Bringing Real Ecological Data into the Classroom: DryadLab on QUBESHub

Gaby Hamerlinck

&

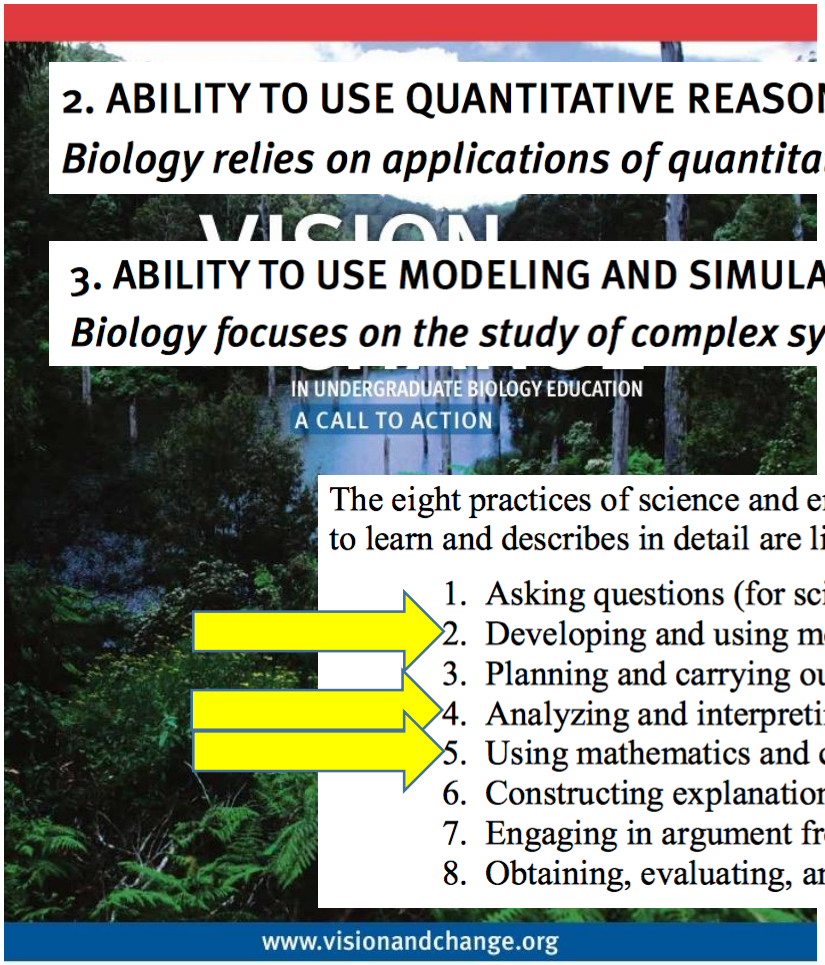
Kristin Jenkins

BioQUEST

ACUBE 2016

BioQUEST
CURRICULUM CONSORTIUM

QUBES
The Power of Biology × Math × Community



NEXT GENERATION SCIENCE STANDARDS
For States, By States

The eight practices of science and engineering that the *Framework* identifies as essential for all students to learn and describes in detail are listed below:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

- Building a strong interdisciplinary curriculum that includes physical sc

Competency M8

Apply quantitative knowledge and reasoning—including integration of data, modeling, computation, and analysis—and informatics tools to diagnostic and therapeutic clinical decision making.

DryadLab is a collection of free, openly-licensed, high-quality, hands-on, educational modules for students to engage in scientific inquiry using real data. DryadLab is a project of the Dryad Digital Repository, which makes a wide variety of research data underlying scientific and medical publications discoverable, freely reusable and citable.

Introduction To Extinctions And Extinction Bias

DryadLab module

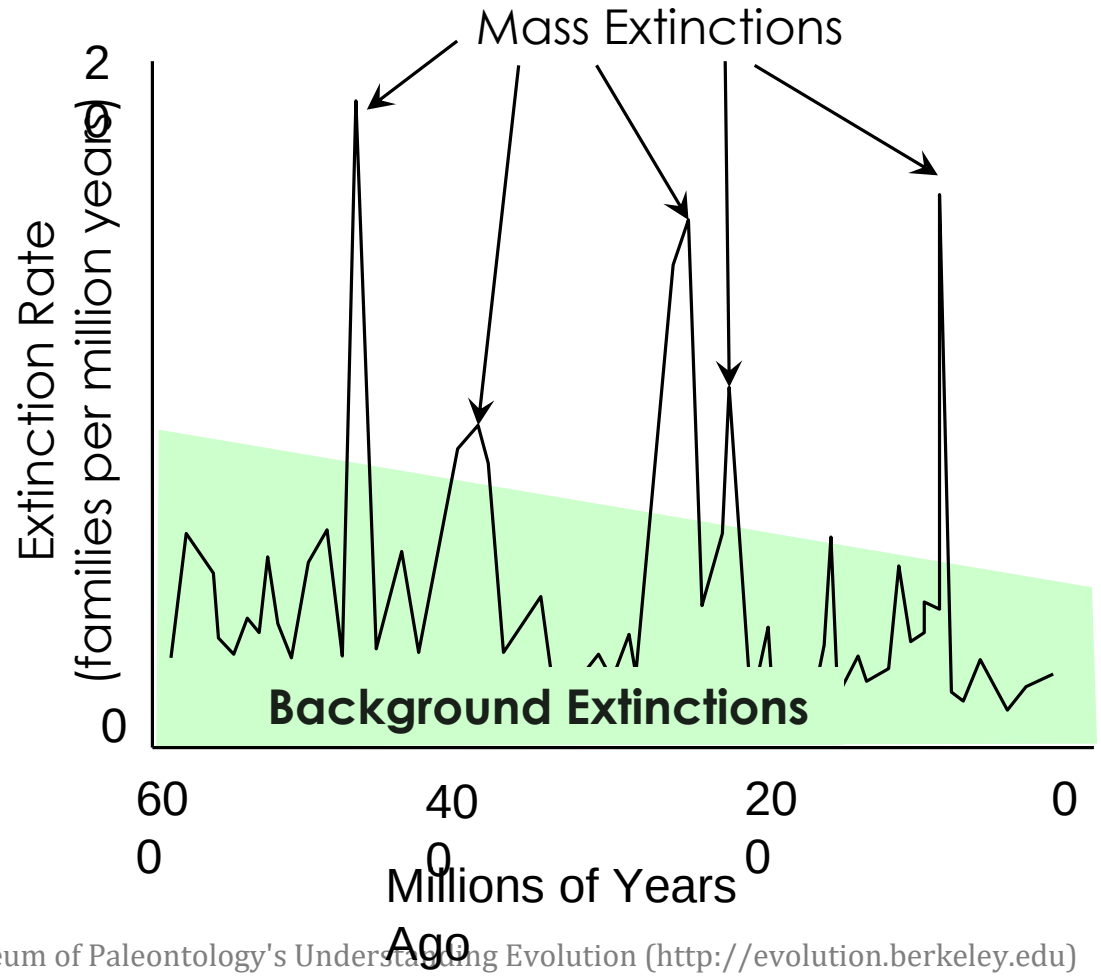
Credits for images appear at the end of the presentation

Sponsored by NESCent

Background vs. Mass Extinction

Background extinction:

