

CSI: Changing Species Investigation

Tuskless Elephants

This file contains real data about elephant populations. Is there evidence of natural selection? You're on the case!

Species Profile

African elephants are sometimes **poached**, or illegally hunted, for their ivory **tusks**. The ivory is carved into ornaments and jewelry. Adult elephants have the biggest tusks, so elephants are often killed around the age they would have calves (babies). Some elephants never grow tusks at all, so they are not killed for ivory.

Poaching is happening less in some places, but in others it's still a big problem for elephant populations.



Is the tuskless trait helpful, harmful, or neutral?

Circle the most likely answer for each environment.

1. In the time before poaching, the tuskless trait was (**helpful / harmful / neutral**) to an elephant.
2. In the present with poaching, the tuskless trait is (**helpful / harmful / neutral**) to an elephant.

Prediction

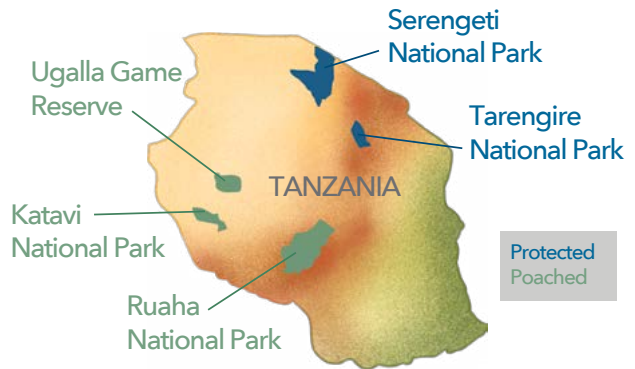
Write a sentence about how **poaching** may affect the **tuskless trait** in elephant populations:

Have elephant populations changed over time?

To find out, you would ideally compare tusklessness in today’s herds to tusklessness in historic herds. But while we know tusklessness used to be rare, we don’t have exact numbers.

There are some modern herds in protected parks that experience low poaching. They can represent historic herds in your study.

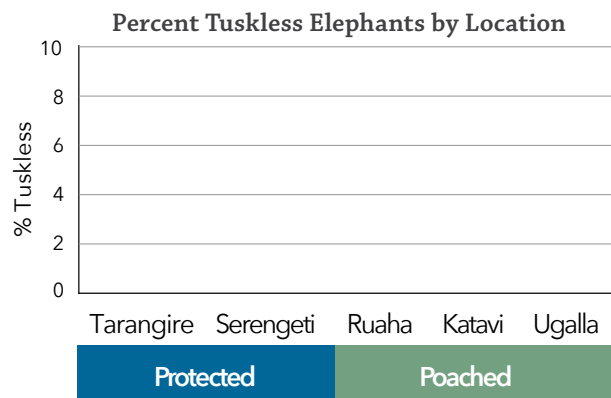
Time to do some field work! You travel to different parks in Tanzania and count elephants with and without tusks.



Let’s analyze your data!

Complete the table (calculate the percent of tuskless elephants). Then make a bar graph of your findings.

Elephant Population	Total Elephants	Tuskless Elephants	Percent (%) Tuskless
Tarangire	443	4	
Serengeti	364	5	
Ruaha	329	23	
Katavi	413	26	
Ugalla	153	15	



Summarize the evidence. Complete the summaries by circling the correct words:

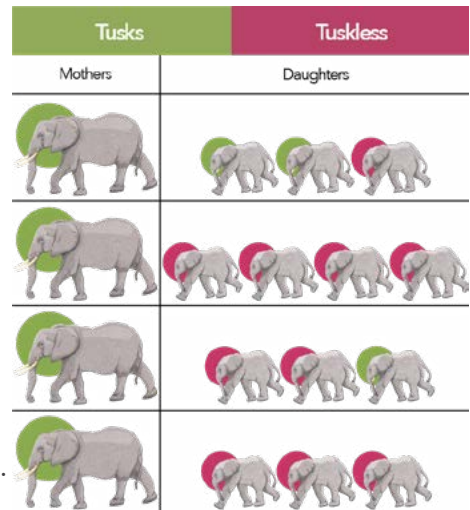
- In poached populations, the percent of tuskless elephants is (**lower / higher**) than in protected populations.
- The evidence suggests that the tuskless trait has become: (**more common / less common / stayed the same**).
- Does the evidence suggest tusklessness in elephant populations is influenced by poaching? (**yes / no**)

Is the tuskless trait inherited?

