BIO 111: **Ecology and Evolution**

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MODULE: BIODIVERSITY AND CONSERVATION BIOLOGY

Part IV CONSERVATION

Is a mass extinction underway currently?

Estimate: About 3 species per hour; and 20,000 per year going extinct

Critically endangered species grew from 10,000 in 1996 to 15,000 in 2004

100-1000 times more than the background extinction rates in the past

Recent extinction Rates

Estimated Number of Extinctions Since 1600

Group	Mainland	Island	Ocean	Total	Approximate Number of Species	Percent of Group Extinct
Mammals	30	51	4	85	4000	2.1
Birds	21	92	0	113	9000	1.3
Reptiles	1	20	0	21	6300	0.3
Amphibians*	2	0	0	2	4200	0.05
Fish	22	1	0	23	19,100	0.1
Invertebrates	49	48	1	98	1,000,000+	0.01
Flowering plants	245	139	0	384	250,000	0.2

*An alarming decrease of amphibian populations has occurred since the mid-1970s, and many species might be on the verge of extinction.

Threats to Biodiversity

Habitat loss and degradation
Invasive species
Pollution
Over-exploitation
Global climate change

Human population increase

Habitat loss and degradation

- destruction, degradation & fragmentation

Estimated that tropical countries are losing
12.5 million hectares (ca. 31million acres) of forest annually.

Photos of forest destruction in Brazil & Malaysia

Slide based on content in slides by Kyle Harms

Invasive Species

Introduced species: Non-native species intentionally or unintentionally transported to a new habitat

Introduced species often reproduce in large numbers (e.g lack of predators) and become *Invasive Species*

Estimated that ca 40% of the extinctions since 1750 are due to invasive species

Nile perch

Deliberately introduced to Lake Victoria (east Africa) in the 1960s to provide food for local fishermen. Has caused the extinction of at least 200 species of fish that were endemic to the lake

Rhinella marinus (Cane Toad)
Photo: Wikimedia / Benjamint444
Introduced to Australia to control sugarcane pests

Photo: Vineyard Conservation Society

Photo: Zeynel Cebeci

Lantana camara. Introduced as an ornamental plant to India and other countries. Has become successfully established in many habitats and displaced native flora. Considered one of the worst invasive species

Pollution

www.surfersvillage.com

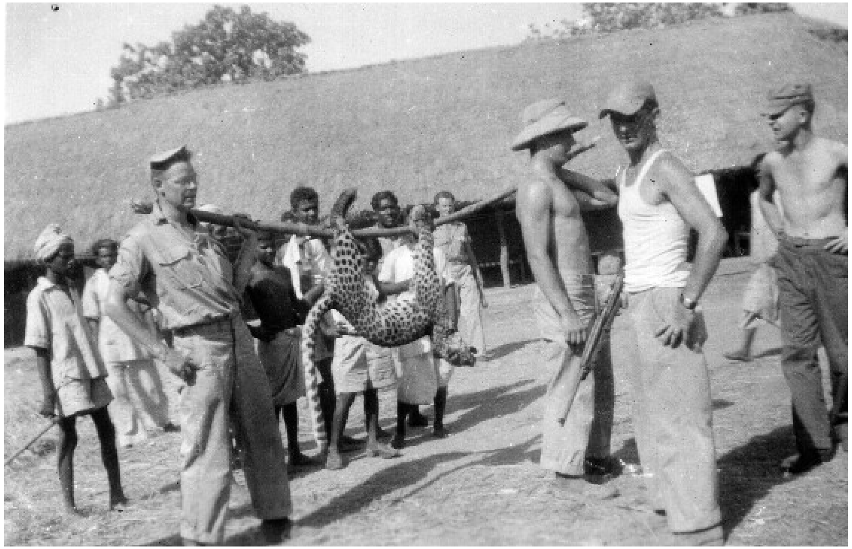
Slide based on content in slides by Kyle Harms

