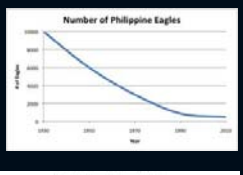
Threats to Biodiversity

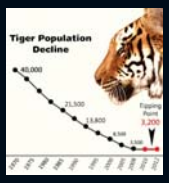
Learning Objectives

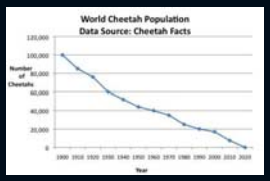
- outline the main threats to biodiversity and which groups of organisms are most susceptible to these threats
- explain the drivers of habitat loss and the typical sequence of land use that accompanies it
- describe physical and biological edge effects that accompany deforestation
- explain the various ways that habitat fragmentation affects biodiversity
- predict which types of species are most vulnerable to extinction
- outline why small populations are most at risk of extinction

Vulnerability:

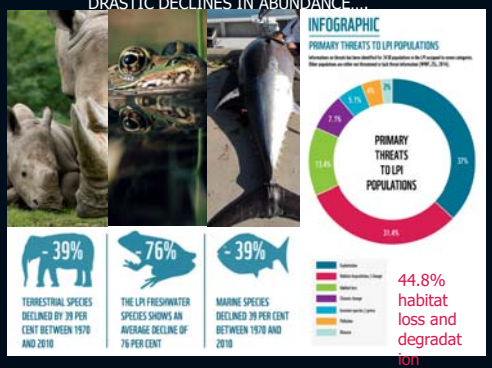
Declining Population Size







DRASTIC DECLINES IN ABUNDANCE....

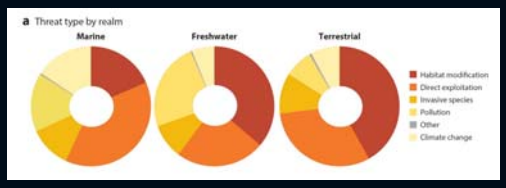


44.8% habitat loss and degradation

"The worst thing that can happen … is not energy depletion, economic collapses, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing [today] that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly that our descendants are least likely to forgive us for."

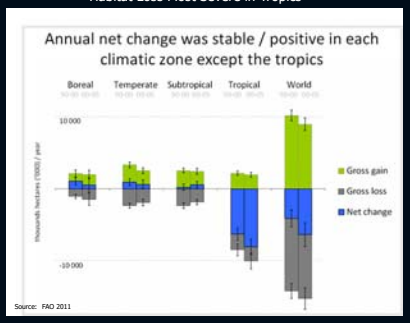
-- E.O. Wilson

Habitat Loss is #1 in terms of proportion of taxa



Source: Young et al. 2016

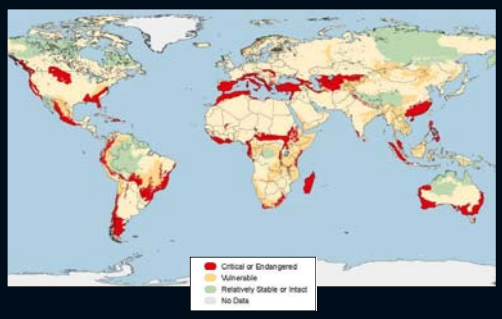
Habitat Loss Most Severe in Tropics



Source: FAO 2011

Change in Forest Cover between 1990 and 2005

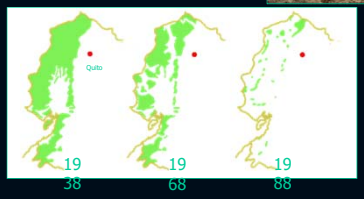
Status of Terrestrial Ecoregions

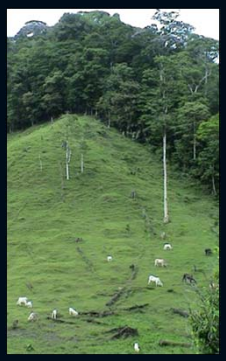


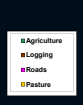
Habitat Loss & Fragmentation

DEFORESTATION

- devours ~1.5 million km²/yr
- twice the size of Texas
- breaks habitat into smaller **fragments**
- follows construction of roads



