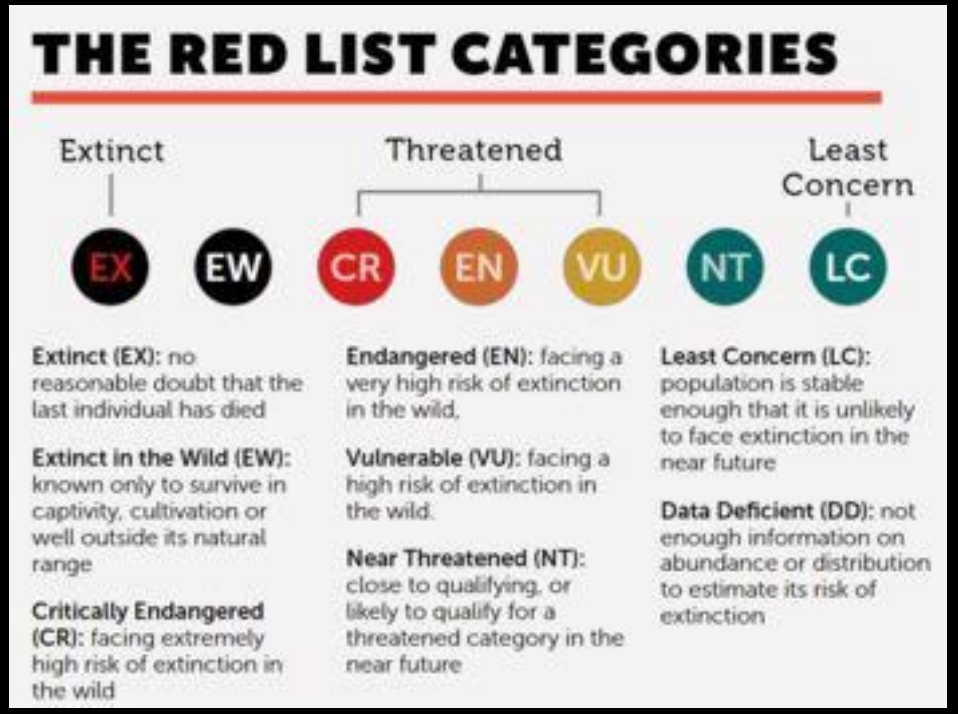
Overexploitation

Destructive Hunting Techniques

- Nets and traps that kill unintended species
- Cyanide and dynamite fishing especially for the aquarium trade

Threatened Species and Habitats

The IUCN Red List evaluates the status of species relative to other species in terms of a species' extinction risk. The IUCN Red List is a tool to help assess and monitor the status of biodiversity at the species level (www.redlist.org).



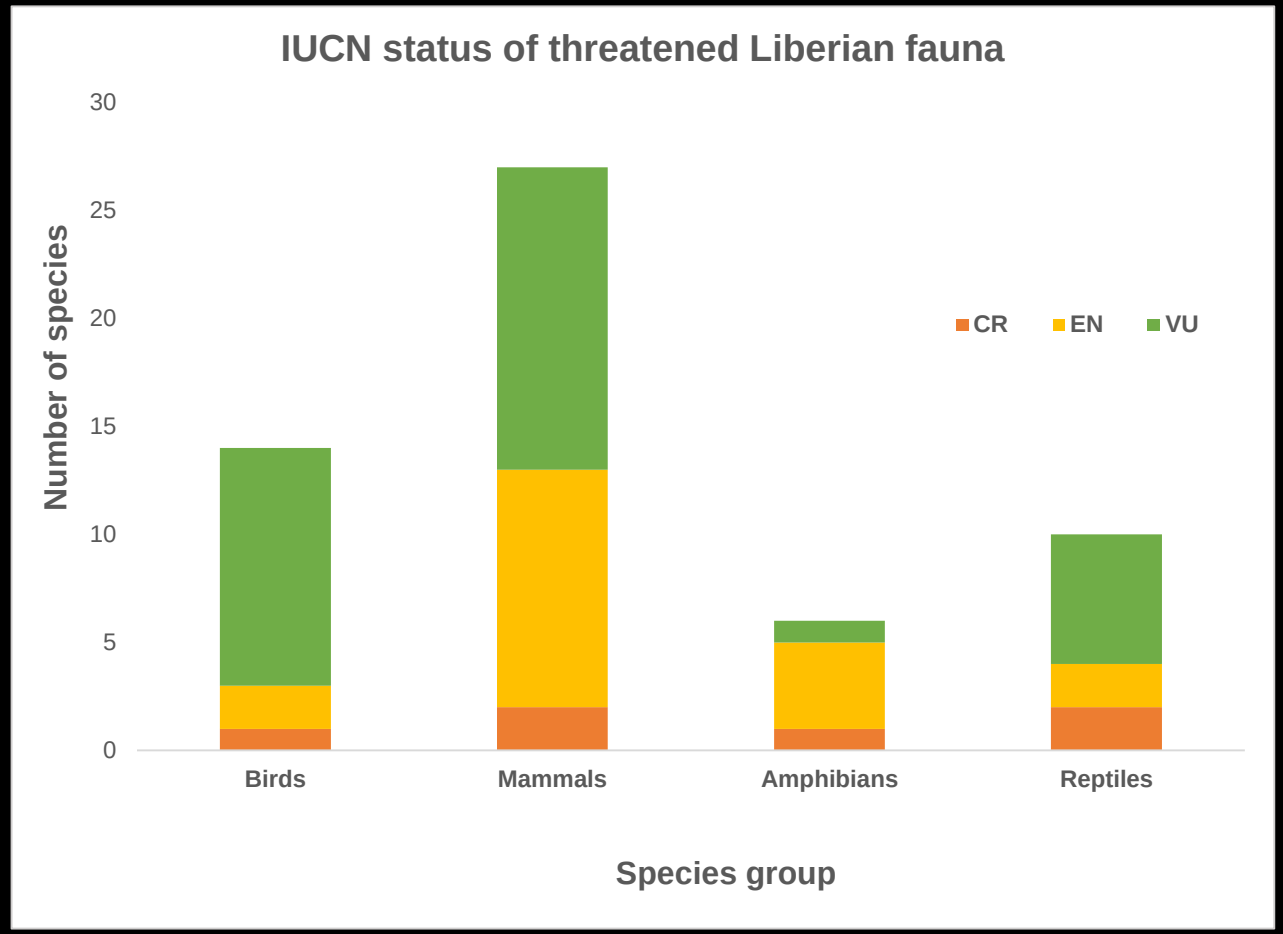
Threatened Species and Habitats

The IUCN Red List identifies those species most in need of conservation attention if global extinction rates are to be reduced. The assessment includes species from a broad range of taxonomic groups including vertebrates, invertebrates, plants, and fungi.

Practicum: Using IUCN Red List

Threatened Wildlife Species in Liberia

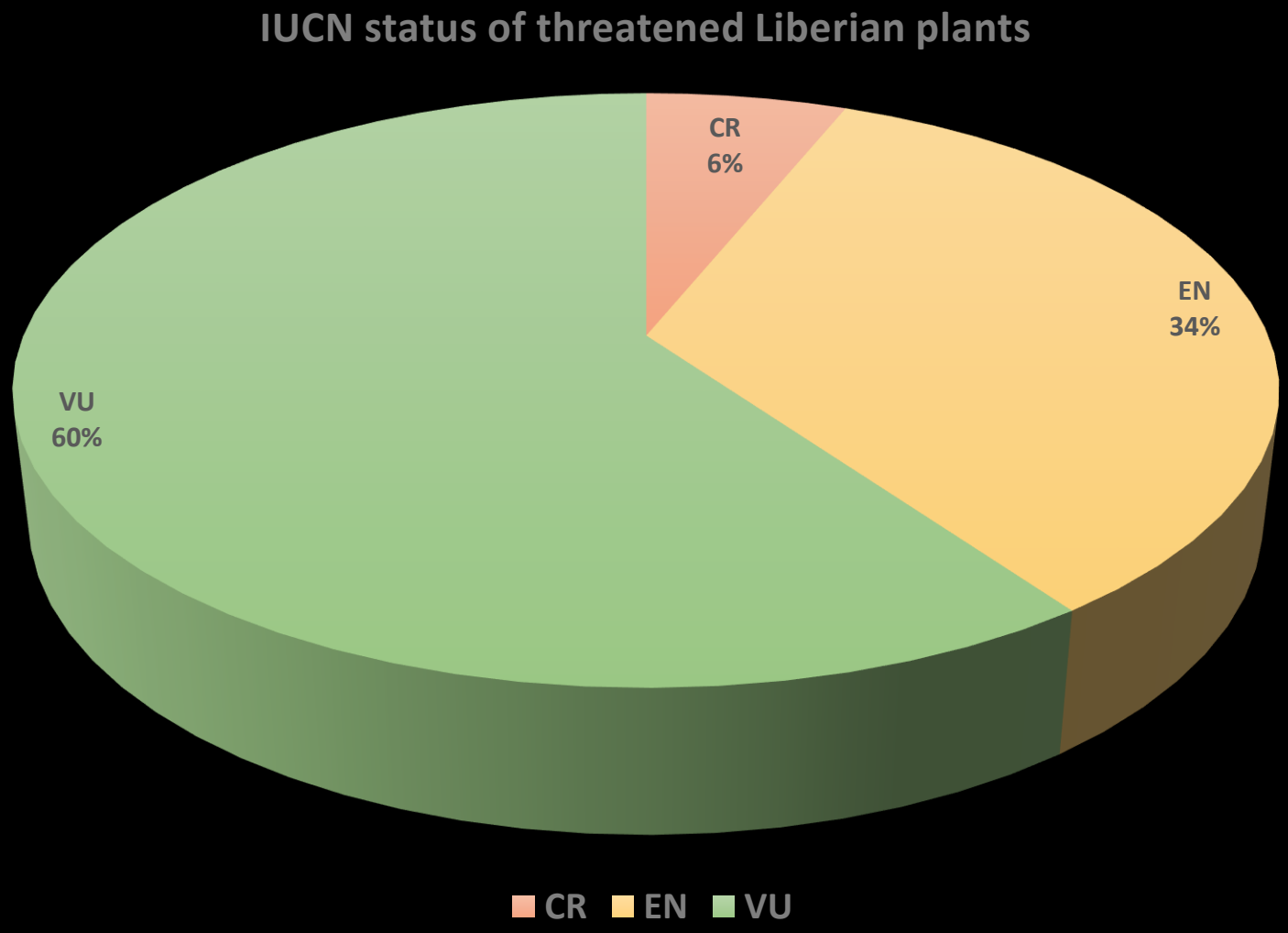
IUCN's RedList is updated regularly and the status of species changes based on conservation actions.



VU – Vulnerable, EN – Endangered, CR – Critically Endangered

Threatened Flora Species in Liberia

IUCN's RedList is updated regularly and the status of species changes based on conservation actions.



VU – Vulnerable, EN – Endangered, CR – Critically Endangered

Threatened Species in Liberia

Class	Total Species	Total Endemic	Total Threatened
Amphibians	38	4	1
Plants	2,200	103	46
Mammals	193	n/a	17
Birds	590	1	22
Reptiles	67	2	2
Mollusks	n/a	n/a	1
Other Vertebrates	n/a	n/a	1
Ants	1,000	n/a	n/a
TOTAL		110	89

Threatened Species in Liberia

Threatened and endangered mammals according to Liberia's National Biodiversity Strategy and Action Plan (NBSAP) (2003):

- African elephant (*Loxodonta africana*)
- Chimpanzee (*Pan troglodytes*)
- Diana Monkey (*Cercopithecus diana*)
- Liberian Mongoose (*Liberritia kuhn*)
- Red colobus (*Procolobus badius*)
- Allens's round leaf Bat (*Hipposideros marisae*)
- Buettilkofer's Epauletted fruit Bat (*Epopops buettikoferi*)
- Sperm whales (*Physeter catodon*)
- West African Manatee (*Trichecnus senegabnsis*)
- Zebra Duiker (*Cephalophus zebra*)
- Nimba otter shrew (*Micropotamogale la mollier*)
- Jenktins Duiker (*Cephalophus jentinki*)
- Pygmy Hippopotamus (*Choeropsis liberiensis*)

