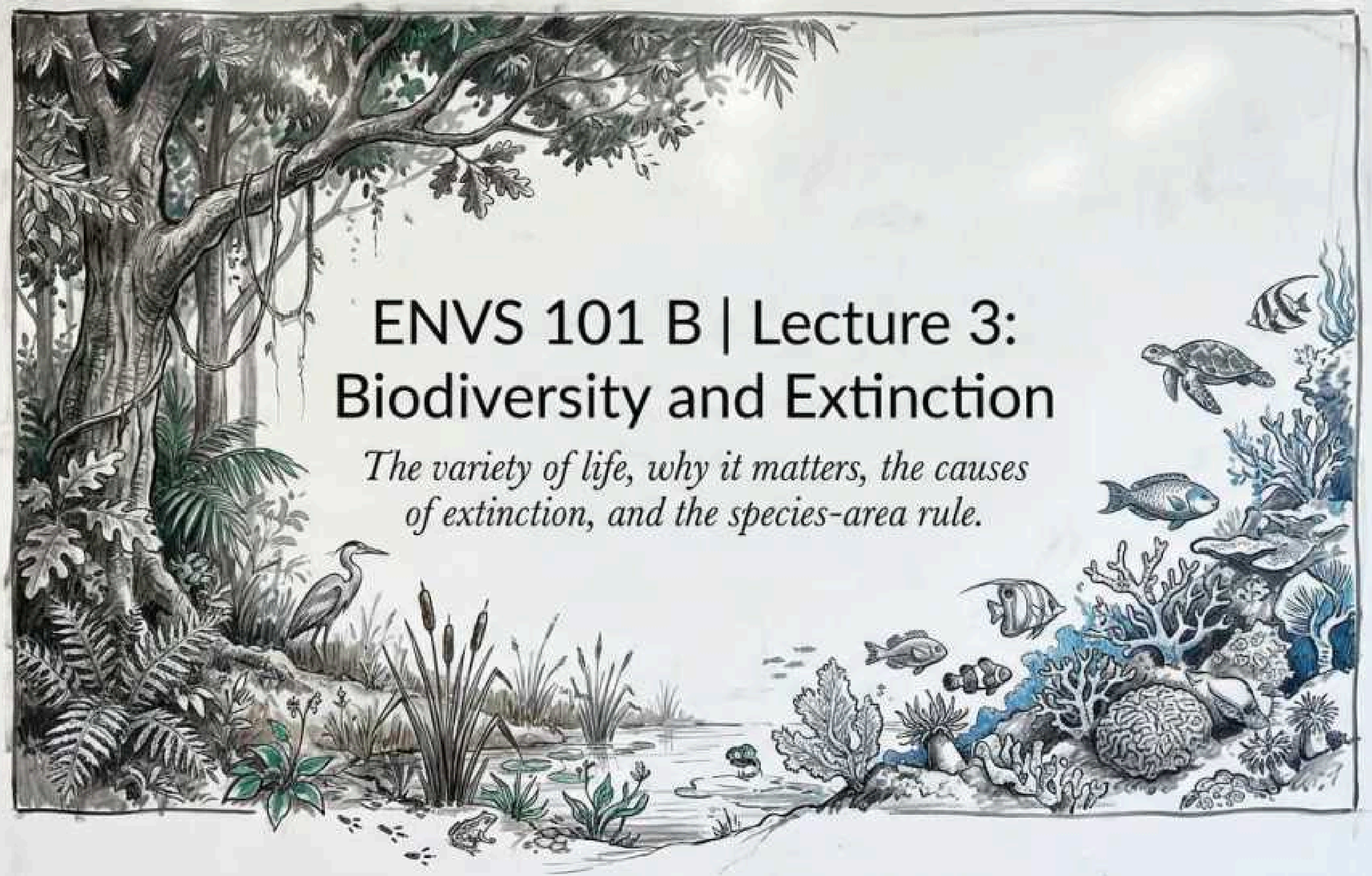
¶ 3.1



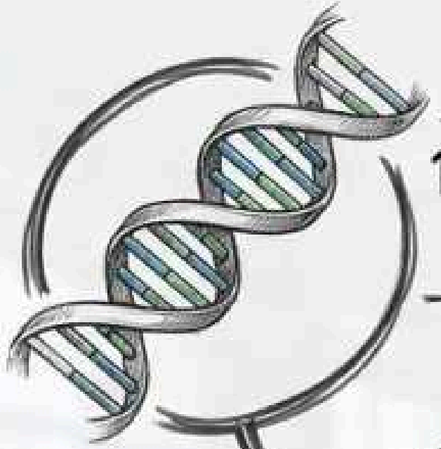
ENVS 101 B | Lecture 3: Biodiversity and Extinction

The variety of life, why it matters, the causes of extinction, and the species-area rule.

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¶ 3.2

Lecture 3 Agenda



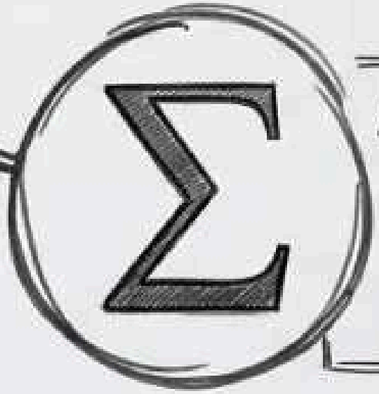
1. Defining Biodiversity
(How we count species)



2. Why Species Matter
(The value of nature)



3. Causes of Extinction
(The main threats)

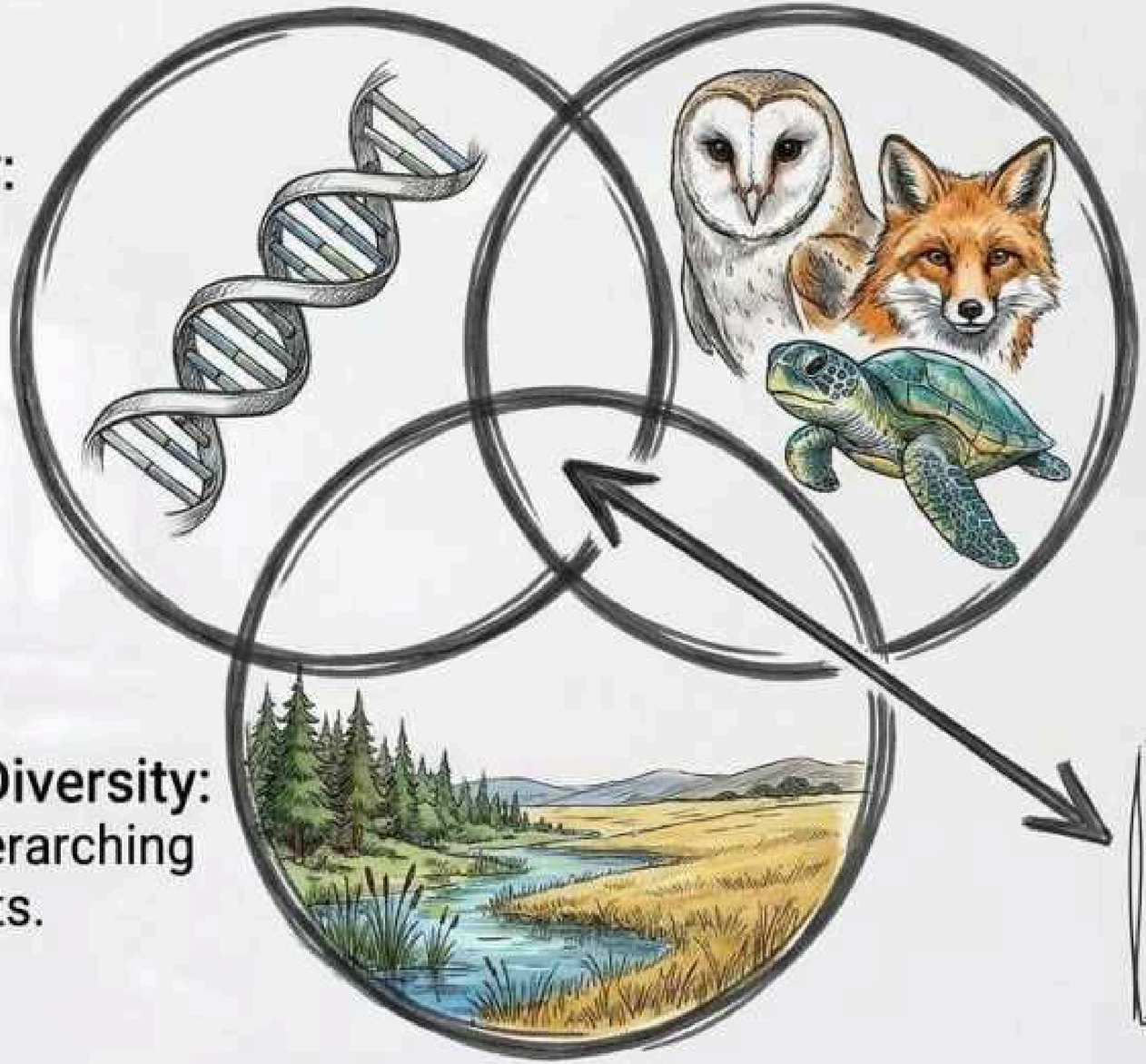


4. The Species-Area Rule
(Mathematical predictions of loss)

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¶ 3.3

Genetic Diversity:
Variation within a single species.



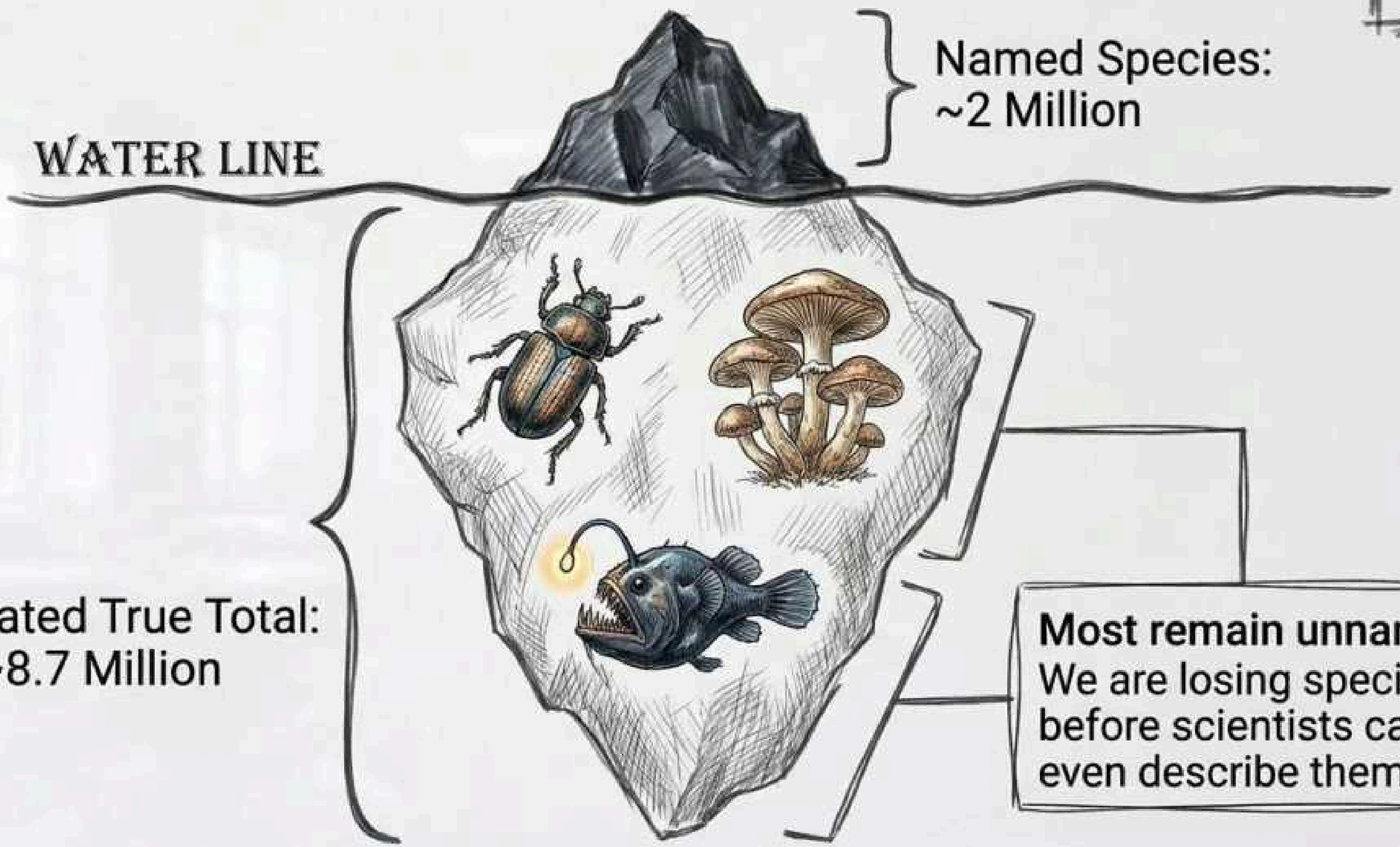
Species Diversity:
Number and mix of different species in a specific place.

Ecosystem Diversity:
Variety of overarching habitats.

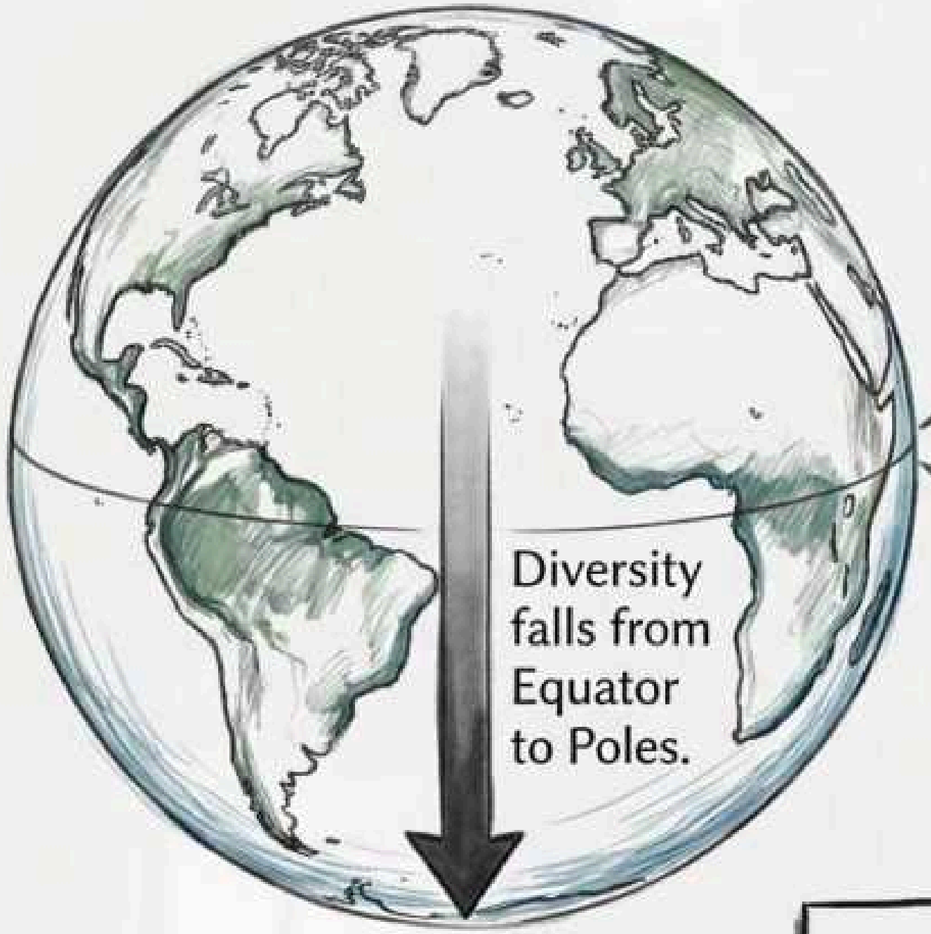
Interdependent:
Each supports the others; each can be lost.

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¶ 3.4

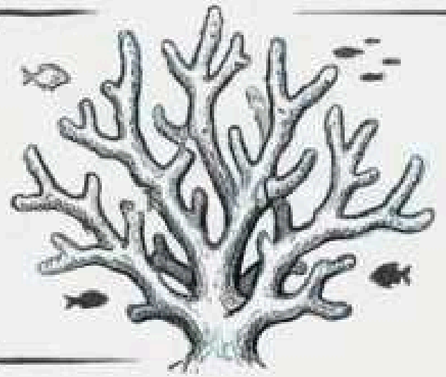

Named Species:
~2 Million
WATER LINE
Estimated True Total:
~8.7 Million
Most remain unnamed.
We are losing species
before scientists can
even describe them.

¶ 3.5





Tropical Rainforests:
Small land share
→ Disproportionately large species share.



Coral Reefs:
<1% of ocean floor
→ Shelters ~25% of all marine species.

Biodiversity Hotspots: Places containing many unique species that are under intense pressure.

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¶ 3.6

Ecosystem Services

(Benefits nature provides to people, hard to replace with machines)

Provisioning

- Food, timber, medicines.





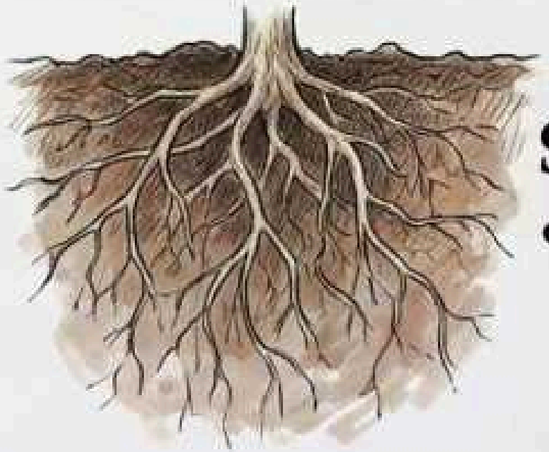
Regulating

- Pollination, flood control, water purification.

Cultural

- Recreation, beauty.





Supporting

- Soil formation, nutrient cycling.

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¶ 3.7



The Biological Work:

Insects pollinate crops supplying most human fruits, vegetables, and nuts.

Pollination



The Economic Value:

Estimated at hundreds of billions of dollars annually.

The Modern Reality:

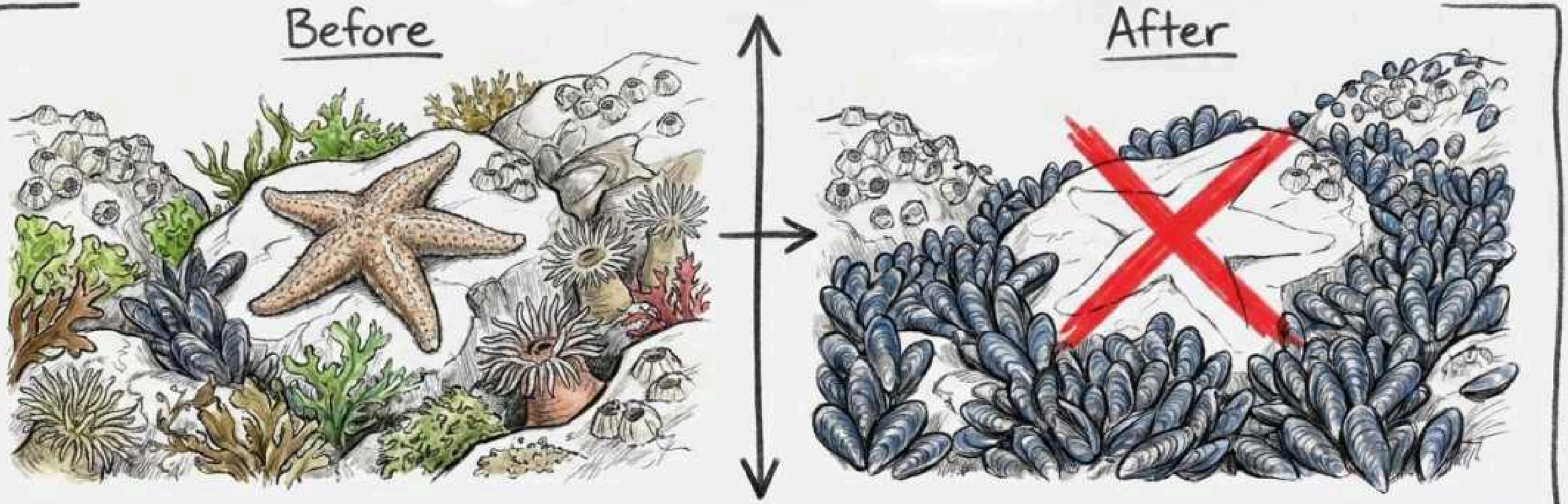
Wild pollinators are declining in intensively farmed landscapes, forcing farmers to rent commercial hives.

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¶ 3.8

Concept: Keystone Species – A species with a remarkably large effect on its ecosystem relative to its abundance.

The Experiment: Robert Paine (1960s, Washington State).



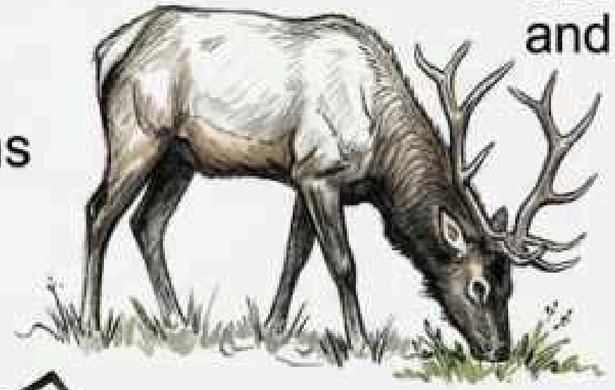
The Result: Removal of *Pisaster* starfish caused mussels to completely take over, sharply driving down overall species numbers.

¶ 3.9



The Timeline:
Wolves removed by the 1920s
→ Returned in 1995.

The Cascade:
Wolf reintroduction altered elk numbers and grazing behavior



→ Willows and aspens recovered along stream banks.



Takeaway: Top predators have the power to dynamically shape the physical landscape.

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¶ 3.10

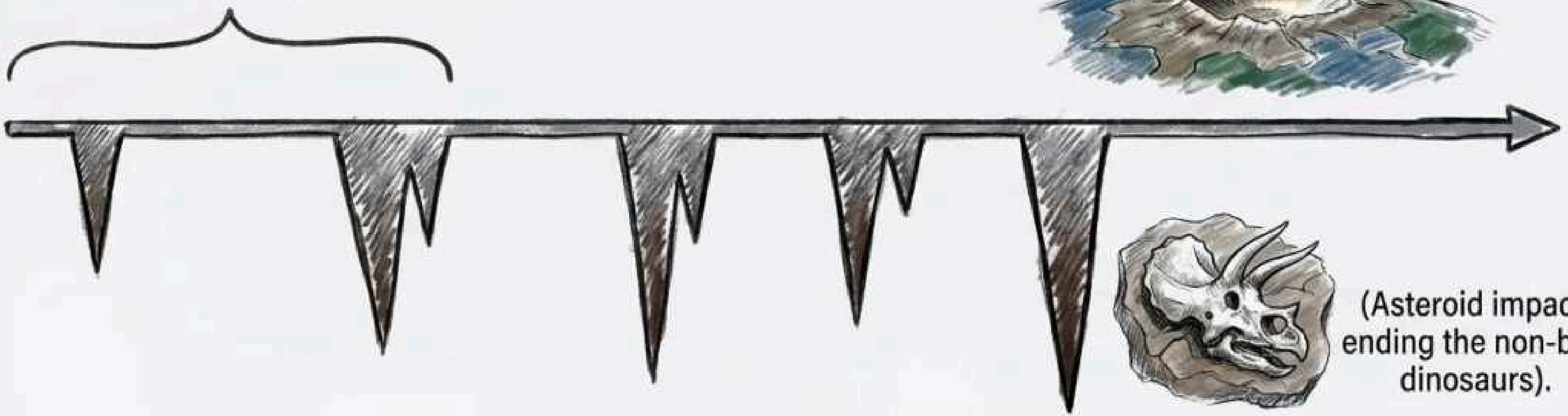
Baseline: Extinction is a natural biological process.

Mass Events: The fossil record shows five periods where a large fraction of all species disappeared rapidly.