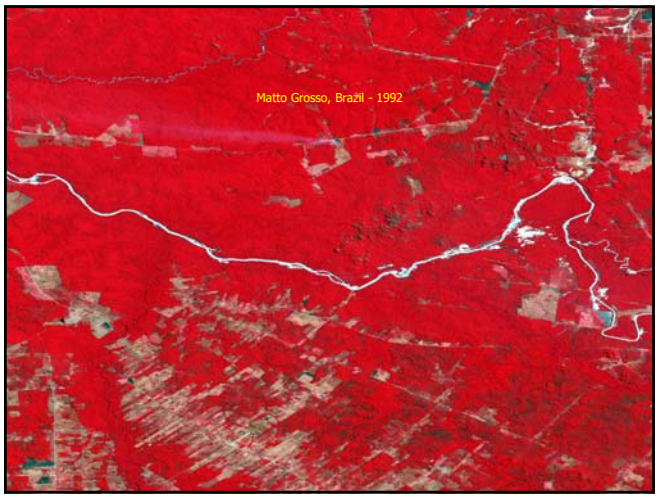


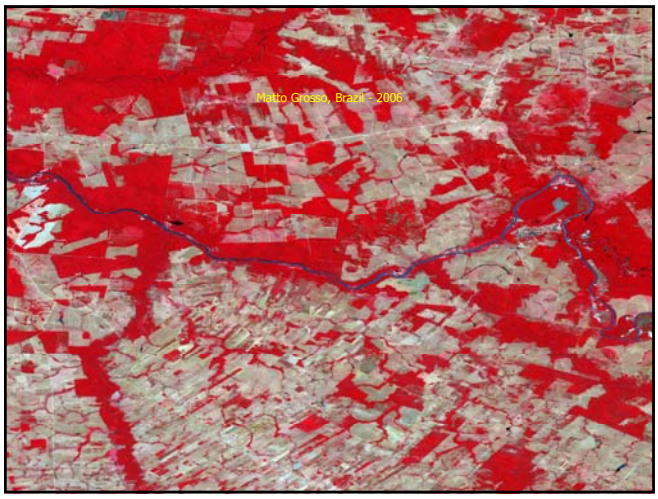


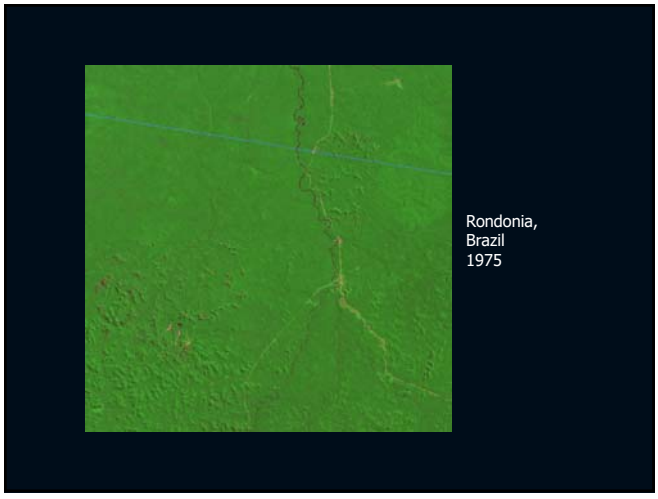
Initial Use

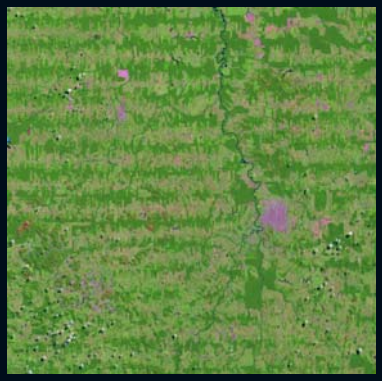
Ultimate Use

Sequence is predictable after roads come in


Matto Grosso, Brazil - 1992


Matto Grosso, Brazil - 2006

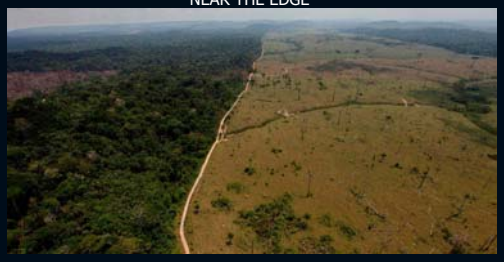

Rondonia,
Brazil
1975



Rondonia,
Brazil
2012

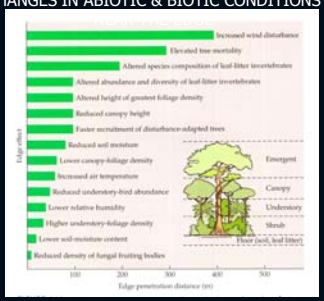
EDGE EFFECTS

CHANGES IN ABIOTIC & BIOTIC CONDITIONS
NEAR THE EDGE



EDGE EFFECTS

CHANGES IN ABIOTIC & BIOTIC CONDITIONS

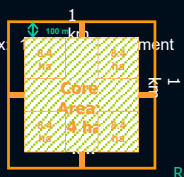


FRAGMENTATION & EDGE EFFECTS

Fragment Area ≠ Habitat Area

Edge effects reduce "core" habitat

Smaller fragments have higher edge:area ratio



Ex 1 ha fragment

edge penetration distance = 100 m

- core area is only 64 ha!

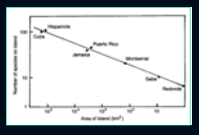
2 roads put in (20 m wide)

- much more edge
- total core area is now 33.6 ha!

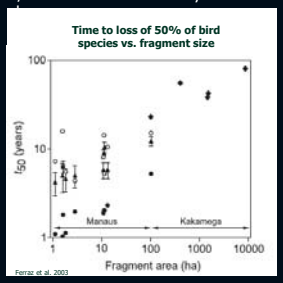
Recall: 1 ha = 100 m x 100 m

FRAGMENT SIZE

As size decreases, abundance and diversity



Recall Island Biogeography