Overexploitation

Moas in New Zealand

Illustration: Sciencesource.com

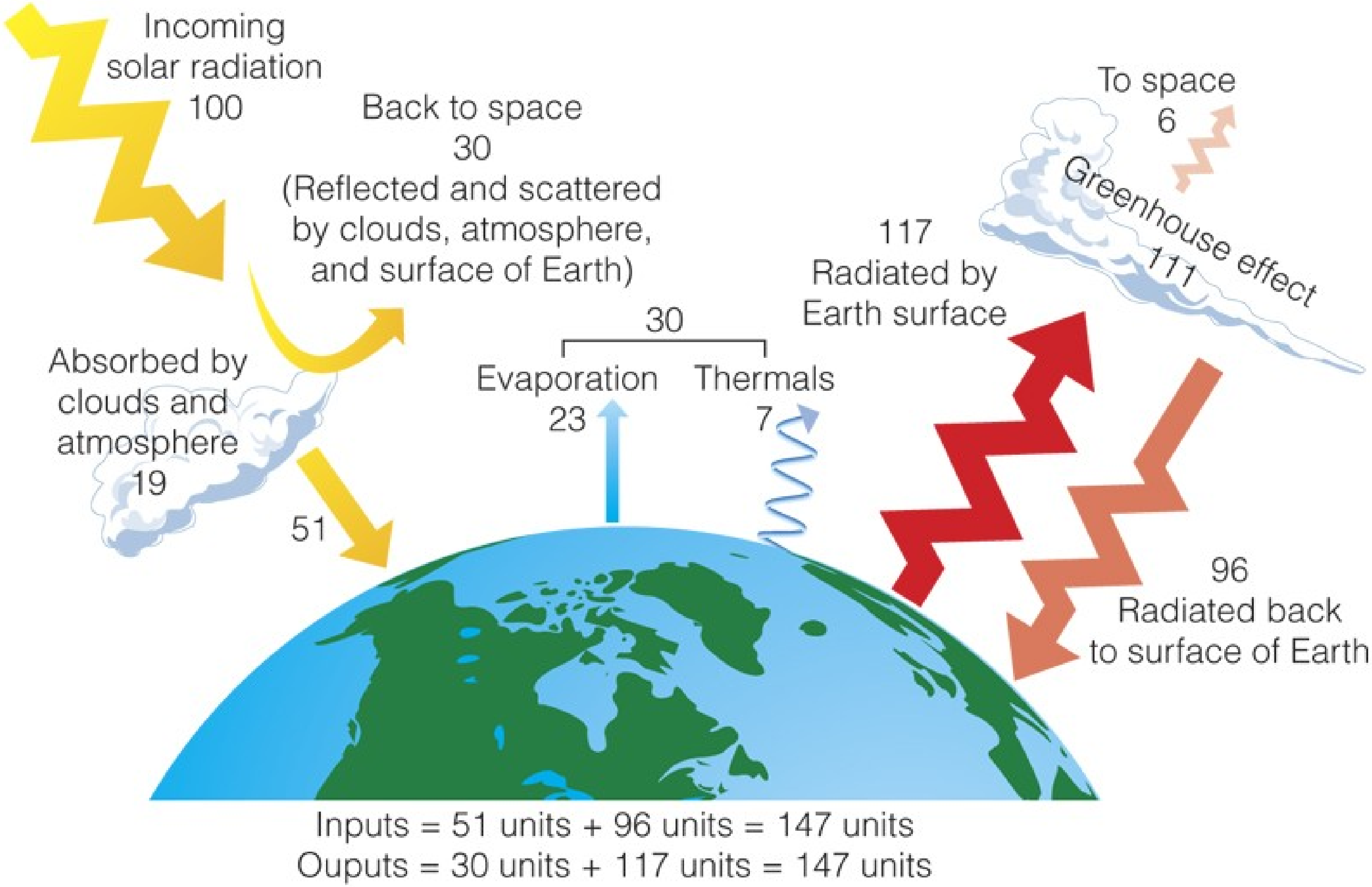
Cheetahs in India



www.444thbg.org

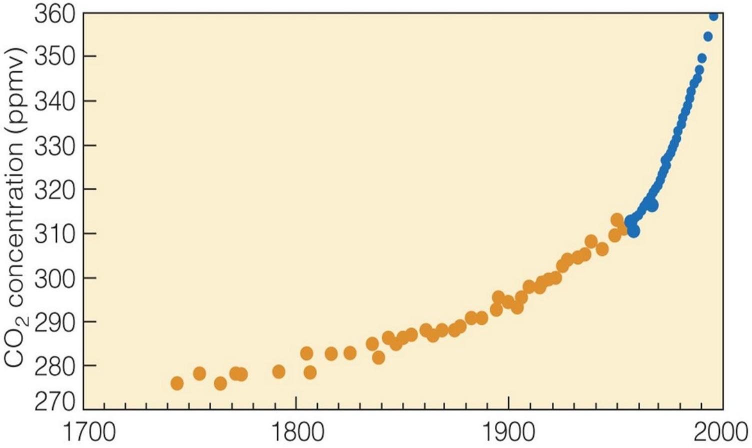
www.drivesouthafrica.co.za

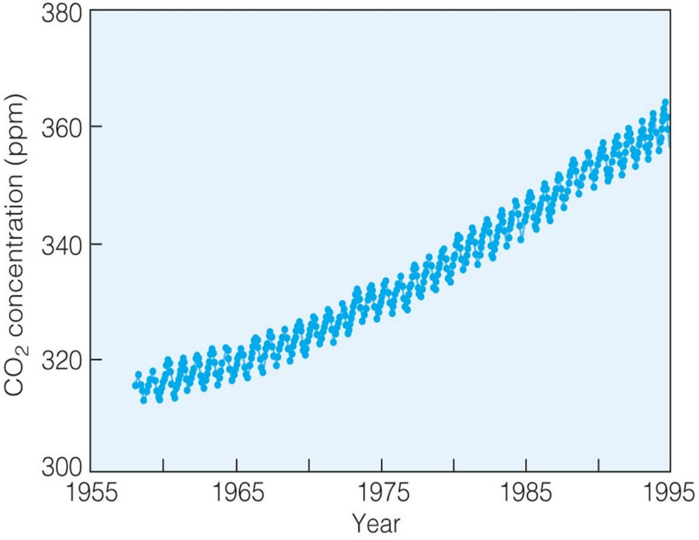
Global Climate Change



Pearson Scientific Inc.

Carbon dioxide increase





Pearson Scientific Inc.

Some atmospheric gases prevent long wave (IR) energy from being dissipated into space (*Green house effect*)

CO2 contributes most to the Green house effect

Reading exercise

- Why does CO2 concentration vary within seasonally within a year?

