Past Mass Extinctions

Past Extinction/Causes
- Effects, future implications
- Major Events
- Pleistocene events

- **Ordovician-Silurian extinction**, about 439 million years ago, caused by a drop in sea levels as glaciers formed, then by rising sea levels as glaciers melted. The toll: 25 percent of marine families and 60 percent of marine genera.

- **Late Devonian extinction**, about 364 million years ago, cause unknown. It killed 22 percent of marine families and 57 percent of marine genera. Little is known about land organisms at the time.
Permian-Triassic extinction, about 251 million years ago. The Permian-Triassic catastrophe was Earth's worst mass extinction, killing 95 percent of all species, 53 percent of marine families, 84 percent of marine genera and an estimated 70 percent of land species such as plants, insects and vertebrate animals.

Past Mass Extinctions

Fig. 1. Reconstructions of the ancient seabed in southern China immediately before (a) and after (b) the Permo-Triassic mass extinction. Note the richness of reef life and the burrowing animals before the crisis, and the absence of such species after. A marine fauna of 100 or more species is reduced to four or five.

Past Mass Extinctions

CAUSES

VOLCANIC ERUPTIONS:
- Fire, smoke, debris into atmosphere
- Loss of land, lava flow
- Aerosols in air become acid rain

EXAMPLE:
End-Permian Extinctions, 250 mya
End Triassic extinction, roughly 199 million to 214 million years ago, The death toll: 22 percent of marine families, 52 percent of marine genera. Vertebrate deaths are unclear.

Cretaceous-Tertiary extinction, about 65 million years ago, The extinction killed 16 percent of marine families, 47 percent of marine genera (the classification above species) and 18 percent of land vertebrate families, including the dinosaurs.

Past Mass Extinctions
CAUSES
ASTEROID HITS EARTH
“Impact Theory”
- Creates tsunamis, fires, launches debris
- smoke into atmosphere
- Darkness lasts for years, “impact winter”

EXAMPLE: Cretaceous-Tertiary extinction (KT Boundary), 65 mya
**Past Mass Extinctions**

**CAUSES**

**SEA LEVEL CHANGE:**
- Interior continental seas drain
- Drop in primary production, collapse in food chain
- Change in topography, terrain affects wind patterns, climate
- Seasonal climates develop, deserts emerge

**EXAMPLE:** KT Boundary

**CLIMATE CHANGE:**
- Cooling, from glaciation or darkness
- Warming, from greenhouse gases

**EXAMPLE:** Pleistocene Megafauna extinctions

**HUMANS AS HUNTERS**
- Overkill Theory for Pleistocene megafauna extinctions

**HUMANS AS FARMERS**
- Habitat destruction and fragmentation from human population
Past Mass Extinctions Effects

- **Evolutionary impacts**: debate about the role of mass extinction events in spurring new evolutionary directions and opportunities.

- **Biodiversity**: While the loss of biodiversity is catastrophic at the time of the event, it has rebounded each time, and perhaps will rebound again despite the current rate of extinctions.

Quaternary Events/Extinctions of the Past
Where have all the Megafauna gone.....?

I. The Facts: once there were megafauna….
   - now there are none
   - Extinctions occurred
   - Climate Changed
   - Humans came to North America

II. The Explanations
   - Climate- Evolution
   - Overkill (P.A. Martin)
   - Other Alternatives (a compromise?)

III. Conclusions
   - Extinctions happen everyday
   - Will we ever know..do we care ????

Megafaunal Extinction
Megafauna: > 44kg (100 lbs)
mostly large grazers, browsers and carnivores
Pleistocene: 2 MYA—43 KYA
Some examples

- **Mastodon**

- **Woolly rhinoceros** (*Coelodonta antiquitatis*)

- **Doedicurus** (*Glyptodon*)

- Beautiful armadillo (*Dasypus bellus*)
Dire wolf

Short faced bear

Smilodons
Extinctions occurred without replacement !!!!!!!!!!!!!

Explanations:

- Climate change
- Pleistocene Overkill
  Human occupation of N. America directly caused extinction of larger mammals

Climatic Change?:

- Extinctions occurred with an episode of climatic change
- Magnitude of change are correlated with the magnitude of extinctions
- Mechanisms identified that link climatic change with extinctions given with type of change, extinctions would be the expected result
Many combined reasons for extinction based on climate changes

- Increased Seasonality
- Decrease plant diversity
- Increased anti herbivory mechanisms
- Restricted resources
- Gestation/Breeding and Birth (Kiltie)

Increased Seasonality

- Axelrod (1967) argues early interglacials were more equitable than the early Holocene.
- It is this loss of equitability that caused extinction.
- Decrease plant diversity

Plaid vs. Stripes

Gunthrie argues changing seasonal regimes at the end of the Pleistocene led to an increasingly homogeneous plant community with decreased quality and quantity of plant resources available.

Plaids: monogastrics:
- mammoths, horses,
- camels

vs.

Stripes: ruminants:
- antelopes, sheep,
- bison
Anti-herbivory mechanisms
• Plants may have evolved with increase anti-herbivory mechanisms
• Restricted resources led to decreased faunal diversity, body size and led to extinction

Gestation/Breeding and Birth (Kiltie)
- Shifting birthing and breeding to accommodate drastic climatic changes isn't feasible for megafauna in short time spans.
- Having offspring during a cold season or delaying mating may comprise a population’s viability

Social Organs

Giant Irish Elk
Extinctions have occurred before

Or was it people??

- Paul Martin: 1973
  *The Discovery of America*

  *Pleistocene Overkill*
  Human occupation of N.
  America directly caused extinction of larger mammals.

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**Pleistocene Overkill**

- Gradual destruction of fauna over thousands of years
- Suddenly in as little as 100 years
Nature of human impact classified as 3 types:

BLITZKRIEG Effect
INNOVATION Effect
ATTRITION Effect:

Blitzkrieg: rapid deployment of human populations w/ big game hunting = rapid demise of big game

Advanced technology - Clovis point

Innovation: long established human populations adopt new hunting technologies and erase fauna stressed by climate.
in Conclusion.............................

- It seems to me that it is a combination of factors. Populations could have been stressed to the breaking point due to climatic changes and the consequent changes in plant life, gestation and fertility. Then humans came along and were the final straw.

- It seems implausible to rule out one over the other, when we have evidence of the two occurring simultaneously.

Historic examples

Moa – New Zealand
Elephant Bird – Madagascar
More recent extinctions

- Colonization
- Hunting
- Habitat Loss
- Invasions

Mass Extinctions—Today

- “On average, one extinction happens somewhere on earth every 20 minutes.”
  (Levin, 2002, p6)
- “Ecologists estimate that half of all living bird and mammal species will be gone within 200 or 300 years.”
  (Levin, 2002, p6)

Mass Extinctions: FUTURE IMPLICATIONS

- Do today’s extinction rates compare?
- Will human disturbance lead to ecosystem decay and mass extinction?
- Or will it lead to fragmented “islands” that lead to more speciation and evolution?