Most Recent:
66 million years ago



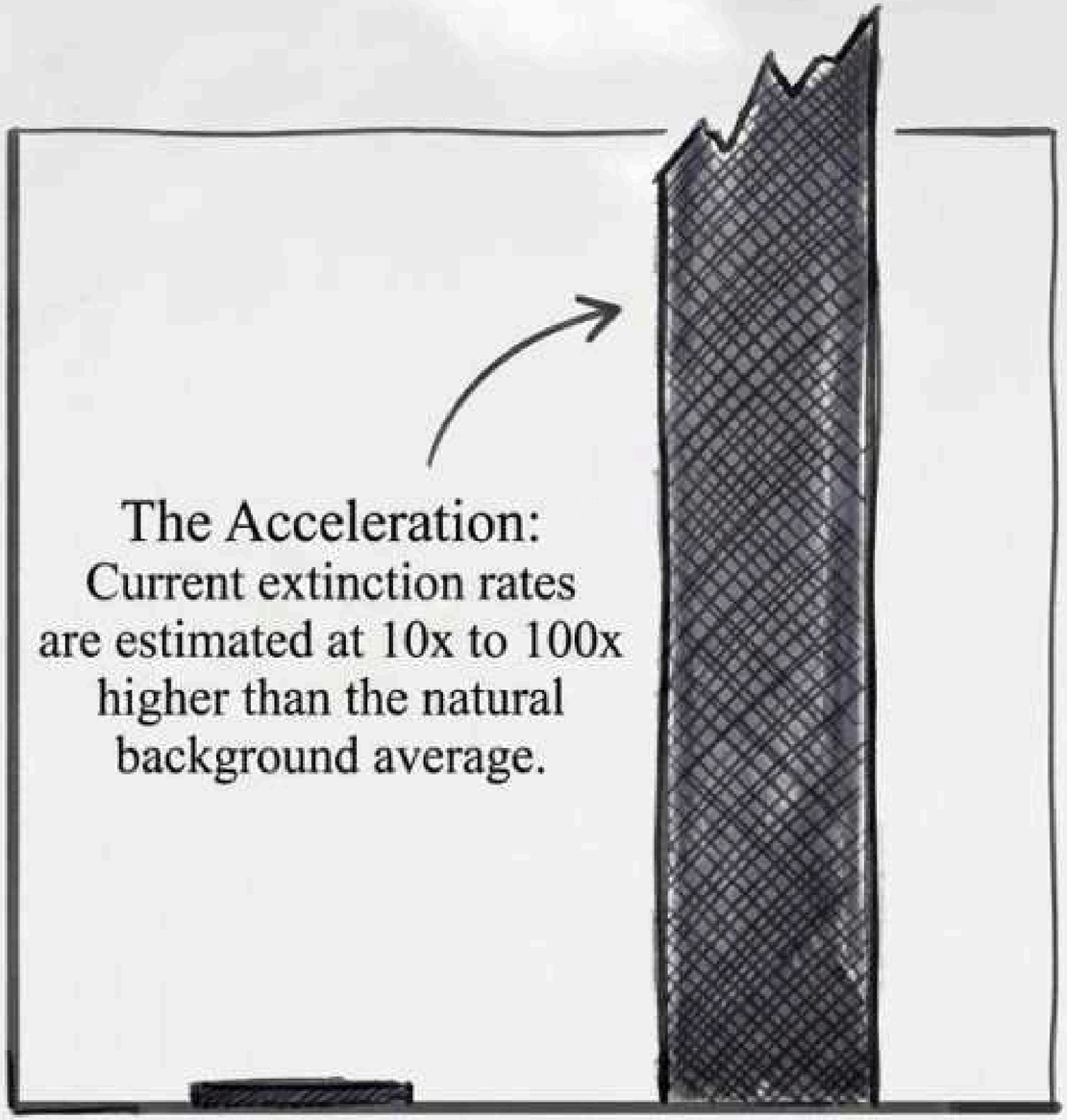
Typical species lifespan:
1 to 10 Million years.

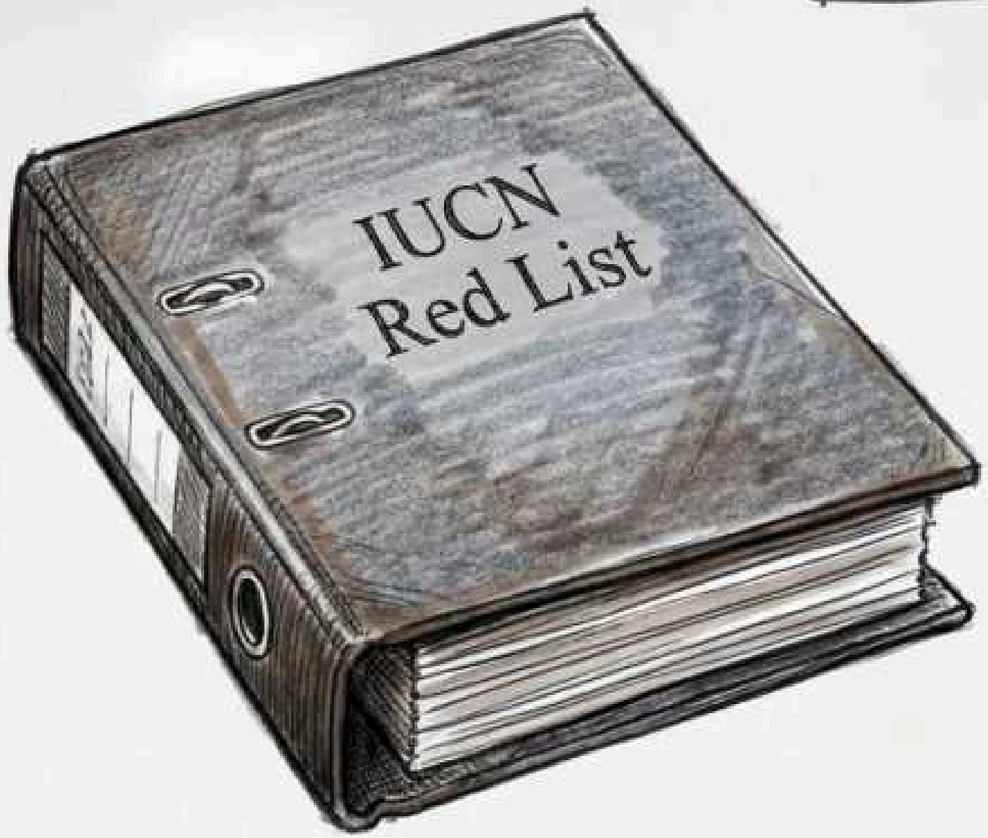


(Asteroid impact ending the non-bird dinosaurs).

