Introduction to Biology and Conservation of

Large Vertebrates

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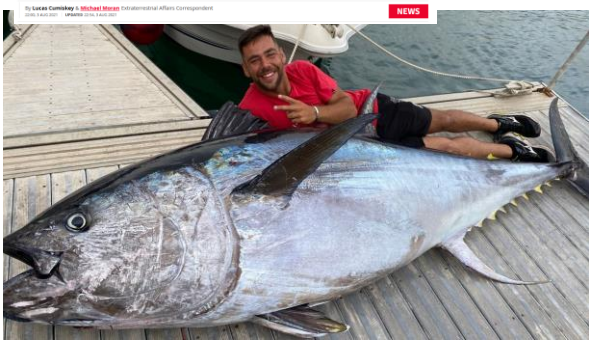
What is a Large Vertebrate?

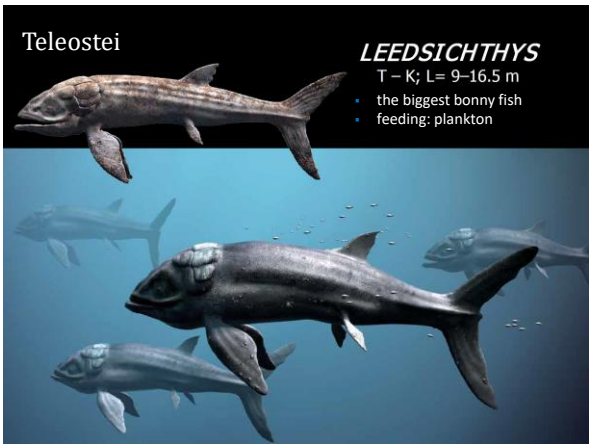
Stunned Brit lads wrestle monster 51 stone bluefin tuna from water in gigantic catch

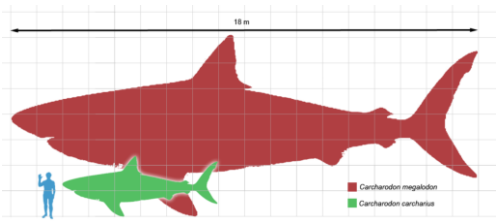
The gigantic 51-stone fish was pulled from the sea in the waters off Gibraltar by three British lads who say they couldn't even fit on their boat with the massive catch onboard

By Lucas Cumiskey & Michael Moran Extraterrestrial Affairs Correspondent

NEWS







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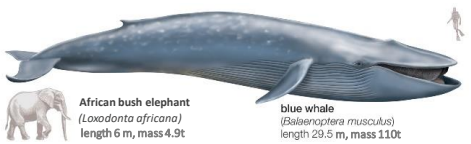
Human arrivals wiped out the Caribbean's giant ground sloths

EARTH 10 November 2017

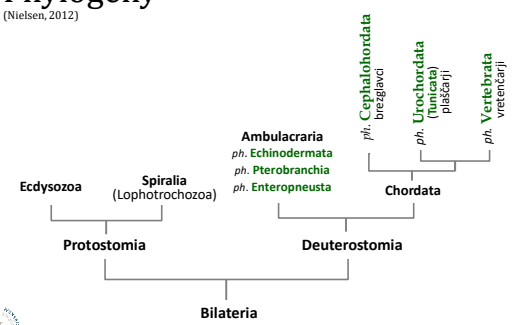
By Fred Pearce

Who killed the giant ground sloth? Or the mammoth and sabre-toothed cat, come to that. Was it humans or a natural event, like the end of the last ice age? The question is endlessly debated. But the answer, at least in the Caribbean, now seems certain: it was humans.

