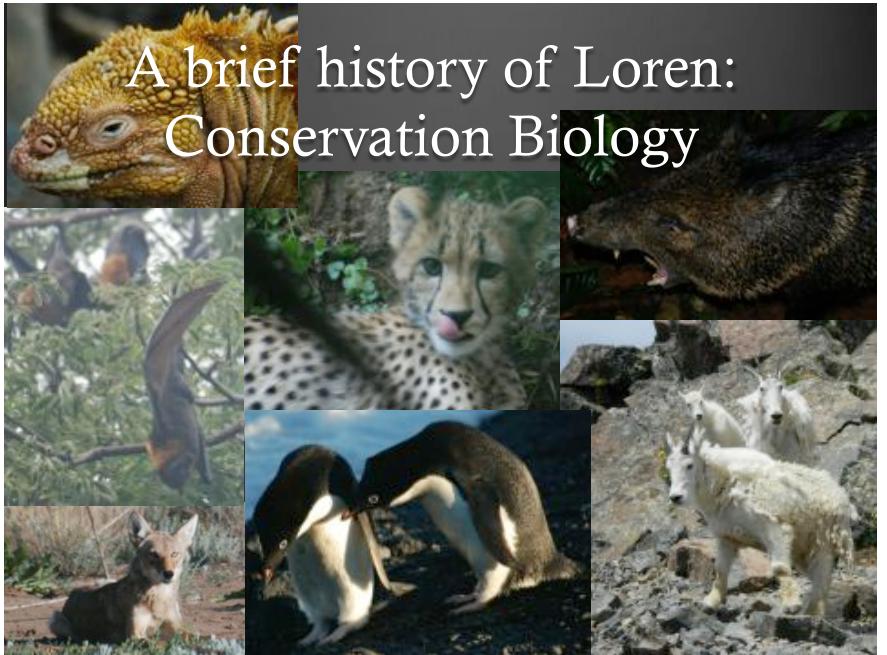


# Human-mediated evolution of wildlife

Loren C. Sackett  
Postdoctoral Fellow, NZP

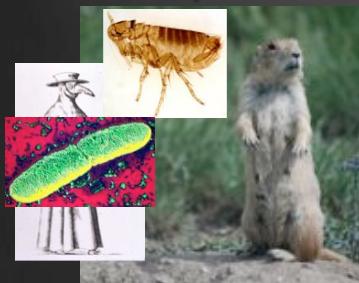
## A brief history of Loren: Conservation Biology



## A brief history of Loren: How do species adapt to introduced diseases?



✉ University of Colorado



✉ Smithsonian Genetics Lab



## A brief history of Loren

✉ [www.colorado.edu/ebio/sackett](http://www.colorado.edu/ebio/sackett)



## For this class...

- ⦿ Please interrupt me to ask questions!
- ⦿ Interactive = better

## For this class...



⦿ Today: How evolution works in nature

\* Aug 12: How humans influence evolution

\* Aug 19: How introduced pathogens influence evolution of hosts



## Understanding Evolution

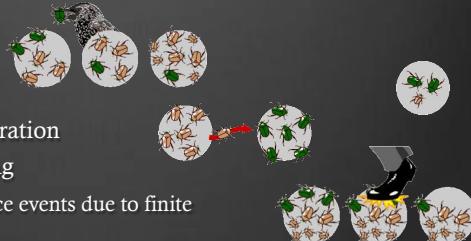
- ⦿ Some really great resources:
  - ⦿ Berkeley's Understanding Evolution website: [evolution.berkeley.edu](http://evolution.berkeley.edu)
  - ⦿ Steve Palumbi's book The Evolution Explosion
  - ⦿ Handout or email the last day, if you want

## Questions?

# Evolution in nature

- ❖ 5 basic ways evolution can happen:

- ❖ 1) natural selection
- ❖ 2) mutation
- ❖ 3) gene flow / immigration
- ❖ 4) non-random mating
- ❖ 5) genetic drift (chance events due to finite population size)



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## Evolution in nature: Natural Selection



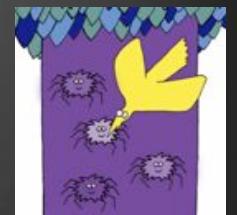
❖ <https://www.youtube.com/watch?v=RcQW-VJSWks>

## Evolution in nature: Natural Selection

- ❖ Moral of the spider story:

- ❖ Evolution = death

*Task: Make a list of everything that could kill you if you were forced to live in the wilderness in your home state*



Most things die young— usually >50% before reproductive age



## Evolution in nature: Natural Selection

- ❖ **Fitness** = the # of offspring an individual produces that survive to reproduce



Alternative views of fitness:

- The # of grandchildren an individual produces
- Likelihood of surviving to produce offspring

Best **fit** to the current environment –things don't (usually) die randomly; they die if they aren't suited to the environment. That is, individuals with the highest fitness survive. Fitness is relative.



## Evolution in nature: Natural Selection

- ❖ Differential Fitness results from individuals with a certain **phenotype** having more surviving offspring

- ❖ **Phenotype** = a physical characteristic of an individual

- ❖ Color, sprint speed, strength, number of hair follicles, hormone balance, shape of ears, type of taste buds, etc.

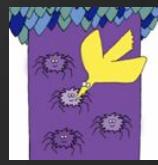
- ❖ **Phenotype** → determined by **genotype** (the set of genes that control a trait)



## Evolution in nature: Natural Selection

- ❖ Differential Fitness results from individuals with a certain **phenotype** having more surviving offspring

- ❖ A particular **phenotype** may confer higher survival, more offspring, or better offspring



- ❖ Which was conferred by the dark spider coloration?



## Evolution in nature: Natural Selection

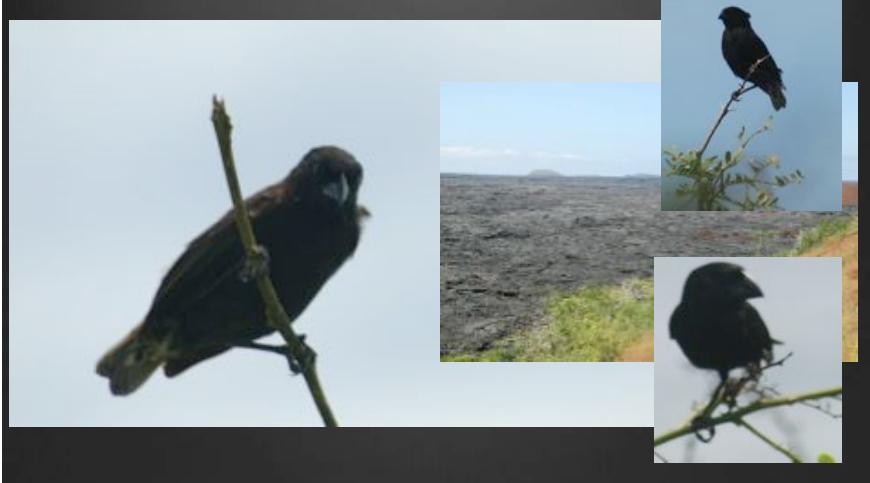
- ❖ Heritability: Offspring have the same **alleles** (versions of a gene) as their parents, and they will tend to have similar **phenotype** (a combination of Mom + Dad)

- ❖ THIS is how evolution happens! Change in a **phenotype** like color is cumulative—spiders get darker each generation.

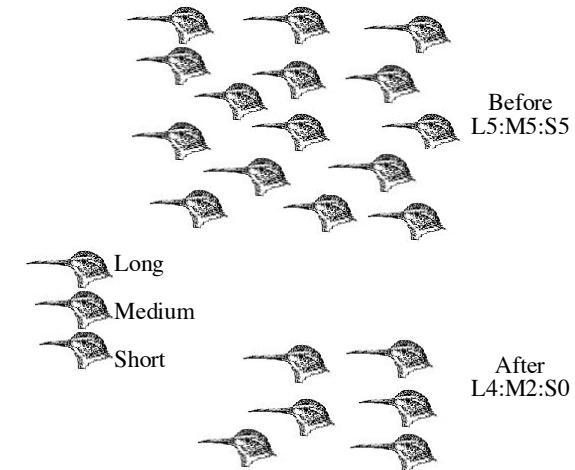




## Evolution in nature: Natural Selection



## Evolution in nature: Natural Selection



## Evolution in nature: Natural Selection

Task: Describe the **phenotype** of the most **fit** gazelle in a population.  
What about the phenotype of the most fit (female) lion? Desert globemallow?