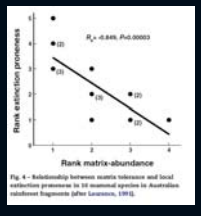


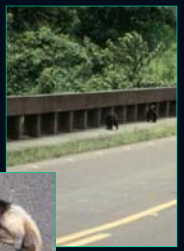
FRAGMENT ISOLATION

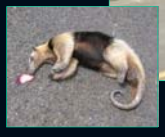
Distance from other forest

Risk of crossing

Matrix permeability

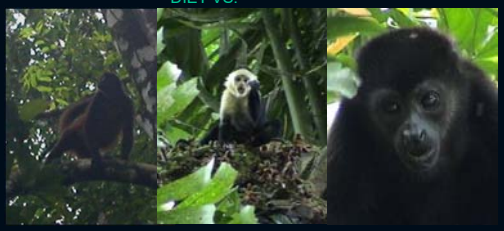






Winners & Losers

DIET VS.



Spider Monkey
Howler Monkey
frugivore
folivore

Capuchin Monkey

omnivore

Winners & Losers

DIET VS.
FRAGMENT SIZE

LOSER: Large Predators

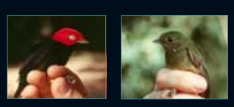
Winners & Losers

Loss of interactions: Reproductive failure & "the living dead"

Loss of pollinator

Loss of

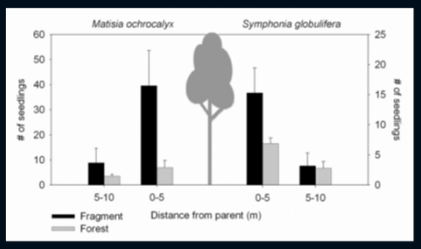
Recruitment failure



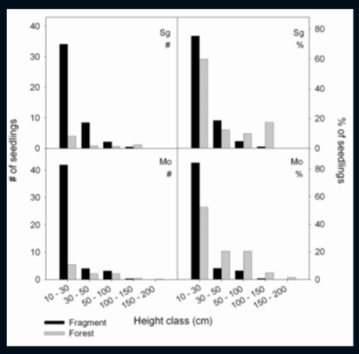
Allee Effects
(Primack pp 163-164)

Complex Interactions:

Case Study: Seed Dispersal and Survival in Costa Rican Forest Fragments



Reduced dispersal distances
From: Woodward 2005



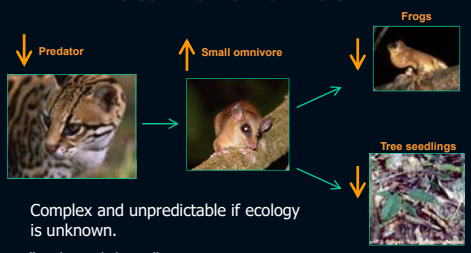
Reduced seedling survival

(lower recruitment)

Winners & Losers

Complex Interactions:

CASCADING TROPHIC EFFECTS



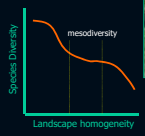
Complex and unpredictable if ecology is unknown.