Effects of climate change

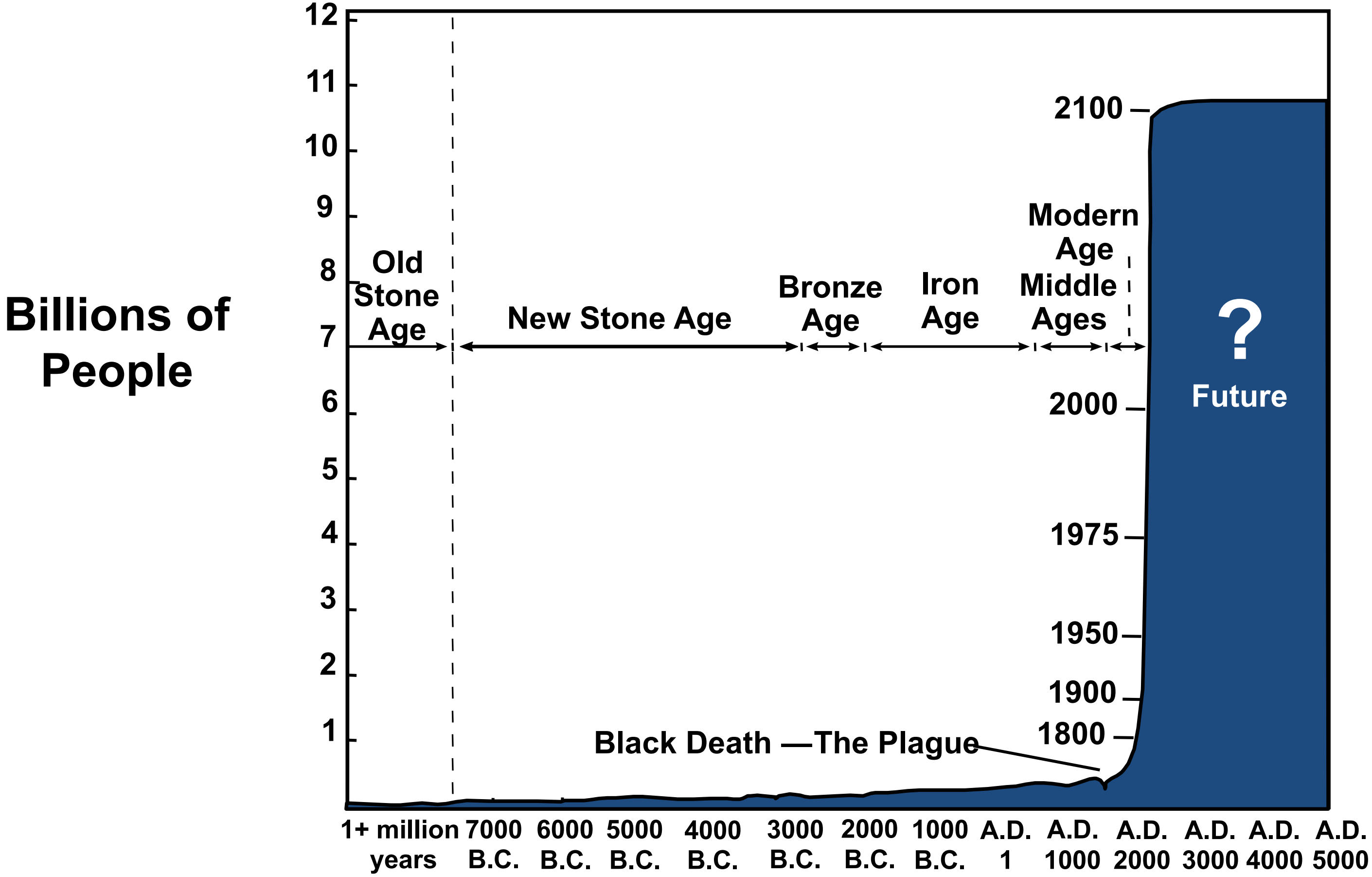
Global temperature increase
Increased sea levels
More extreme weather (floods, drought, cyclones)
Precipitation increase and decrease in different regions

- Extinction of many cold adapted species

- Alterations to geographic ranges of many species (many move towards the poles or higher elevations)

Human Population

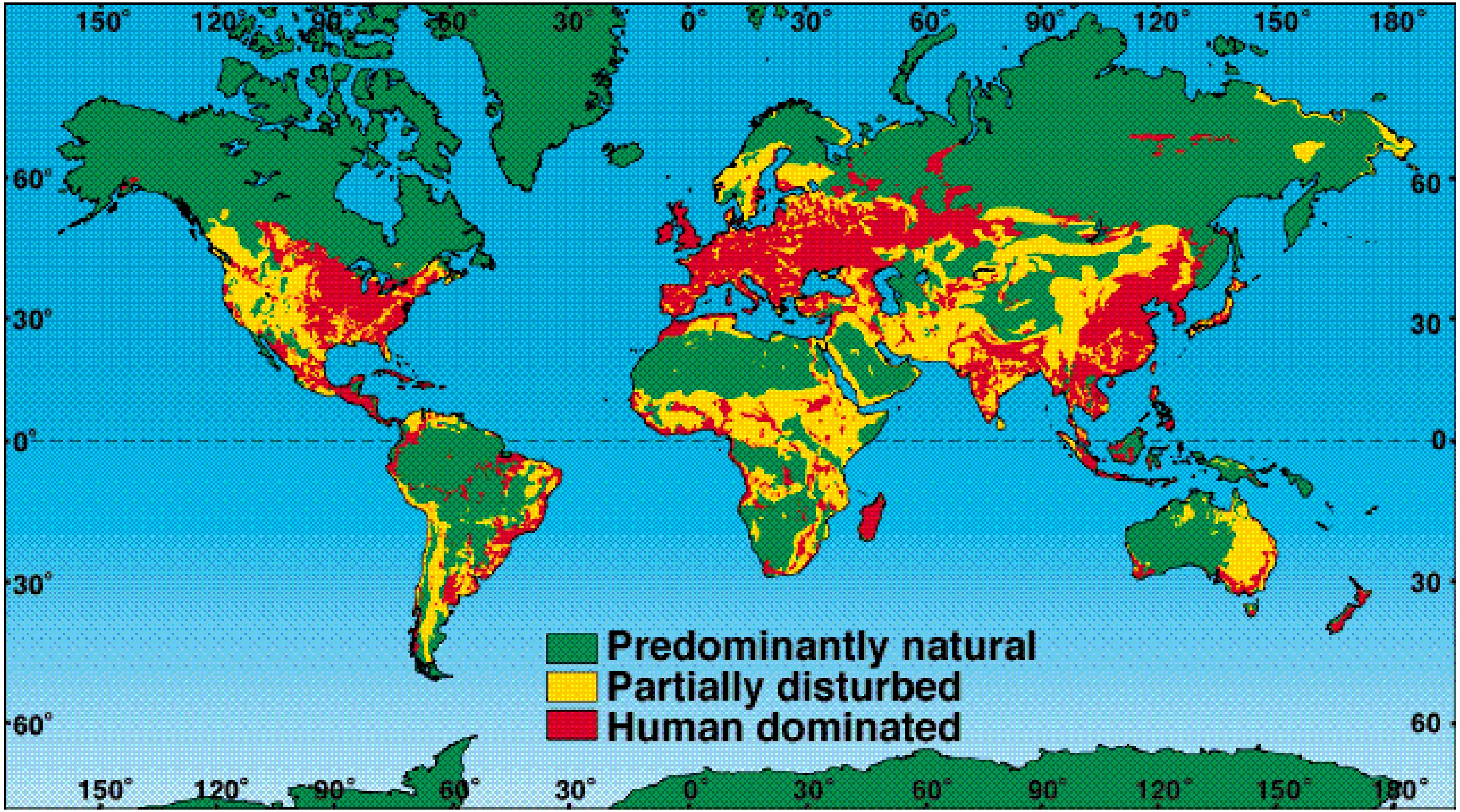
(more people means more of all the other effects)



Source: Population Reference Bureau
© 2006

Slide based on content in slides by Kyle Harms

A human-disturbance map.