While you investigated parks in Tanzania, other researchers observed elephants in South Africa’s Addo National Park. The herd is protected now, but was once heavily poached. Nearly all the females are tuskless. The image below shows the **only** mothers that **do** have tusks and their daughters.

Count the daughters and fill in the top row of the table.

Mothers	Total Number of Daughters	Number of Tuskless Daughters	Number of Tusked Daughters
Tusked			
Tuskless	161	160	1



Summarize the evidence:

Calculate from the top row of the table...

6. **Tusked** mothers have **tuskless** daughters _____ % of the time.

7. **Tusked** mothers have **tusked** daughters _____ % of the time.

Calculate from the bottom row of the table...

8. **Tuskless** mothers have **tuskless** daughters _____ % of the time.

9. **Tuskless** mothers have **tusked** daughters _____ % of the time.

10. The evidence suggests the tuskless trait is (**heritable / acquired**).

Is it natural selection?

Write 2-3 sentences to explain your thinking:

CSI: Changing Species Investigation

Insecticide-resistant Bedbugs

This file contains real data about bedbug populations. Is there evidence of natural selection? You're on the case!

Species Profile

Bedbugs are blood-sucking insects. They hide in bedding and furniture during the day, and sneak out to feed at night. A bedbug bite causes an itchy rash.

Bedbugs were a problem until the 1950s. Then a strong insecticide was invented, and they mostly disappeared. For a long time, "sleep tight, don't let the bedbugs bite" was nothing more than a children's rhyme.

Now bedbugs are back. The insecticide that nearly killed them off isn't used anymore because it's bad for the environment. New, safer insecticides worked at first. But as they're used more, they don't work as well. The ability of a bedbug to survive insecticide toxins is a trait called insecticide resistance (IR).



Is the IR trait helpful, harmful, or neutral?

Circle the most likely answer for each environment.

1. Before insecticides were invented, the IR trait was (**helpful / harmful / neutral**) to a bedbug.
2. Today with insecticide use, the IR trait is (**helpful / harmful / neutral**) to a bedbug.

Prediction

Write a sentence about how ***insecticide use*** may affect the ***IR trait*** in bedbug populations:

Have bedbug populations changed over time?

To find out if IR in bedbugs has changed, you'll compare bedbugs that have been exposed to modern insecticide to those that have not.

Your research team collects bedbugs from cities in Michigan and Ohio where bedbugs have made a comeback. You also have a lab population that was collected from New Jersey 30 years ago. It has never been exposed to modern insecticides. In your notes, you'll refer to each population by where it came from:

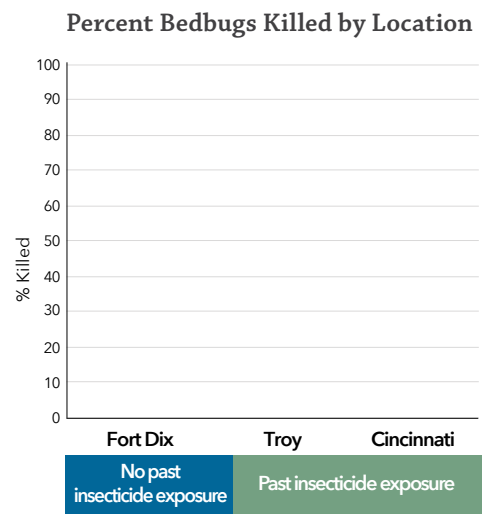
- Fort Dix, New Jersey: no insecticide exposure
- Troy, Michigan: exposed to insecticide
- Cincinnati, Ohio: exposed to insecticide

You applied 1,000 nanograms of insecticide to representatives from each bedbug population, then counted how many bedbugs were killed.

Let's analyze your data!

Fill in the table and make a bar graph of your findings.

Bedbug Population	Number Treated	Number Killed	Percent (%) Killed
Fort Dix	60	60	
Troy	60	16	
Cincinnati	60	17	



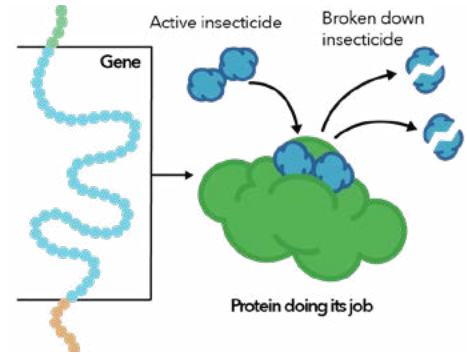
Summarize the evidence. Complete the summaries by circling the correct words:

- The IR trait is (**lower / higher**) in exposed bedbugs, compared to non-exposed bedbugs.
- Evidence suggests the IR trait has become (**more common / less common / stayed the same**).
- Does the evidence suggest the IR trait in bedbug populations changed over time from insecticide use? (**yes / no**)

Is insecticide resistance inherited?