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¶ 3.11



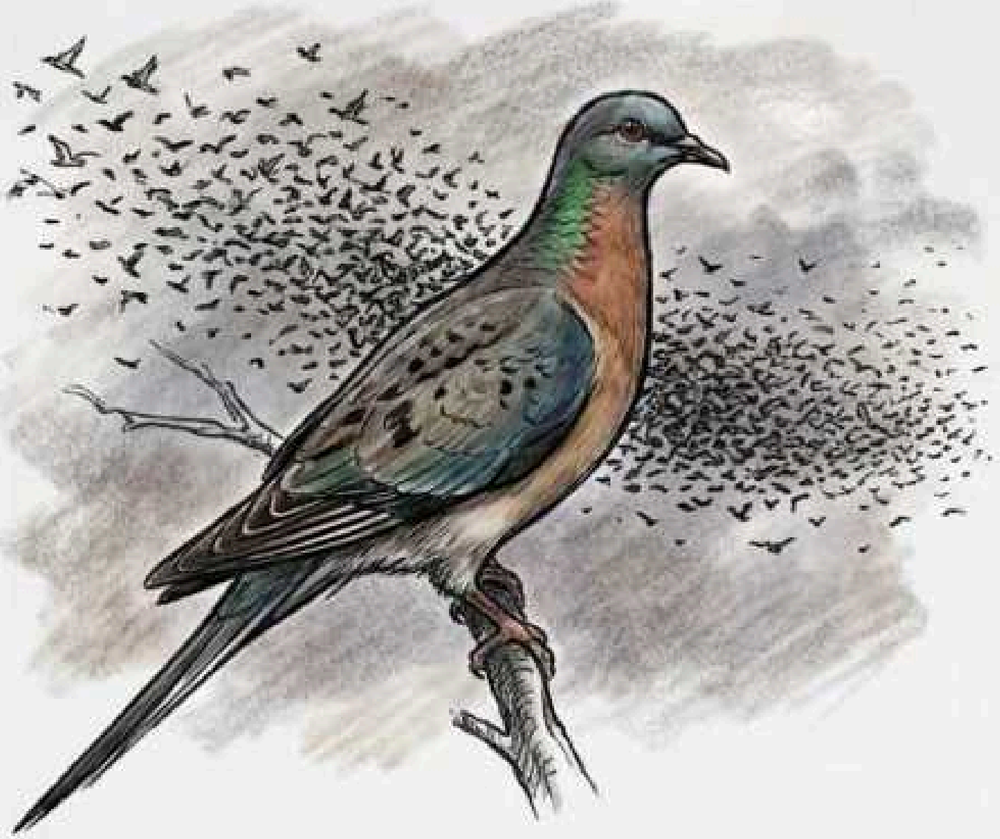


The Ledger: The International Union for Conservation of Nature (IUCN) Red List currently classifies tens of thousands of species as threatened with extinction.

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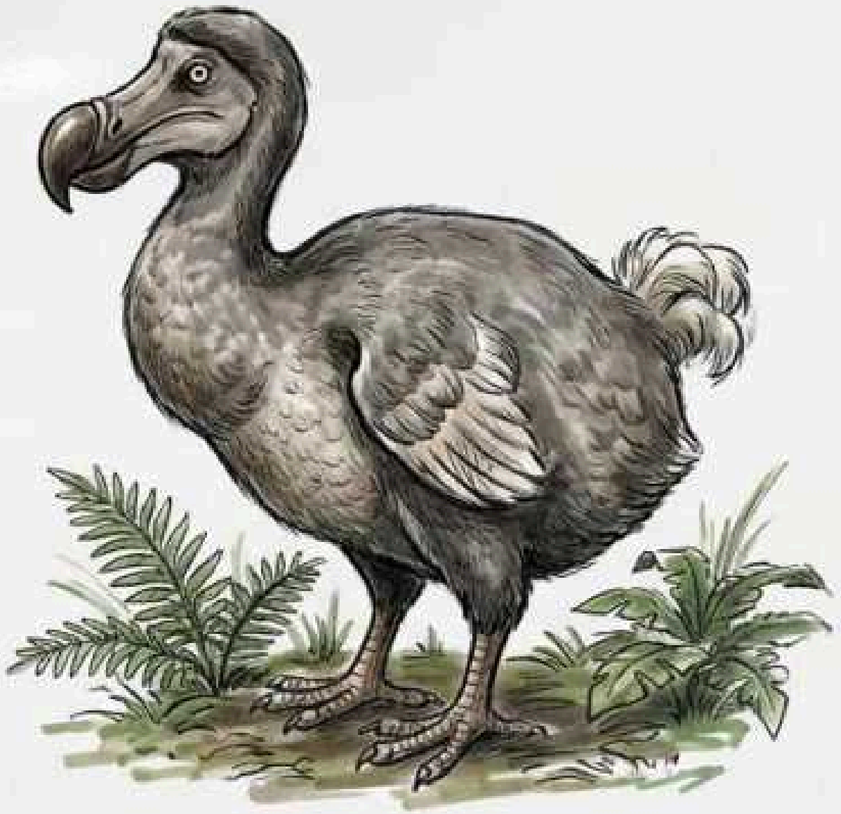
¶ 3.12

Passenger Pigeon



Passenger Pigeon: Hunted from billions to zero. Flocks once darkened the sky. The last one (Martha) died in the Cincinnati Zoo in 1914.

The Dodo



The Dodo: Endemic to Mauritius. Hunted to complete extinction within a century of sailors arriving on the island.

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¶ 3.13

H



Habitat loss and degradation

I



Invasive species

P



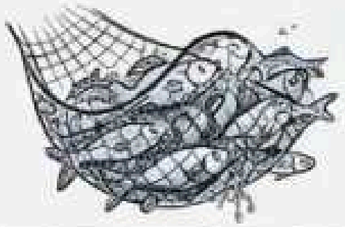
Pollution

P



Population & consumption

O

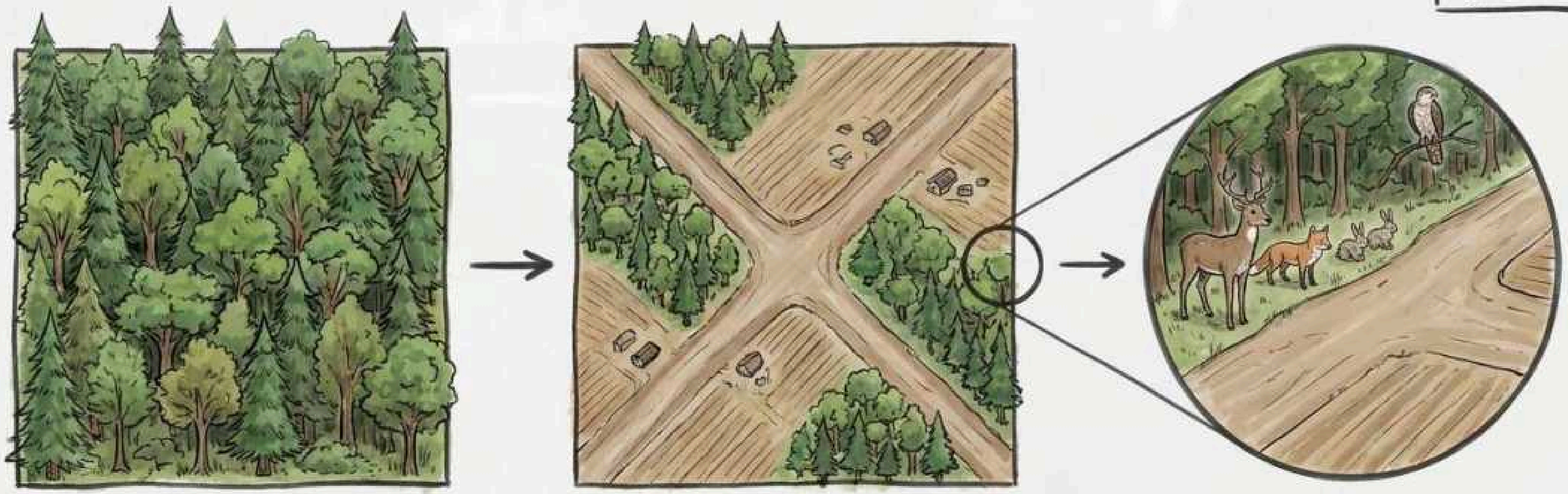


Overharvesting

Note: Climate change is increasingly added as an overlapping threat to this list.