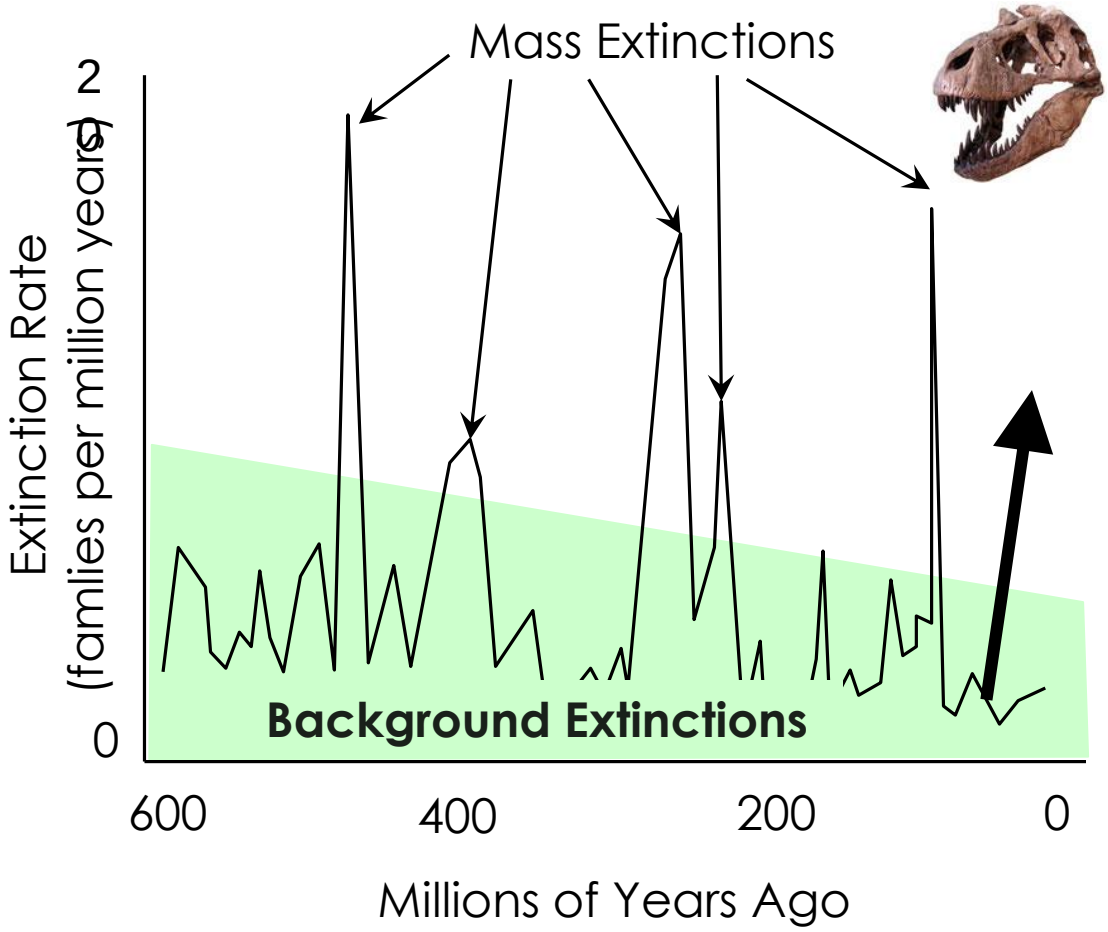
species gradually and continuously go extinct, creating a turnover of species through time.



Graph from University of California Museum of Paleontology's Understanding Evolution (http://evolution.berkeley.edu)

Background vs. Mass Extinction

Mass extinction:
large number of species go extinct over a short period of time



T rex and graph from http://evolution.berkeley.edu

Extinction is non-random

Certain traits may predispose species to extinction or survival

- Diet
- Geographic range

Smilodon, a felid (2.5 million -10,000 years ago)

Eusmilus, a nimravid (37.2 - 28.4 million years ago)

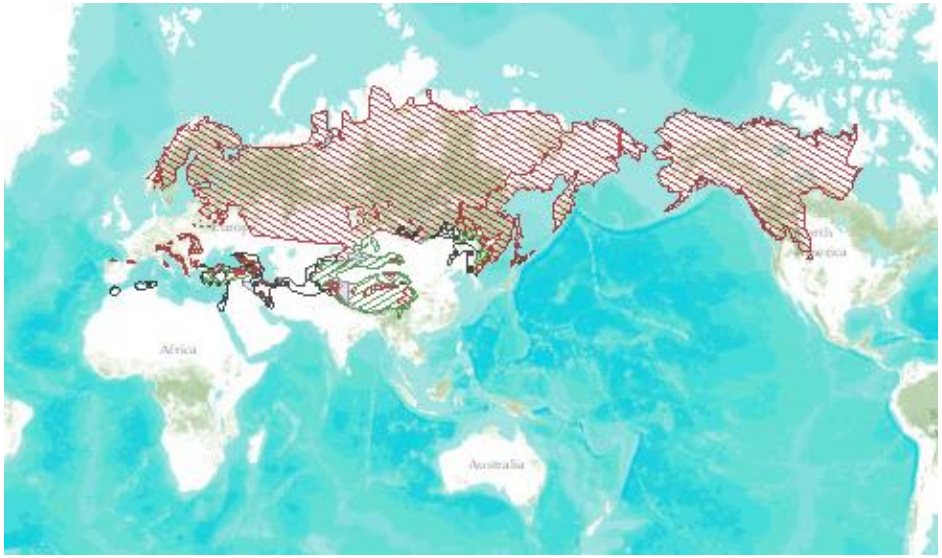
Smilodon photo by Wallace63 at http://commons.wikimedia.org/wiki/File%3ASmilodon_head.jpg, Eusmilus photo by Stickpen at http://commons.wikimedia.org/wiki/File%3AEusmilusskull.jpg,

Extinction is non-random

Certain traits may predispose species to extinction or survival

- Geographic range

Brown bear -
low risk of extinction



Iberian lynx -
critical risk of extinction

Maps from www.iucnredlist.org,

Extinction is non-random

Certain traits may predispose species to extinction or survival

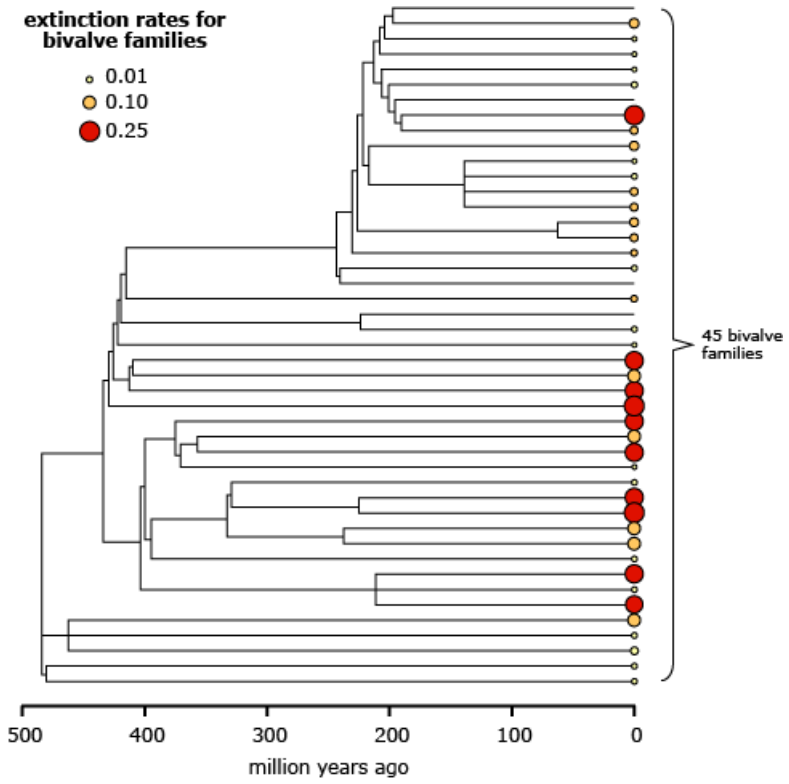
Some traits may only be important under certain threatening processes