Insects with IR often have proteins that can quickly break down the insecticide, before it has toxic effects. Proteins are coded for by genes, which pass from parents to their offspring.

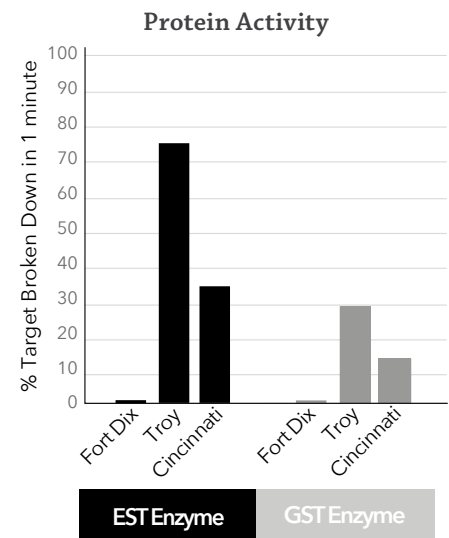
You want to find out if protein differences are causing the IR trait in bedbugs.



From each bedbug population, you collect two proteins: EST and GST. Then, you test each protein’s ability to break down insecticide. To do that, you test how much of the protein’s target it can break down in 1 minute.

Summarize the evidence. Complete the summaries by circling the correct words:

- Proteins that break down insecticide are **(more active / less active)** in exposed bedbugs, compared to non-exposed bedbugs.
- The evidence suggests the IR trait is **(heritable / acquired)**.



Is it natural selection?

Write 2-3 sentences to explain your thinking:

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Tail white in juncos

This file contains real data about junco populations. Is there evidence of natural selection? You're on the case!

Species Profile

You can find dark-eyed juncos in the mountains of the American West. They hop about the forest floor, making a "chip chip" sound.

Individual juncos have different amounts of white in the feathers along the edges of their tails (we'll call this the **tail white** trait). When male juncos court females, they fan out their tails to show off their white feathers. Females prefer mates with more tail white.

In 1983, a group of juncos moved from the mountains to the coastal area around the University of California San Diego (UCSD). Their descendants still live there. Local birdwatchers have noticed these birds look a little different. Males have less tail white.



The coastal birds have a different lifestyle from their mountain cousins. The mild climate makes their breeding season longer, and they can raise up to four broods each year (mountain birds usually raise one). The coastal birds are also less crowded, and birds are visible across greater distances. Most males find a mate.

Is the tail white trait helpful, harmful, or neutral?

Circle the most likely answer for each environment.

1. In the past when all juncos lived in the mountains, the tail white trait was (**helpful** / harmful / **neutral**) to a bird.
2. In today's coastal population, the tail white trait is (**helpful** / harmful / **neutral**) to a bird.

Prediction

Write a sentence about how the environment (for example, *mate preference*) may affect the **tail white** trait in junco populations:

Has the bird population changed over time?

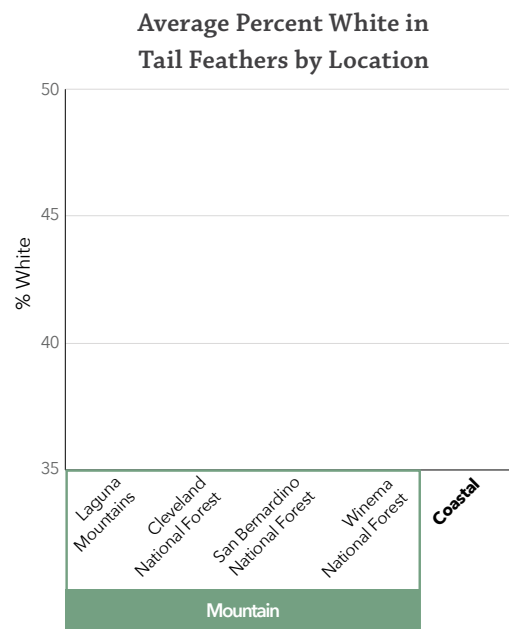
To find out if tail white has changed, you would ideally compare the trait in today’s coastal birds to their ancestors soon after they arrived from the mountains. But since you can’t travel back in time, the next best thing is to compare the coastal birds to their mountain cousins.