Invasive Species and Diseases

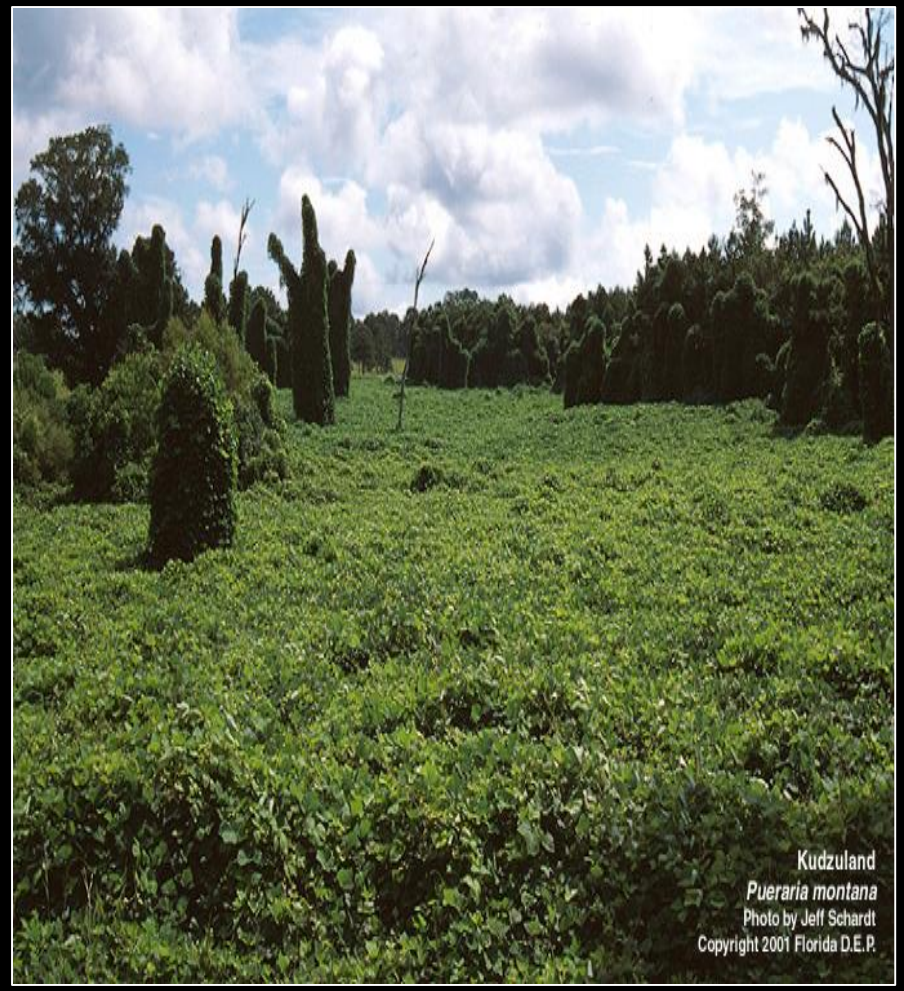
Invasive species are generally non-indigenous species with large, expanding populations that cause significant (usually detrimental) effects in this new region. Although movements of populations into new habitats are natural occurrences, the geographic scope of biological invasions, frequency, and the number of species involved have grown enormously in recent centuries. This is a direct consequence of the development of human civilization, particularly advances in human distribution, transportation, and commerce.

Invasive species: Ecosystem effects

- Predation on native species
- Competition with native species
- Habitat alteration
- Trophic alteration
- Hybridize with native species

Invasive species: Ecosystem effects

- Invasives outcompete, displace or extirpate local species
- Exotic species
  - Live outside their native range, not always invasive
- 3 Phases
  - Dispersal
  - Establishment
  - Integration



Some systems are more vulnerable to invasion

- -Low native species diversity
- -Empty niches
  - -disturbance/primary succession
- -Absence of predators, parasites, diseases

Invasive Species

Prevention is the best solution

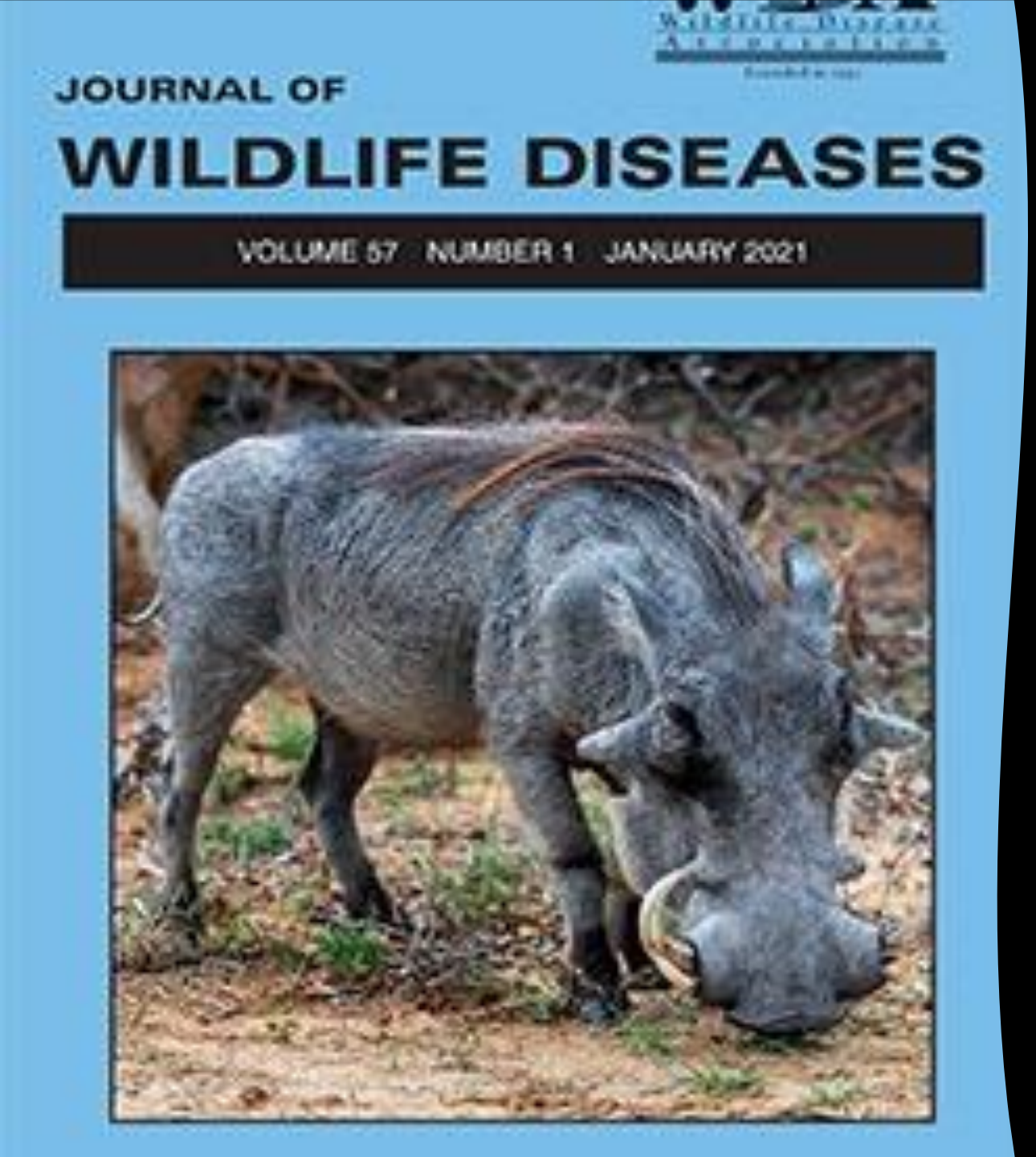
- Quarantine process
- Strict controls on what allowed in an area

Control programs

- Wide variety of methods
- Need to start early, if an exotic meets success, by the time it is a big problem it is often too late

Invasive Species and Diseases

The introduction of exotic flora and fauna into fragmented forests via logging threatens wildlife populations. The increased proximity of feral animals to their wild relatives increases the transfer of diseases.



Wildlife Diseases

The term disease broadly refers to any condition that impairs normal function. Commonly, this term is used to describe infectious diseases caused by the presence of viruses, bacteria, parasites and fungi.

Wildlife Diseases

Population density can influence the health and survival of organisms.