- ⌘ There are costs to adaptations. Very often, you can't be the quickest runner AND the strongest hunter; you can't be the best at protecting offspring AND the best at providing food for them
- ⌘ Fitness is maximized with a balancing act



## Evolution in nature: Natural Selection

- ⌘ Sexual selection: females often choose the males they think are going to be the best providers for their offspring or the donors of the best genes





## Evolution in nature: Natural Selection

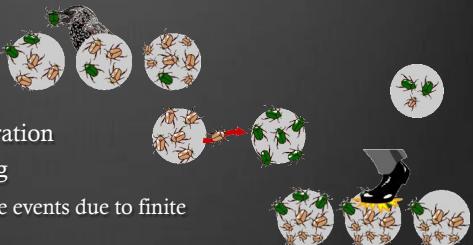
- ❖ Selection occurs over multiple generations, and changes are cumulative
- ❖ (spider color got darker over time, not just immediately)—the spider babies that survived were a little bit darker than their parents, and the grandchildren that survived were darker yet.



## Evolution in nature

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## Evolution in nature: Natural Selection

- ❖ Questions about natural selection?

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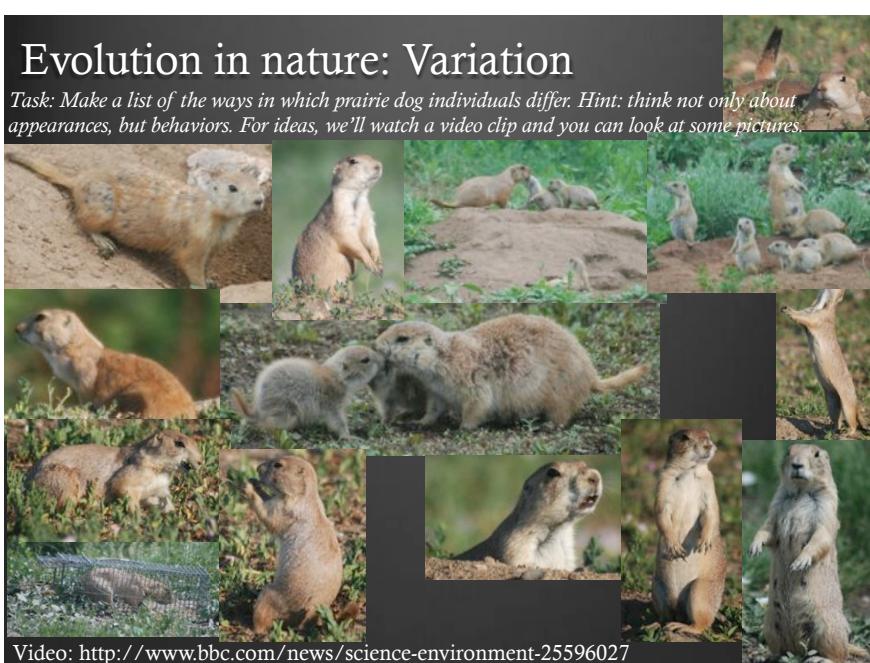
## Evolution in nature: Mutation and Variation

- ✿ Variation in nature is ubiquitous – every individual is different
- ✿ This is how natural selection can work (if everyone were identical, evolution could not occur)



### Evolution in nature: Variation

*Task: Make a list of the ways in which prairie dog individuals differ. Hint: think not only about appearances, but behaviors. For ideas, we'll watch a video clip and you can look at some pictures.*

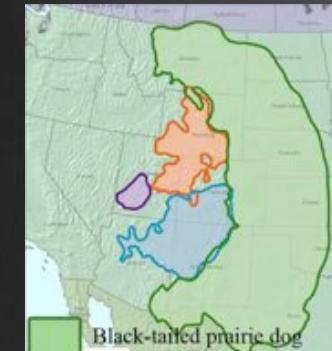


Video: <http://www.bbc.com/news/science-environment-25596027>



## Evolution in nature: Mutation and Variation

- ✿ Case study of variation among individuals of the same species: Black-tailed prairie dogs