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¶ 3.14



Pristine Forest → Fragmented Habitat → Isolation Barrier

The Primary Threat:

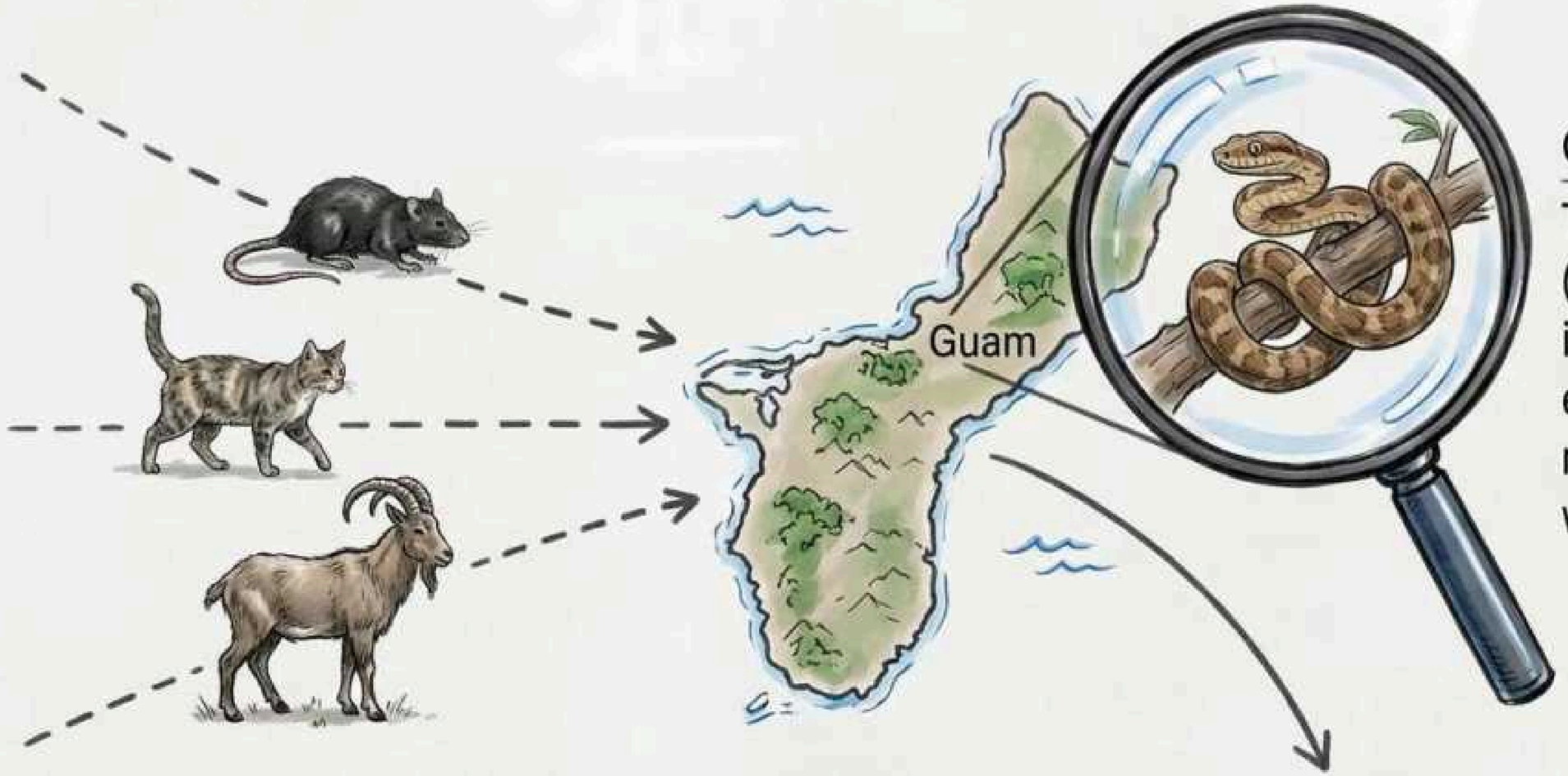
Habitat clearing (farms, cities, drained wetlands) is the largest cause of extinction on land.

The Fragmentation Multiplier:

Sliced habitats support fewer species. Small, isolated populations die out by chance, and wildlife cannot safely cross the modified gaps.

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¶ 3.15



Guam Case Study:

The brown tree snake (accidentally introduced) eliminated most native forest birds within decades.

The Victims:

Island birds are devastated by introduced mammals (rats/cats/goats).

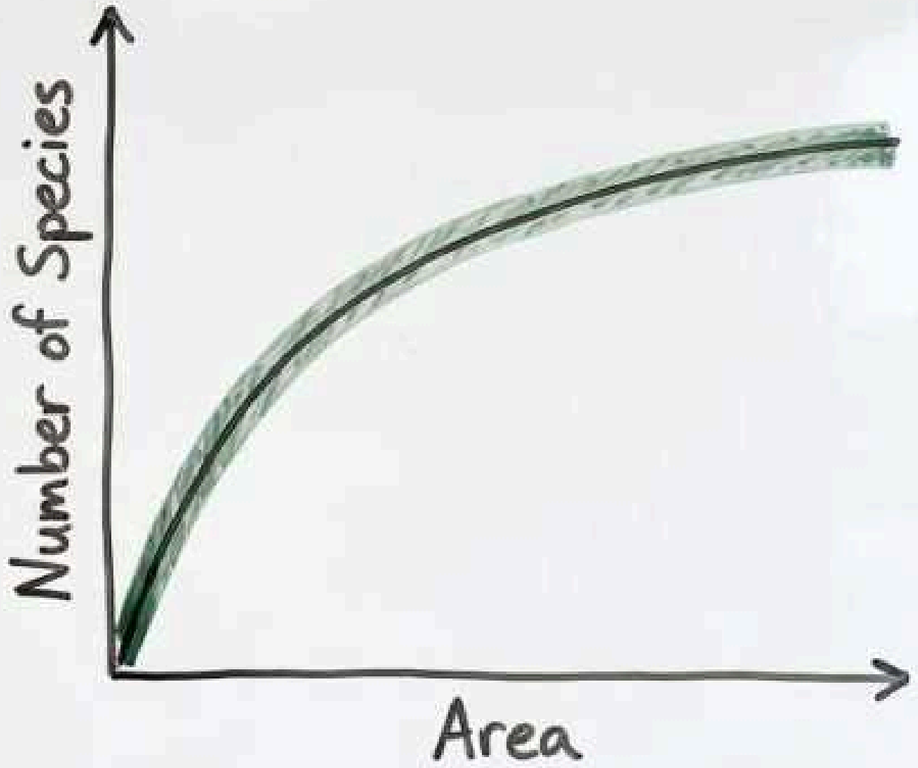
The Mechanism:

Introduced species leave natural predators and diseases behind, allowing explosive population growth.