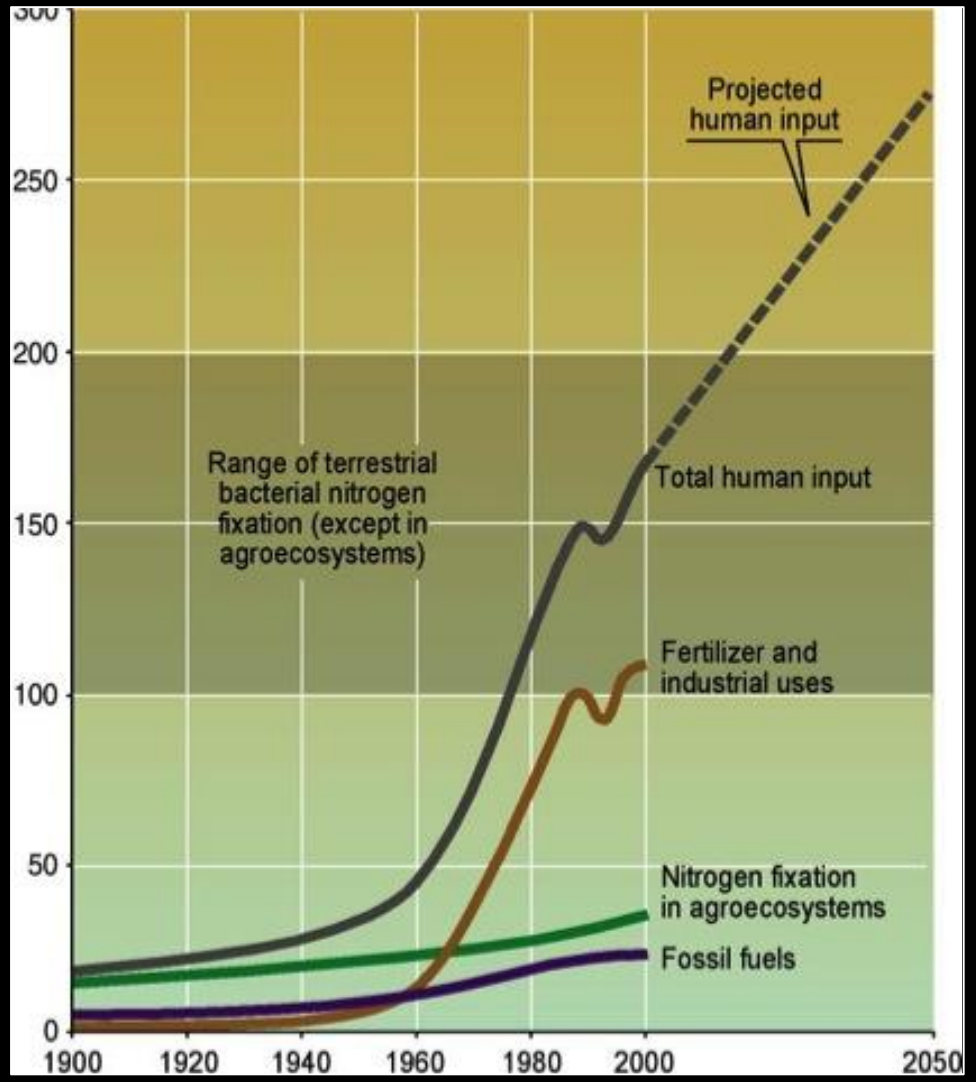
In dense populations, pathogens can spread more rapidly.

Virtually all diseases that can harm humans can harm the great apes since we share so many genetic and physiologic properties.

Pollution

Since 1960:

- Flows of biologically available nitrogen in terrestrial ecosystems have doubled.
- Flows of phosphorus have tripled.
- > 50% of all the synthetic nitrogen fertilizer ever used has been used since 1985.
- 60% of the increase in the atmospheric concentration of CO_2 since 1750 has taken place since 1959.



Pollution

Toxic and Non-toxic contaminants

- Toxic - Lethal or interfering with organisms natural functioning (immune, reproductive, etc.)
- Non-toxic – harms ecological systems

Pollution

Point and Non-Point source

- Where does it come from?
- Is there a series of single identifiable sources or is it widespread and harder to control

Other types of pollution

– Noise, Light

Pollution

Pollution can be difficult to classify and to measure. There are a wide variety of types and impacts of pollution. For wildlife and fauna, the result is disruptive, persistent and cumulative impacts on species.

Toxic Pollutants

- Include trace metals, biocides/pesticides and by products of industrial processes and combustion
- Last a long time and spread fairly easily
- Can accumulate in an organism over time - Bioaccumulation
- Result can be felt far from the source - Acid Rain

Organic Pollutants or Biostimulants

- Primarily from agricultural fertilizers and sewage waste
- Stimulates plant growth that cannot be consumed
- Results in increased decomposition which causes hypoxic or anoxic environments
- Reduced water clarity impacting other plants & shellfish

Climate Change

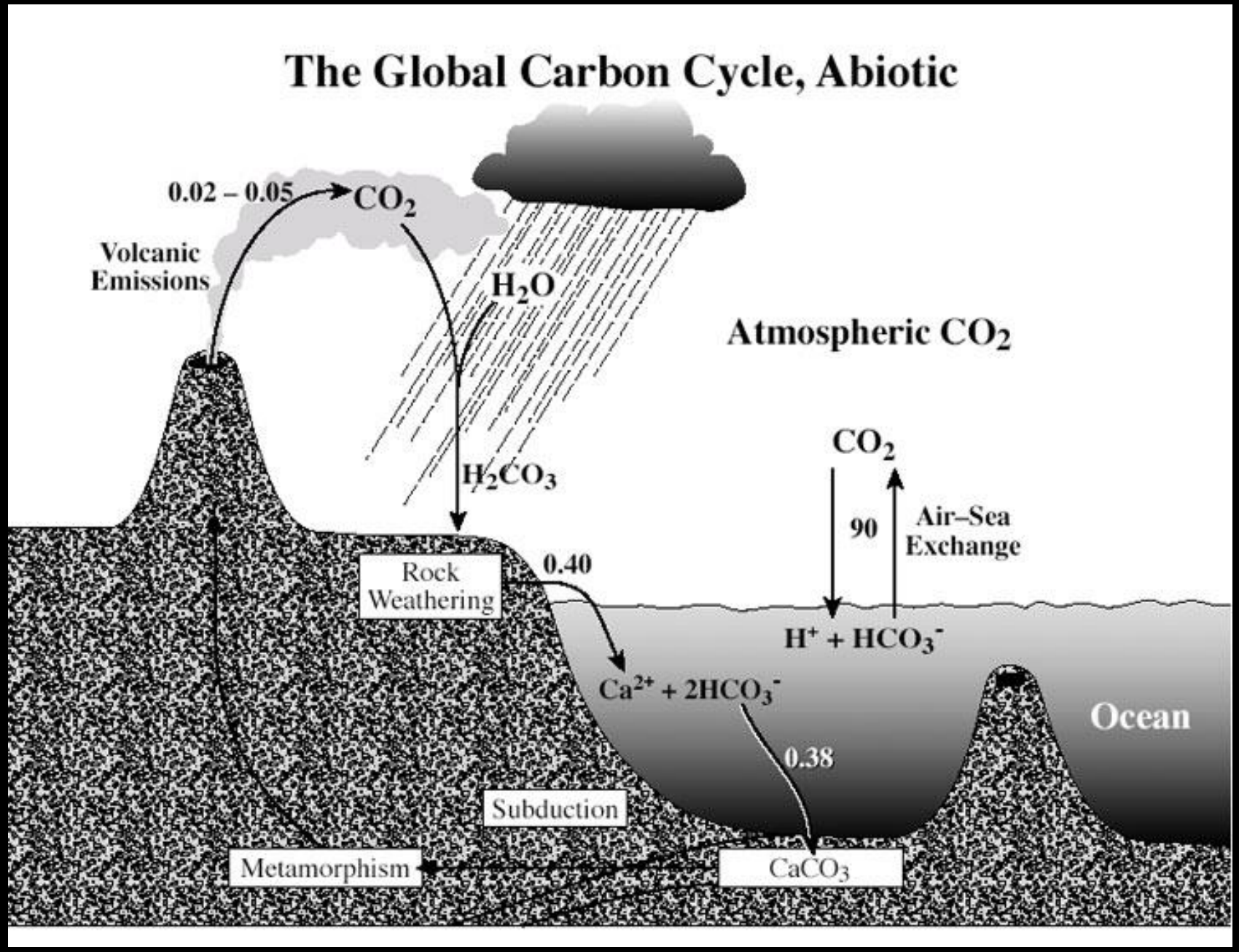
Climate change is a term that encompasses many different processes and interactions that include :