Large vertebrates

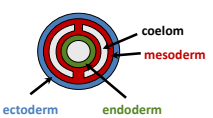


Vertebrata:
Phylogeny
(Nielsen, 2012)



Chordata
Characteristics

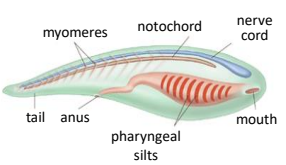
- Triploblastic
- Bilateral¸ly symmetrical (Bilateria)
- Deuterostomes (Deuterostomia)
- Body cavity: coelom („Celomata“)



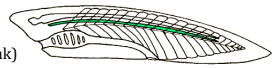
Body plan

1) Notochord
2) Tubular nerve cord
3) Pharyngeal silts
4) Endostyle
5) Postanal tail
6) Segmented muscles (myomeres)

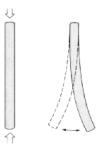
Body regions: head, body, tail

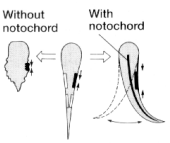


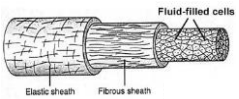
Notochord



- *Chorda dorsalis* (*si*. struna; *hr*. svitak)
- Endoskeleton, support to the body
- Mesodermal origin
- Present in Cephalochordata and Agnatha (jawless vertebrates)
- Gnathostomata: present only in embryonic stage, replaced by vertebrae

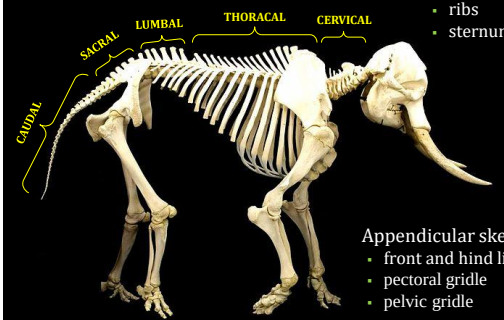




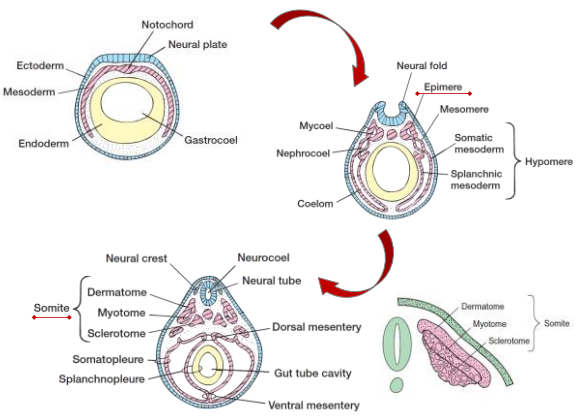


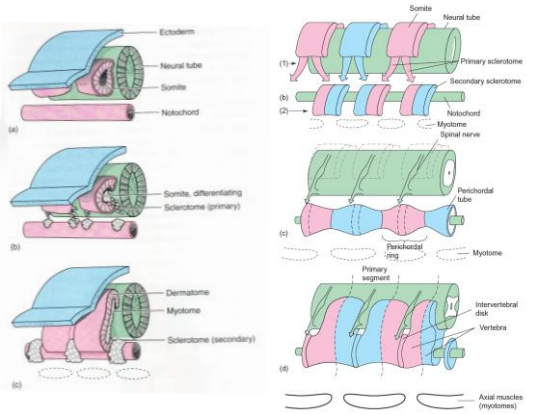
Skeleton

Axial skeleton
- skull (cranium)
- vertebrae
- ribs
- sternum



Appendicular skeleton
- front and hind limbs
- pectoral gridle
- pelvic gridle





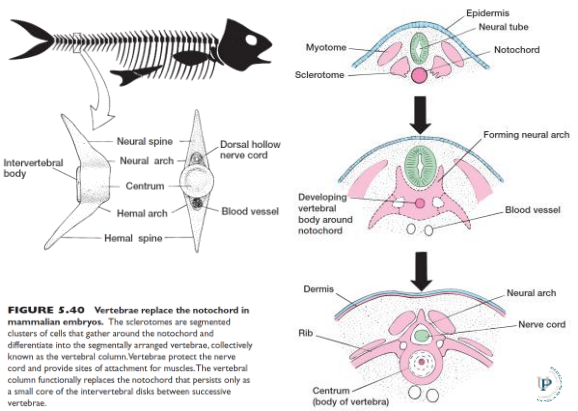
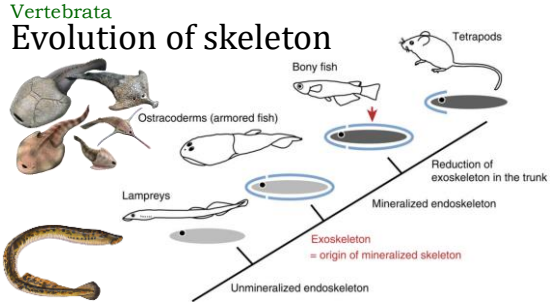


FIGURE 5.40 **Vertebrae replace the notochord in mammalian embryos.** The sclerotomes are segmented clusters of cells that gather around the notochord and differentiate into the segmentally arranged vertebrae, collectively known as the vertebral column. Vertebrae protect the nerve cord and provide sites of attachment for muscles. The vertebral column functionally replaces the notochord that persists only as a small core of the intervertebral disks between successive vertebrae.

Vertebrata

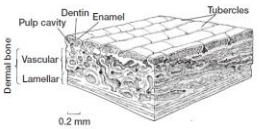
Evolution of skeleton

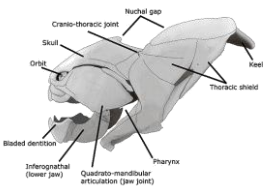


Vertebrates have two distinct sets of skeletons, exoskeleton (dermal skull roofs, teeth, scales, fin rays and so on.) and endoskeleton (neurocranium, vertebra, appendicular skeleton and so on). While the endoskeleton consists of endochondral bones that are preformed by cartilage and later replaced by mineralized bones, the major components of the exoskeleton are the dermal bones that develop in the dermis only by membranous ossification. A mineralized skeleton is thought to have emerged initially as exoskeletonal elements. Bony fish retain the exoskeleton in the form of dermal scales and fin rays. During terrestrial evolution, however, the exoskeleton has been drastically reduced or lost in the trunk region. Outer blue circles show the exoskeleton. Inner solid pale circles show the unmineralized endoskeleton. Inner solid-dark circles show the mineralized endoskeleton. The red arrow indicates the trunk exoskeleton we focused on in the present experiment.

Dermal bones

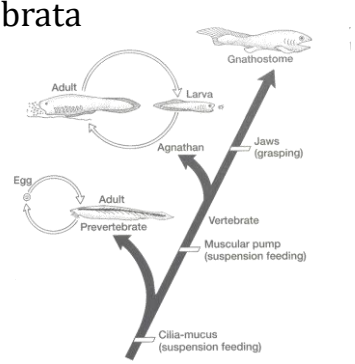
- fused dermal bones: → exoskeleton
- Ostracodermi (†), Placodermi (†)
- Reptilia: crocodiles, alligators, gavials
- Mammalia: armadillos

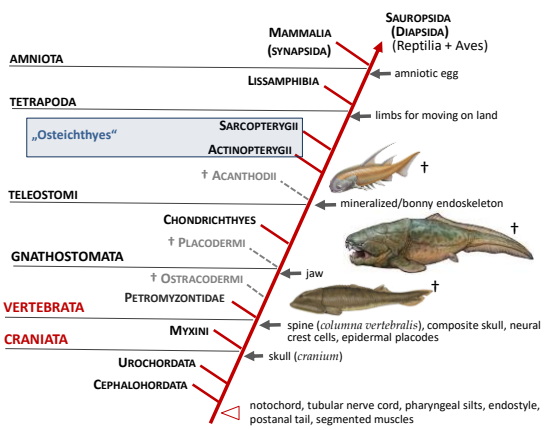


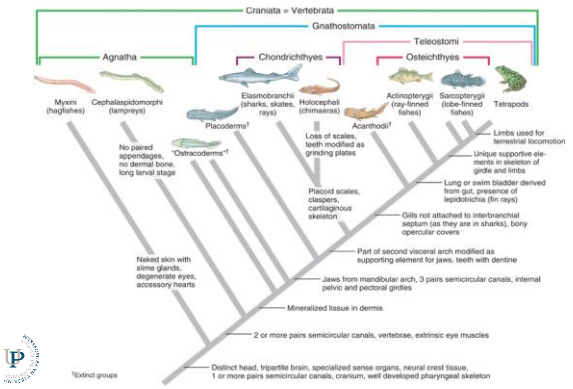


Evolution

Vertebrata

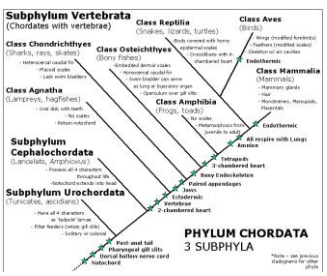






Linnean Systematics

Chordata

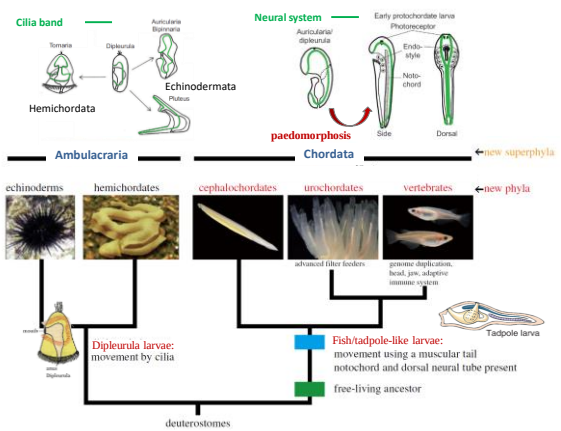


Phylum: Chordata
(Superphylum)

Subphylum: Urochordata
(Phylum) (Tunicata)
Class: Apendicularia
Class: Thaliacea
Class: Ascidiacea

Subphylum: Cephalochordata
(Phylum)
Class: Amphioxus

Subphylum: Vertebrata
(Phylum)
Class: Agnatha
Class: Chondrichthyes
Class: Osteichthyes
Class: Amphibia
Class: Reptilia
Class: Aves
Class: Mammalia



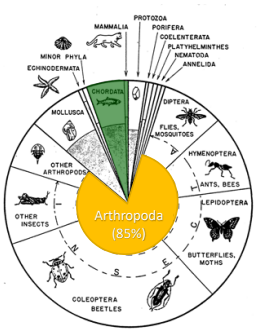
Vertebrata
Diversity

- Chordata: ≈70.800 described species

Vertebrata:

- >95% described Chordates

Vertebrata	≈68 300 species
Agnathans	≈ 110
Elasmobranches	≈ 1.050
Bonny fishes	≈ 33.200
Amphibians	≈ 6.200
Reptiles	≈ 11.340
Birds	≈ 10.000
Mammals	≈ 6.400



Chinese giant salamander *Andrias davidianus*

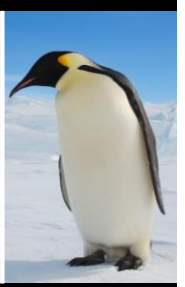
Saltwater crocodile (*Crocodylus porosus*)

Leatherback sea turtle (*Dermochelys coriacea*)