"Biological decay"

Read Terborgh 2001

VALUE OF SMALL FRAGMENTS

- may be the only forest left
- maintain common species
- retain some “meso-diversity”
- “stepping-stones”
- day-time refuges for nocturnal species
- protection of waterways
- habitat for pollinators
- source of natural resources
- recreation and education



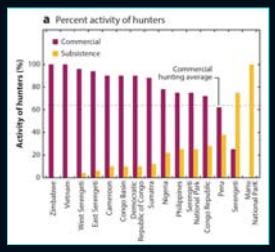
Mitigating Habitat Loss & Fragmentation

- maintain landscape heterogeneity
- maintain habitat connectivity
  - riparian corridors
  - living fences
  - private lands conservation
- protect large (source) populations

Overexploitation

Large mammals, marine fish, tropical trees, & temperate conifers

- Historical: 200 million animals killed in U.S. alone.
- Commercial harvest greatly outweighs subsistence



Overexploitation

Killing wild animals for food

The Bushmeat Crisis

- Brazil: 23.5 million animals/yr consumed
- Central Africa: 1.1 million metric tons/yr consumed

Overexploitation

Overexploitation

Greatest Threat to Wildlife in West and Central Africa

- Originally: Need for protein, subsistence
- Demand incr. 2-4% per year (esp. in cities!)
- Now: Commercial exploitation – role of logging,

sold in

Bushmeat and zoonotic illness (e.g. Ebola)

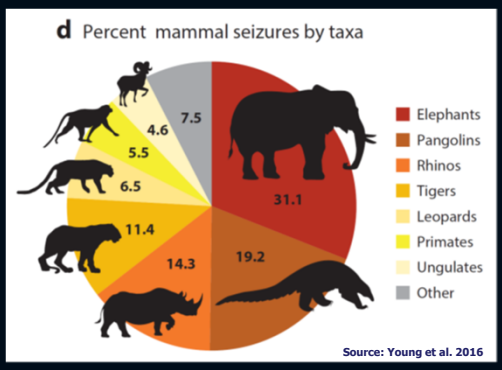
Poaching

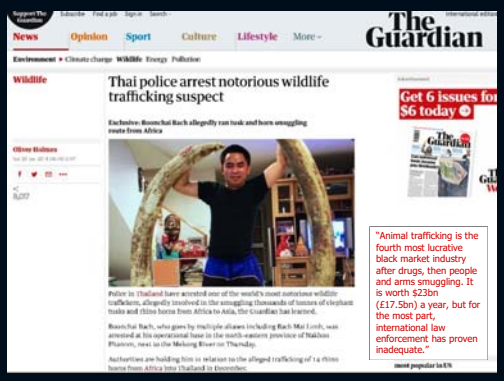
7 of the 350 remaining mountain gorillas in Virunga park killed in 2 months in 2009

Traffickers in Peru earn $1,700 for every illegal mahogany tree sold on the black market

2500 elephants poached in 2011 for their ivory

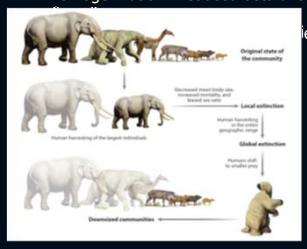
7,700%
Rhino poaching in South Africa increased from 13 to 1,004 between 2007 and 2013.





Ecological Consequences of Overexploitation

1. Reduced body size: cascading effects (e.g. large-seeded plants)
2. Homogenization: reduced beta and gamma
   ies, herbivores
4. altered nutrient cycles
5. removal of adaptive genes



Think about evolutionary consequences!