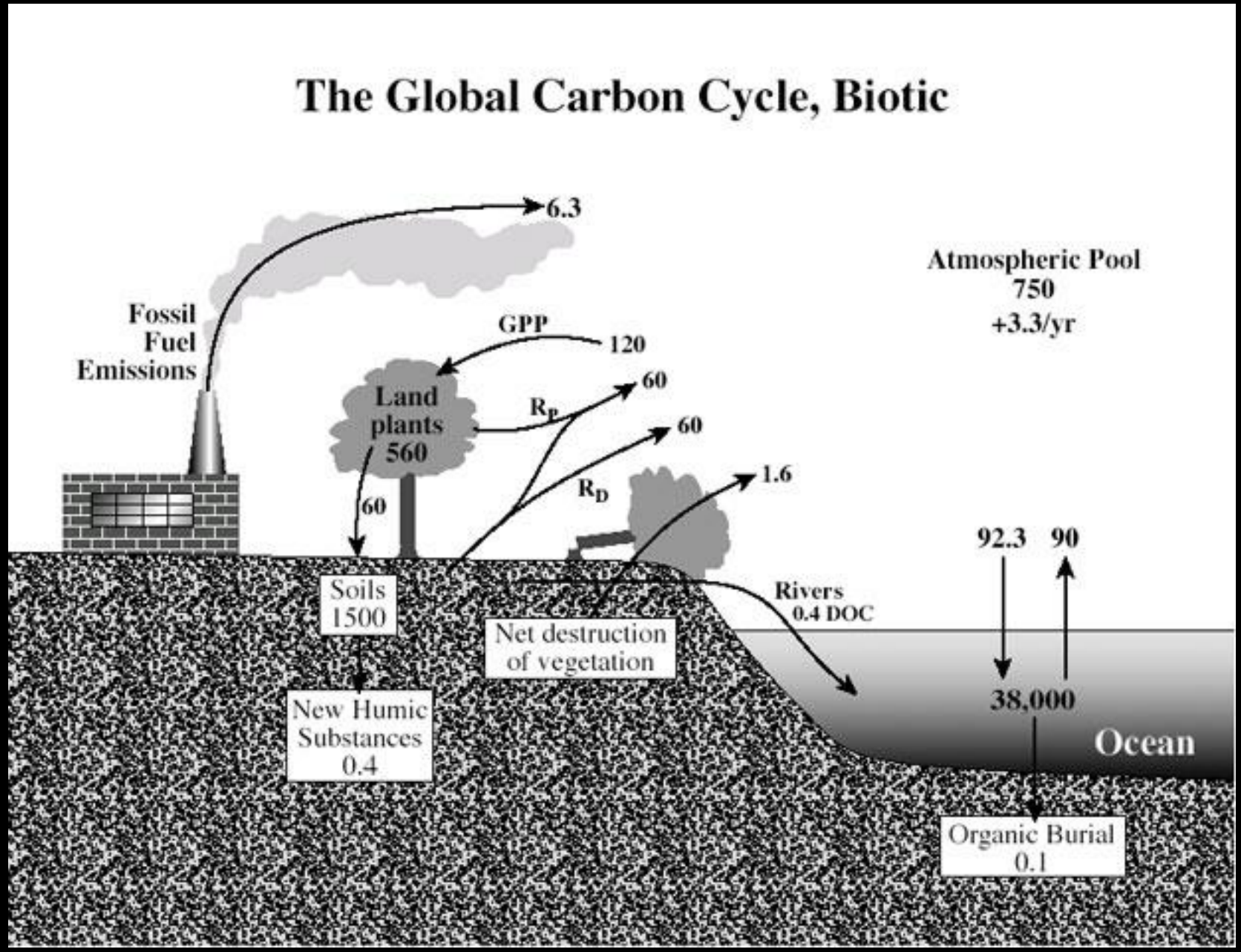
- Rising global temperatures
- Changes in precipitation
- Less frequent but more intense extreme events
- More heat waves and droughts

Because of the complex nature of climate change, the impacts on biodiversity are varied and wide-ranging.

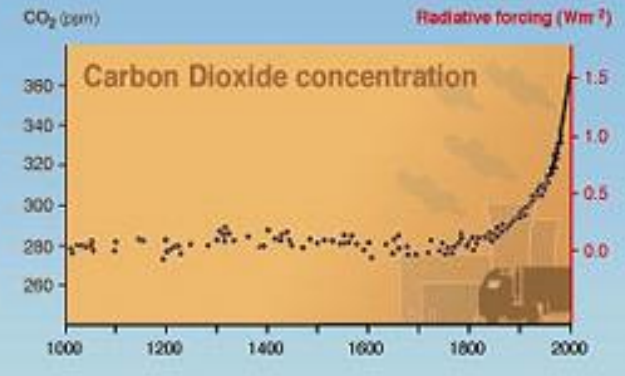
Climate Change

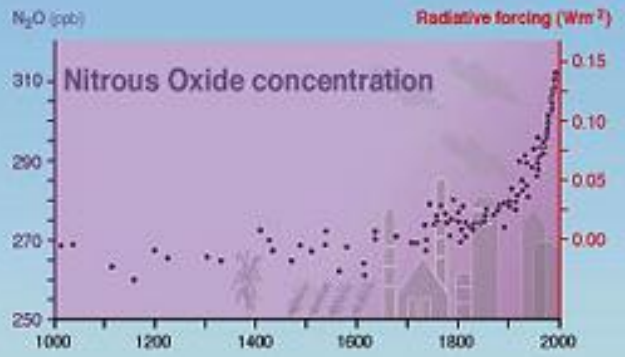
- Increasing rates of change
- Not all areas affected equally
  - Alpine and Coastal areas most impacted