Large birds

Common ostrich
Struthio camelus

Southern cassowary
Casuarius casuarius

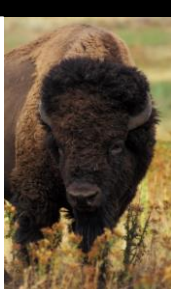


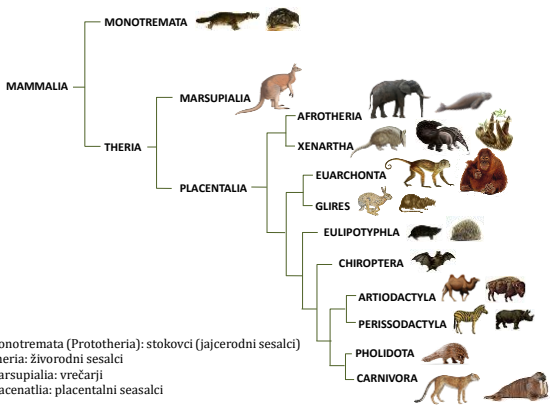
Emperor penguin
Aptenodytes forsteri

Biggest birds: Top 15

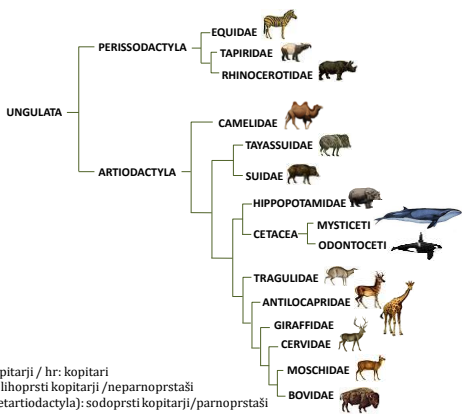
Rank	Common name	Latin name	Average mass (kg)	Average total length (cm)	Flight
1	Common ostrich	*Struthio camelus*	104	210	No
2	Somali ostrich	*Struthio molybdophanes*	90	200	No
3	Southern cassowary	*Casuarius casuarius*	45	155	No
4	Northern cassowary	*Casuarius unappendiculatus*	44	149	No
5	Emu	*Dromaius novaehollandiae*	33	153	No
6	Emperor penguin	*Aptenodytes forsteri*	31.5	114	No
7	Greater rhea	*Rhea Americana*	23	134	No
8	Wild turkey	*Meleagris gallopavo*	13.5	124.9	Yes
9	Dwarf cassowary	*Casuarius bennetti*	19.7	105	No
10	Lesser rhea	*Rhea pennata*	19.6	96	No
11	Mute swan	*Cygnus olor*	11.9	130	Yes
12	Great bustard	*Otis tarda*	10.6	115	Yes
13	King penguin	*Aptenodytes patagonicus*	13.6	92	No
14	Kori bustard	*Ardeotis kori*	11.4	150	Yes
15	Wandering albatross	*Diomedea exulans*	11.9	135	Yes

Large mammals





Monotremata (Prototheria): stokovci (jajcerodni sesalci)
Theria: živorodni sesalci
Marsupialia: vrečarji
Placenatlia: placentalni seasalci



Ungulata: si: kopitarji / hr: kopitari
Perissodactyla: lihoprsti kopitarji /neparnoprstaši
Artiodactyla (Cetartiodactyla): sodoprsti kopitarji/parnoprstaši

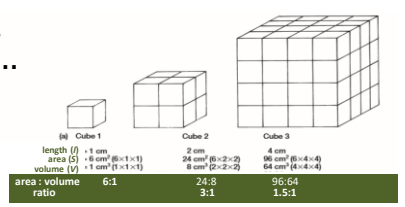
Large Vertebrates

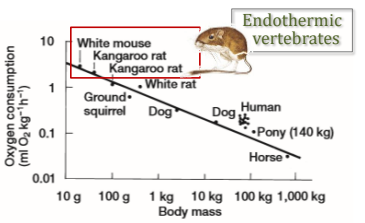
Going big…

Benefits

- outgrowing predators (increased survival)
- higher energetic efficiency

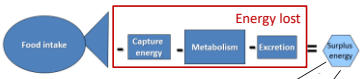
Down sides of being big?





Large Vertebrates

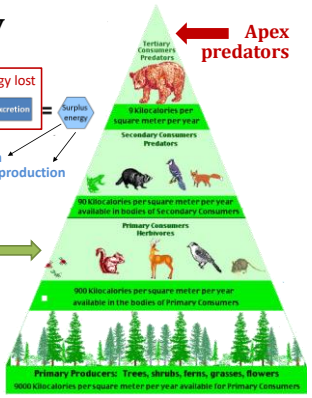
Trophic ecology



Goal: maximize intake for amount of energy consumed.

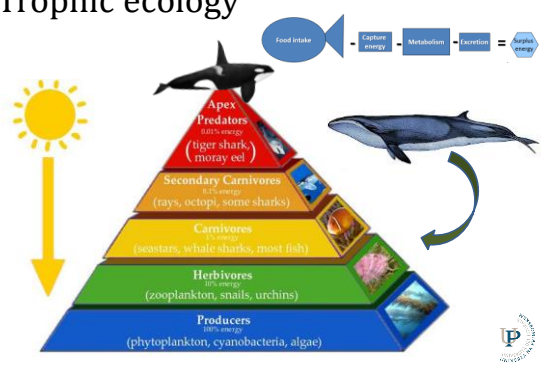
Grazers

- *eating big* (big prey): at top trophic level
- *eating a lot*: (constant) grazing



Large Vertebrates

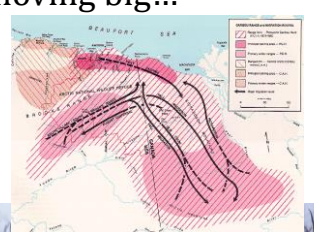
Trophic ecology



Growing big - moving big…

Terrestrial migrations

- Caribou, N America: 4,800 km/yr
- record for terrestrial migration



…moving big…

Terrestrial migrations
- 1.3 million wildebeest
  - plus antelopes and zebras
- ≈3.000 km each year as they follow the rains around the Serengeti

biology letters
Marine biology
Biol. Lett. (2007) 3, 302–305
doi:10.1098/rsbl.2007.0067
Published online 3 April 2007

Southern Hemisphere humpback whales wintering off Central America: insights from water temperature into the longest mammalian migration

Kristin Rasmussen[1,2,*], Daniel M. Palacios[3,4], John Calambokidis[5], Marco T. Saborío[1], Luciano Dalla Rosa[6,7], Eduardo R. Secchi[7], Gretchen H. Steiger[3], Judith M. Allen[3] and Gregory S. Stone[3]

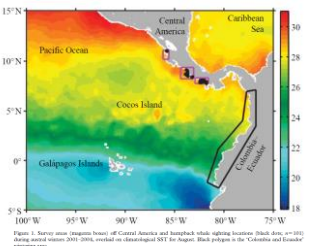


Figure 1. Survey areas (magenta boxes) off Central America and humpback whale sighting locations (black dots; $n=101$) during austral winters 2001–2004, overlaid on climatological SST for August. Black polygon is the 'Colombia and Ecuador' wintering area.

Marine migrations

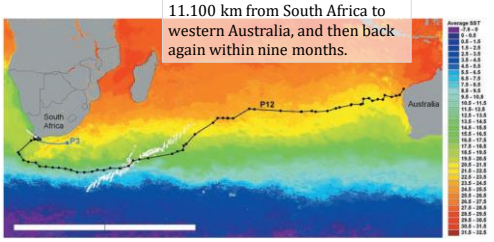
Humpback whales:
- 8.300 km btw. feeding areas off Antartica and wintering areas off Pacific Central America

7 OCTOBER 2005 VOL 310 SCIENCE www.sciencemag.org

Transoceanic Migration, Spatial Dynamics, and Population Linkages of White Sharks

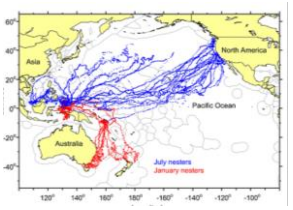
Ramón Bonfil,[1]* Michael Meÿer,[2] Michael C. Scholl,[3] Ryan Johnson,[4] Shannon O'Brien,[1] Herman Oosthuizen,[2] Stephan Swanson,[2] Deon Kotze,[2] Michael Paterson[2]†

11.100 km from South Africa to western Australia, and then back again within nine months.



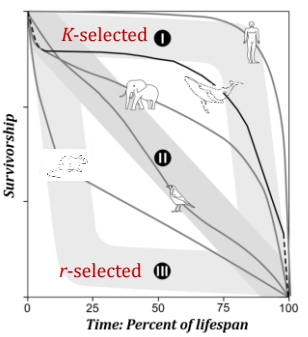
Leatherback turtle

- 20.500 km from Indonesian breeding ground to feeding grounds off the Pacific coast



...long time to grow big...

- Larger animals tend to have longer lifespans
- Requires high survival of large-size individuals
  - large juveniles/subadults, adults



Oldest known age: 83 yrs.
Average lifespan: 35 yrs.

Greater flamingo
Phoenicopterus roseus

Oldest known age: 150 yrs.
Average lifespan: 100 yrs.

Atlantic sturgeon
Acipenser oxyrinchus

Oldest known age: 255 yrs.
Average lifespan: 150 yrs.

Galapagos tortoise
Geochelone elephantopus


Lifespan: > 60-65 years
Laysan albatross
Phoebastria immutabilis


Bowhead whale (Greenland right whale)
Balaena mysticetus
Lifespan: > 100 years
In 2007, a bowhead whale was killed in Alaska by local whalers. They found the tip of a harpoon embedded in it's blubber that dated back to the 1880s- a whale had survived over 130 years with a victorian-era harpoon in it's neck.


Science
LONG
IN THE TOOTH
Lifespan: ≈400 years
Somatic growth rate: 1 cm/yr
Age-at-maturity: ≈150 yrs
Greenland shark
Somniosus microcephalus

Large Vertebrates

Life history traits

Large body size:

- Long life span
- High survival of large-size individuals
  - large juveniles/subadults, adults
- Low reproduction
- High energy demands
  - Grazers
  - Top predators
- Large home-ranges
  - migrations…

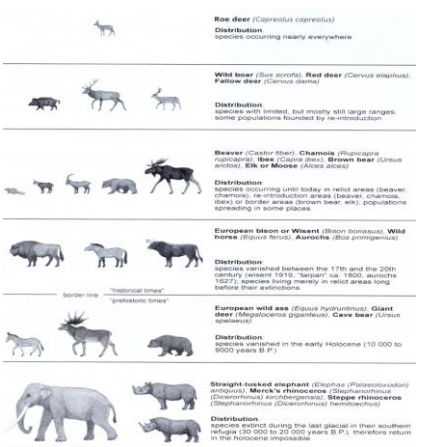
K-selected life history

DIRECT USE

Highly sensitive to anthropogenic perturbations

HABITAT DESTUCTION AND DEGRADATION

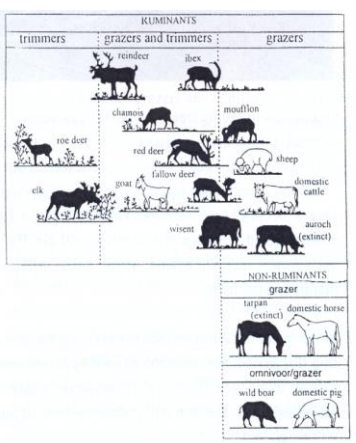
Changes in species composition of large herbivores in Europe

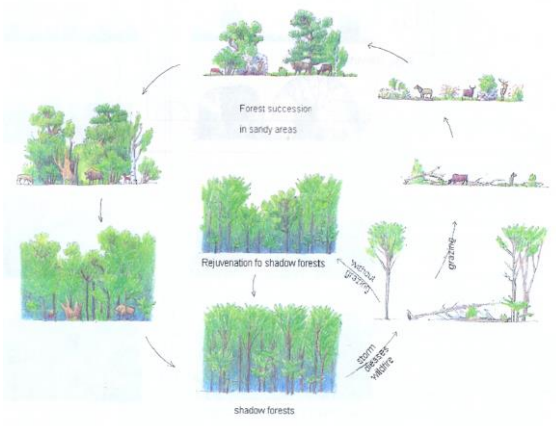


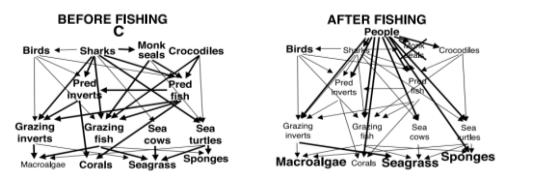
Large herbivores of Europe

Foraging types (grazers, trimmers)

- wild species
- domesticated species







Readings

Kardong 2012:

- *Chapter 2*: Origin of chordates
  - Chordate characteristics
  - Chordate origins and phylogeny
- *Chapter 3*: The vertebrate story