Chiru photo by yun dan http://www.flickr.com/photos/yongzhong/4405796270/

Extinction is non-random

Certain traits may predispose species to extinction or survival

Extinction selectivity can lead to extinction risk being clustered within families or genera as closely related species tend to inherit similar traits from their common ancestor.



Introduction to the Dataset: Extinction Bias in Living Artiodactyla

Artiodactyla = Even-Toed Hoofed Mammals

RUMINANTS

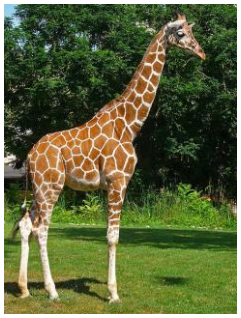
TRAGULIDAE: mousedeer

MOSCHIDAE: muskdeer

CERVIDAE: deer

ANTILO-CAPRIDAE: pronghorn

BOVIDAE: Antelopes, cows & goats

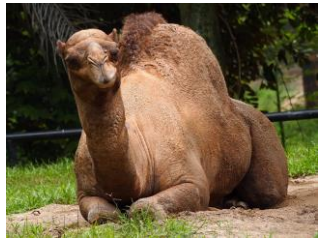


GIRAFFIDAE: giraffes

SUIFORMES

TAYASSUIDAE: peccaries

SUIDAE: pigs



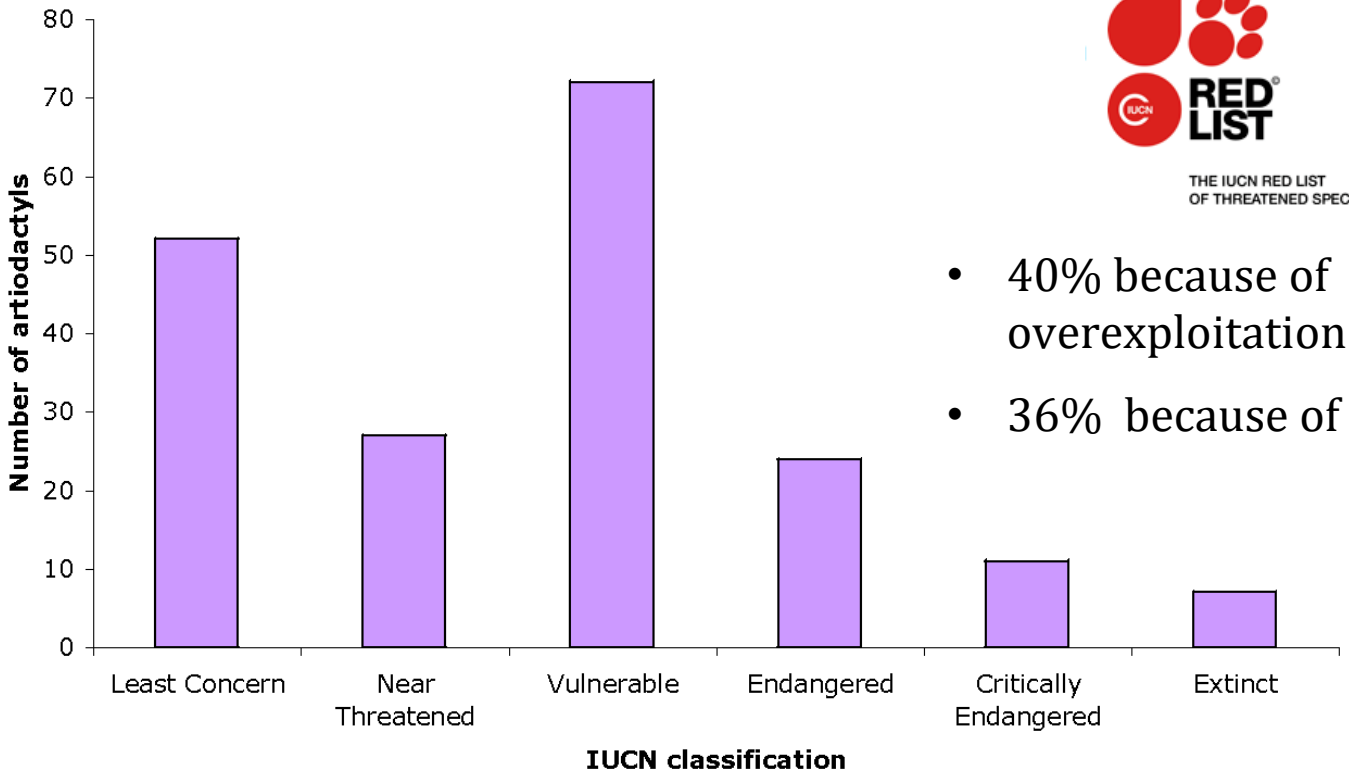
CAMELIDAE: camels

HIPPOPOTAMIDAE: hippos

Credits for images appear at the end of the slide show

Artiodactyla Extinction Risk

According to the IUCN Red List 50% of all artiodactyl species are threatened with extinction



RED LIST
THE IUCN RED LIST OF THREATENED SPECIES™

- 40% because of overexploitation (hunting)
- 36% because of habitat loss

Artiodactyl Extinction Dataset

- IUCN extinction risk 2006 (Threatened or Not Threatened)
- Body mass (grams)
- Age at first birth (days)
- Gestation Length (days)
- Weaning age (days)
- Inter-birth interval (days)
- Geographic range size (km^2)
- Home range size (km^2)
- Population density (per km^2)
- Mean human population density across species range (per km^2)
- Minimum human population density across species range (per km^2)
- Gross National Income across species range (2006 US$)
- Habitat breadth
- Diet (Specialist or Generalist)
- Mating system (Monogamous or Polygamous)
- Hunted illegally? (yes or no)
- Family (Bovidae, Cervidae, Moschidae, Antilocapridae, Giraffidae, Tragulidae, Suidae, Tayassuidae, Hippopotamidae, Cameilidae)

Data from: Price, S.A. & Gittleman, J. L. (2007) Hunting to extinction: biology and regional economy influence extinction risk and the impact of hunting in artiodactyls. Proceedings of the Royal Society of London, B. 274, 1845-1851.

Hypothesis

- An educated guess
- Idea that we are uncertain about

Scientific Hypothesis

- More informed than just an educated guess
- Usually based on prior knowledge, experience, background, or preliminary observations
- Usually supported by many lines of evidence so that scientists are more confident in them
- Explanatory gives us the why
- Testable because it generates ideas of what we should observe

http://undsci.berkeley.edu/teaching/misconceptions.php#a4

Example

You might *hypothesize* that a substance in apple flesh reacts with oxygen to form a brown colored chemical. We could then test the many different *expectations* generated by this single hypothesis, for example:

- If cut apples are exposed to air, then they will turn brown.
- If cut apples are exposed to air with more oxygen in it, then they will turn brown more rapidly.
- If cut apples are exposed to pure carbon dioxide, then they will not turn brown, etc.

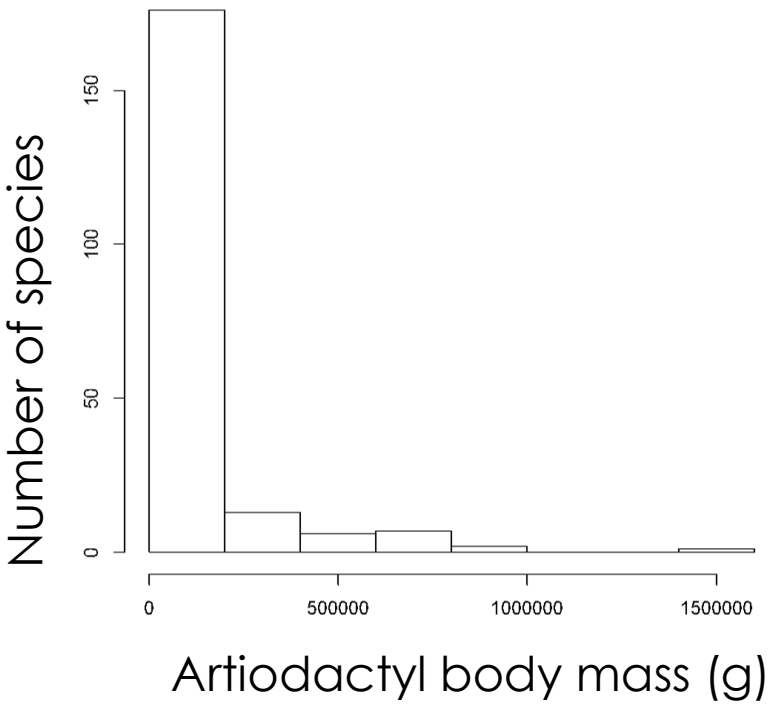
"if a species cannot disperse easily, then it's risk of extinction will be higher" is not a hypothesis. It just describes a pattern. Instead, the relevant, more explanatory hypothesis might be something like ***"Species that have poor dispersal abilities are less able to move away from local threats that can cause extinction."***

Introduction To Log And T-test

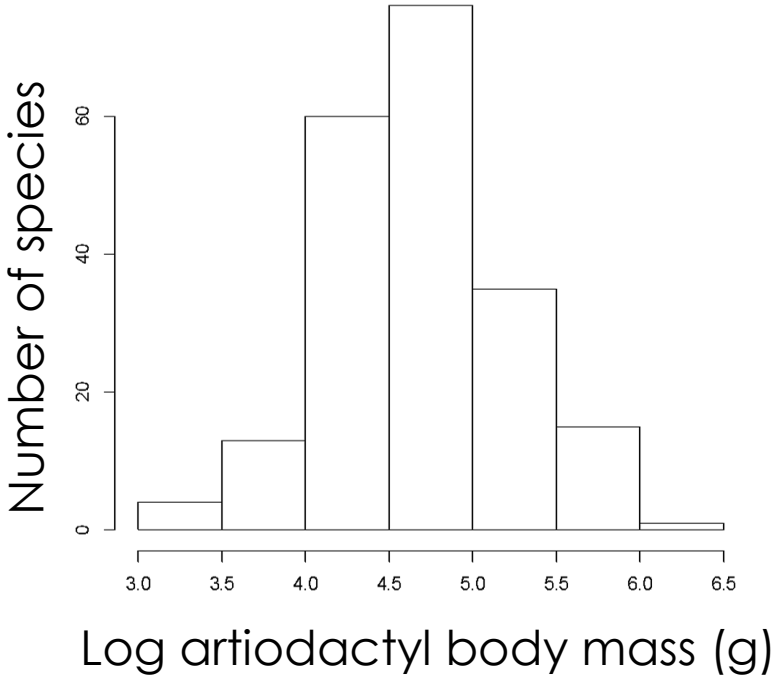
Why log transform data?

Many statistics assume the distribution of the data is normal (bell-shaped curve) but the distribution of trait data is often not normal – log transforming the data can help.

