The ecological role of large carnivores, a review

Andrés Ordiz, PhD

Department of Ecology &
Natural Resource Management
Norwegian University of Life Sciences
(Scandinavian Brown Bear Research Project)

Ecosystems: species + interactions + environment

Ecology: discipline that studies species, environment, and interactions. *Biology of the ecosystems*

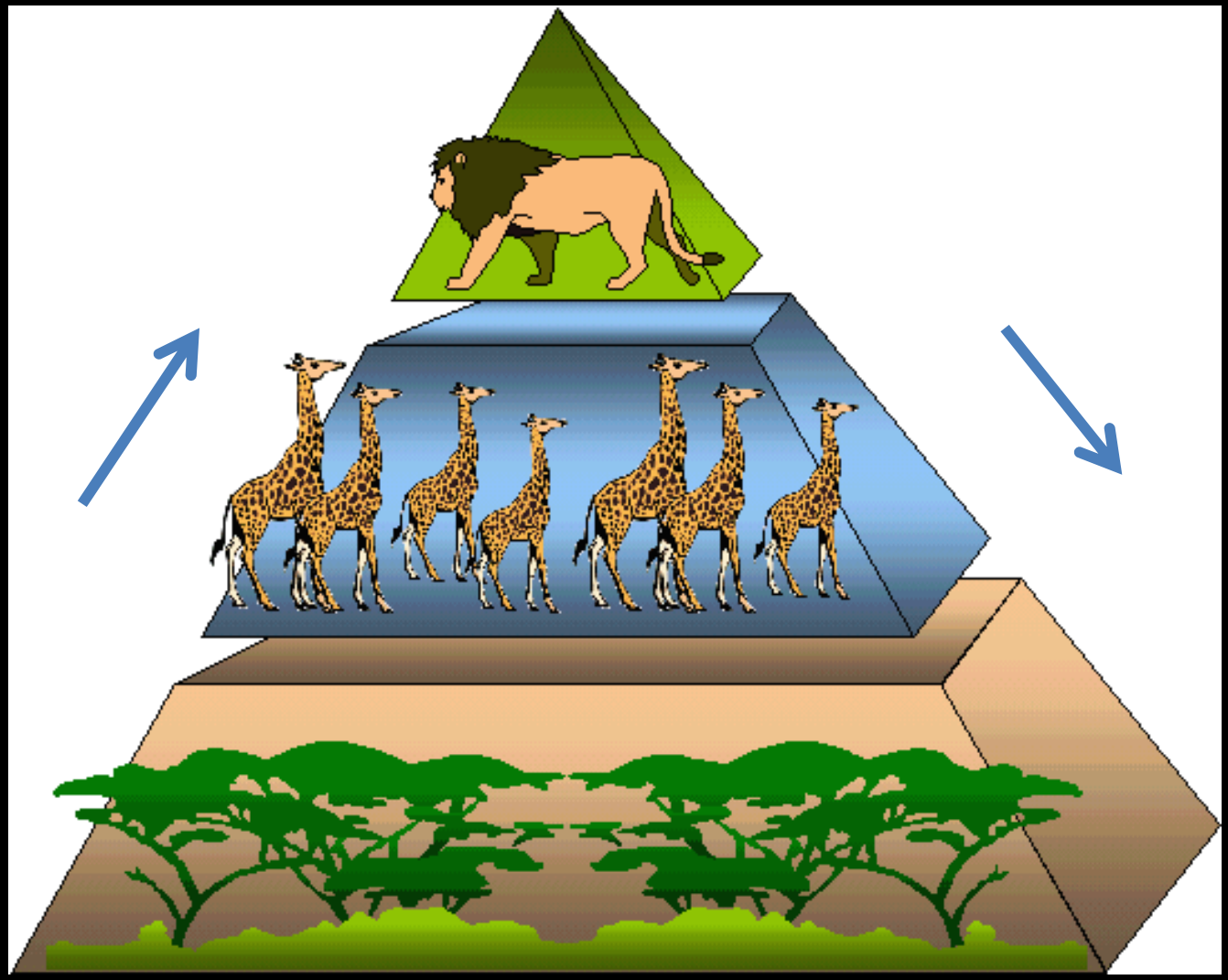
Biodiversity: from the mere number of species to the interactions among them and their functional role

Ecosystems: species + **interactions** + environment

Ecology: discipline that studies species, environment, and **interactions.** *Biology of the ecosystems*

Biodiversity: from the mere number of species to the **interactions** among them and their functional role

Long-term debate on the processes governing ecosystems:
Bottom-up, top-down, combinations



Hairston et al. (1960) Green World hypothesis

Predators maintain global plant biomass by limiting herbivore densities

Effect of predators regulating ungulates (e.g. Elton 1927);
Ungulate eruption following the loss of predators (Leopold et al. 1947)

- “Bottom-up”: productivity determines vertebrate population growth
  (e.g. Sinclair and Krebs 2002)

- Importance of all interactions to understand, manage and conserve wildlife populations

- Top-down + bottom-up

  (e.g. Elmhagen et al. 2010)

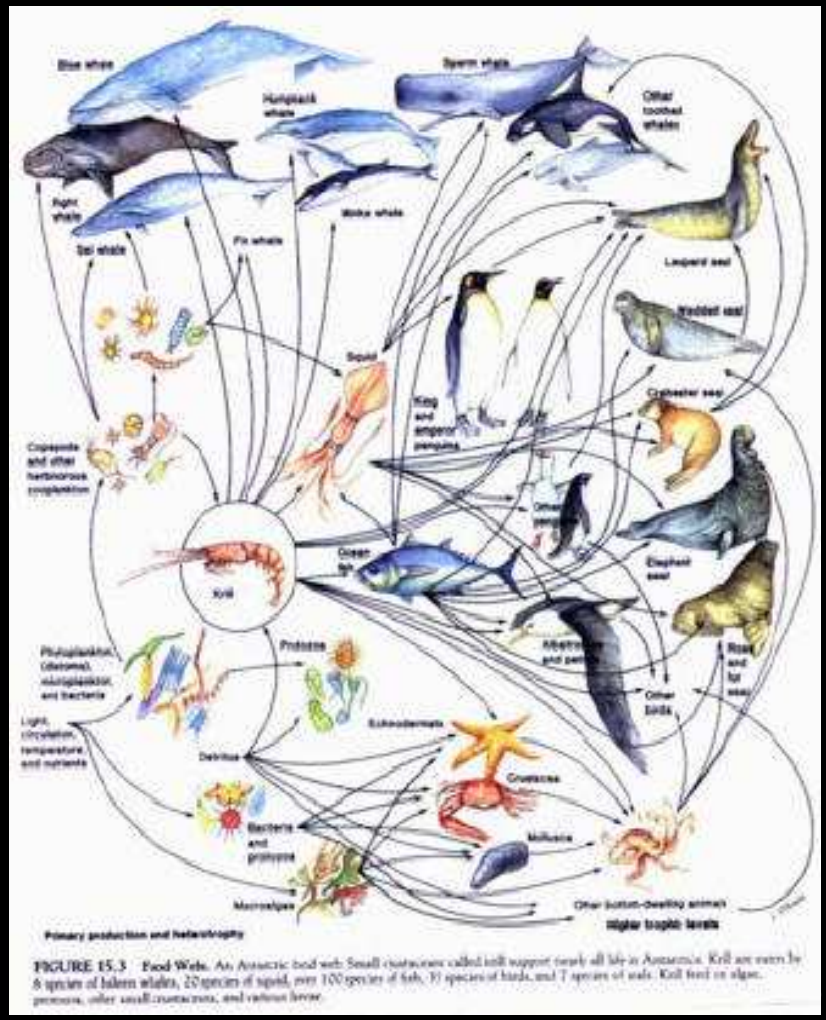


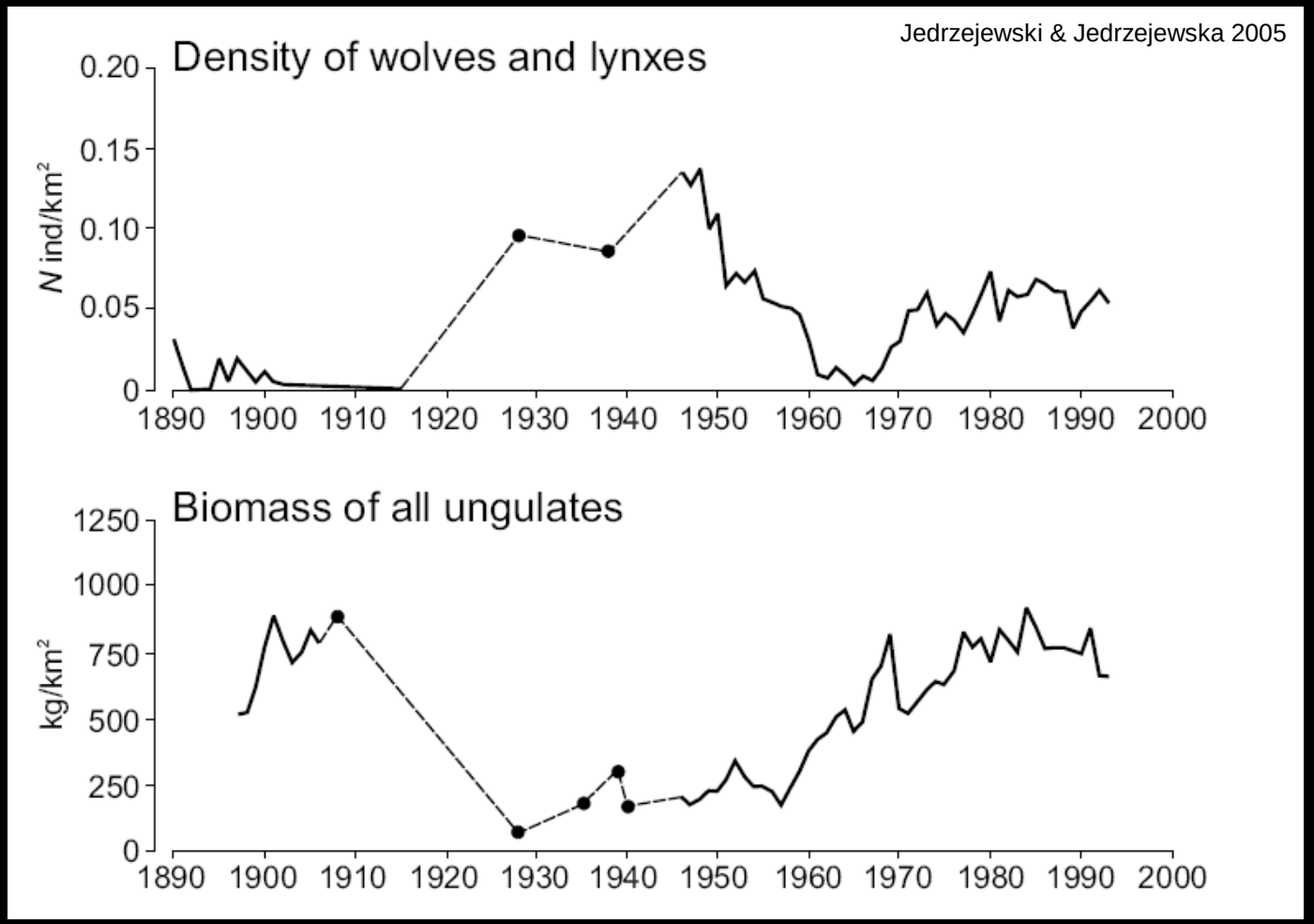
FIGURE 15.3 Food Webs. An Antarctic food web. Small crustaceans called krill support nearly all life in Antarctica. Krill are eaten by 6 species of baleen whales, 20 species of squid, over 100 species of fish, 31 species of birds, and 7 species of seals. Krill feed on algae, protozoa, other small crustaceans, and various larvae.

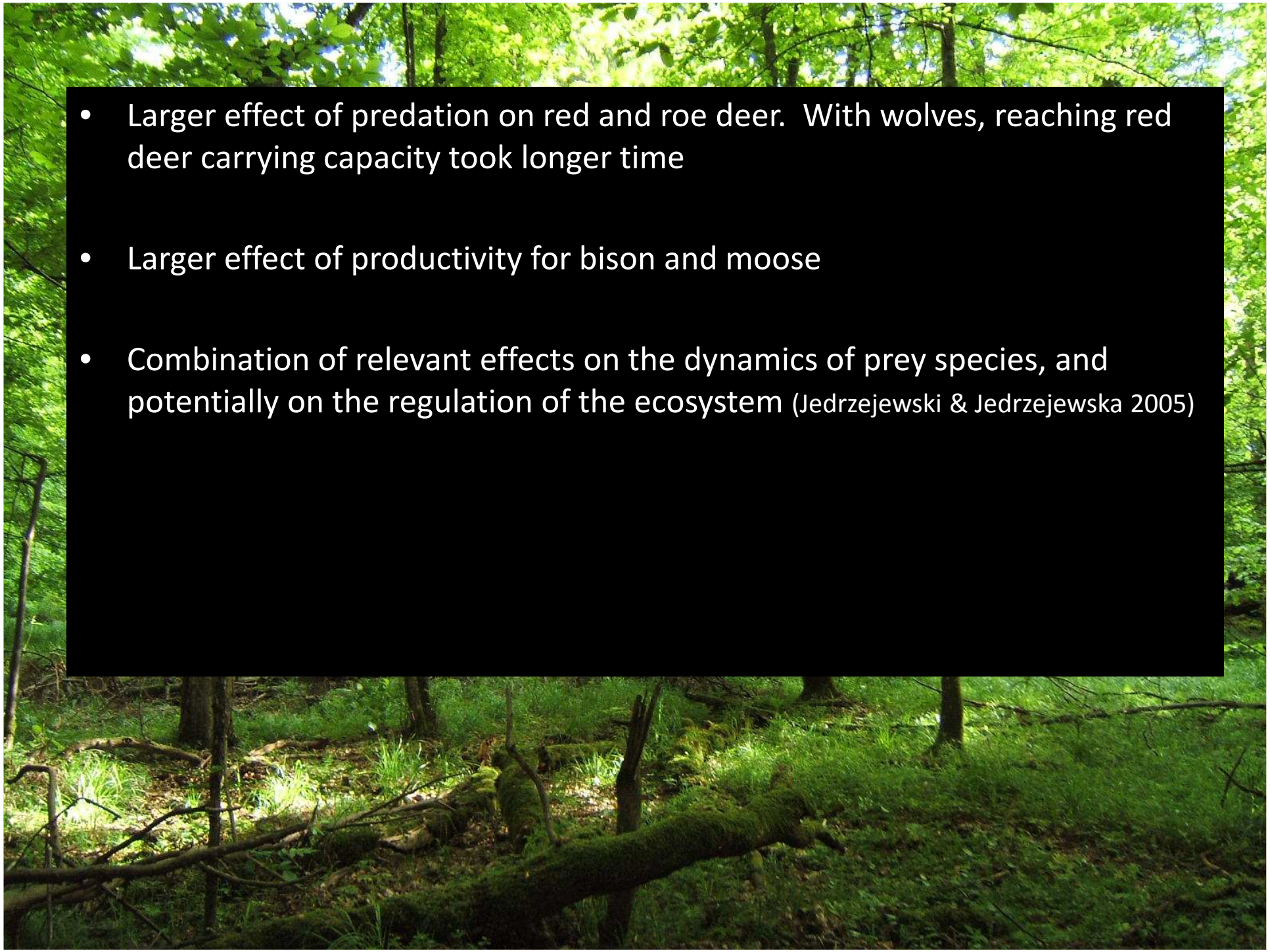
Prevalence of top-down regulation in boreal ecosystems:
productivity not controlled by hervibory (Krebs et al 2003)

Far south (Serengeti): predation and limited resources regulate ungulate populations (Sinclair et al. 2003)


Bialowieza (Poland)

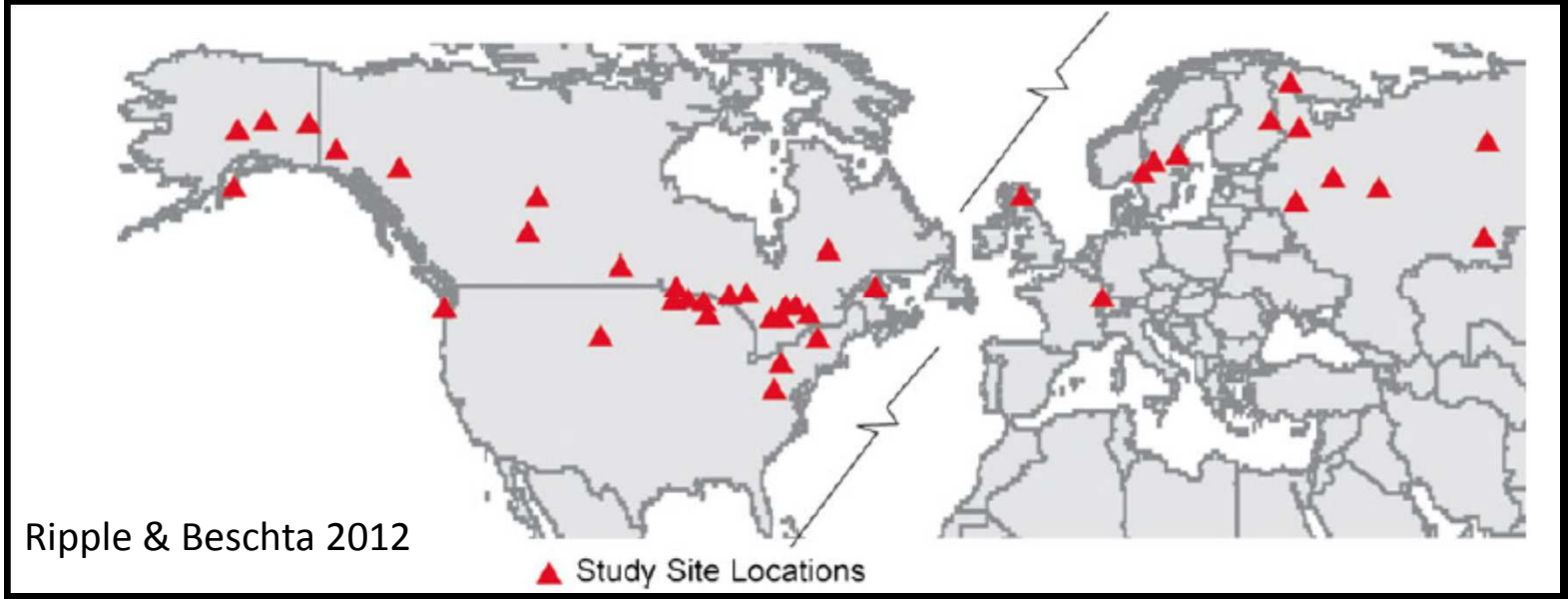
- 100 years of dynamics of predators (wolf, lynx) and prey (bison, moose, red deer, roe deer).



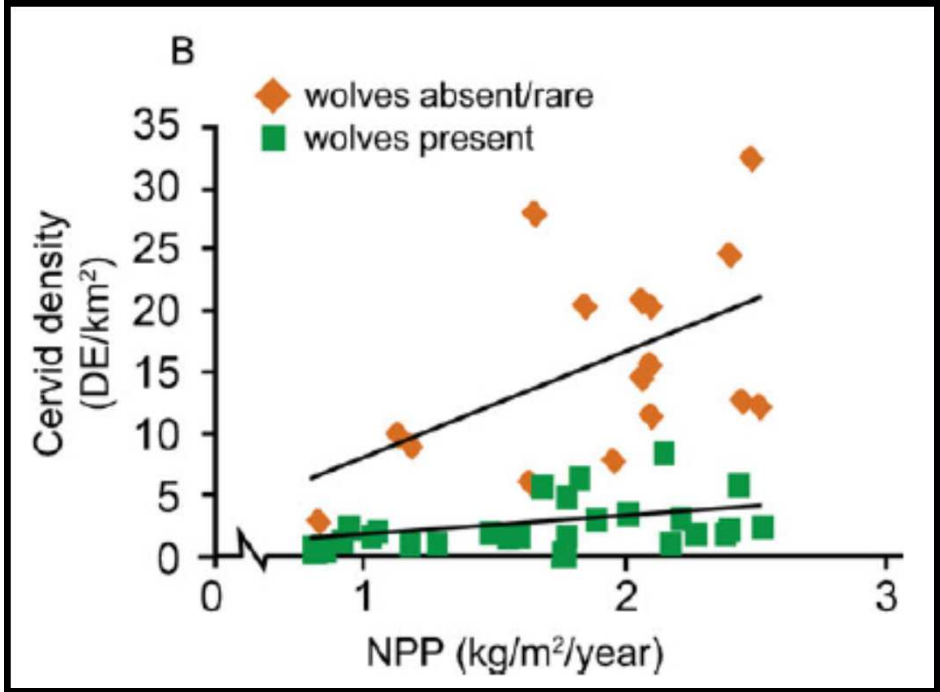


- Larger effect of predation on red and roe deer. With wolves, reaching red deer carrying capacity took longer time
- Larger effect of productivity for bison and moose
- Combination of relevant effects on the dynamics of prey species, and potentially on the regulation of the ecosystem (Jedrzejewski & Jedrzejewska 2005)

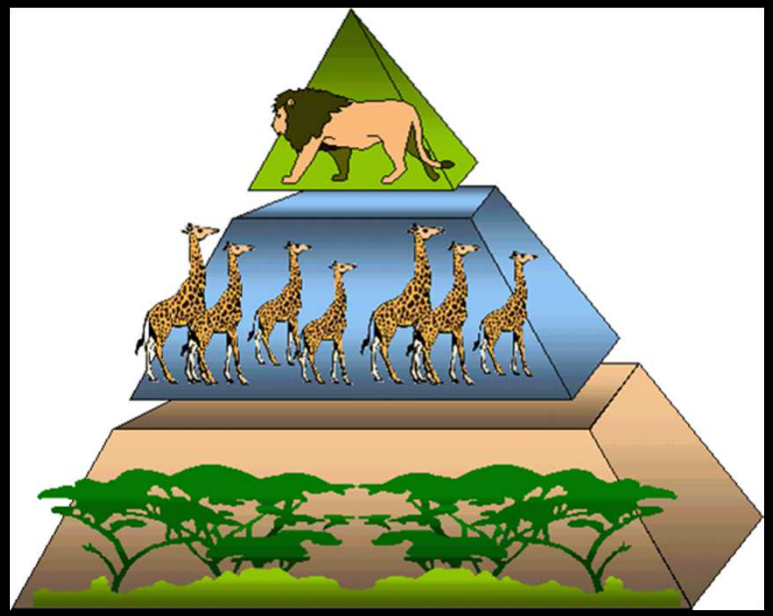
The discussion is still open …



Ripple & Beschta 2012



- Increasing relevance to the role of predators in recent times
- Trophic cascades: progression of indirect effects of predation through lower steps (Estes et al. 2001)
- Increasing importance in terrestrial systems (e.g Terborgh & Estes 2010)
- The concept of *keystone species* is a solid argument for the conservation of large carnivores (Hebblewhite et al. 2005)