### Evolution in nature: Why is Variation Important?

- ✿ There are thousands of ways in which individuals vary, including ways we notice only subconsciously.
- ✿ These variations will often influence how likely an individual is to survive or reproduce





## Evolution in nature: How bad are Mutations?

### Population

ATGTGATGATC

ATGTGATGATC

ATGTGATGATC

ATGTGATGATC

ATGTGATGATC

ATGTGATGATC

### Mutation

ATGTGATGATC

AT~~T~~GATGATC

ATGTGATGATC

ATGTGAC~~G~~ATC

ATGTGATGATC

AT~~A~~AGATGATC

### Selection



## Evolution in nature: How bad are Mutations?



## Evolution in nature: Mutation and Variation

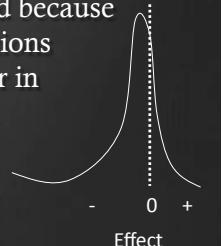
### ⊗ Is evolution random?

- ⊗ The *occurrence* of mutations is random (all nucleotides in a genome have an equal probability of undergoing mutation), but the *persistence* of mutations is not. Why?
- ⊗ Natural selection will remove mutations that have a negative effect on fitness



## Evolution in nature: How bad are Mutations?

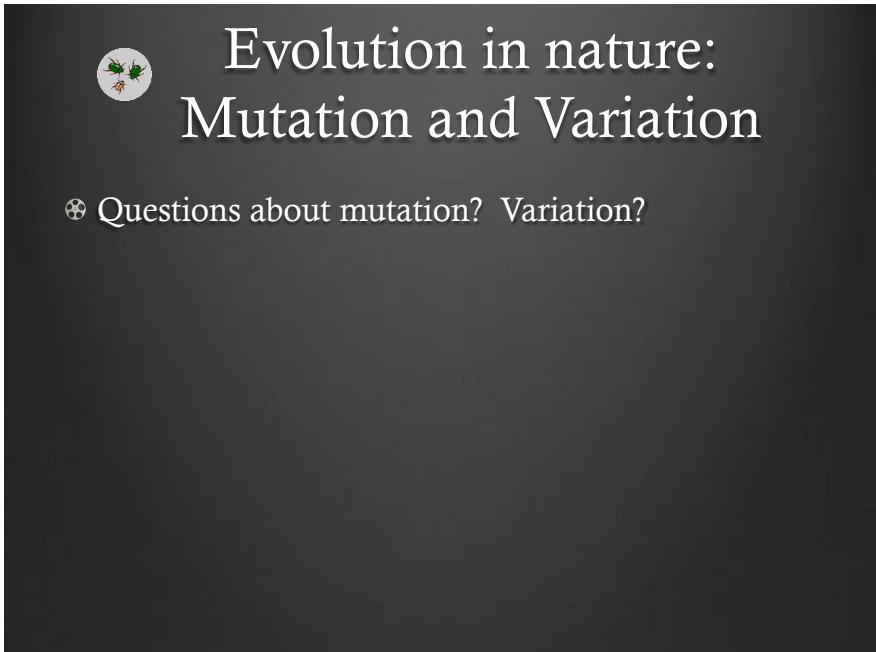
- ⊗ Thus, for an individual (gamete), mutations are usually bad.
- ⊗ For the species as a whole, mutations are good because the really bad ones don't survive. Other mutations generate variation that might be useful later or in another environment.





## Evolution in nature: Mutation and Variation

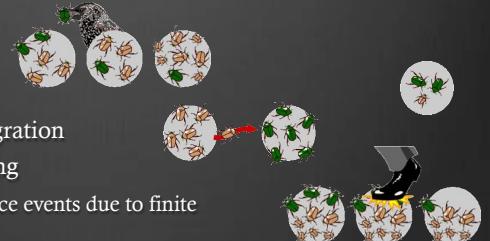
- ❖ Questions about mutation? Variation?