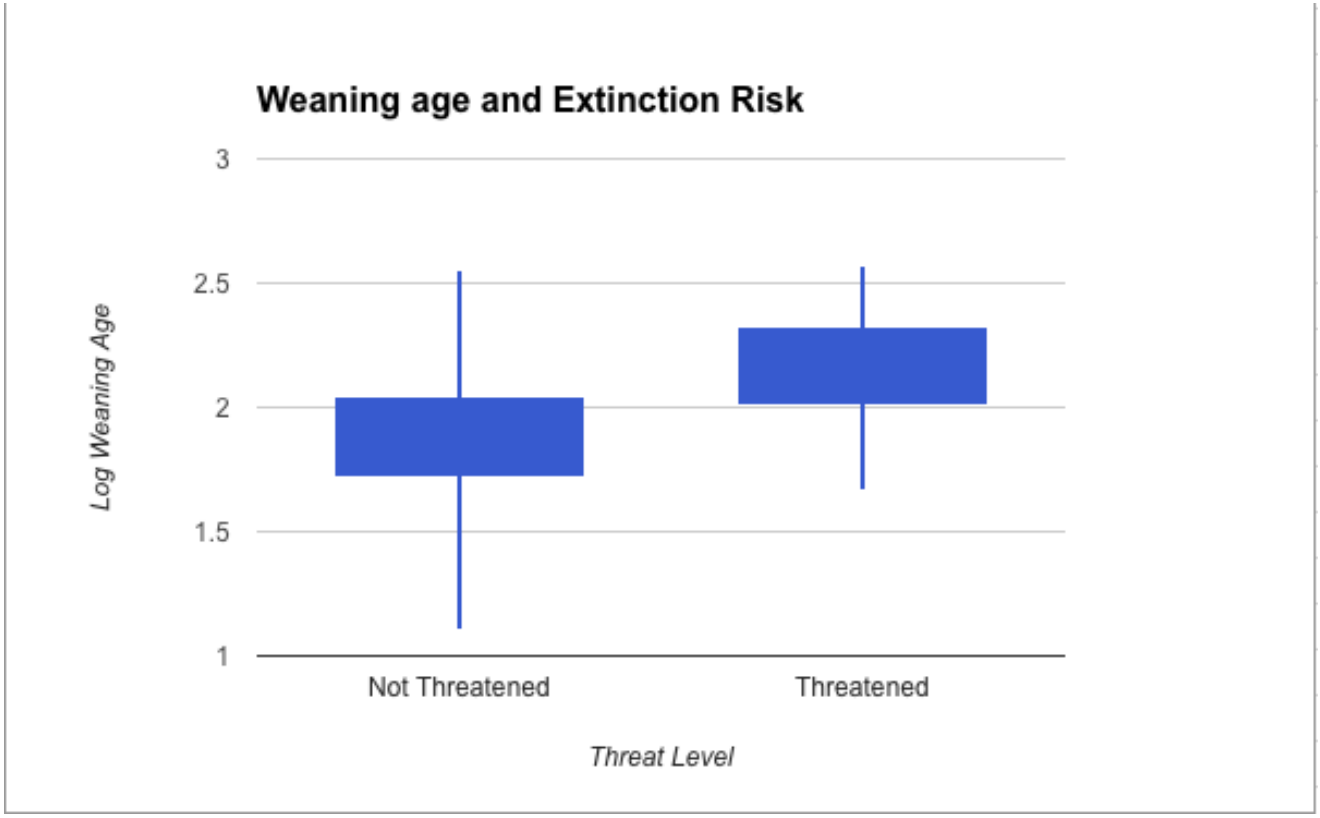
Not a normal distribution



Normal distribution

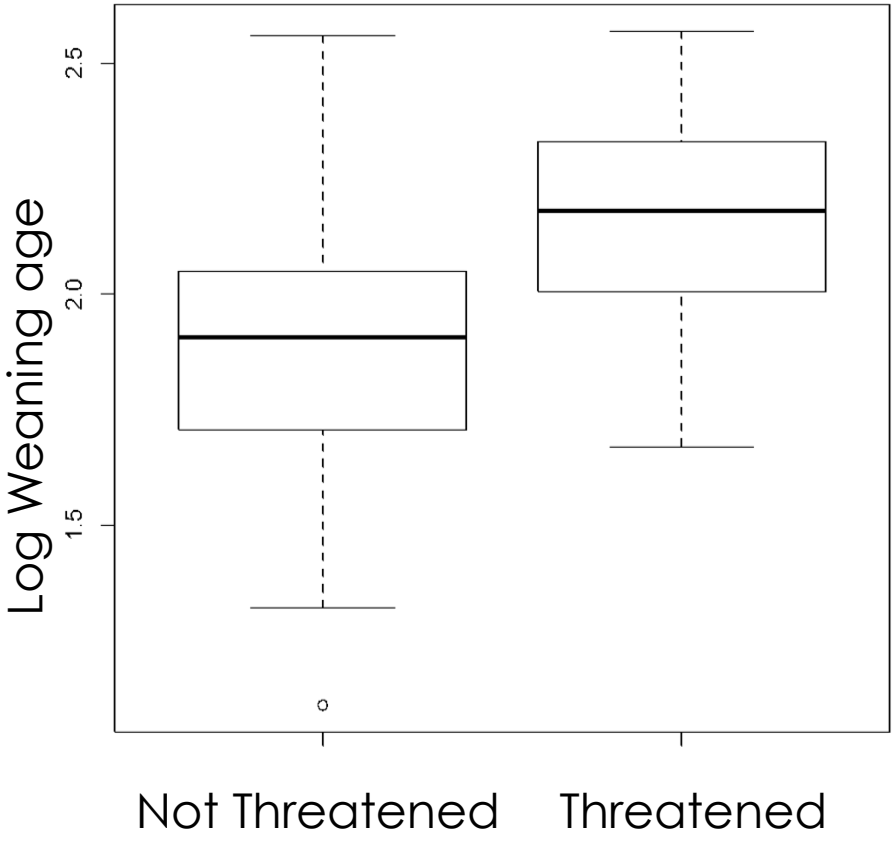


Extinction Risk by Weaning Age



What is a t-test

A t-test will tell you if there is a significant difference between the mean values in Threatened and Non-Threatened artiodactyls.



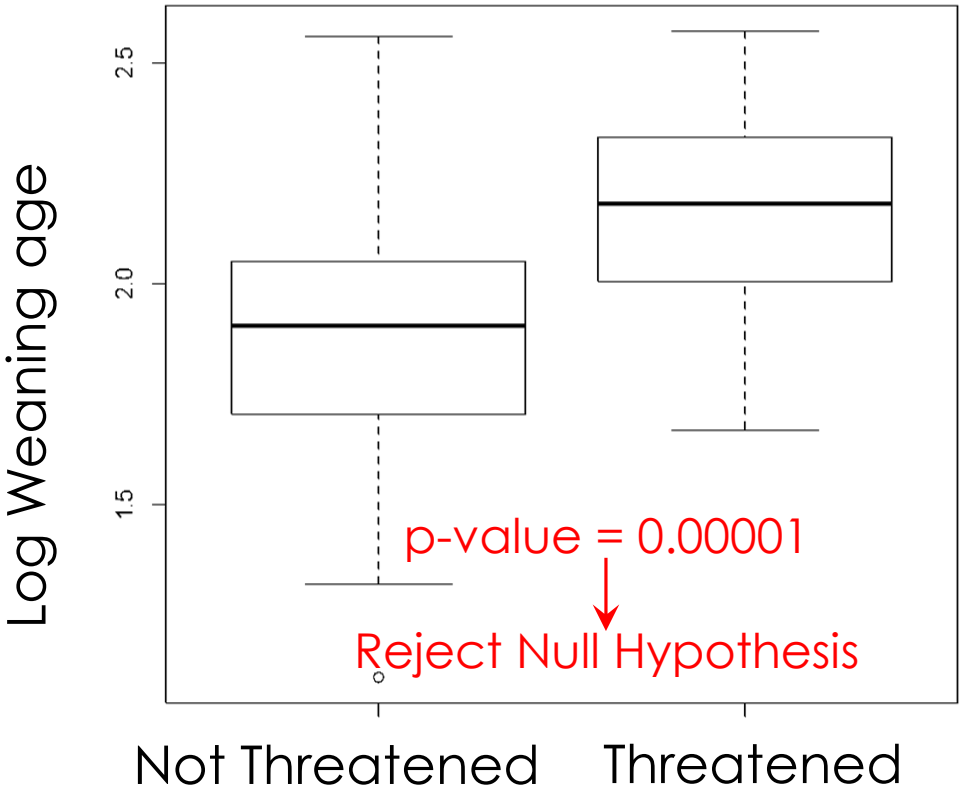
Mean weaning age of threatened species = 2.155

Mean weaning age of species that are not threatened = 1.895

This graphs shows that within artiodactyls, threatened species have older weaning ages.

Statistical significance

The statistical significance of the t-test is given by the p-value which is the probability of getting the observed relationship with random data in which threat has no effect on weaning age (this is the null hypothesis).