- *Top, Apex* predators:
- Most dominant members of carnivore guilds
- Virtually free of predation

Ecological position is context dependent

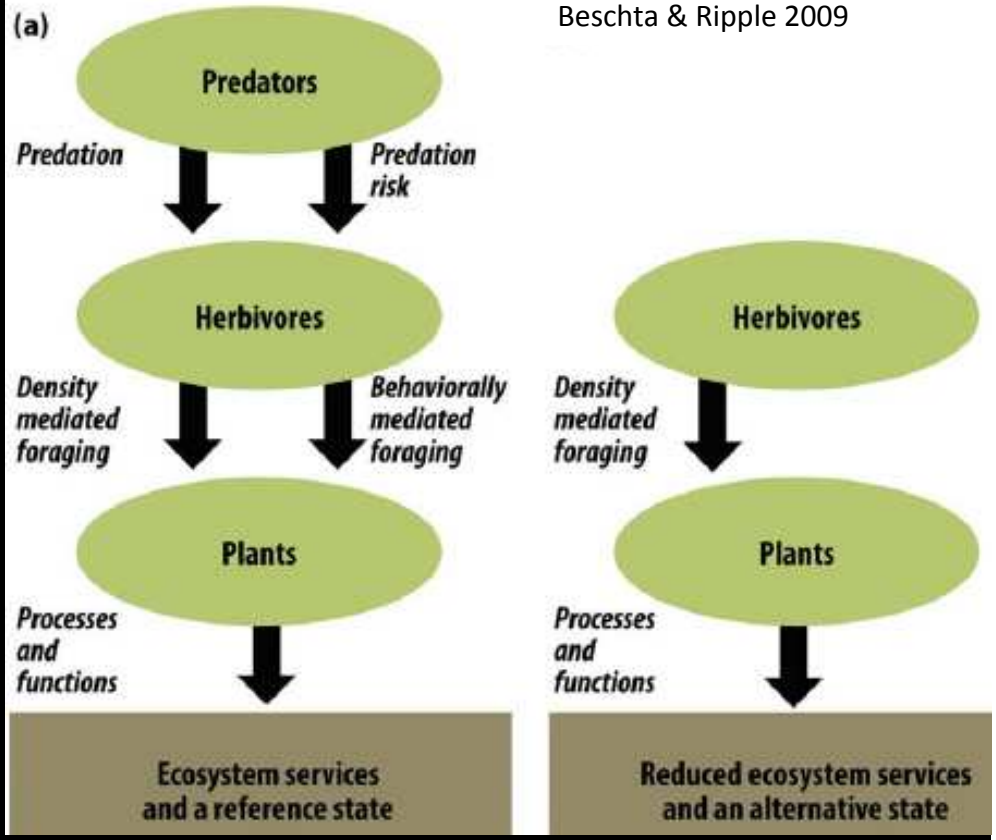
¿How do LC play their role?

- Numerically: reducing prey through predation
- Trough behavioral changes of their prey, which try to be less vulnerable

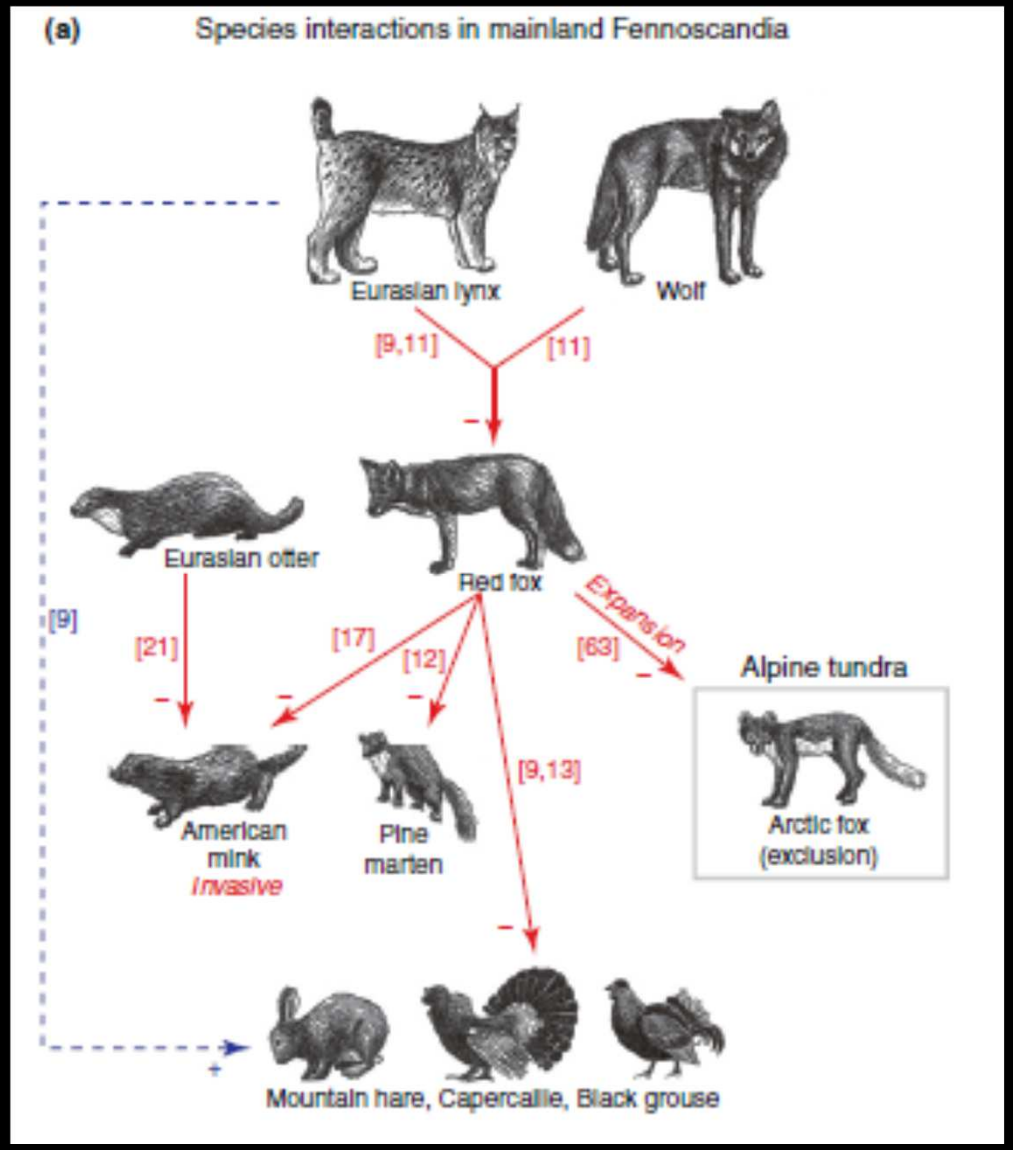
- The latter may drive trophic cascades (e.g. Schmitz et al. 2004; Peckarsky et al. 2008)
- Prey dynamics affected by direct predation and behavioral changes

- Herbivore prey eat seeds and plants. Therefore predation may modify the structure of vegetation

Beschta & Ripple 2009

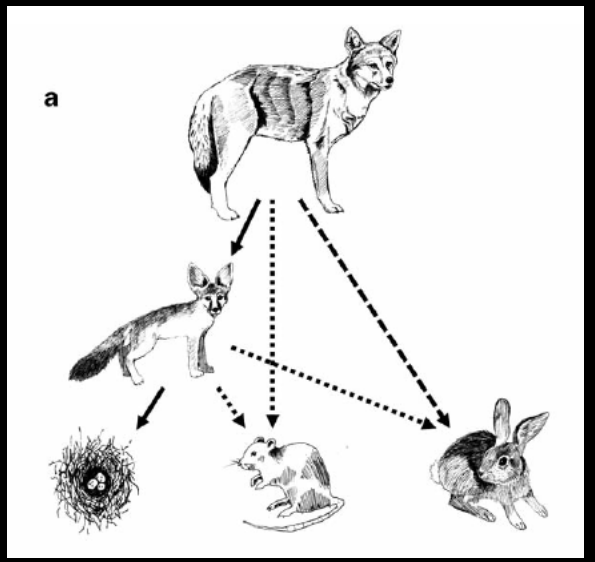


Interactions: mesopredator control



From Ritchie et al., in press (Trends in Ecology and Evolution)

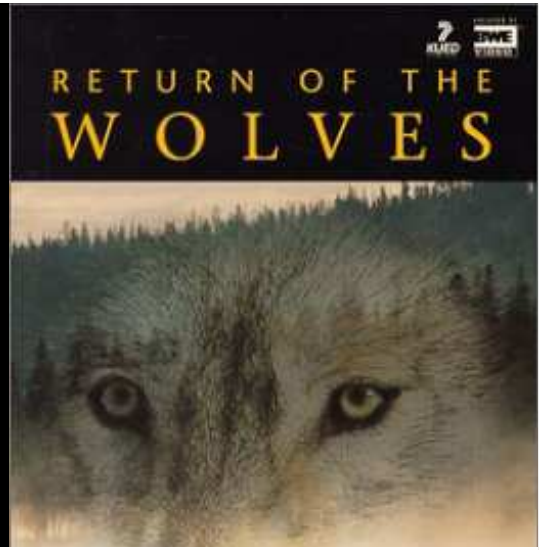
From Prugh et al. 2009



Habitat selection by elk before and after the wolves

Mao et al 2005 Fortin et al 2005

The return of wolves to Yellowstone restores important ecosystem processes



BIOLOGICAL CONSERVATION 138 (2007) 514–519

available at www.sciencedirect.com

ScienceD

journal homepage: www.elsevier.

BIOLOGICAL CONSERVATION

ELSEVIER

Short communication

Restoring Yellowstone's asp

William J. Ripple, Robert L. Beschta*

ELSEVI

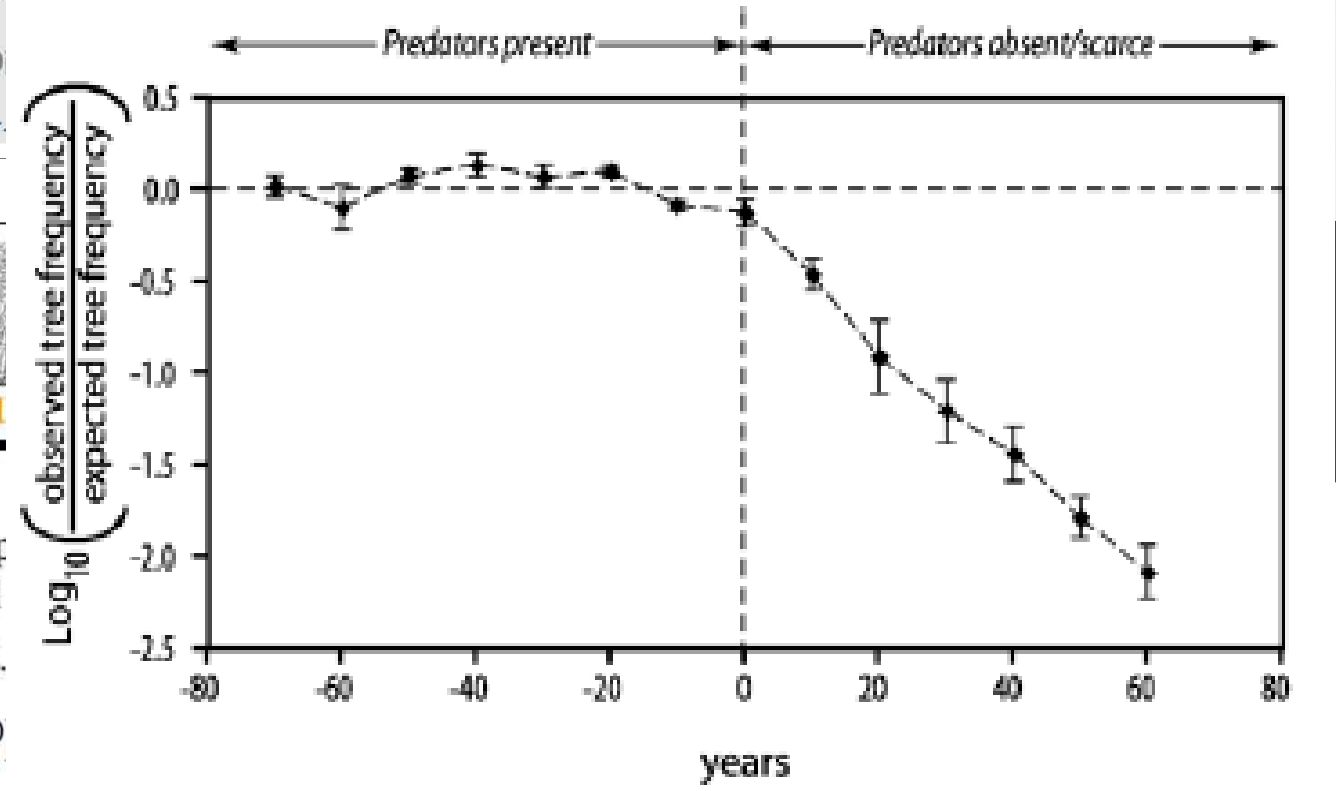
Ecology, 90(9), 2009, pp. 2454–2466
© 2009 by the Ecological Society of America

Review

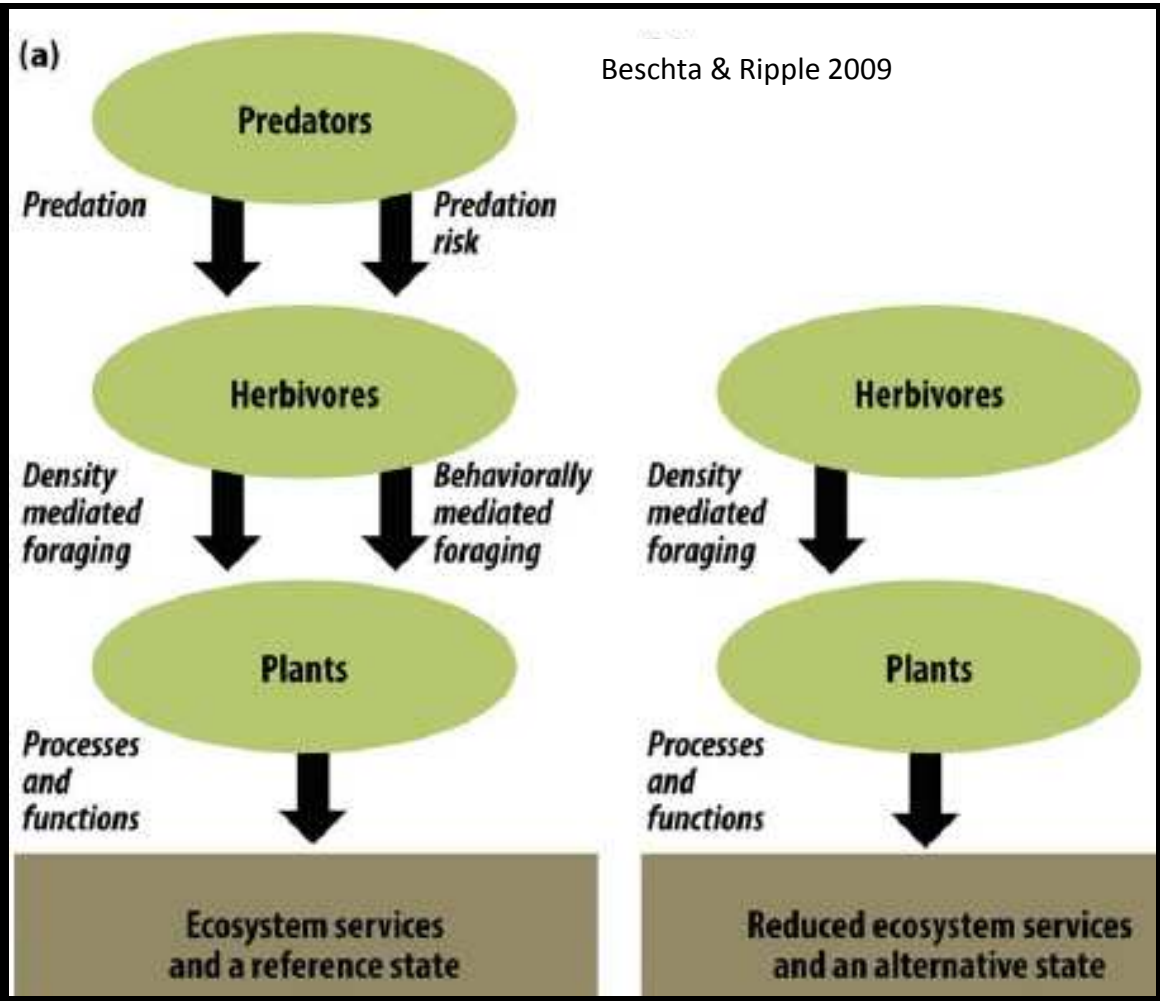
Large p
United

Wolf presence and increased w Robert L.
implications for tro

SCOTT CREEL[1] AND DAVID CHRISTIANSON



- Invertebrates communities
- Soil nutrients
- Buffer climate change
- Increasing evidence in the scientific literature *(Nature, Science,* etc.)

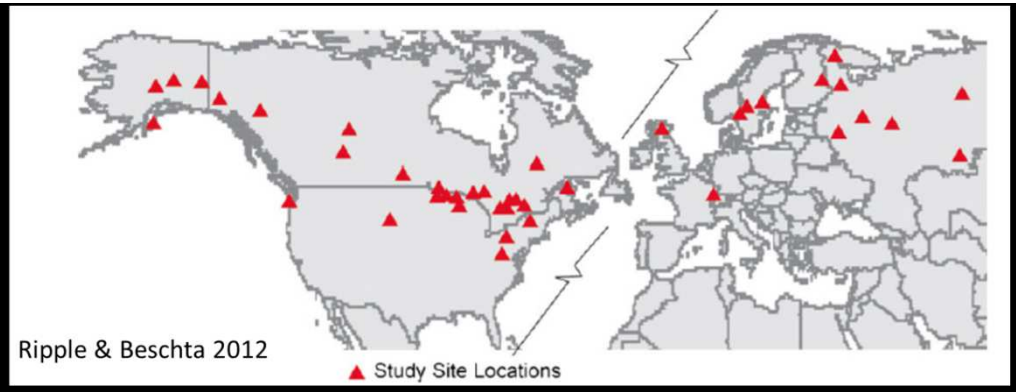


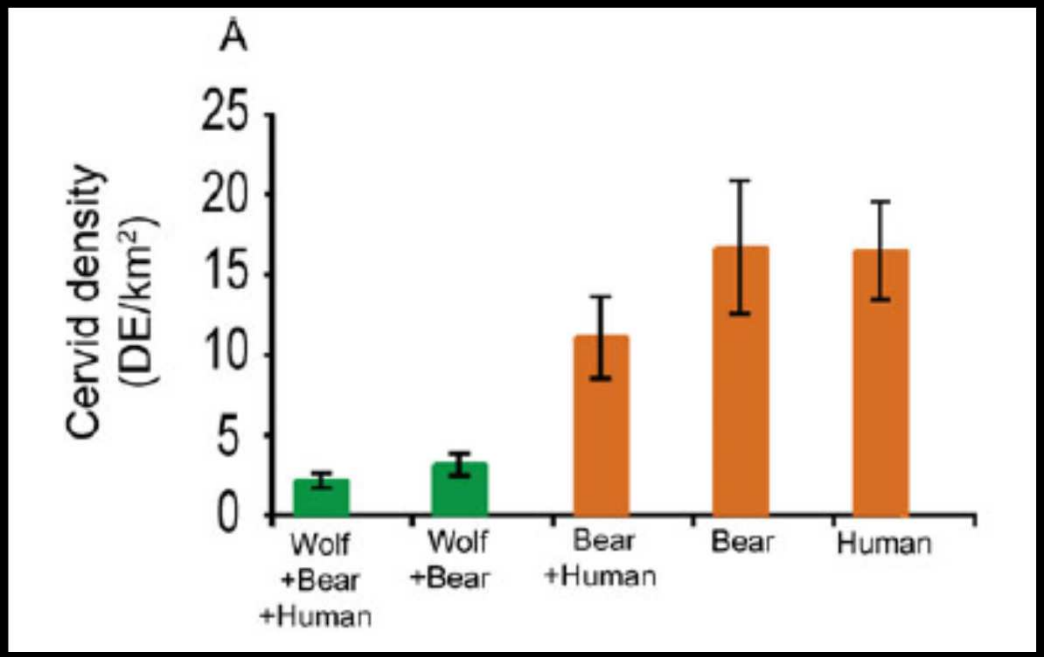
Beschta & Ripple 2009

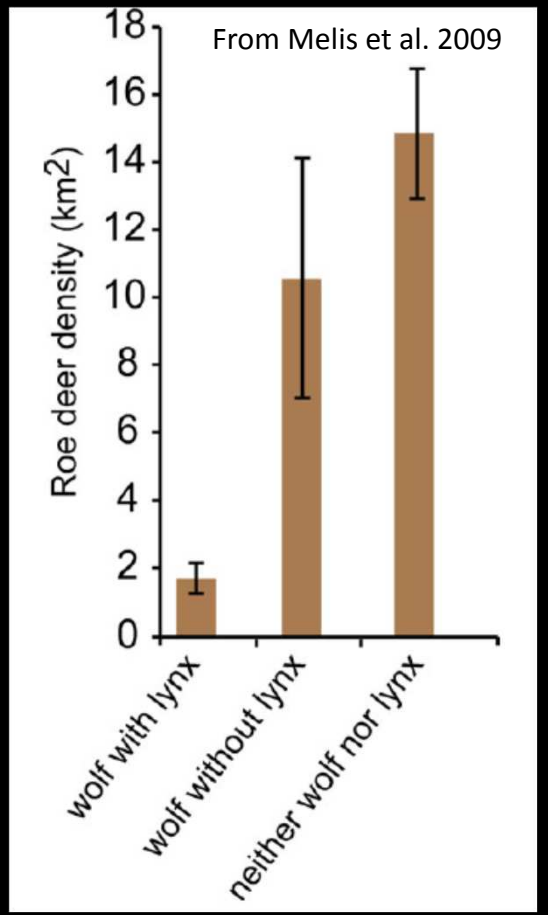
- In boreal areas bears feed largely on ungulates (Swenson et al. 2006)
- Most important cause of moose calves' mortality (Boertje et al. 2010)
- Example of predation as selective force (Genovart et al. 2010)
- Ecosystem efficiency and relation between ecosystems, transferring nitrogen from ocean to terrestrial systems (Soulé et al. 2003)