You catch 10-27 male birds from each study site, photograph their tail feathers, and release the birds. Then you measure the percent of white in each bird’s tail from your photos. The table on the next page lists your measurements for representative birds from each location.

Let’s analyze your data!

Fill in the table and make a bar graph of your findings.

Location	% White in Tail of Representative Birds	Average % White in Tail
Laguna Mountains	52, 46, 48, 37, 39	
Cleveland National Forest	50, 50, 45, 37, 48	
San Bernardino National Forest	51, 43, 57, 36, 29	
Winema National Forest	37, 35, 35, 52, 43	
Coastal	43, 30, 32, 37, 38	



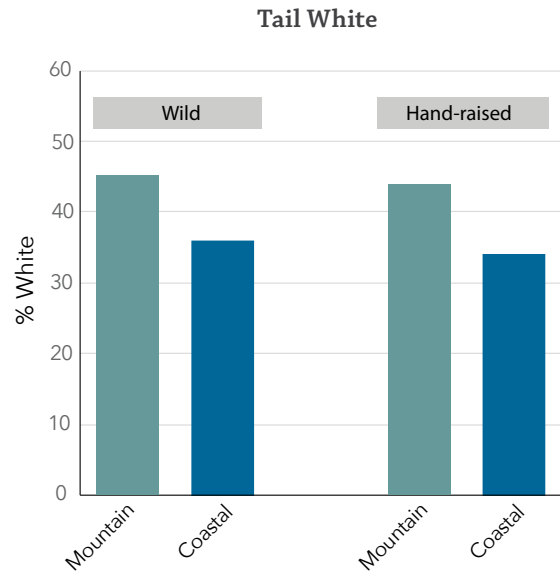
Summarize the evidence. Complete the summaries by circling the correct words:

- The percent white in tail feathers is (**lower / higher**) in coastal birds, compared to their mountain cousins.
- If mountain birds represent past populations, and coastal birds the present, the percent of white tail feathers has (**increased / decreased / stayed the same**).
- Does the evidence suggest tail white in junco populations is influenced by the environment they live in? (**yes / no**)

Is tail white inherited?

To test if tail white is inherited, you gather eggs from nests in the mountains and the coast. Then you care for them in identical conditions.

When the chicks reach adulthood, you compare the tail feathers of hand-raised and wild birds. Your data is shown on the graph.



Summarize the evidence. Complete the summaries by circling the correct words:

6. For hand-raised vs. wild birds, tail white is **(different / about the same)**.
7. For hand-raised coastal vs. hand-raised mountain birds, tail white is **(different / about the same)**.
8. The evidence suggests tail white is **(heritable / acquired)**.

Is it natural selection?

Write 2-3 sentences to explain your thinking:

CSI: Changing Species Investigation

Winged aphids

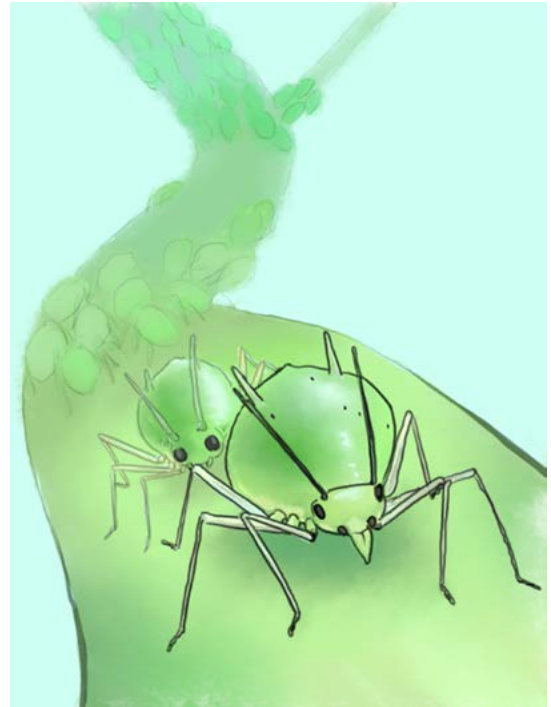
This file contains real data about aphid populations. Is there evidence of natural selection? You're on the case!