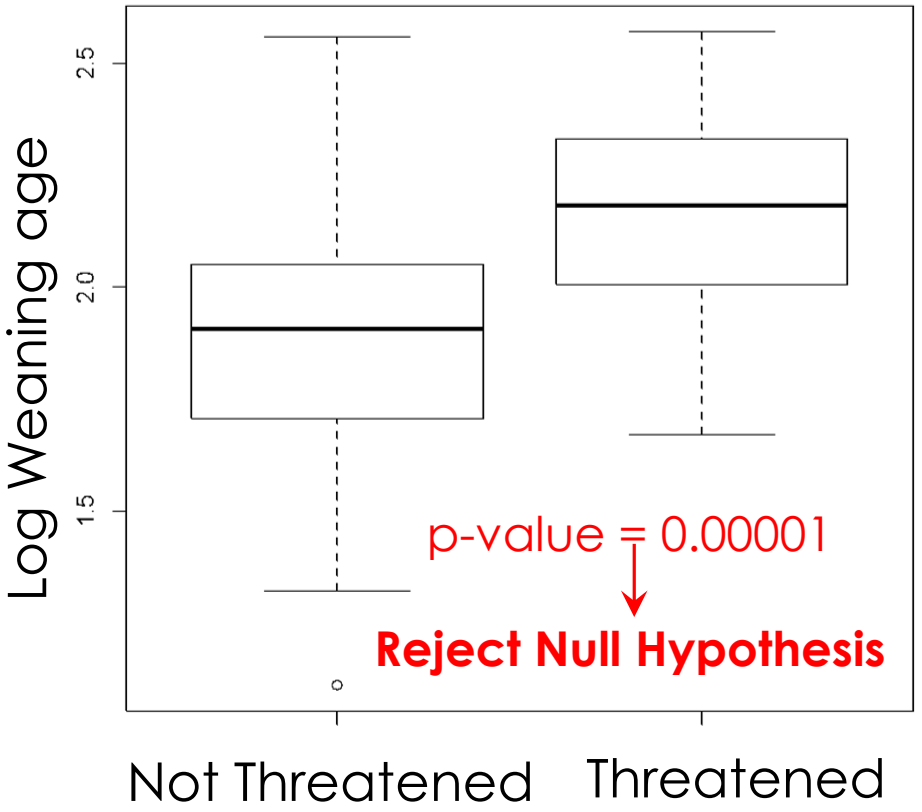


The standard for rejecting the null hypothesis is a 95% probability that the relationship was not generated by random data, so the p-value = <0.05

t-tests and Extinction Risk

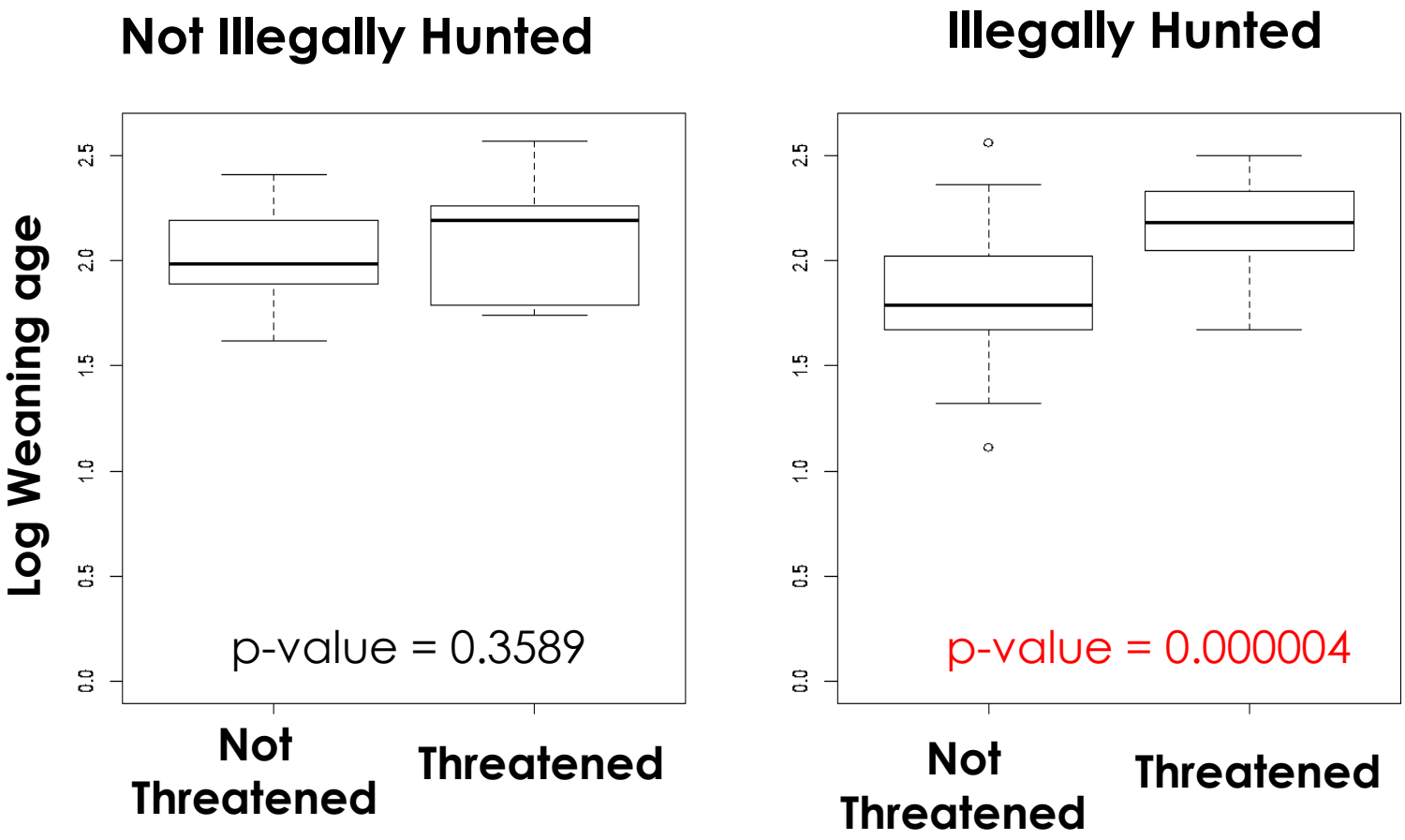
This kind of analysis is called data exploration; a scientist makes simple plots each time they generate a new dataset to find patterns or errors in the dataset.

Use the threat classification to create simple box plots and estimate the means in threatened and not threatened artiodactyls.