Guild conservation:

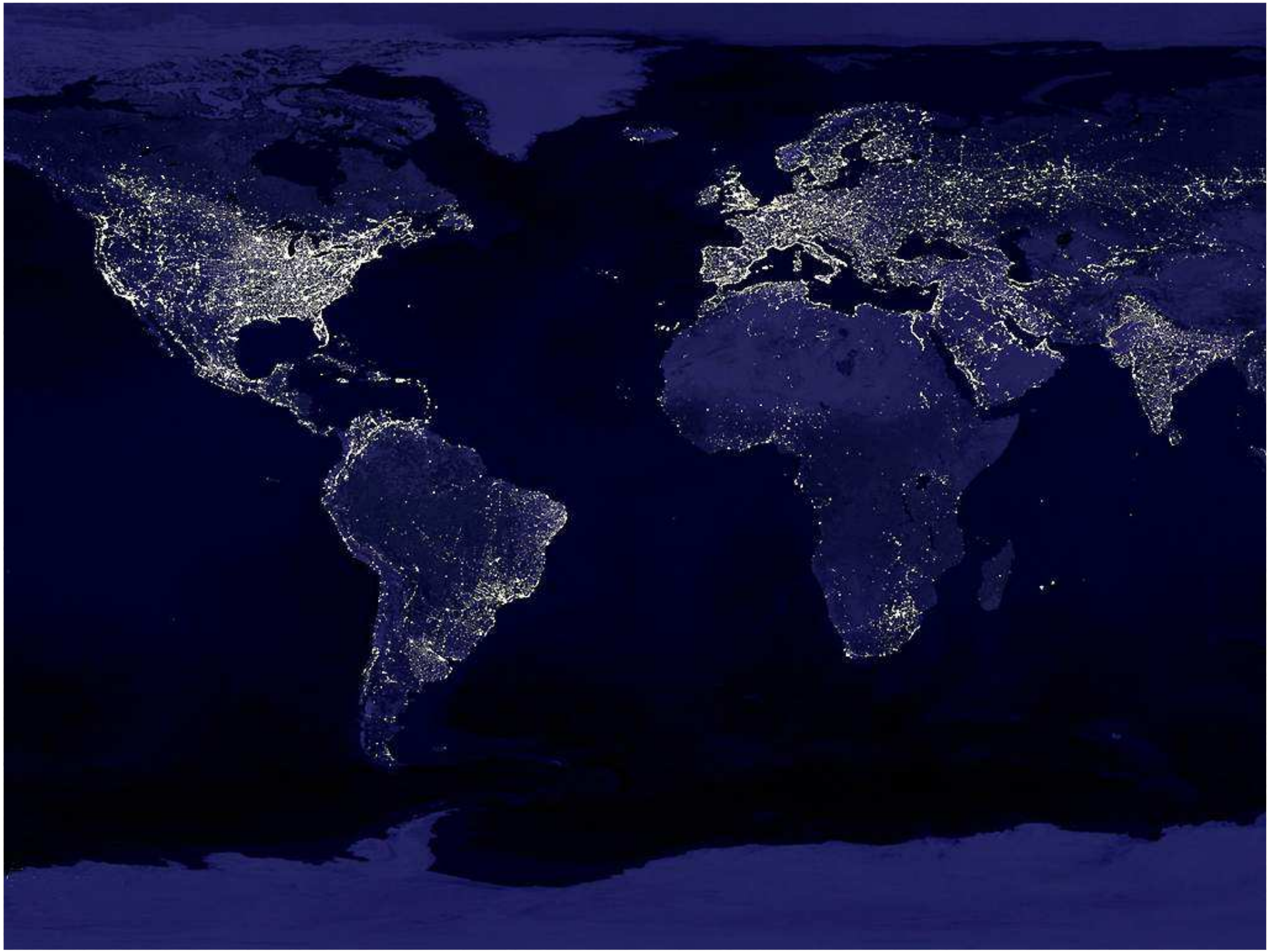
Bears alone appear insufficient to preclude cervid irruptions; bears + wolves much more efficient





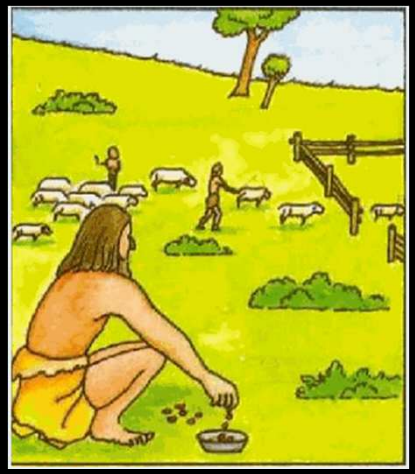


The guild must be complete for LC to provide their ecological role as keystone species (Dalerum et al. 2008)



Large carnivores and humans

- We have always been in conflict with LC...



Humans have been killing large carnivores for a long time

- Competition for prey
- Protection of human life
- Protection of livestock from predation
- Disease control
- Sport hunting
- Trade with fur and other body parts…

Most LC are killed to remove a nuisance
rather than for consumption (Frank & Woodroffe 2001)

What are the consequences of human persecution for large carnivores?

- Demography

Most large carnivore mortality is human induced
Even in protected areas (Woodroffe & Ginsberg 1998)

Wolves 83% Brown bears 89%

Ecosystem-level consequences

PROCEEDINGS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Anthropogenic extinction of top carnivores and interspecific animal behaviour: implications of the rapid decoupling of a web involving wolves, bears, moose and ravens

Joel Berger

Proc. R. Soc. Lond. B 1999 **266**, 2261-2267
doi: 10.1098/rspb.1999.0917

Ecological Applications, 11(4), 2001, pp. 947–960

A MAMMALIAN PREDATOR–PREY IMBALANCE: GRIZZLY BEAR AND WOLF EXTINCTION AFFECT AVIAN NEOTROPICAL MIGRANTS

JOEL BERGER,[1,4] PETER B. STACEY,[2] LORI BELLIS,[3] AND MATTHEW P. JOHNSON[3]

Science

Ecological Meltdown in Predator-Free Forest Fragments

John Terborgh, *et al.*

Science **294**, 1923 (2001);

Strong modifications in terrestrial ecosystems after eliminating LC

What are the consequences of human persecution for large carnivores?

- Demography

  Most large carnivore mortality is human induced
  Even in protected areas Woodroffe & Ginsberg 1998

  Wolves 83% Brown bears 89%

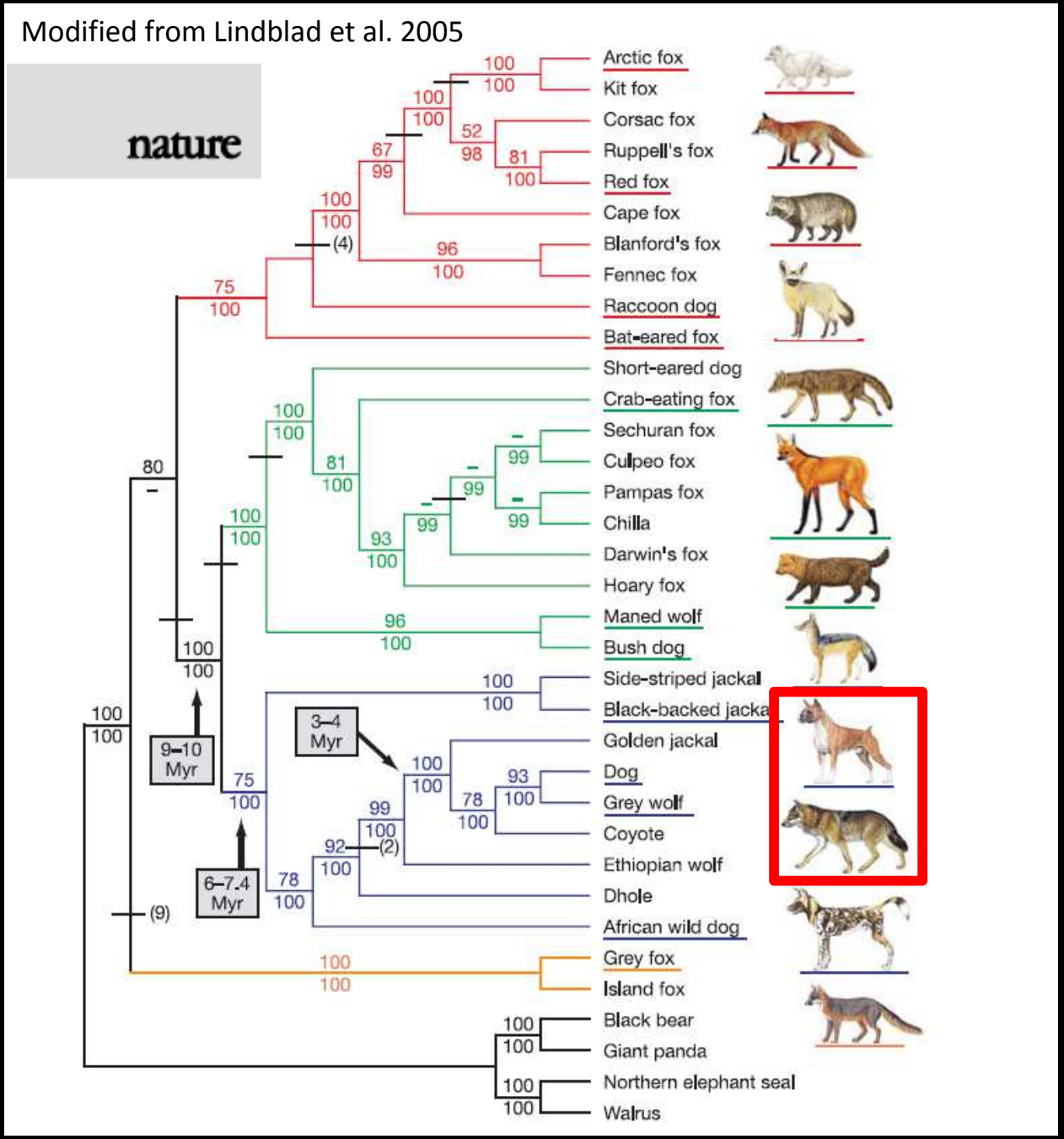
- Behavioral consequences?

  Behavior: the actions and reactions, innate and learned,
  of an animal under specified circumstances
  Behavioral consequences may influence the role of LC in the ecosystems

- Even solitary carnivores live in social systems; stable neighborhoods
- Group-living species are dependent on integrity and stability of groups
- High mortality rates disrupt social stability
- -> changes in activity patterns, reproductive rates, habitat use, etc.
  (Frank & Woodroffe 2001)

- Wolves: strong links
  among members
  keep group stability
  (Boitani 2000)

Modified from Lindblad et al. 2005



Behavioral changes of LC - Time scale of persecution:

Europe

Roman emperors founded wolf-hunting corps 1200 years ago; In Greece, 2500 years ago

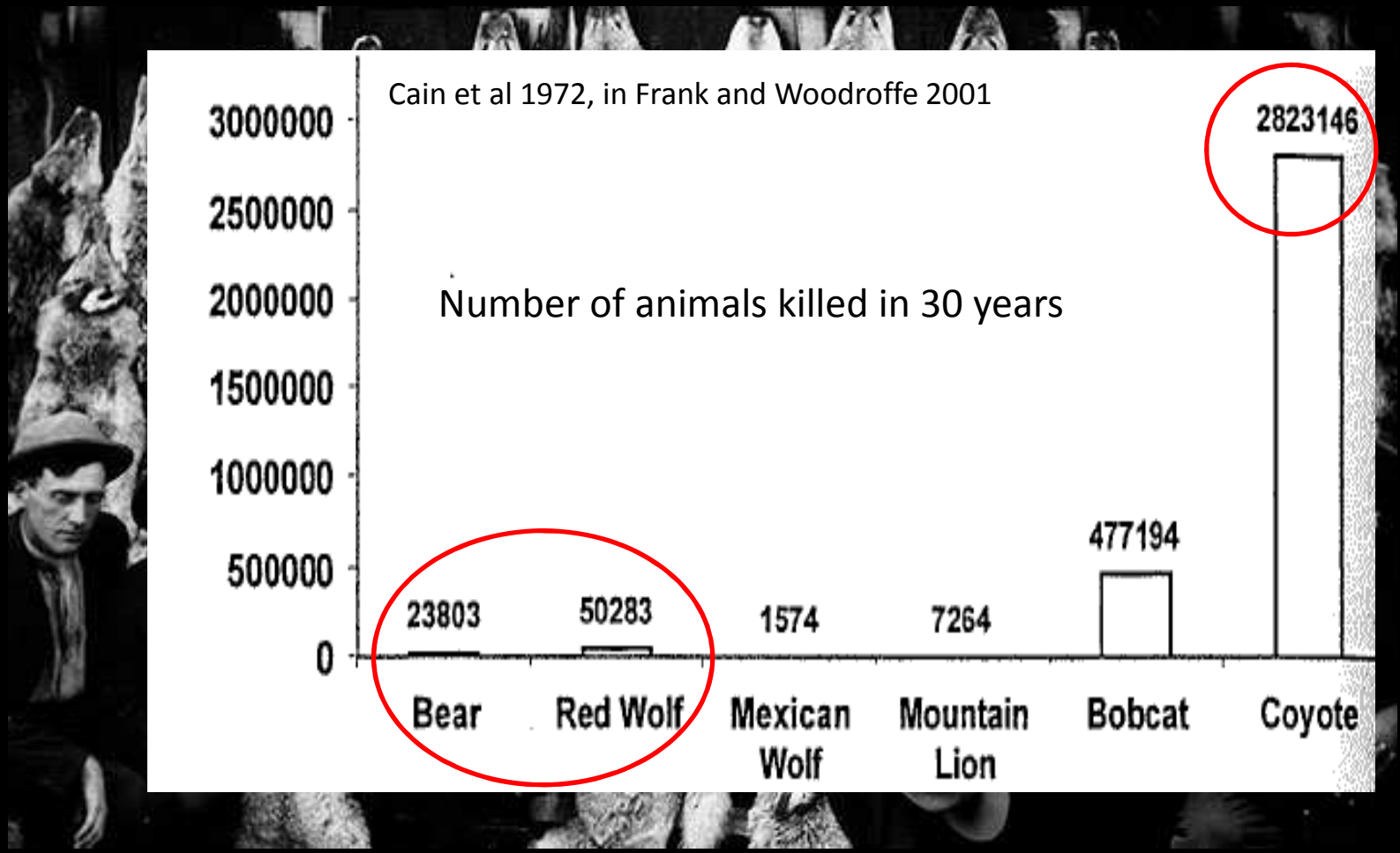
Time scale of persecution:

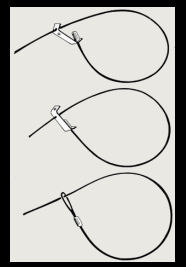
Europe

Roman emperors founded wolf-hunting corps 1200 years ago; In Greece, 2500 years ago

North America:

Eradication much faster after the arrival of "modern methods"



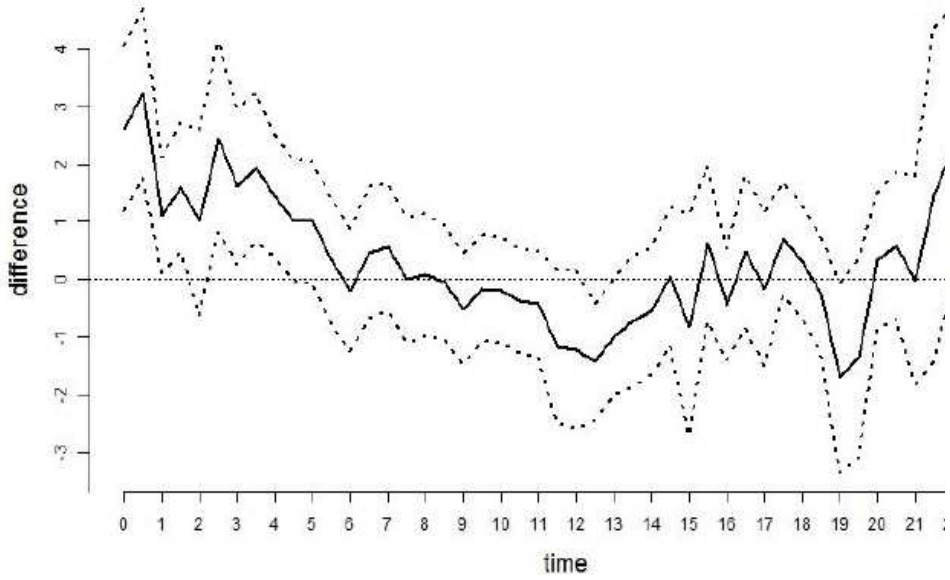


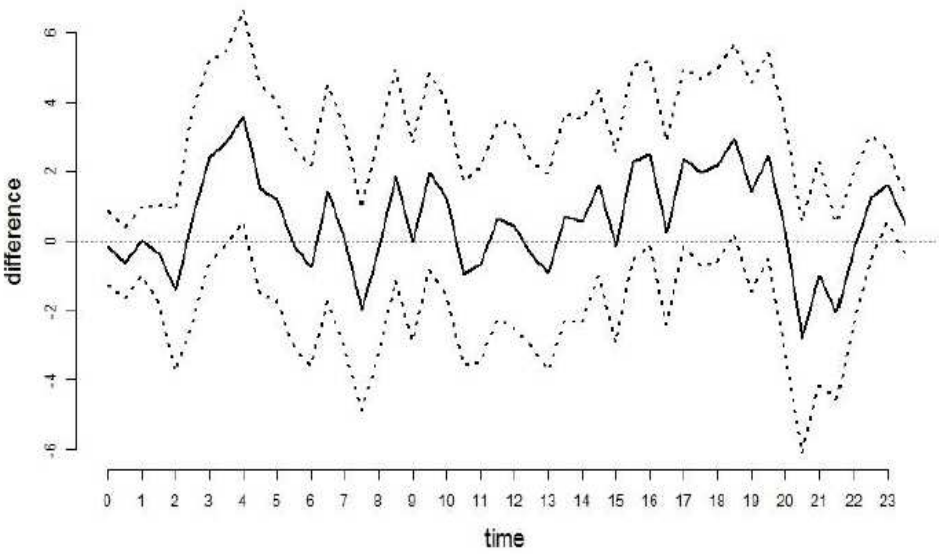
Persecuted carnivores are more nocturnal

Brown bears and wolves are more nocturnal in Europe than in North America

Avoidance of people= survival in areas with high human densities

and with longer persecution Woodroffe 2000

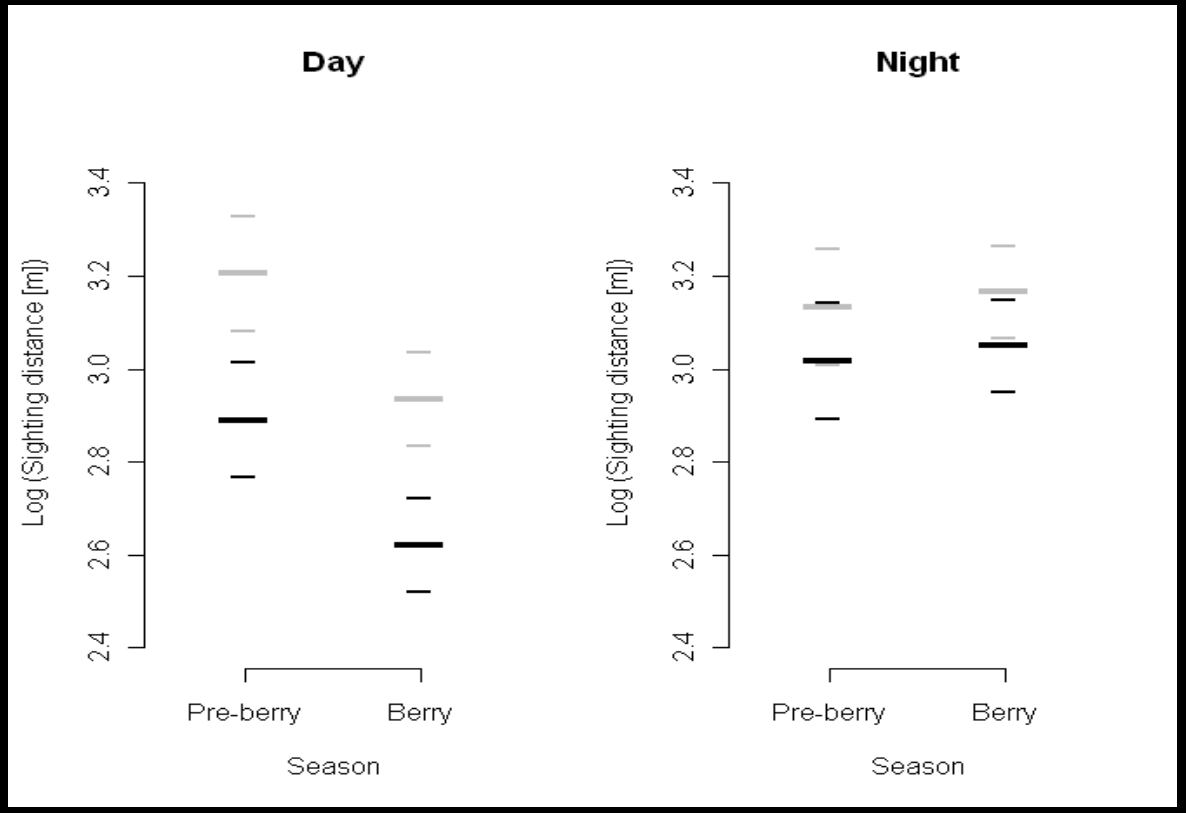




Ordiz et al. 2012, in press (Biological Conservation)

Predators becoming prey: spatial and temporal discrimination of human-derived risk by brown bears

(Ordiz et al. 2011)