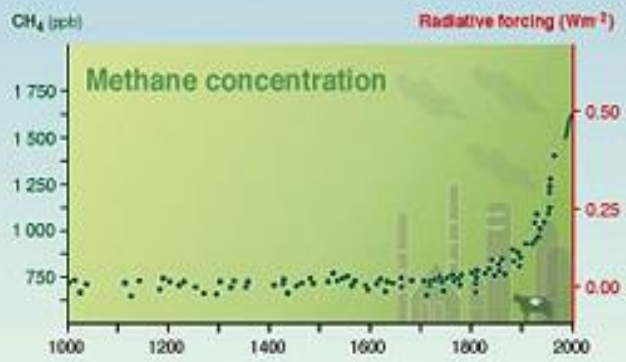

The Global Carbon Cycle, Abiotic
0.02 – 0.05
CO_2
Volcanic Emissions
H_2O
Atmospheric CO_2
CO_2
H_2CO_3
90
Air–Sea Exchange
Rock Weathering
0.40
$H^+ + HCO_3^-$
$Ca^{2+} + 2HCO_3^-$
Ocean
0.38
Subduction
Metamorphism
$CaCO_3$

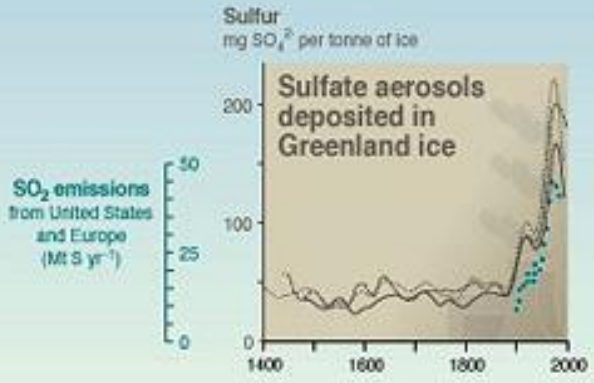

The Global Carbon Cycle, Biotic
6.3
Fossil Fuel Emissions
Atmospheric Pool
750
+3.3/yr
GPP
120
Land plants 560
60
R_P
60
R_D
1.6
60
92.3
90
Soils 1500
Rivers
0.4 DOC
Net destruction of vegetation
New Humic Substances 0.4
38,000
Ocean
Organic Burial 0.1

Indicators of the human influence on the atmosphere during the Industrial era









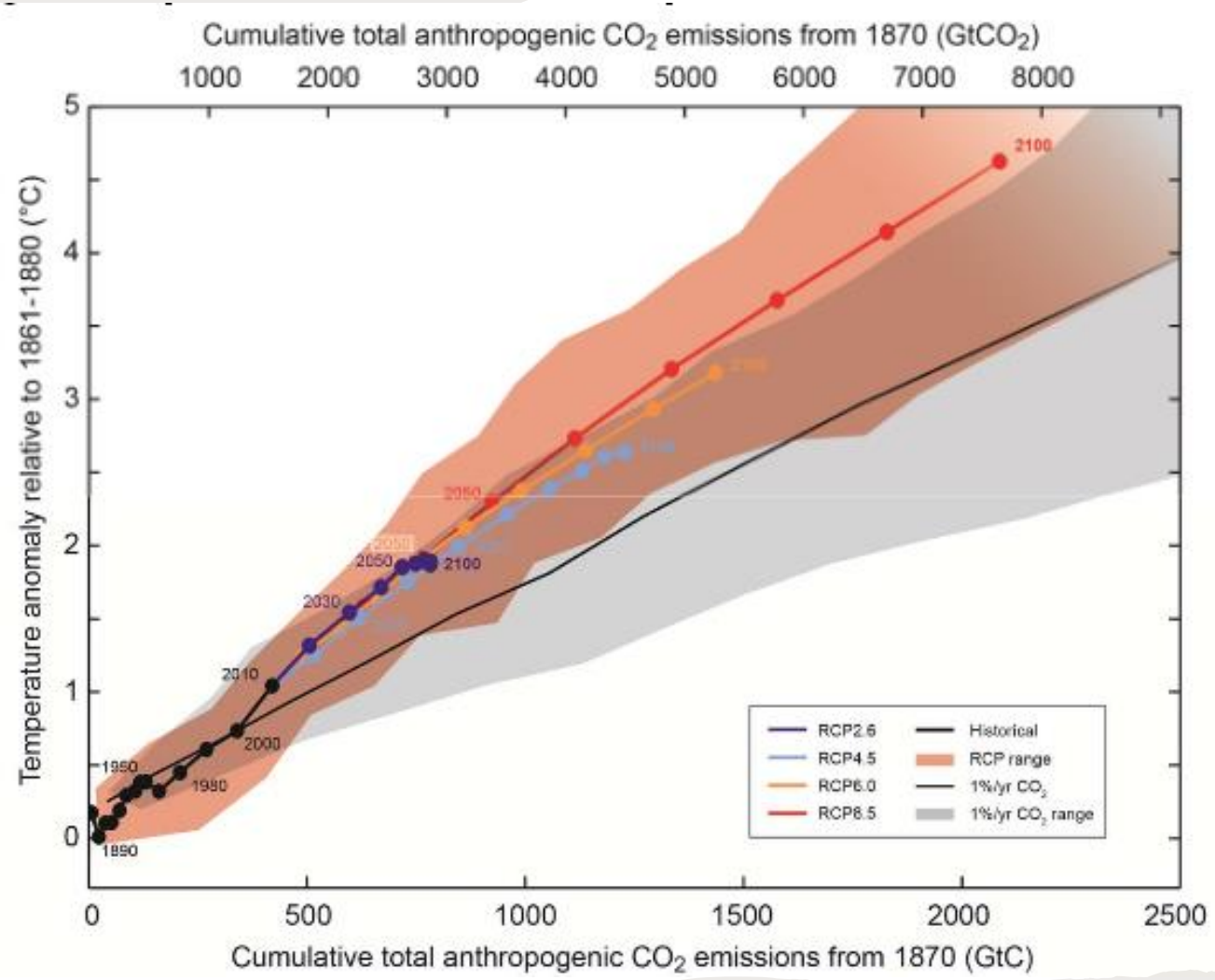
SYR - FIGURE 2-1
WG1 FIGURE SPM-2

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

Climate Change

- Recent anthropogenic emissions of greenhouse gases are the **highest in history**.
- Climate system warming is indisputable, with each of the last three decades being successively warmer than any other decade since 1850.



Climate Change Effects

- Increases in average air and ocean temperatures
- Melting glaciers and rising sea levels
- Regional changes in precipitation patterns
- Variations in extreme weather events (including droughts, heat waves, and the intensity of tropical cyclones).

Observed Impacts of Climate Change on Biodiversity

Poleward Distribution Shifts

Upslope Distribution Shifts

Disease Risk

Phenological Changes

Community-Level Impacts

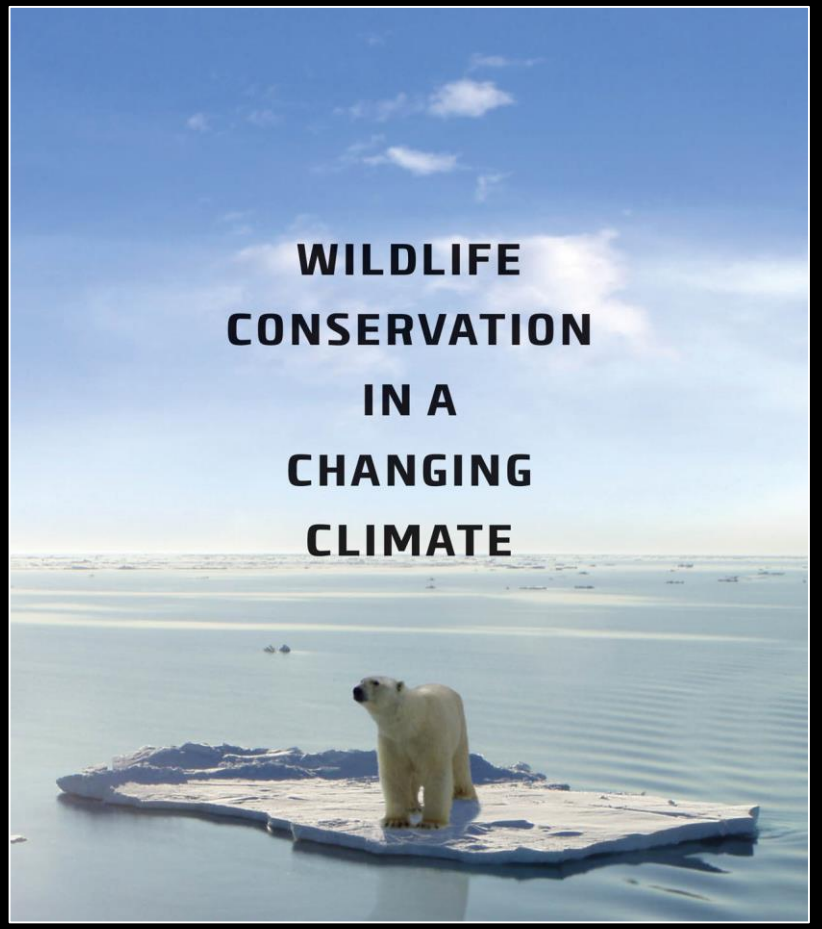
Climate Change:
Impacts on Biodiversity

- Wide and rapid changes in distribution of vegetation types and animal species
- Rise in sea level as glaciers and snow cover retreat
- Species living close to their limits will be most immediately impacted
- Amplify threats to already endangered ecosystems

Climate Change: Impacts on Biodiversity

Species may adapt to climate change in three different ways:

Space: changing their range
Time: changing phenology
Self: changing their own physiology and evolving



Climate Change: Disease Risks

Climate change can alter climate conditions and weather events in a way that would benefit diseases and infections.

For example, in humans ,we could expect:

Climate Change: Liberia

Although endowed with bountiful and diverse natural resources, Liberia is susceptible to the adverse effects of climate change. Contributing factors include shifting cultivation, unsustainable logging practices, unregulated coastal mining, high levels of biomass consumption (charcoal and firewood) and decreasing river flows due to high evaporation.

Climate Change: Liberia

Climate change in Liberia is resulting in higher temperatures, more extreme weather events such as heavy rains and rising sea levels. The effects of increasing climatic variability and climatic change threaten key economic sectors in Liberia, namely agriculture, fisheries, forestry, energy, health, meteorology/hydrology.

Climate Change: Liberia

Agricultural productivity and fisheries are vulnerable to a changing climate, and saltwater and freshwater fisheries are likely to suffer as sea temperatures increase and coastal ecosystems (mangroves and wetlands) are damaged.

Climate Change: Liberia

Coastal zones are home to the majority of Liberia’s population, infrastructure, and economic activity and are at risk from flooding and erosion associated with sea level rise. Sea level rise is projected to increase along Liberia's coast and cause more frequent flooding in coastal cities, especially Monrovia.

- 1-meter rise in sea level would put an estimated 230,000 Liberians at risk and cause a loss of 2,150 square kilometers of land and infrastructure, which is valued at US$250 million.

Climate Change: Liberia

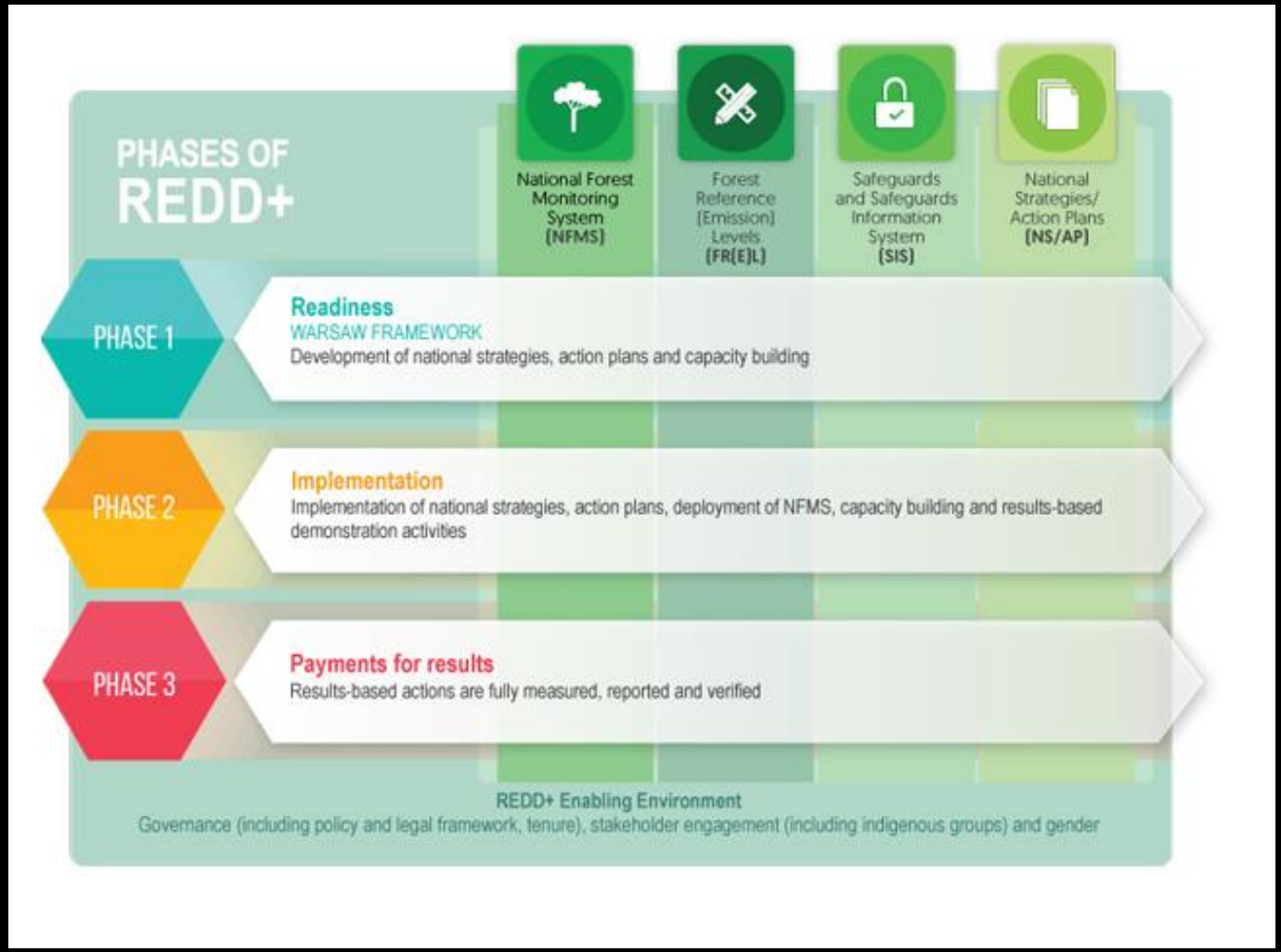
An increase in flooding due to sea level rise will also put Liberians at greater risk to epidemics of malaria, cholera, and diarrheal diseases, and increases in the incidences of Lassa fever, schistosomiasis, lymphatic filariasis, yellow fever, hepatitis A, and intestinal worms. Malaria poses the most significant threat to public health as it has the highest mortality rate.