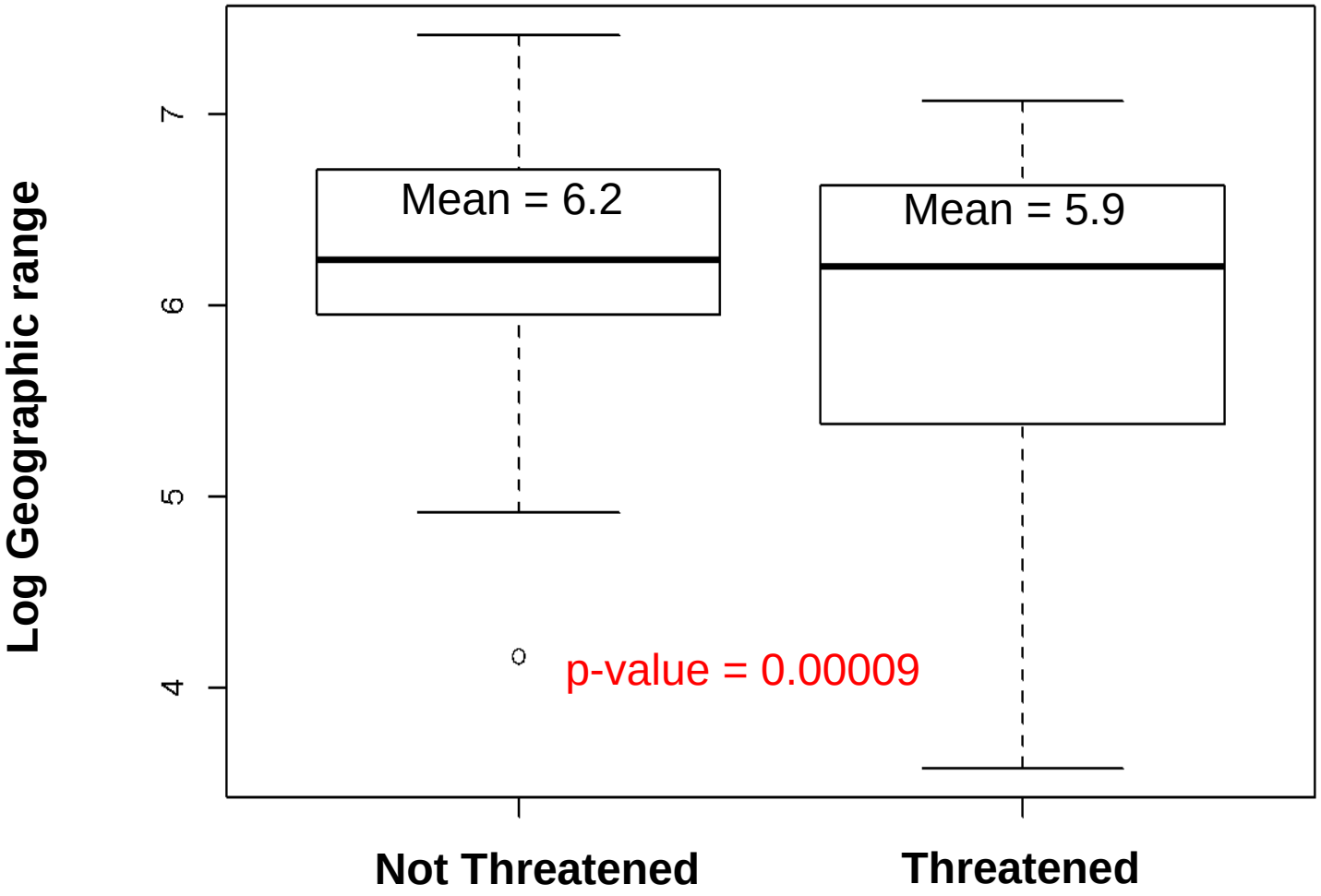


Slides for Wrap-Up Discussion

Reproductive rates matter more for illegally hunted species than for others

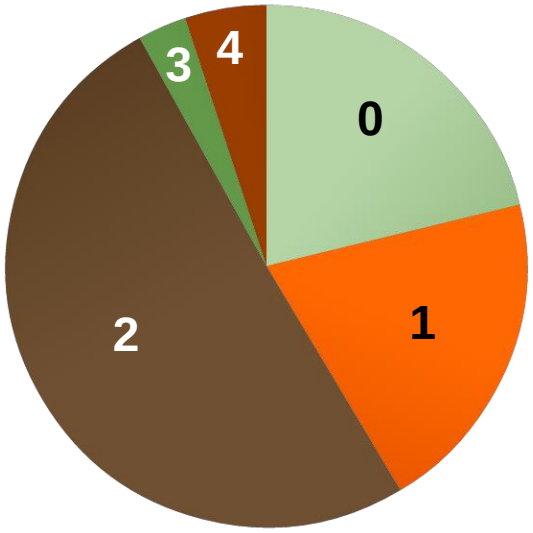


Broad Geographic Range Protects Species from Extinction

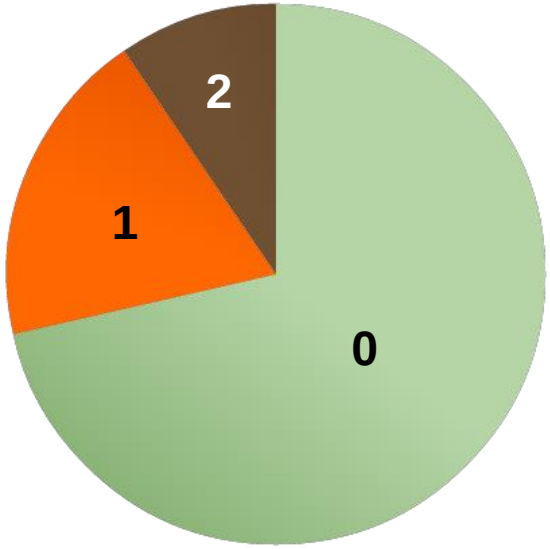


Phylogenetic patterning of threat

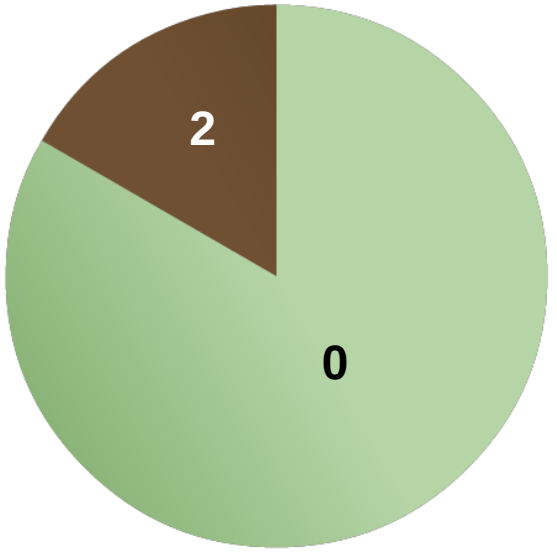
BOVIDAE:
antelope, sheep, cows etc.