¶ 3.16

$$S = cA^z$$

The Variables:
S = number of species
A = area
z ≈ 0.25.



The Concept: The Species-Area Relationship (derived from the theory of island biogeography). Predicts how species numbers rise with habitat area.

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¶ 3.17

Given: $z \approx 0.25$

Scenario 1: Massive Loss

$$(0.1)^{0.25} \approx 0.56$$

Result: Shrinking habitat to 1/10th its area (90% losr) eventually costs ~44% of its species.

Scenario 2: Halved Habitat

$$(0.5)^{0.25} \approx 0.84$$

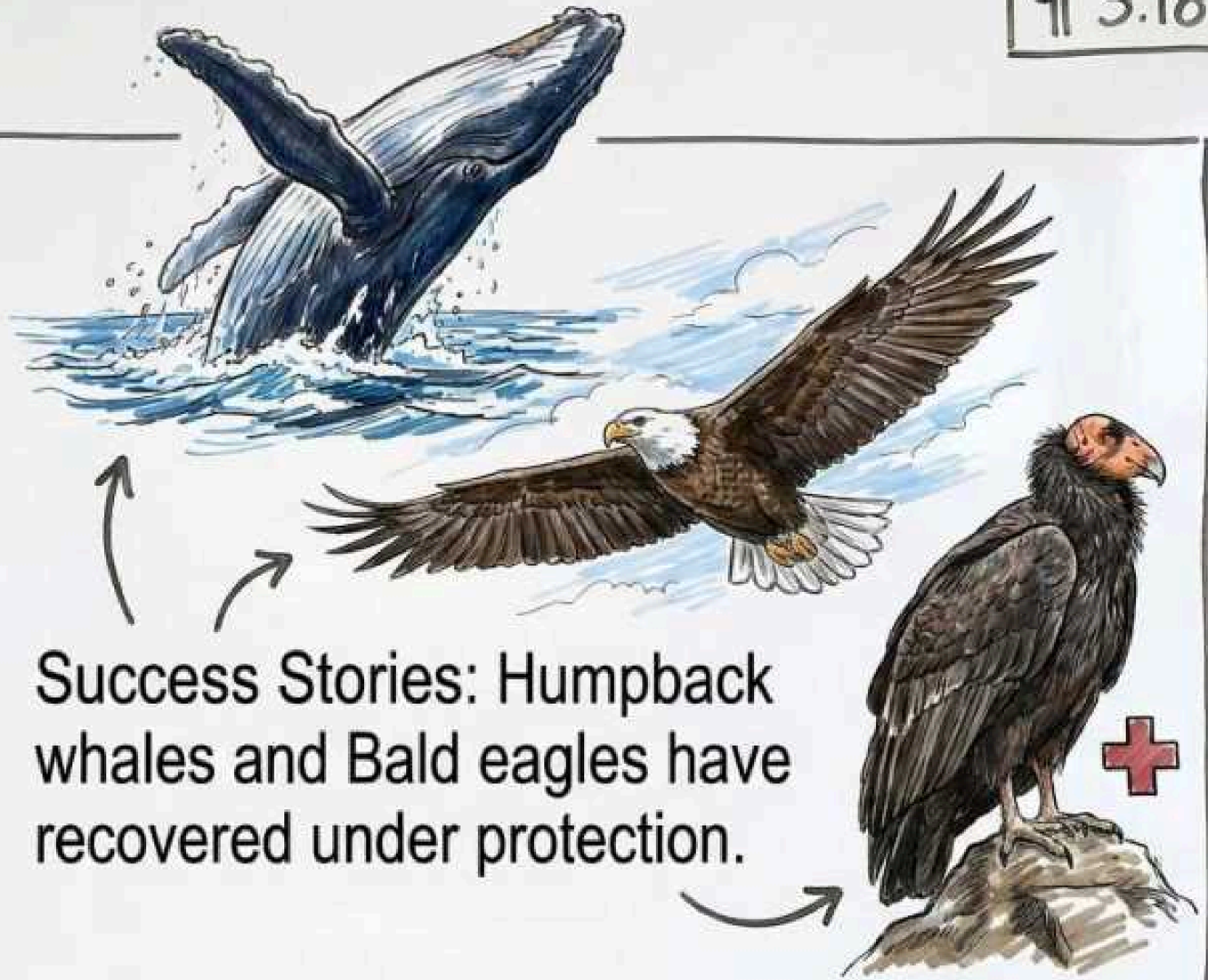
Result: Losing 50% of the area eventually costs ~16% of species.

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¶ 3.18

Interventions that Work:

- ✓ National parks/reserves
- ✓ Linking wildlife corridors
- ✓ Anti-hunting/trade laws
- ✓ Land restoration
- ✓ Landowner conservation payments



Success Stories: Humpback whales and Bald eagles have recovered under protection.

Note: The California condor is recovering but still relies on intensive human care.

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The Strategic Debate

¶ 3.19

Approach A:
Strictly protected, protectiry "people-free" zones.



Approach B:
Empowering local and Indigenous communities as primary stewards and partners.

The Global Consensus: The 2022 international target to officially protect 30% of all land and sea by the year 2030.

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Lecture Knowledge Check

The Problem: A forest of 400 km^2 is reduced by farming to 100 km^2.

Task 1 (Math): Use $S = cA^z$ (with $z = 0.25$) to estimate the fraction of species that will survive in the long run.

Task 2 (Biology): Name two ecological strategies to reduce this species loss without restoring the 300 km^2 of cleared forest (e.g., building wildlife corridors).

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¶ 3.21

Looking Ahead to Lecture 4

Next Topic:
The Human Footprint

We will turn to the total number of people on Earth, the mechanics of population growth, and how land and food are utilized to support humanity.