Climate Change: Liberia's Policies

Liberia is a signatory to the United Nations' Paris Climate Change Agreement. The 2017 National Policy and Response Strategy on Climate Change guides the country's efforts to mitigate the risks of climate change and reduce vulnerability.

Climate Change: Liberia's Policies

REDD+ designates a dollar value for territories with standing forests according to the amount that would be released if the forests were destroyed. This gives developed countries a way to meet emissions standards by paying to keep forests in the developing world standing. The money is then allocated to incentivize forest community-members, who would otherwise need to cut down the forests for income.



Climate Change: Liberia's Policies

Objectives of REDD+ in Liberia

- Reducing emissions from deforestation
- Reducing emissions from forest degradation
- Conservation of forest carbon stocks
- Sustainable management of forests
- Enhancement of forest carbon stocks

Climate Change: Liberia's Policies

The Forest Development Authority (FDA) and the Environmental Protection Agency (EPA) are the key government agencies involved in the REDD+ program, which will offer Liberia a new opportunity to benefit financially from serving global conservation goals. It will provide mechanisms to manage forests in a balanced way for long-term sustainable economic growth, to support the livelihoods of local and rural communities, and to ensure that important national and global heritage is conserved.

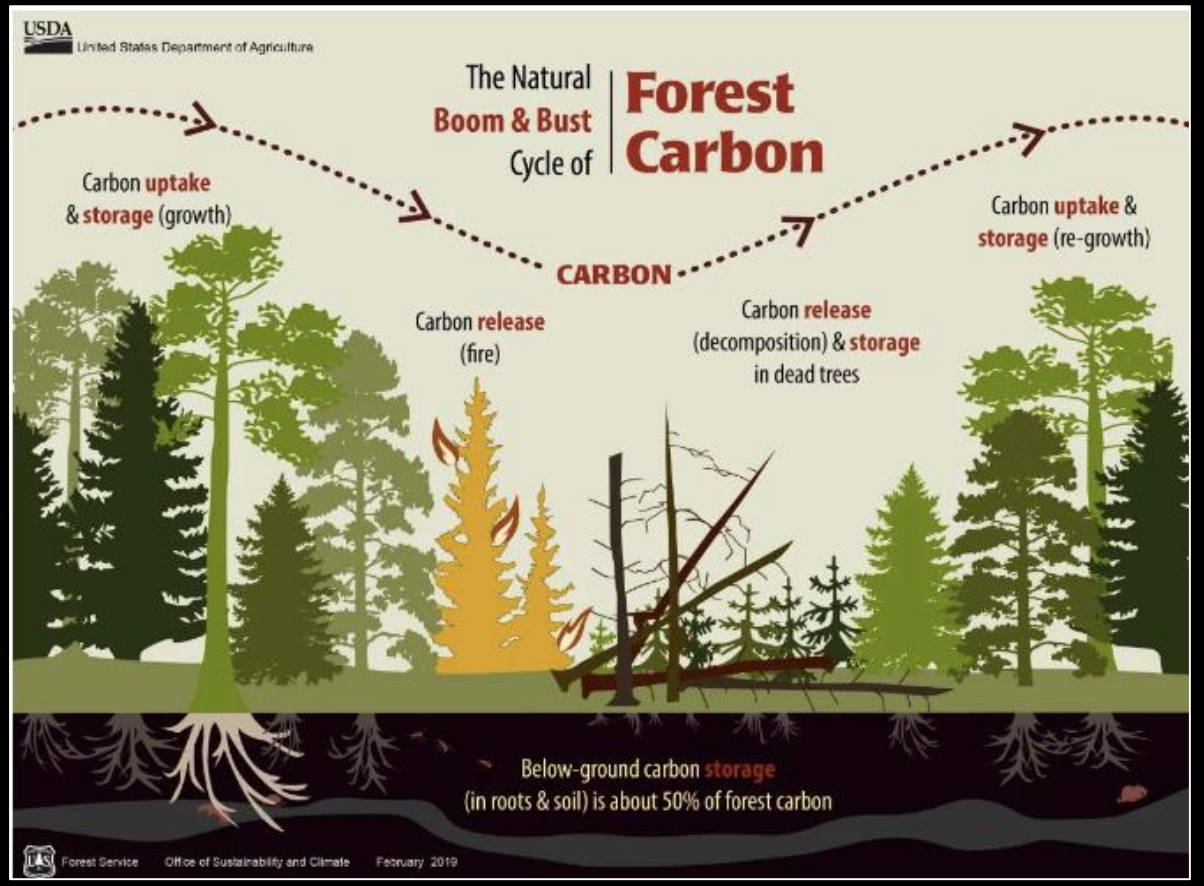
Afforestation: cost/benefit analysis

Requires large inputs of energy for planting, irrigation, and fertilization.

- Cost ranges from $1 to $69 per ton of carbon stored: median value $13

Forests and Carbon Uptake

- If total forest area increases, there is potential for increase in carbon uptake.
- Changes in climate appear to have increased global net primary productivity in recent decades.
- Rate of carbon sequestration normally decreases with time.



Conclusions

Interconnected processes can rapidly amplify the impacts of human threats to biodiversity.

A detailed understanding of the processes and impacts of human threats can help us design responses.

Successful responses are being developed and implemented.