Read Young et al. 2016

Overexploitation

Solutions
- Enforcement
- Education
- Affordable protein substitutes
- Economic alternatives (wildlife worth more alive

Rising murder toll of park rangers calls for tougher laws

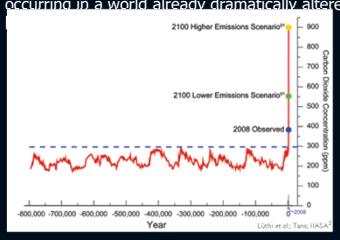
29 July 2014 | News story

With poachers responsible for more than half of ranger deaths over the past two years, IUCN, the International Union for Conservation of Nature, and the International Ranger Federation (IRF) call for a toughened stance against wildlife crime globally, marking World Ranger Day celebrated across the globe on 31 July.

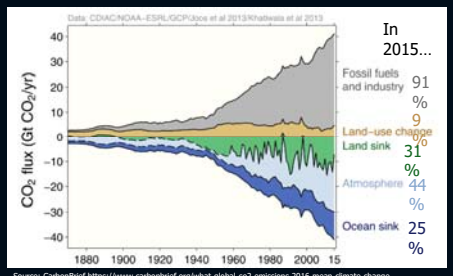
Fifty-six rangers have lost their lives in the line of duty in the last 12 months, 29 of whom have been killed by poachers, according to the latest information released today by the International Ranger Federation, which has been monitoring ranger deaths since 2000. Last year's death toll has reached 102, with poachers and militia responsible for 69 of those deaths.

Climate Change

Is contemporary climate change different?
- much more rapid (100's vs. 100,000's of years)
- occurring in a world already dramatically altered by



CO_2 Emissions – Sources & Sinks



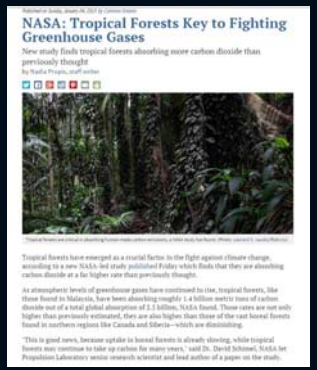
In 2015…

- Fossil fuels and industry: 91 %
- Land–use change: 9 %
- Land sink: 31 %
- Atmosphere: 44 %
- Ocean sink: 25 %

Source: CarbonBrief https://www.carbonbrief.org/what-global-co2-emissions-2016-mean-climate-change

FORESTS & CLIMATE

- Forests as a ***carbon stock***
- Forests as a net carbon *sink* vs. *source*
  - Balance between photosynthesis and respiration
  - Decomposition and burning = rapid release of CO_2
- Photosynthetic sequestration of CO_2 can help offset climate change.



NASA: Tropical Forests Key to Fighting Greenhouse Gases

New study finds tropical forests absorbing more carbon dioxide than previously thought

Tropical forests have emerged as a crucial factor in the fight against climate change, according to a new NASA-led study published Friday which finds that they are absorbing carbon dioxide at a far higher rate than previously thought.

As atmospheric levels of greenhouse gases have continued to rise, tropical forests, like those found in Malaysia, have been absorbing roughly 1.4 billion metric tons of carbon dioxide out of a total global absorption of 2.1 billion, NASA found. Those rates are not only higher than previously estimated, they are also higher than those of the vast boreal forests found in northern regions like Canada and Siberia—which are diminishing.

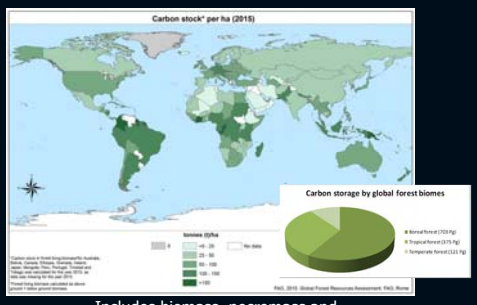
"This is good news, because uptake in boreal forests is already slowing, while tropical forests may continue to take up carbon for many years," said Dr. David Schimel, NASA Jet Propulsion Laboratory senior research scientist and lead author of a paper on the study.

Forests as CO_2 Sinks

CO_2 "fertilization effect"?

When are forests
- Carbon sinks?
- Carbon sources?
- Carbon neutral?