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## Evolution in nature: Gene Flow

- ❖ Gene flow = immigration

- ❖ Introduces variation from a different place



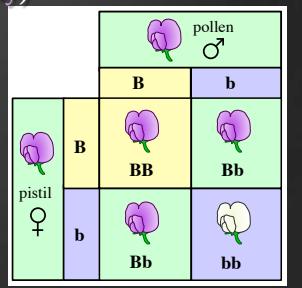
- ❖ Prevents inbreeding



## Evolution in nature: Gene Flow

- ❖ How does gene flow prevent inbreeding?

“Closed” populations inevitably experience a reduction in within-individual variation (heterozygosity)



## Evolution in nature: Gene Flow

- ❖ Too much gene flow can be bad if it erodes local adaptation (hybridization)



## Evolution in nature: Gene Flow

- ❖ Too much gene flow can be bad if it erodes local adaptation (hybridization)
- ❖ Too little gene flow can be bad if it leads to inbreeding



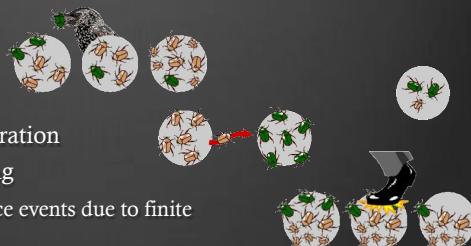
## Evolution in nature: Gene Flow

- ❖ Questions about gene flow?

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## Evolution in nature: Non-random mating

- ❖ How do individuals choose mates? It is usually not random.
- ❖ In humans, there is **assortative mating** by height and **dissassortative mating** by MHC.



## Evolution in nature: Non-random mating



- ❖ What senses are the most important for choosing mates in mammals? In birds?
- ❖ What role does behavior play?
  - ❖ Aggression, showing off, sociality

## Evolution in nature: Non-random mating



- ⊗ The phenomenon of non-random mating, in terms of evolution, does not refer to the fact that individuals choose mates based on a characteristic (e.g., they are pretty), but that individuals choose mates who are more similar (**assortative mating**) or more different (**disassortative mating**) to themselves than expected by chance.

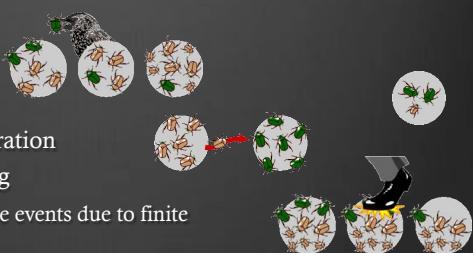
## Evolution in nature: Non-random mating

- ⊗ Questions about non-random mating?

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## Evolution in nature: Genetic Drift

- ✿ Genetic drift = the increase or decrease in frequency of an allele due to chance events
- ✿ This happens in small populations



## Evolution in nature: Genetic Drift

- ✿ Questions about drift?

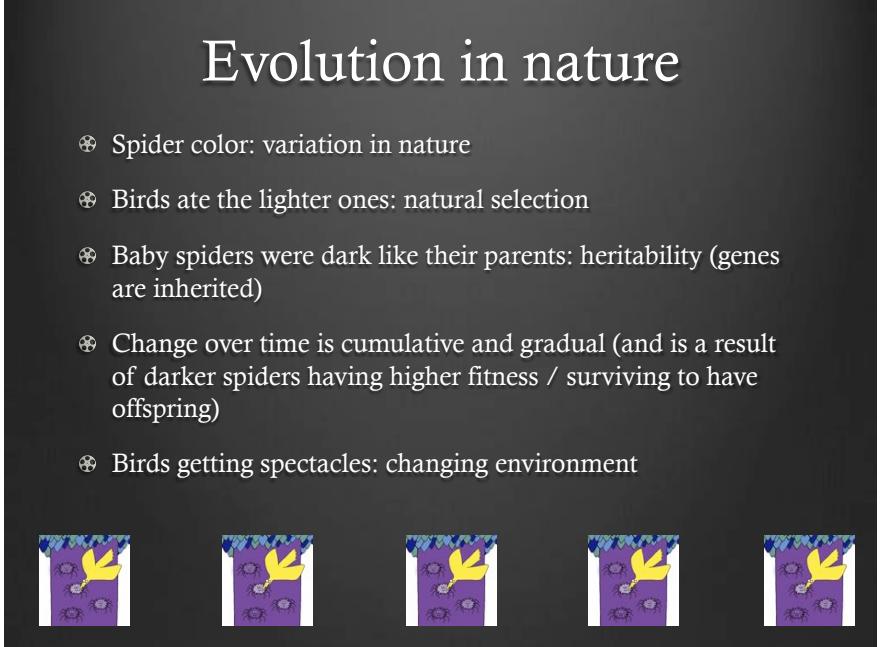


## Evolution in nature: Genetic Drift

- ✿ Can you think of some other examples of chance events that could cause alleles to be lost in small populations?