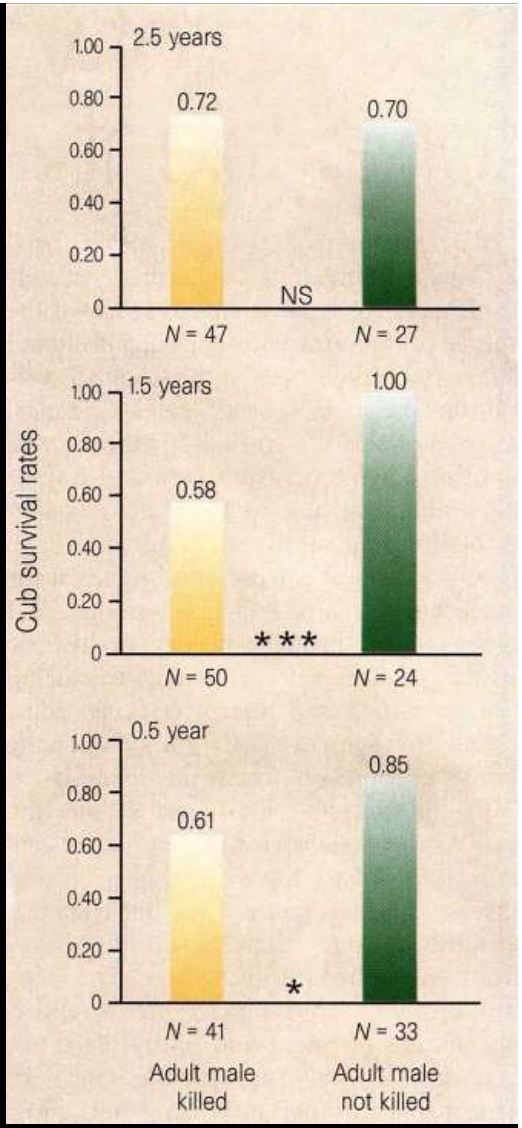


Reproductive rates and social disruption

Behavioral findings are of special conservation interest if they affect population growth rates (Caro 1998)

Scandinavia: Higher cub mortality after the hunting of resident males (Swenson et al 1997)

Lower cub survival decreased λ by 3.4%



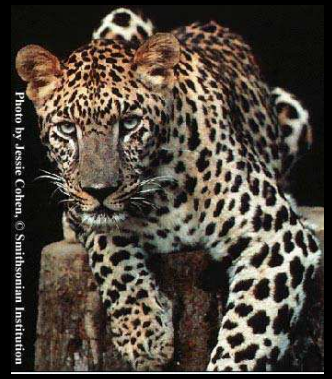
Predation affected by human presence

Anim. Behav., 1993, **45**, 1233–1235

SHORT COMMUNICATIONS

Human presence reduces predation in a free-ranging vervet monkey population in Kenya

LYNNE A. ISBELL*† & TRUMAN P. YOUNG‡



Ecological functionality must account for indirect anthropogenic effects on species´ distributions and behavior

biology letters

Biol. Lett. (2007) 3, 620–623
doi:10.1098/rsbl.2007.0415
Published online 9 October 2007

Animal behaviour

Fear, human shields and the redistribution of prey and predators in protected areas

Joel Berger[1,2,*]

Few places left where LC roam without human-induced changes

Extinctions and population reductions

Altered activity patterns

- social structure
- predation patterns
- reproductive rates
- habitat use

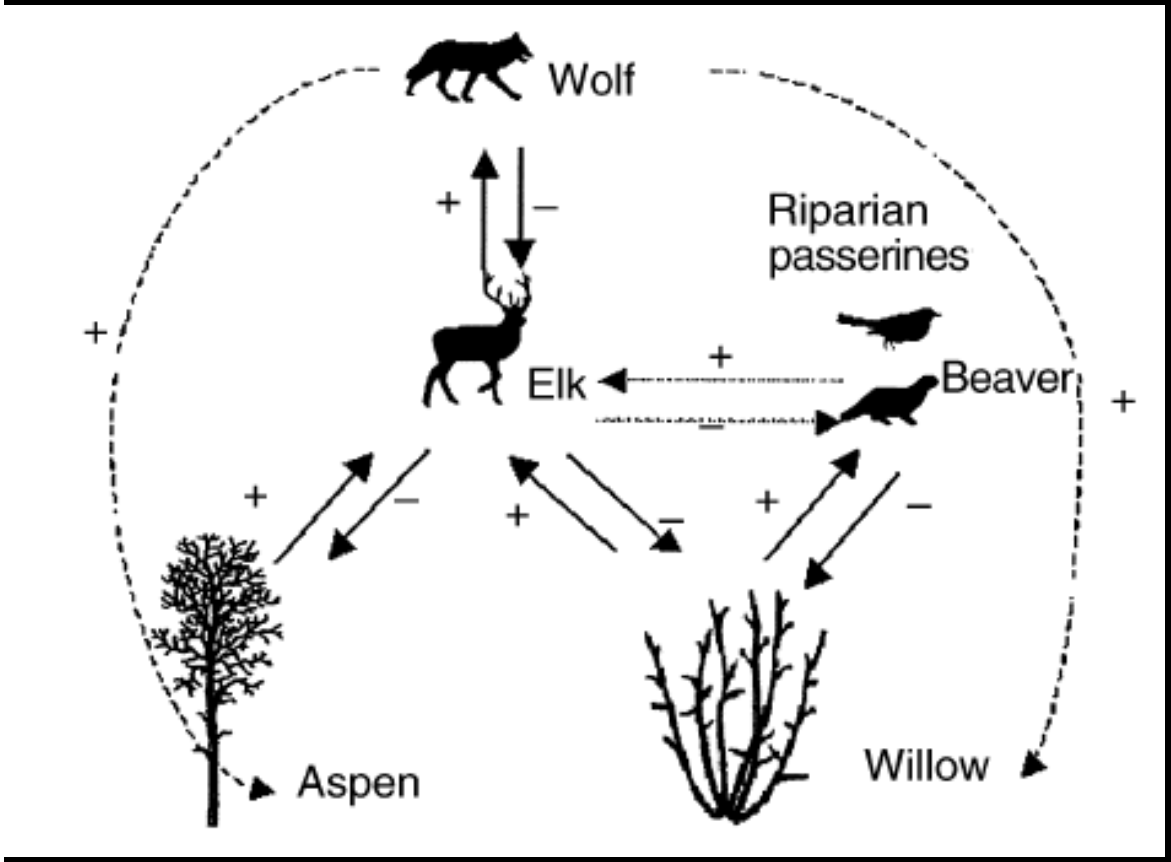
«Landscape of fear» for the LC

(Ordiz et al. 2011; Valeix et al. 2012)

Ecology, 86(8), 2005, pp. 2135–2144

HUMAN ACTIVITY MEDIATES A TROPHIC CASCADE CAUSED BY WOLVES

MARK HEBBLEWHITE,[1,7] CLIFFORD A. WHITE,[2,3] CLIFFORD G. NIETVELT,[1] JOHN A. MCKENZIE,[4,5] TOMAS E. HURD,[2] JOHN M. FRYXELL,[4] SUZANNE E. BAYLEY,[1] AND PAUL C. PAQUET[6]




M. Hebblewhite

More attention must be placed to the social structures and behavior of predators, in relation with the dynamics of trophic interactions

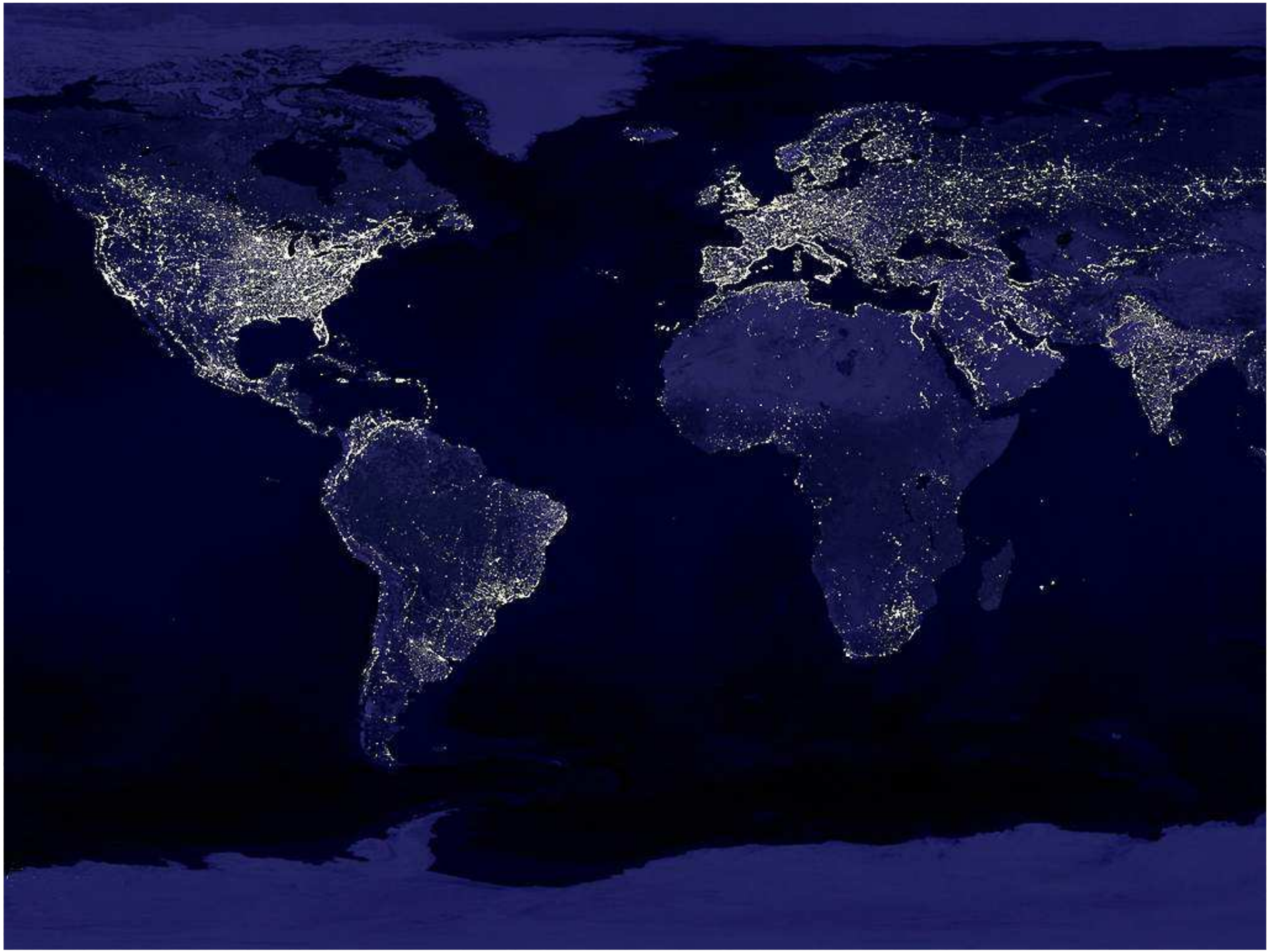
Ecosystem restoration with teeth: what role for predators?

Euan G. Ritchie[1], Bodil Elmhagen[2], Alistair S. Glen[3], Mike Letnic[4], Gilbert Ludwig[5] and Robbie A. McDonald[6]

Conservation policy should consider effects of harvesting beyond influences on population size

Protection from harvesting restores the natural social structure of eastern wolf packs

Linda Y. Rutledge [a,*], Brent R. Patterson [b], Kenneth J. Mills [a,1], Karen M. Loveless [a], Dennis L. Murray [c], Bradley N. White [d]

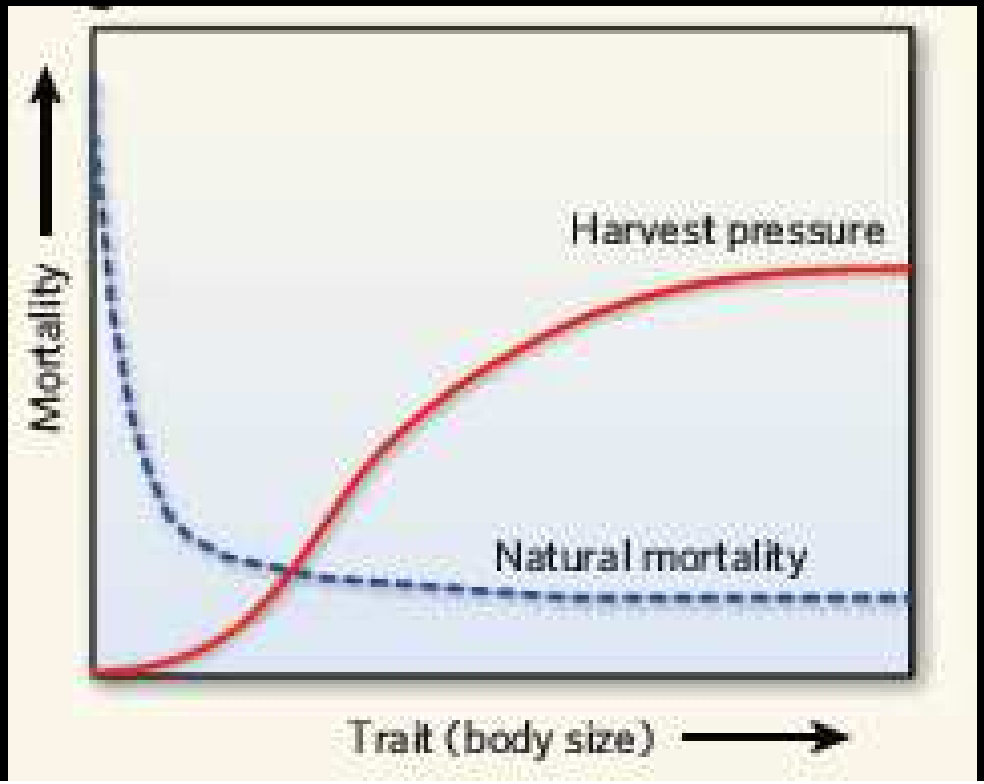


¿Can hunting replace predation?

- General lack of redundancy between hunting and predation (Berger 2005; Genovart et al. 2010)
- Predation is an important agent of natural selection, with hunting and fishing going often in opposite directions (Darimont et al. 2009)

The Young, the Weak and the Sick: Evidence of Natural Selection by Predation

Meritxell Genovart[1]*, Nieves Negre[2], Giacomo Tavecchia[1], Ana Bistuer[3], Luís Parpal[4], Daniel Oro[1]



EVOLUTION

Unnatural selection

Nils Chr. Stenseth and Erin S. Dunlop

Hunting is often not functionally equivalent to predation by LC

Intensity and timing of predation

Removal of different prey age and sex classes

Modulation of mesopredator densities

Infrastructure to support human hunting

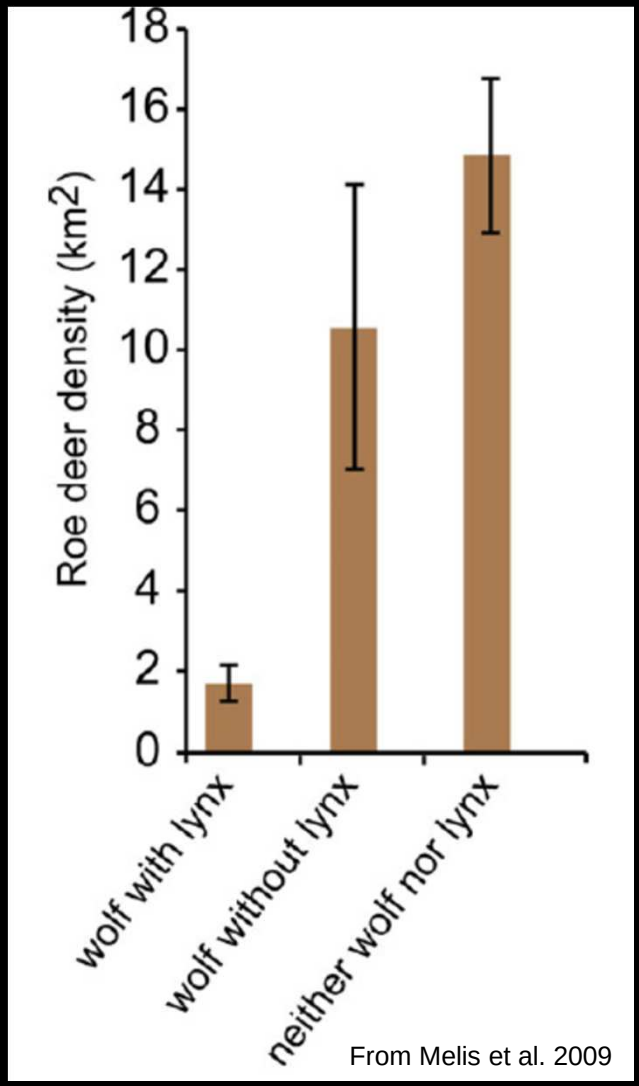
Manipulation of carrion–scavenger relationships

Modification of intra-guild predation (Berger 2005)

Humans do not replace carnivores in an ecologically functional way
(Ray et al. 2005)

- Lynx vs. hunter-killed roe-deer (Andersen et al. 2007, Norway):
- 151 lynx-killed roe deer:
- % of males, females, adults and fawns not statistically different from the population
- Hunters killed especially males
- Hunting did not replicate natural predation

European scale



From Melis et al. 2009

Common goals of hunting:

target population level

preventing conflicts

public support for conservation


Journal of Applied Ecology

Journal of Applied Ecology 2009, 46, 1350–1356 doi: 10.

REVIEW

Hunting for large carnivore conservation

Adrian Treves*

Target population level: Not simple… Undetected mortality of offspring

Not clear how hunting prevents property damage:

Difficulty to kill the individuals that provoke damages. Need to protect livestock and to impede LC accessing human food.

Risk of disrupting social organization -> increase property damage

Gompper 2002

Robinson et al 2008

Frank 1998

Allen and Gonzales 1998

OPEN ACCESS Freely available online

PLOS one

More than Mere Numbers: The Impact of Lethal Control on the Social Stability of a Top-Order Predator

Arian D. Wallach[1]*, Euan G. Ritchie[2], John Read[3], Adam J. O'Neill[4]

Management decisions on large social predators must consider social stability to ensure their conservation and ecological functioning

Hunting wolves fractures their social structure:

Changes in age composition, pack size, survival, social behavior… (Haber 1996)

It is the pack that is the top predator, not the individual animal

Conservation of large carnivores: Sustainability is not enough

Conservation of biodiversity is facilitated by maintaining

population densities and distributions of strongly

interactive species above thresholds for ecological effectiveness

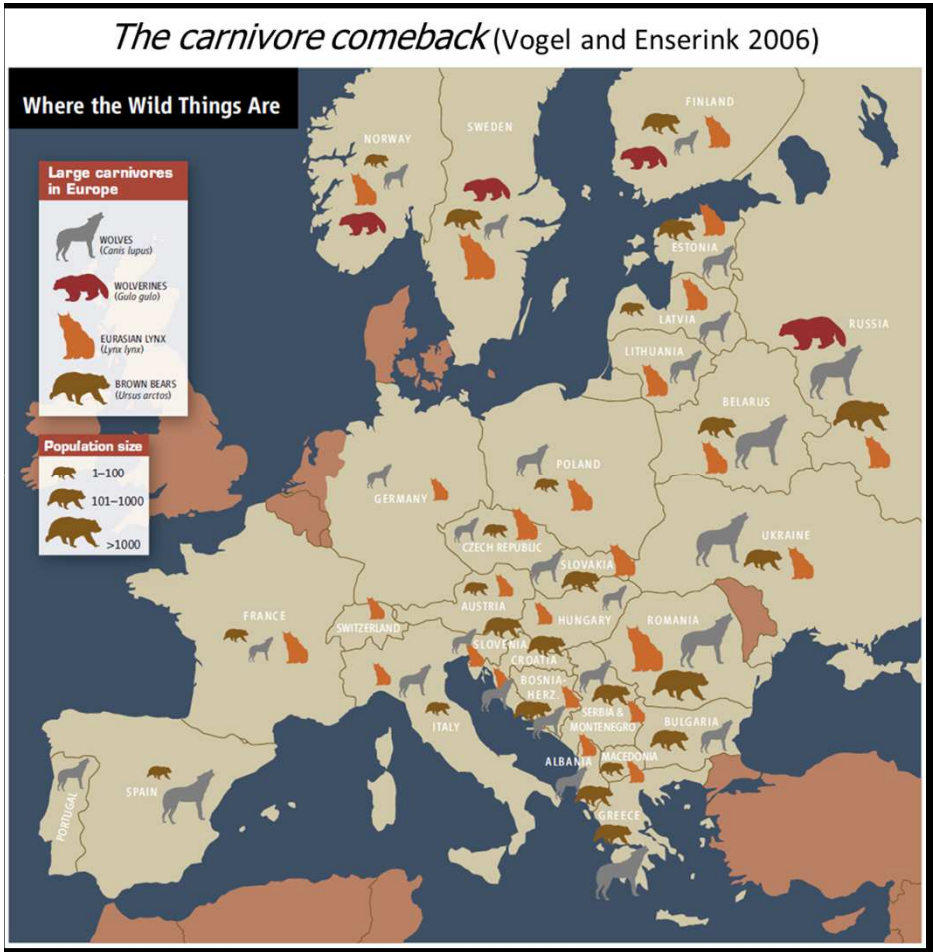
Soulé et al. 2005

Attention to behavioral responses

Importance of single individuals and social interactions in non-social species (Ordiz et al. 2008)

Breeder loss is particularly influential in wolves (Brainerd et al. 2008)

The carnivore comeback (Vogel and Enserink 2006)



Conservation Biology perspective:

Ecologically efficient densities (Soulé et al. 2003)

Conservation Biology

Editorial

Bolder Thinking for Conservation

Editorial

Conservation or Convenience?

How about Scandinavian wolves' conservation and management?

Opportunities: recolonizing population, large availability of prey

Problems: inbreeding, small population (far from carrying capacity)

Conflict with some human uses (e.g. free-ranging livestock)

Favorable Conservation Status (Hansen et al. 2011): 3000-5000 wolves (Swe, Nor, Fin and Karelia-Kola).

Higher population size, lower increase of inbreeding (Hansen et al. 2011)

Ecologically efficient densities

GYE: «*Ecosystem recovery should be a recovery criterion for this unique keystone predator*» (Bergstrom et al. 2009).


Viewpoint

Gray Wolf Conservation at a Crossroads

ADRIAN TREVES AND JEREMY T. BRUSKOTTER

Thank You

andres.ordiz@gmail.com