Cunningham/Salgo, Environmental Science, A Global Concern

CONSERVATION STRATEGIES

In situ conservation

Conserving species in their natural habitat
E.g. Reserves / Protected Areas (National parks, Wildlife Sanctuaries)

Ex situ conservation:

Conserving species outside their natural habitat
E.g. Zoos, Botanical gardens, Seed banks

Some National Parks of India

- Corbett (Uttarakhand)
- Bandhavgarh (MP)
- Kanha (MP)
- Kaziranga (Assam)
- Ranathambore (Rajasthan)
- Gir (Rajasthan)
- Eravikulam (Kerala)
- Bandipur (Karnataka)
- The Great Himalayan (HP)

Photo: flickr.com/photos/hdnature

Photo: Soumyajit Nandy

National Parks of Kerala

- Eravikulam
- Silent Valley
- Pampadum Shola
- Mathikettan Shola
- Anamudi Shola

Eravikulam. Photo: eravikulam.org

Slient Valley. Photo: keralatourism.guide

Periyar Tiger Reserve	Idukki
Neyyar Wildlife Sanctuary	Thiruvananthapuram
Peechi - Vazhani Wildlife Sanctuary	Thrissur
Parambikulam Wildlife Sanctuary	Palakkad
Wayanad Wildlife Sanctuary	Wayanad
Idukki Wildlife Sanctuary	Idukki
Peppara Wildlife Sanctuary	Thiruvananthapuram
Thattekkad Bird Sanctuary	Ernakulam
Shendurney Wildlife Sanctuary	Kollam
Chinnar Wildlife Sanctuary	Idukki
Chimmony Wildlife Sanctuary	Thrissur
Aralam Wildlife Sanctuary	Kannur
Mangalavanam Bird Sanctuary	Ernakulam
Kurinjimala Sanctuary	Idukki
Choolannur Pea Fowl Sanctuary	Palakkad
Malabar Wildlife Sanctuary	Kozhikode

http://www.forest.kerala.gov.in/

Chinnar. Photo: StarVeaBond/teambhp.com

Periyar. Photo: periyartigerreserve.org

Peppara WLS
(Agasthyamalai
Biosphere Reserve)

Reading exercise

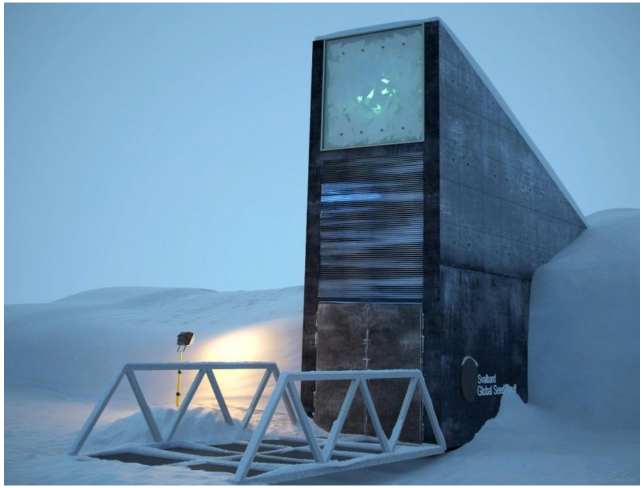
- What is a biosphere reserve and how is it different from a National Park or Wildlife Sanctuary?

Advantages of *In situ* conservation

- Availability of all the resources that the species is adapted to
- Species can continue to evolve in their natural environment
- (Usually) more space
- (Usually) bigger breeding populations
- Often cheaper than *ex situ*

In situ conservation

- Usually a last resort when *In situ* approaches are unlikely to work
- Zoos, Seed banks, Botanical Gardens
- *Advantages*: Better protection, Better survival, artificial insemination