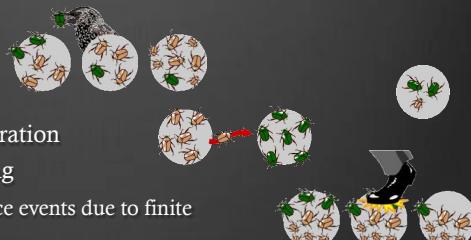
- ✿ Genetic drift simulator:  
[http://www.biology.arizona.edu/evolution/act/drift/  
simulation.html](http://www.biology.arizona.edu/evolution/act/drift/simulation.html)



# Evolution in nature

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Now we can talk about how these processes translate to *species*

# Evolution in nature: Species

- ⌘ Selection + mutation + immigration + non-random mating
  - ⌘ → result in **adaptation** to an environment

What is an **adaptation**?

We usually think of **adaptations** as morphological features that make a species suited to its environment. This includes the biotic environment (e.g., an orchid is part of a fly's environment).

## Evolution in nature: Species

Good examples of **adaptation** are things we consider weird



What environment/ conditions are these organisms adapted to?



# Evolution in nature: Species

Icons of adaptation (from Google Images)



What environment/  
conditions are these  
organisms adapted  
to?

# Evolution in nature: Species

Icons of adaptation (from Google Images)



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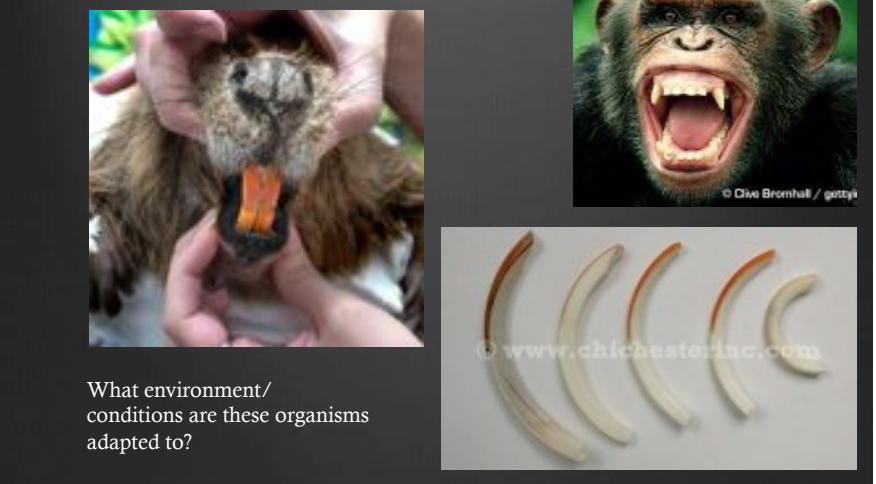
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What environment/  
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# Evolution in nature: Species

Icons of adaptation (from Google Images)



What environment/  
conditions are these organisms  
adapted to?

# Evolution in nature: Species

*Task: Pick your favorite species (not domesticated) and make a list of adaptations.*

Remember, adaptations are the features themselves (but you can also describe WHY they are adaptations / what environment the species is adapted to).

*If you get stuck, think about what is unique about that species—it's probably an adaptation!*

# Evolution in nature: Species

Remember that **adaptations** are environment-specific.

Penguins are exceptional swimmers and incredible cold-tolerators (they have morphological & behavioral adaptations to the cold).



## Evolution in nature

- ✿ Now you have a good understanding of evolution in nature (in the absence of humans), and we are ready to discuss how humans influence these processes.
  
- ✿ More questions?



## Evolution under human influence

*Activity: Go on a hunting trip on the table in front of you and select the elk you will kill to bring back for food, mounting on your wall, or other purpose.*