CERVIDAE:
deer

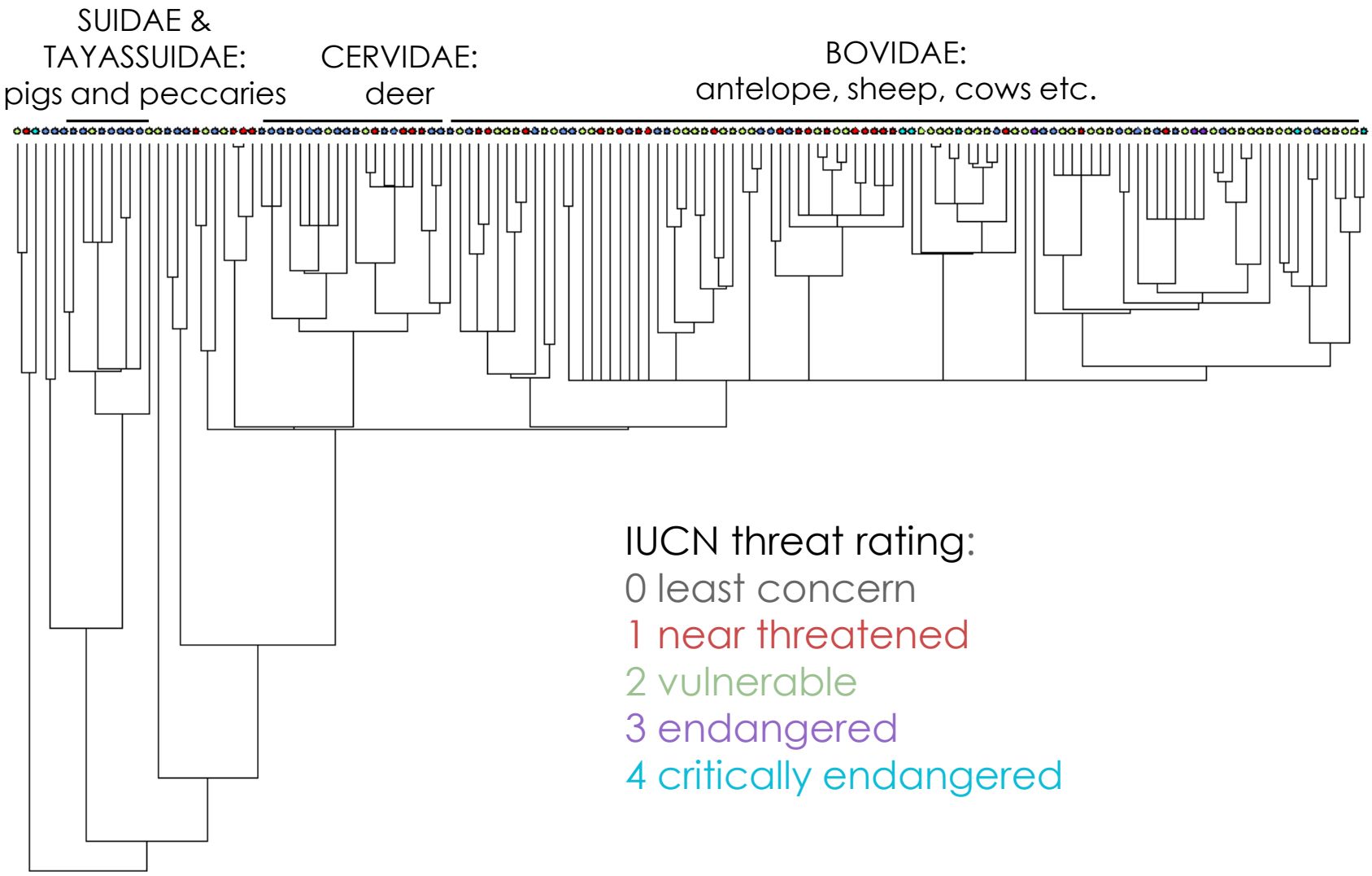


SUIDAE &
TAYASSUIDAE:
pigs and peccaries

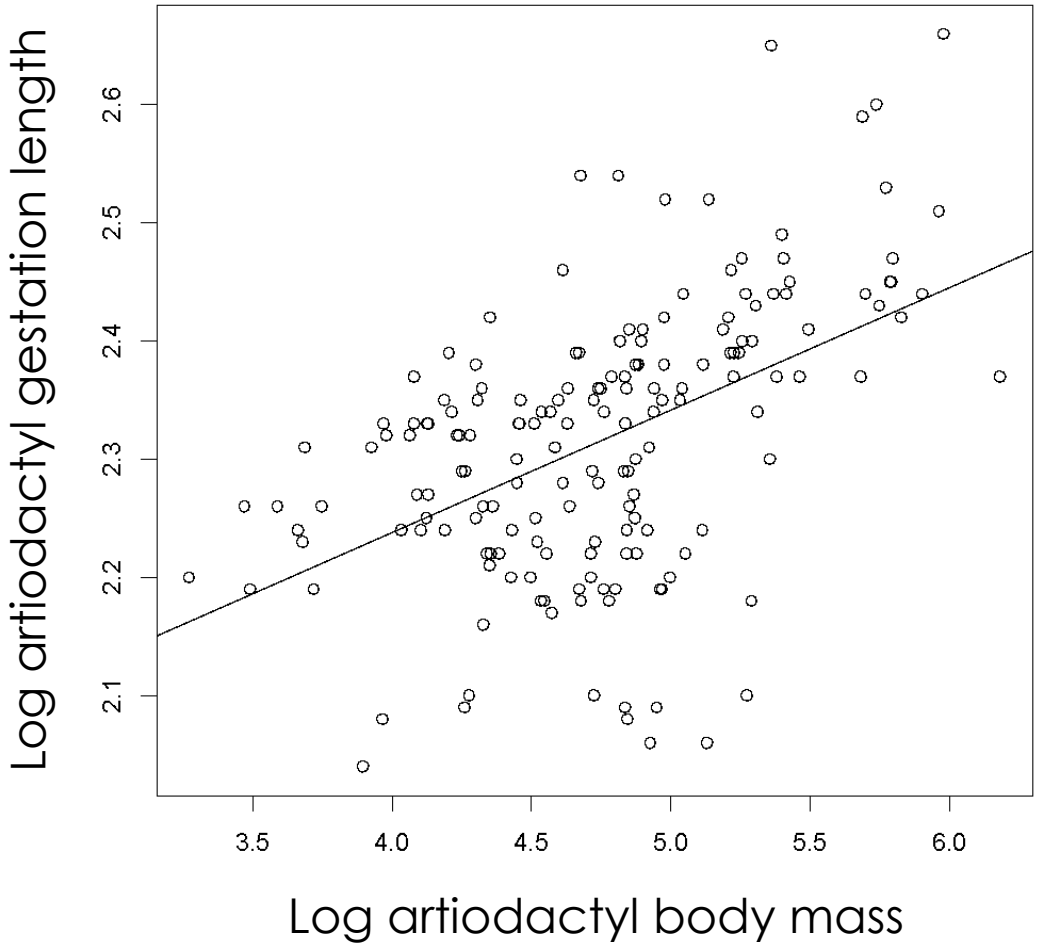


IUCN threat rating: **0 least concern**, **1 near threatened**, **2 vulnerable**, **3 endangered**, **4 critically endangered**

Phylogenetic patterning of threat



Body size is confounded with reproductive rate



Credits

1. mousedeer image: by UncaJon at http://www.flickr.com/photos/uncajon/3187637125/
2. muskdeer image: CC image at http://commons.wikimedia.org/wiki/File:Moschustier.jpg
3. deer image: by Bruno Girin at http://commons.wikimedia.org/wiki/File:Deer_at_Richmond_Park,_Surrey.jpg
4. giraffe image: by H. Zell at http://commons.wikimedia.org/wiki/File:Giraffa_camelopardalis_reticulata_01.JPG
5. pronghorn image: by James C. Leupold at http://commons.wikimedia.org/wiki/File:Pronghorn_Antelope_USFWS.jpg
6. antelope image: by Ikiwaner, from http://commons.wikimedia.org/wiki/File:Ngorongoro_Grant-Gazelle.jpg
7. peccary: by Nilfanion at http://commons.wikimedia.org/wiki/File:Collared_Peccary_in_Paignton_Zoo.jpg
8. Pig image: by USDA at http://commons.wikimedia.org/wiki/File:Sow_with_piglet.jpg
9. Camel image: by Tu7uh at http://commons.wikimedia.org/wiki/File:CamelZooMalaysia.jpg
10. Hippo image: by by Micha L. Rieser at http://commons.wikimedia.org/wiki/File:Hippopotamus_amphibius_-_Homosassa_Springs_Wildlife_State_Park,_Florida_-_2010-01-13.jpg
11. Hypothesis Slide http://undsci.berkeley.edu/teaching/misconceptions.php#a4