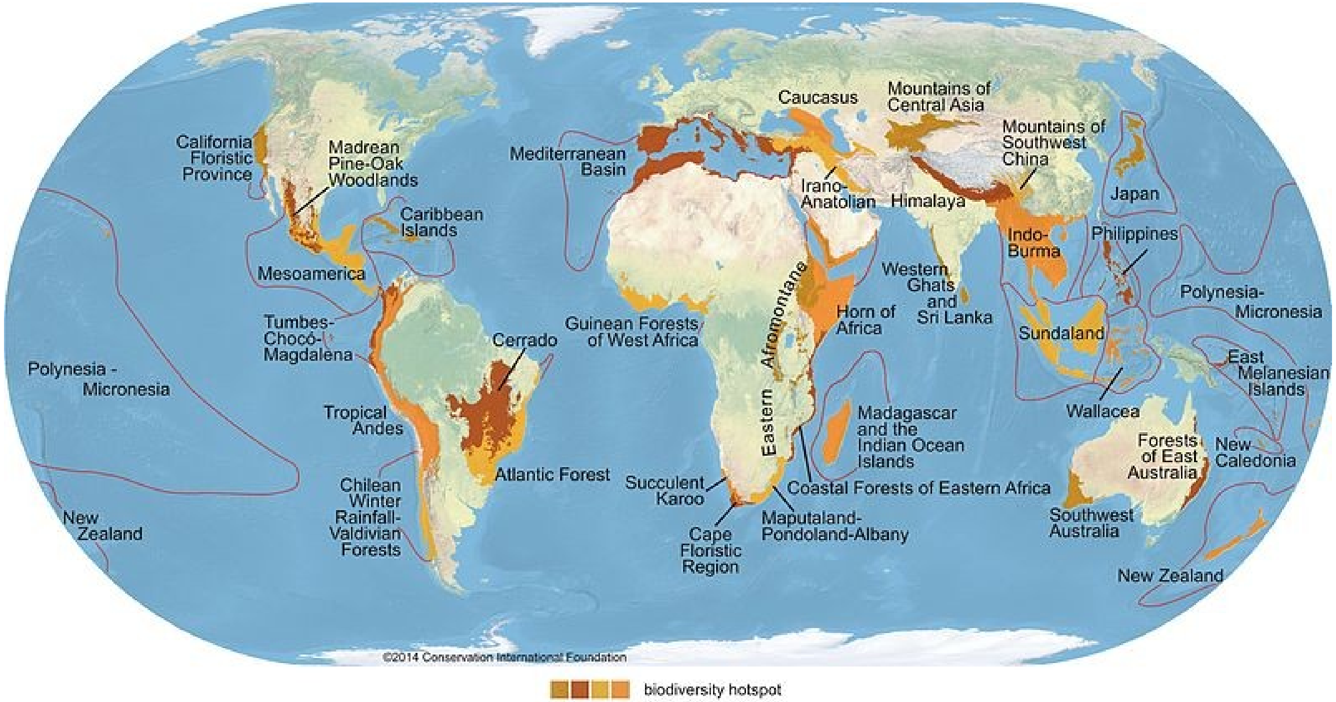


Entrance to the Svalbard Global Seed Vault.

Photo: Jizza/http://i.imgur.com/UvVggft.jpg

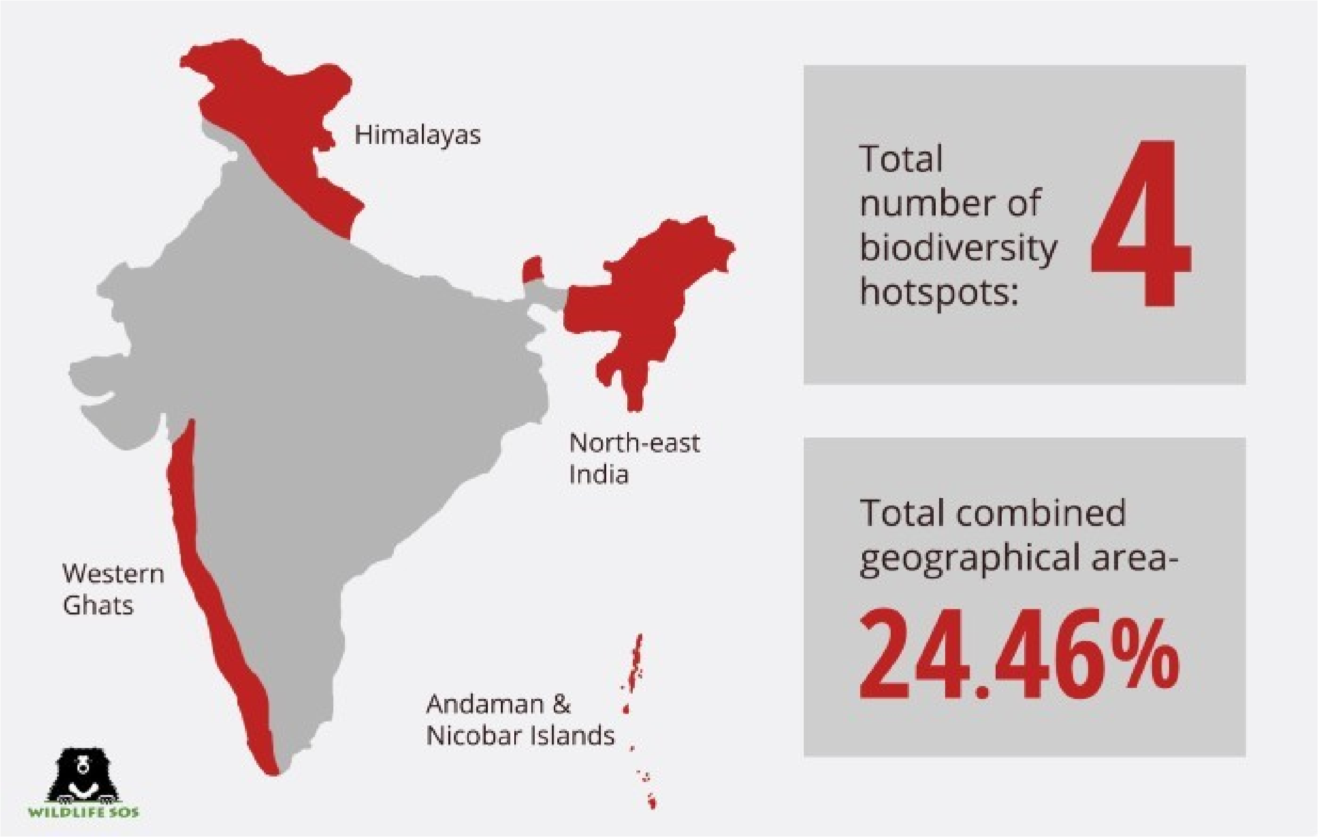
Biodiversity Hotspots

Regions with very high biodiversity & endemic species, that are under severe threat. Currently 36 recognized



Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

Biodiversity Hotspots of India



Wildlife SOS/Shivalika Swar

- ***Himalaya***: Includes the entire Indian Himalayan region (and that falling in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar)
- ***Indo-Burma***: Includes entire North-eastern India, except Assam and Andaman group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China)
- ***Sundalands***: Includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines)
- ***Western Ghats and Sri Lanka***: Includes entire Western Ghats (and Sri Lanka)

V. ISLAND BIOGEOGRAPHY

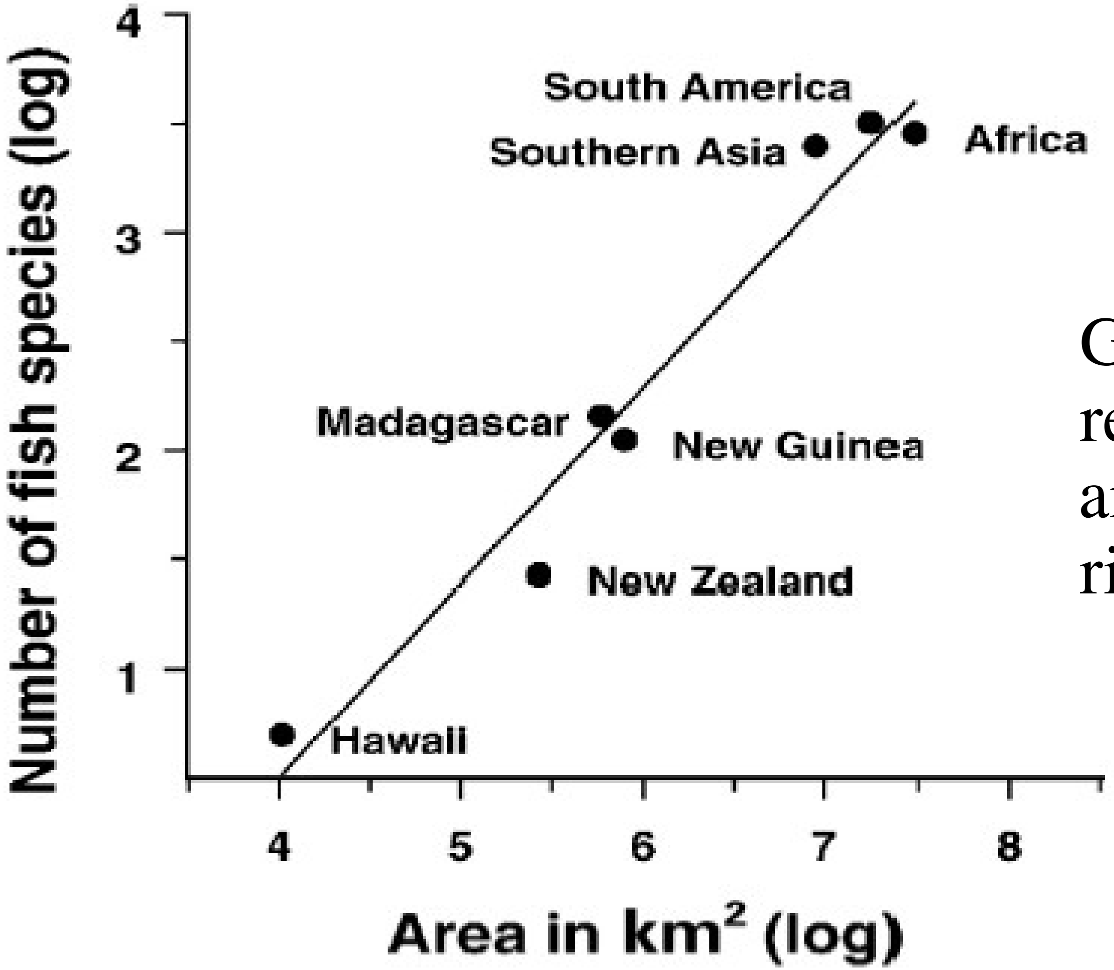


Fig. 1 Interprovincial species-area relationship for tropical freshwater fishes. The z-value is 0.89. Data courtesy Peter Reinthal. Figure from Rosenzweig (2003) with permission.

General positive relationship between area and species richness. WHY?

Theory of Island Biogeography

Eugene Monroe (1948, PhD Thesis), MacArthur and Wilson (1963):

The number of species of a given taxon that become established on an island represents a dynamic equilibrium controlled by the rate of immigration of new species and the rate of extinction of previously established species.

Focusses on short-term *ecological* processes rather than long-term *evolutionary* processes such as speciation

Rate of Immigration (i.e., rate of colonization of new species into a region) decreases with increasing species richness on the island, because there are fewer potential colonists and fewer unexploited niches.

Rate of Extinction increases with increase in the number of species on an island, because of increased inter-specific competition which can displace some species and lower population sizes when species can coexist

At equilibrium between immigration and extinction, the number of species remains stable, although the composition of species may change.

This is the *dynamic equilibrium*.

The rate at which some species are lost and others becomes established (i.e, the rate at which species composition changes) is the *turnover rate*.

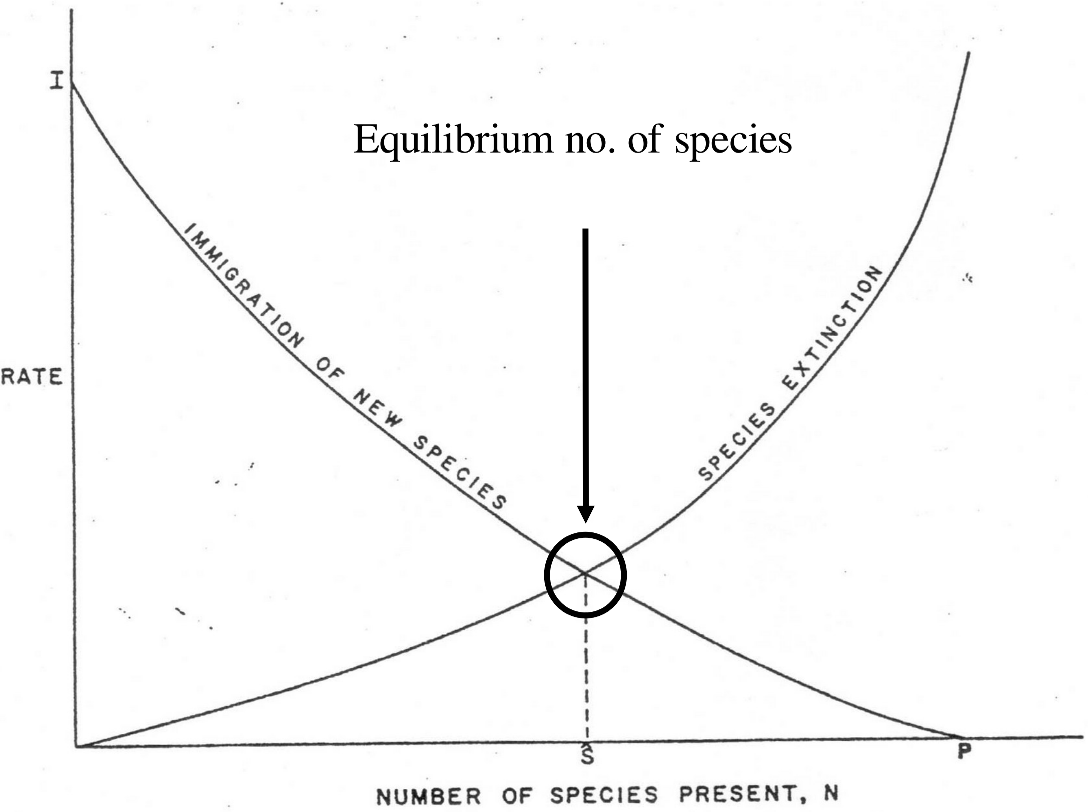


FIG. 4. Equilibrium model of a fauna of a single island. See explanation in the text.

Equilibrium number of species, but constant *turnover*

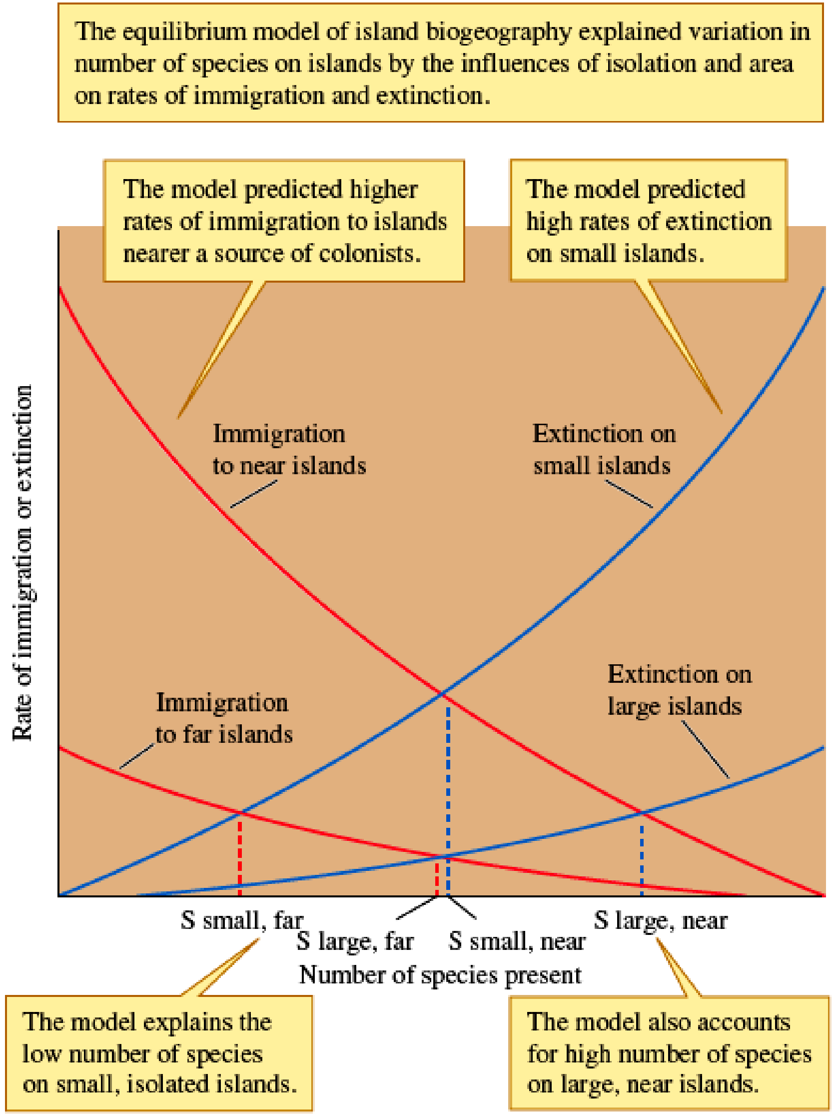
Immigration slows as richness increases

Extinction increases with richness

Equilibrium = rate of extinction, rate of colonization intersect. Here, immigration rate balances extinction rate

Immigration rate also depends on distance of the island from the mainland (or the pool of potentially colonizing species); more distant islands have slower/lower immigration rates.

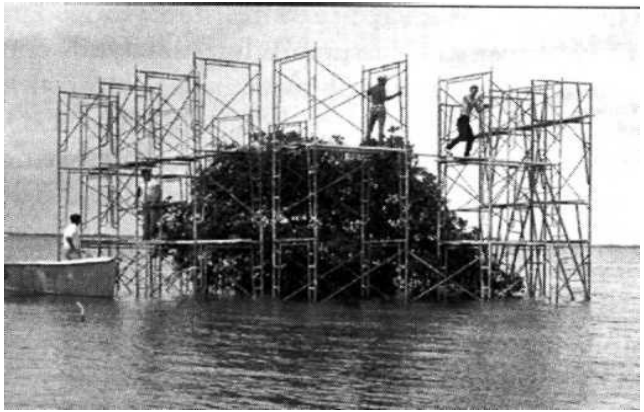
Extinction rate also depends on the size of the island. Larger islands can support larger population sizes, and large populations are less prone to extinction. So, the smaller the island, the greater the probability of extinction, and, therefore, higher/faster rates of extinction.

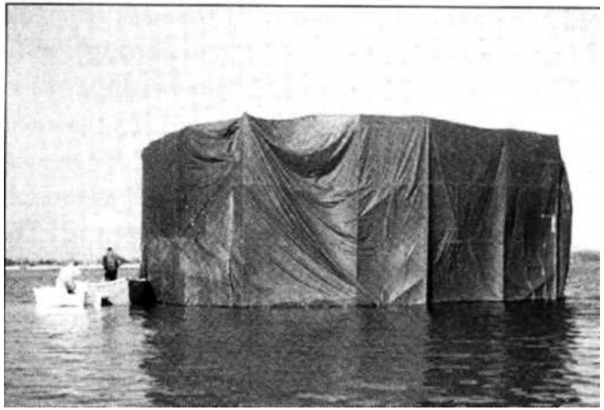

The equilibrium model of island biogeography explained variation in number of species on islands by the influences of isolation and area on rates of immigration and extinction.
The model predicted higher rates of immigration to islands nearer a source of colonists.
The model predicted high rates of extinction on small islands.
Immigration to near islands
Extinction on small islands
Immigration to far islands
Extinction on large islands
Rate of immigration or extinction
S small, far
S large, far
S small, near
S large, near
Number of species present
The model explains the low number of species on small, isolated islands.
The model also accounts for high number of species on large, near islands.

Higher species richness in larger islands compared to smaller ones (compare equilibrium number of species for Small-Near v/s Large and Small-Far v/s Large-Far)

Higher turnover rate in near islands

Experimental test of theory



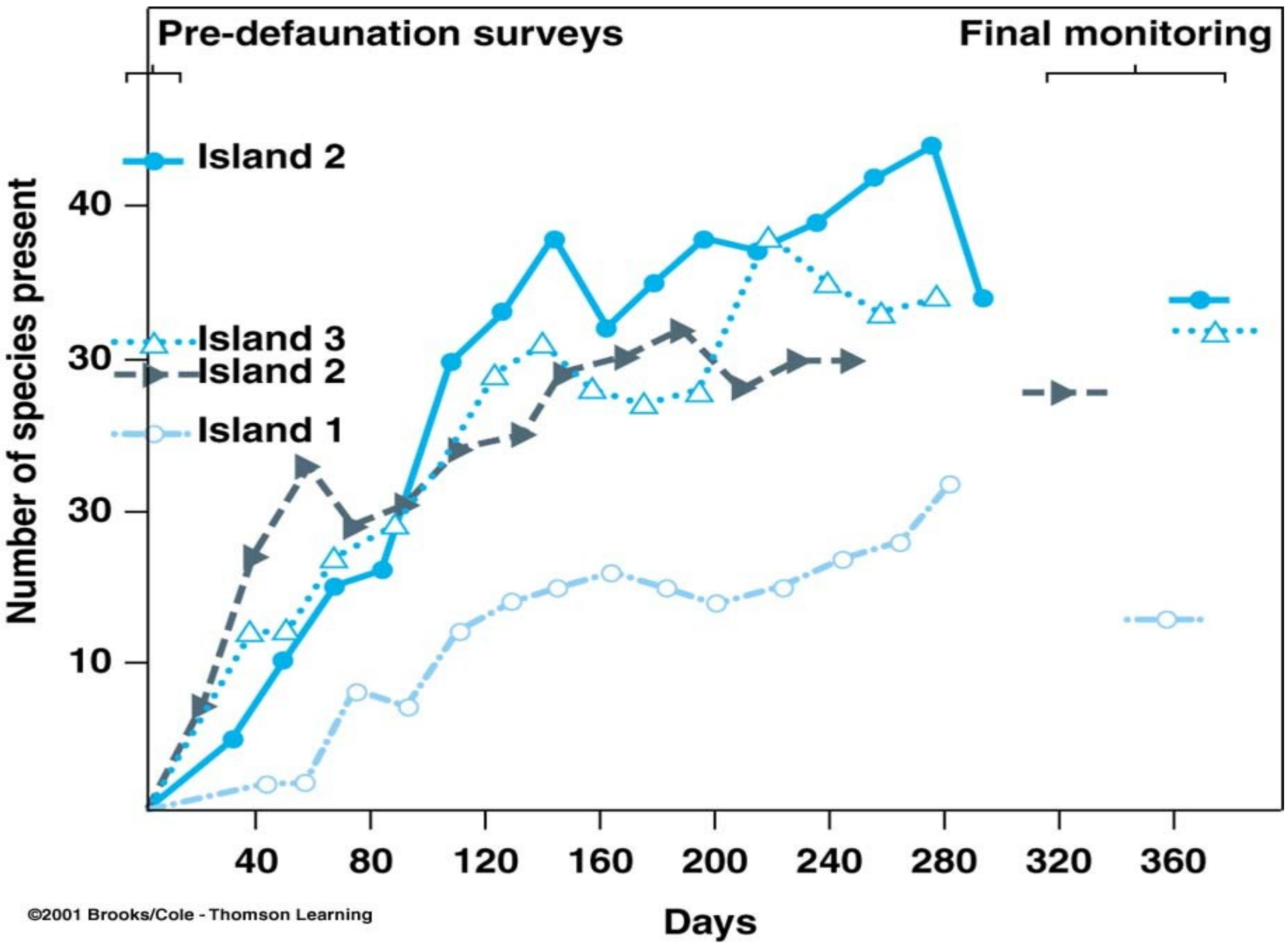


Wilson and Simberloff (1968, 1969), mangrove islets in Florida Keys

- first surveyed arthropods on a series of islands of differing sizes and distances from shore
- exterminated all arthropods on islands (methyl bromide)

Pictures taken from Stuart Allison's slides

Repeated census over 2 yrs



Species increased for a while, then reached an equilibrium state approximately equal to the original number. But the makeup of the species had changed.

Lowest rates of turnover on distant islands.

- Strongest evidence for the theory from oceanic islands
- Does not always hold true for other kinds of island like habitats such as caves, lakes, fragmented forests, etc

- Some confounding factors

  - Habitat diversity

  - Habitat age

  - Speciation and other evolutionary processes

Island biogeography theory in conservation

Historical declines in mammals in national parks in the US. Extinctions increased with smaller size

Reserve (protected area) design: SLOSS debate

- Conservation biologists have used the theory of island biogeography to try and maximize species richness (equilibrium number of species) in habitat fragments and reserves.

SLOSS =

- **S**ingle **L**arge **O**r **S**everal **S**mall [Reserves]

Content modified from slides by Catherine Toft

SLOSS: Pros and Cons

Large reserve

- More total species?
- Area sensitive species
  - Species that have huge home ranges and/or low population densities
- Species that depend on habitat diversity & edges?
- “All your eggs in one basket”….?
  - Epidemics?
  - Negative interspecific interactions?

Small reserves

- More total species in several small?
- Edge effects?
- Small home range sizes
- Eggs in several baskets?
  - Refuge from competition, predation, disease?

Content modified from slides by Catherine Toft

- Nothing in biology makes sense except in the light of evolution

  - Theodosius Dobzhansky

- Nothing in evolution makes sense except in the light of phylogeny

  - Society of Systematic Biologists