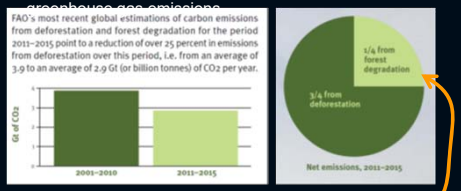
Forest Carbon Stocks



Includes biomass, necromass and soil

Emissions from Deforestation and Forest Degradation

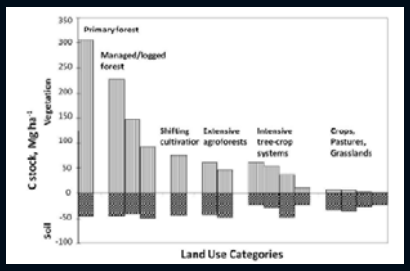
Deforestation + degradation emit ~10% of greenhouse gas emissions



Source: FAO 2015

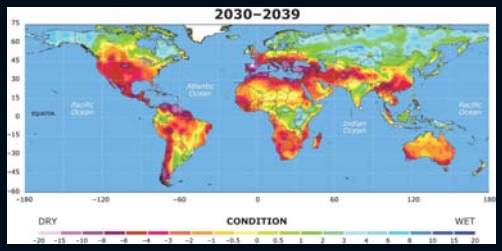
Forests as CO_2 Sources

Carbon and Land Use Change

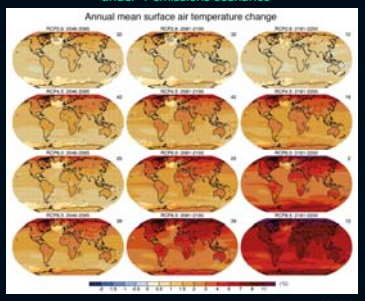


Carbon stocks of different land use systems

Predicted Effects on Moisture

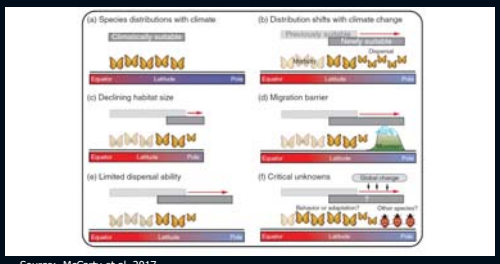


Predicted Temperature Change
under 4 emissions scenarios



Source: IPCC 2013

Biological Impacts of Climate Change



Source: McCarty et al. 2017

Biological Impacts of Climate Change

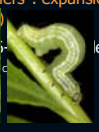
Phenological Changes

- 254 spp. of European trees, ave. 2.5 days earlier onset of spring events/decade (Menzel et al. 2007)

Range Shifts

- "losers": expansion < loss (= decrease range)
- "winners": expansion > loss (= increase

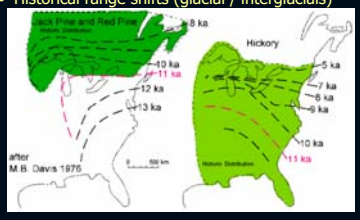
Glo


Climate Change Impacts

What does history tell us?

- Historical range shifts (glacial / interglacials)



- rainforest tree diversity increased during historical

Glacial retreat

Tropical studies are few:
Cold-ward shifts in >50% of tropical plant species studied (Feeley et al. 2011)

Range contraction of arctic species

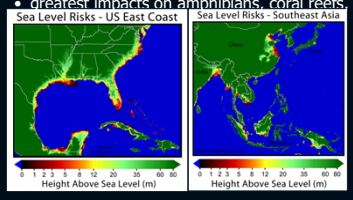
Biological Impacts of Climate Change

Altered/disrupted species interactions

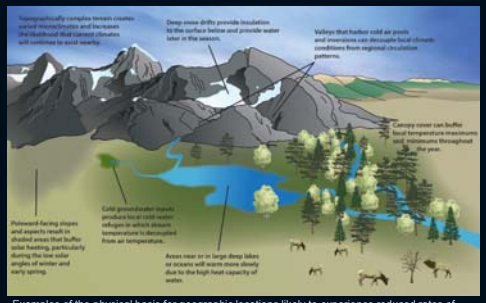
- Spruce budworm U.S.: warming favors outbreaks, range expansion, multiple breeding cycles per year

Responses complex, vary greatly

- greatest impacts on amphibians, coral reefs, coastal



Climate Change Refugia



Examples of the physical basis for geographic locations likely to experience reduced rates of climate change (Source: Morelli et al. 2016)