Species Profile

Aphids are tiny insects that suck sap from plants. They're the opposite of picky eaters! If you have a garden, take a close look at any plant. There's a good chance you'll find aphids.

Aphids reproduce quickly. A mother can have around 80 nymphs (young offspring) in a week. The nymphs take about a week to grow up, then they have offspring of their own.

Most aphids don't have wings. They tend to live on the plant where they were born. It gets crowded fast. Sometimes there are so many that they literally suck the life out of the plant. Not surprisingly, gardeners have watched aphids closely. And they noticed something. When the aphids got crowded, some developed wings as they grew up. The winged aphids could fly away to new plants.



Is the winged trait helpful, harmful, or neutral?

Circle the most likely answer for each environment.

1. Before a plant gets crowded, the winged trait is (**helpful** / harmful / neutral) to an aphid.
2. When a plant gets crowded, the winged trait is (**helpful** / harmful / neutral) to an aphid.

Prediction

Write a sentence about how **crowding** may affect the **winged trait** in aphid populations:

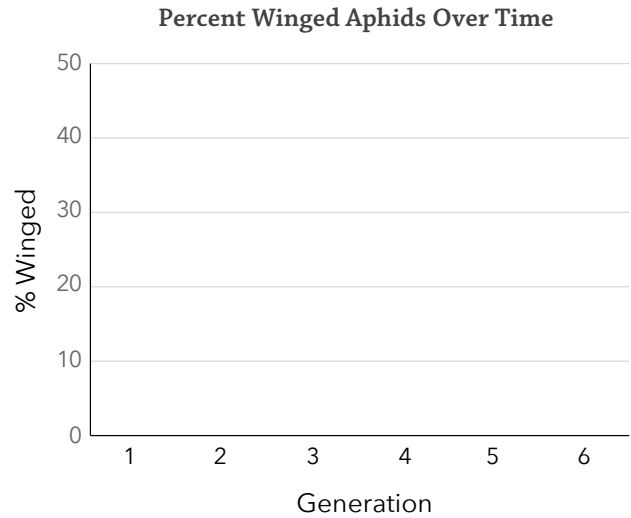
Have aphid populations changed over time?

To test if the winged trait in aphids can change, you collect some wingless adults. You spread them out on healthy plants then watch for six generations as the aphids reproduce and become more crowded. For every generation, you count the number of insects with wings.

Let's analyze your data!

Fill in the table and make a bar graph of your findings.

Generation	Total Aphids	Winged Aphids	Percent (%) Winged Aphids
1	15	0	
2	54	0	
3	63	0	
4	124	7	
5	150	44	
6	208	89	



Summarize the evidence. Complete the summaries by circling the correct words:

- The percent of winged aphids is (**lower / higher**) as insects become more crowded.
- The winged trait has become (**more common / less common / stayed the same**).

Observation

While doing your experiment, you also tracked what happened when the winged aphids flew away to non-crowded plants. The winged aphids had only wingless nymphs! In fact, you didn't see any more winged aphids until a few generations later when the insects were crowded once again.

Interpretation: Write a sentence that may explain your observation:

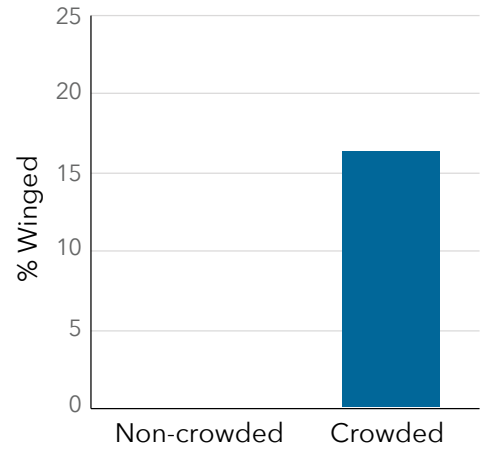
Are aphid wings inherited?

To find out if wings are inherited, you let nymphs from wingless mothers grow up in either crowded or non-crowded conditions. After lots of counting, you make this graph of your data:

Summarize the evidence. Complete the summaries by circling the correct words:

- 5. Aphids grow wings in non-crowded conditions (**often / sometimes / never**).
- 6. Aphids grow wings in crowded conditions (**often / sometimes / never**).
- 7. The evidence suggests wings are (**heritable / acquired**).

Winged Aphids by Condition



Is it natural selection?

Write 2-3 sentences to explain your thinking: