Chapter 6 The ways of change: drift and selection continued….

1. Hardy-Weinberg-how do we use it?
2. Genetic Drift (Drosophila example bottlenecks and founder events)
3. Landscape genetics (Gene Flow, is at end of chapter but I am moving forward)
4. Digging around in the field of Population Genetics

(Make sure you do not confuse gene flow and genetic drift!!!)

3. Landscape Genetics (In your text 6.8)

What does this mean?

Real populations are not continuously distributed over the landscape.

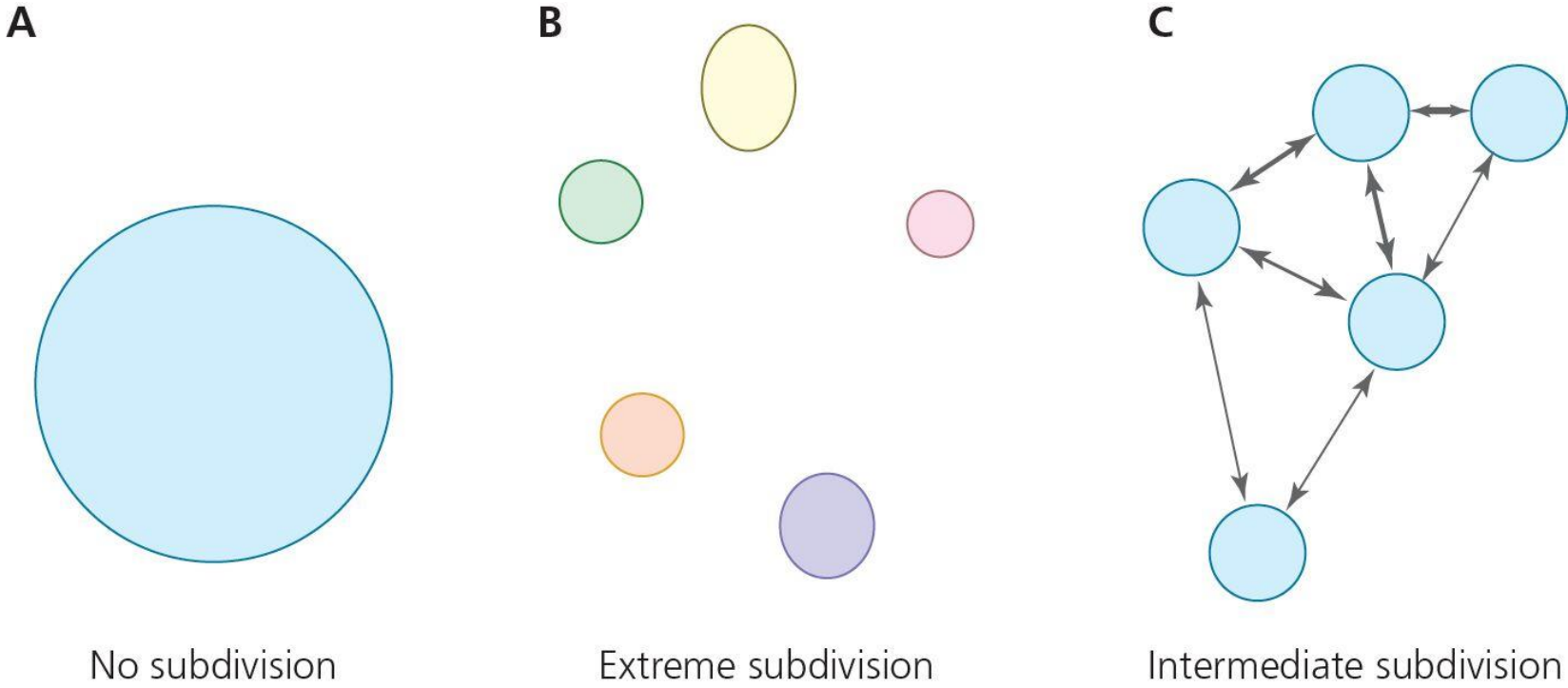
Instead of being one big super mixed population there may be many **subpopulations** with **gene flow** between them.

- Subpopulations may vary in number (few or lots)
- Subpopulations may vary in size (small with very few individuals, big with lots of individuals)
- Subpopulations may vary in terms of the **gene flow** that occurs between them.

What does that mean?

Which of the three populations is most subdivided? Which kind of distribution will result in the most dramatic genetic differences between randomly chosen individuals?

In C **gene flow** may homogenize the populations-the different subpopulations may have similar alleles and similar allele frequencies if gene flow is high.



Ex. Bighorn sheep

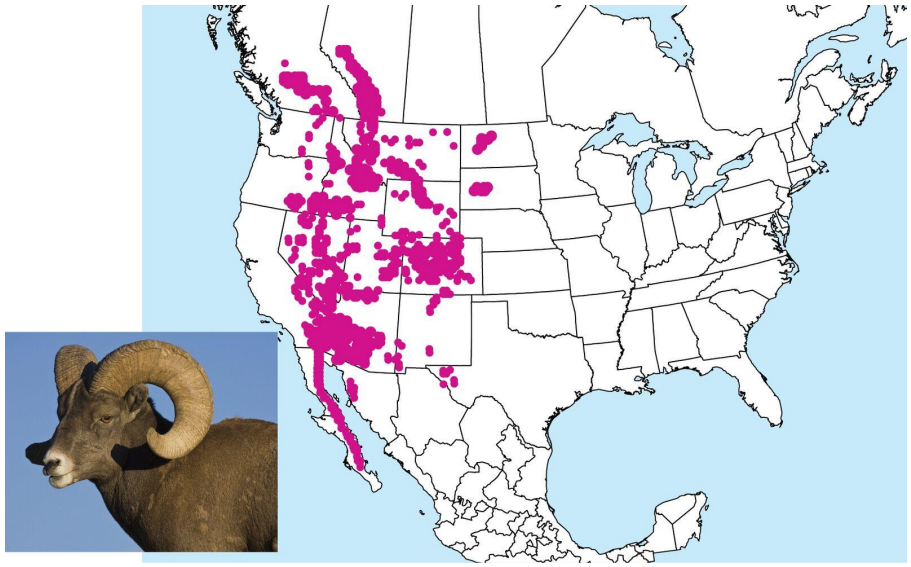
Imagine plucking random bighorn sheep from various locations around the US and comparing their genomes.

Which populations would you expect to be genetically different from one another? Which would be similar? Which are experiencing more gene flow? Why?

This subdividing of populations may result in <u>Genetic Structuring</u> in the population.
Ex. Bighorn sheep

If these sheep are able to move long distances across the whole western US, gene flow will be high and any two individuals are likely to be genetically similar.

If they are not able to move, gene flow will be low and any two randomly chosen individuals may be genetically quite different.



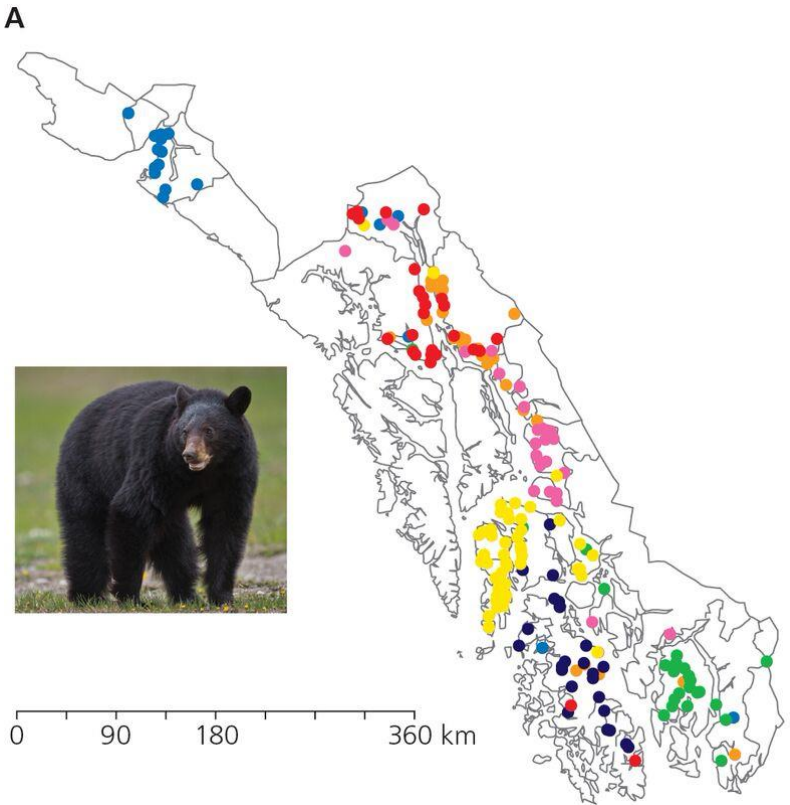
Gene flow is actually small in bighorn sheep

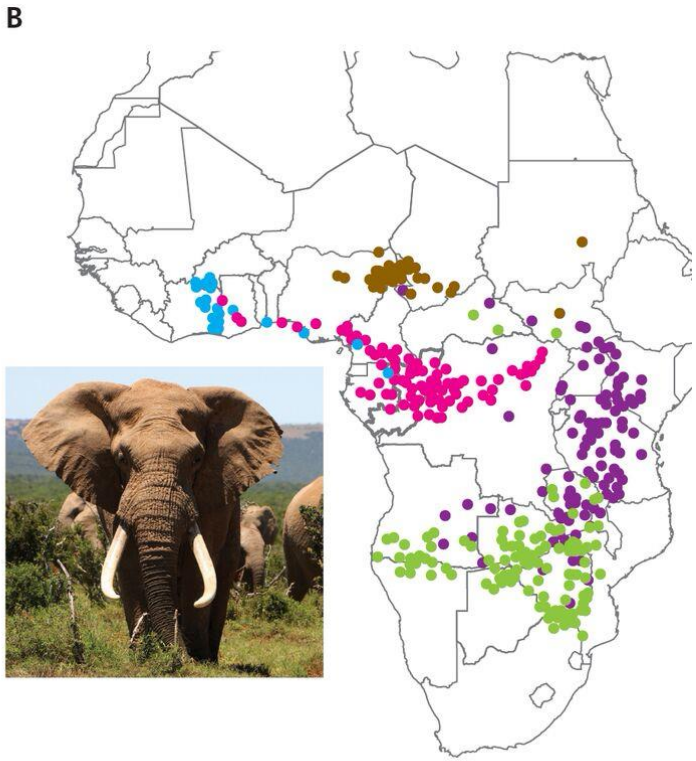
Ex. Bears and Elephants

Actual genetic structuring illustrated by colored dots.

Remember more genetic structuring really means more subpopulations and larger differences between subpopulations.

Do any of these patterns surprise you?



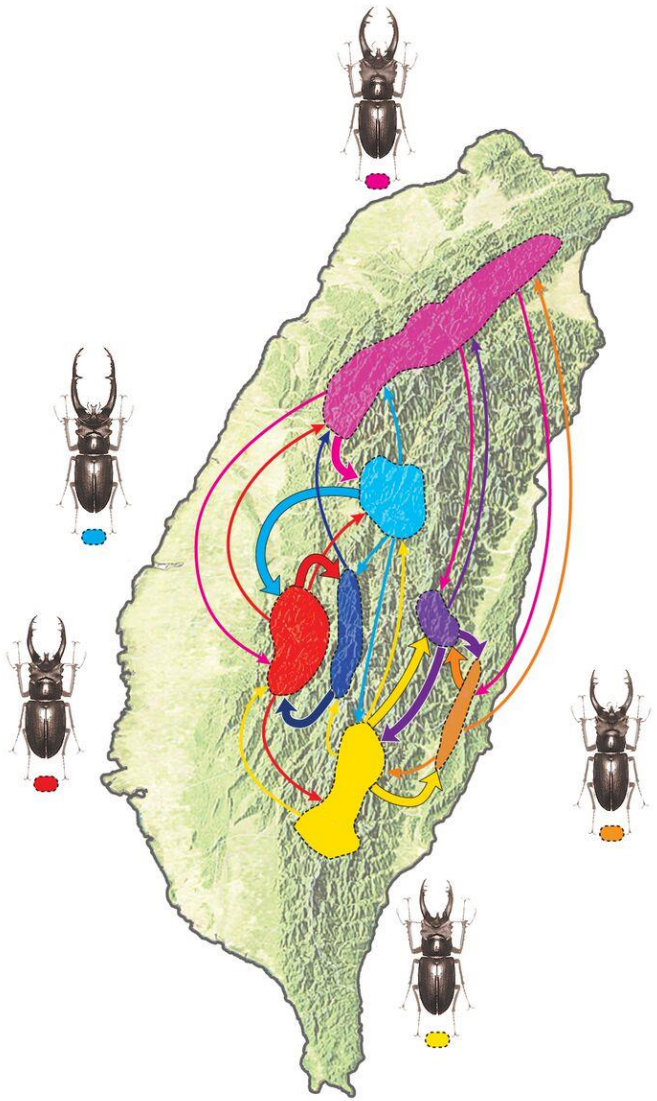


Ex. Beetles

What does the thickness of the arrows mean?

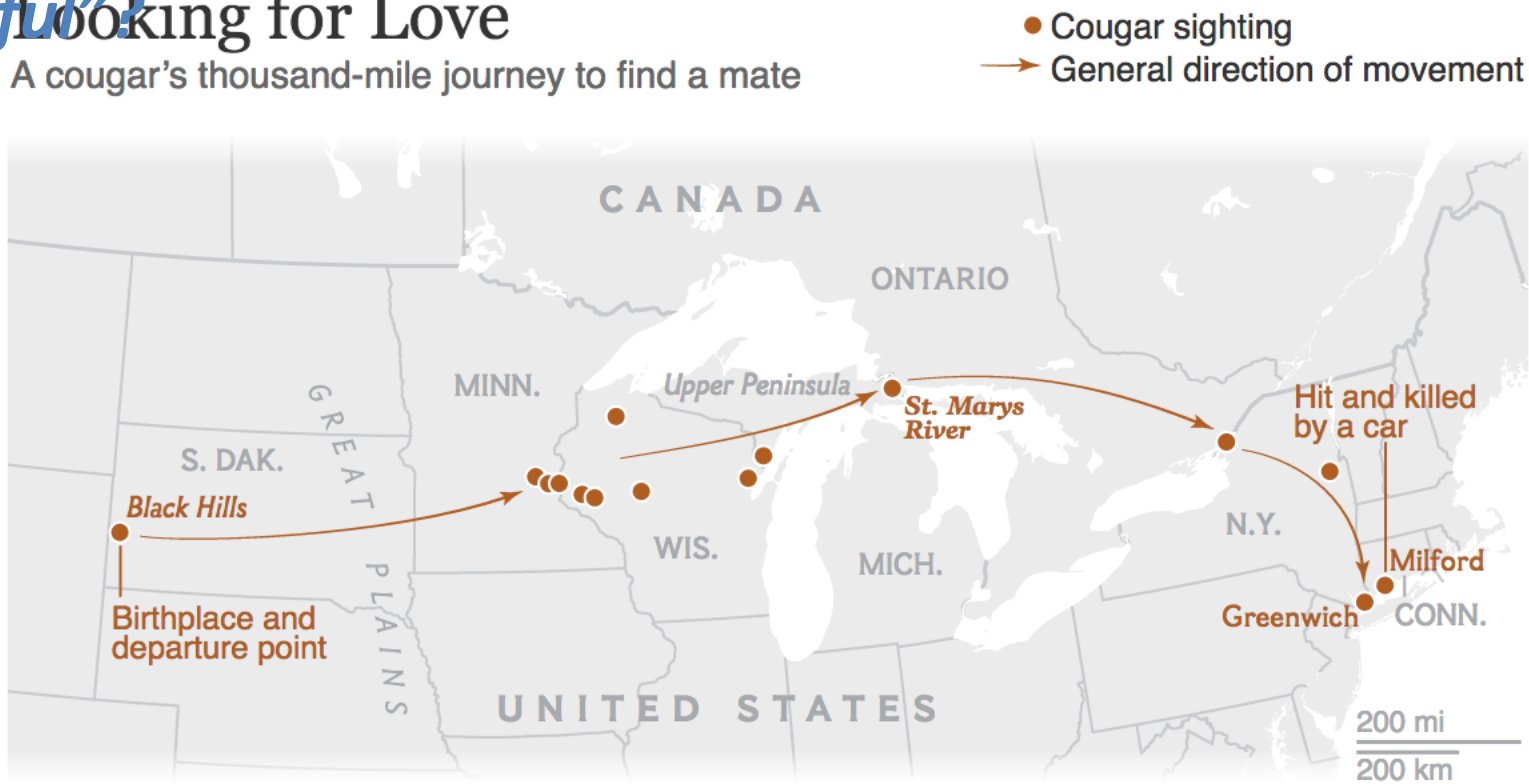
Which populations would you expect to be more similar?

Which populations seem more isolated?



Ex. Mountain Lion/Cougar-*Was this gene flow "successful"?*

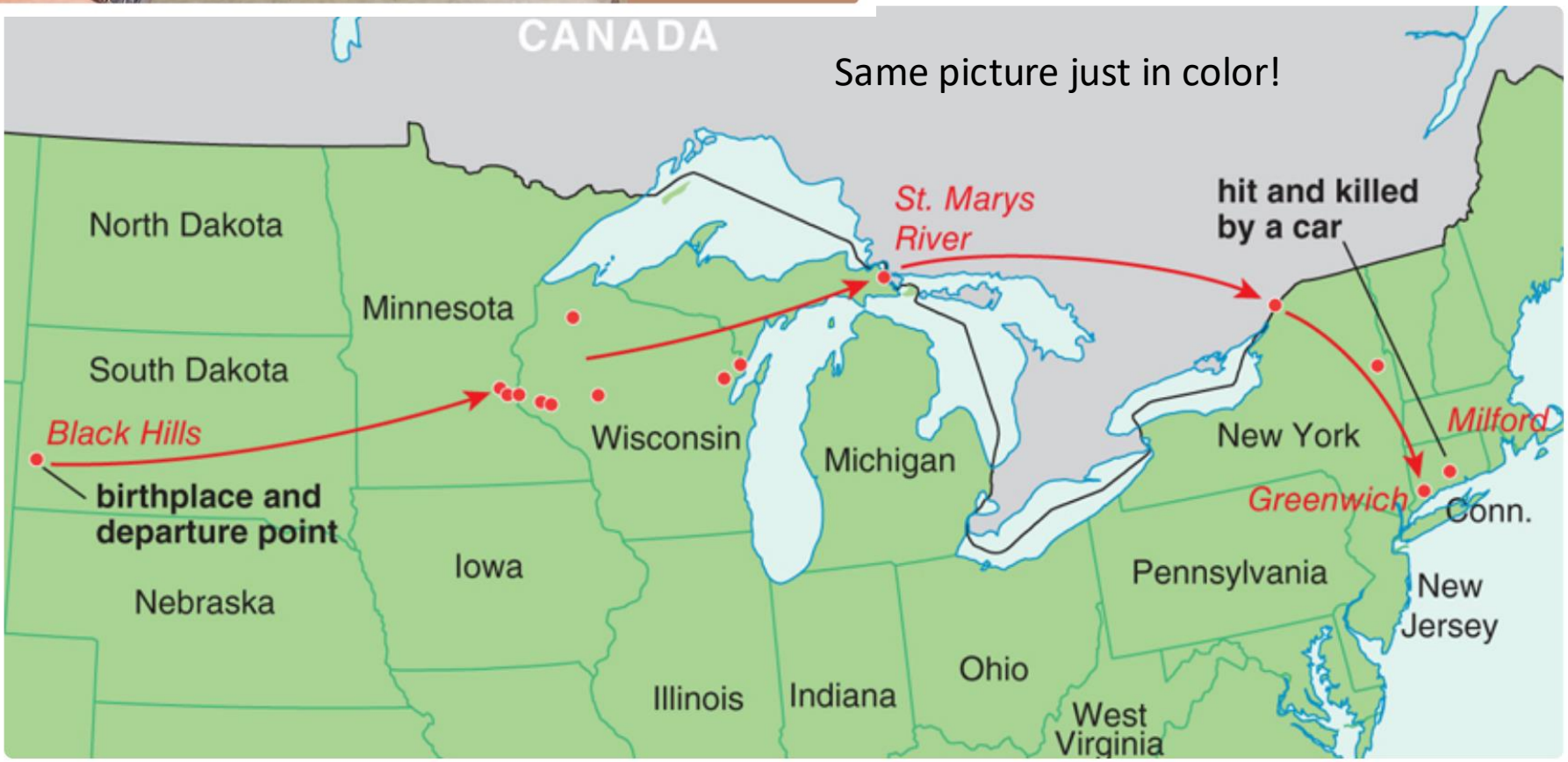
https://news
lgeographic.
16/05/16052
cougar-mou
lion-puma-
connecticut-
animals-scie



As far as we know, he started out from the Black Hills of South Dakota sometime in the late summer of 2009. At that time he was probably about one and a half years old, a young male just coming into adulthood. As most young males do, he set off in search of a mate. But instead of going west, as most lions in that part of the country do, he headed east into the Great Plains. Over time he showed up in the Twin Cities of Minnesota and in Wisconsin. He disappeared for a couple months, then shows up almost two years later, 30 miles from Manhattan, in Greenwich, Connecticut. In all he probably traveled 2,000 to 5,000 miles, enough to cross the country twice. He forded all the major rivers of the East, navigated highways and an international boundary. It was one of the most spectacular journeys by an animal ever recorded.

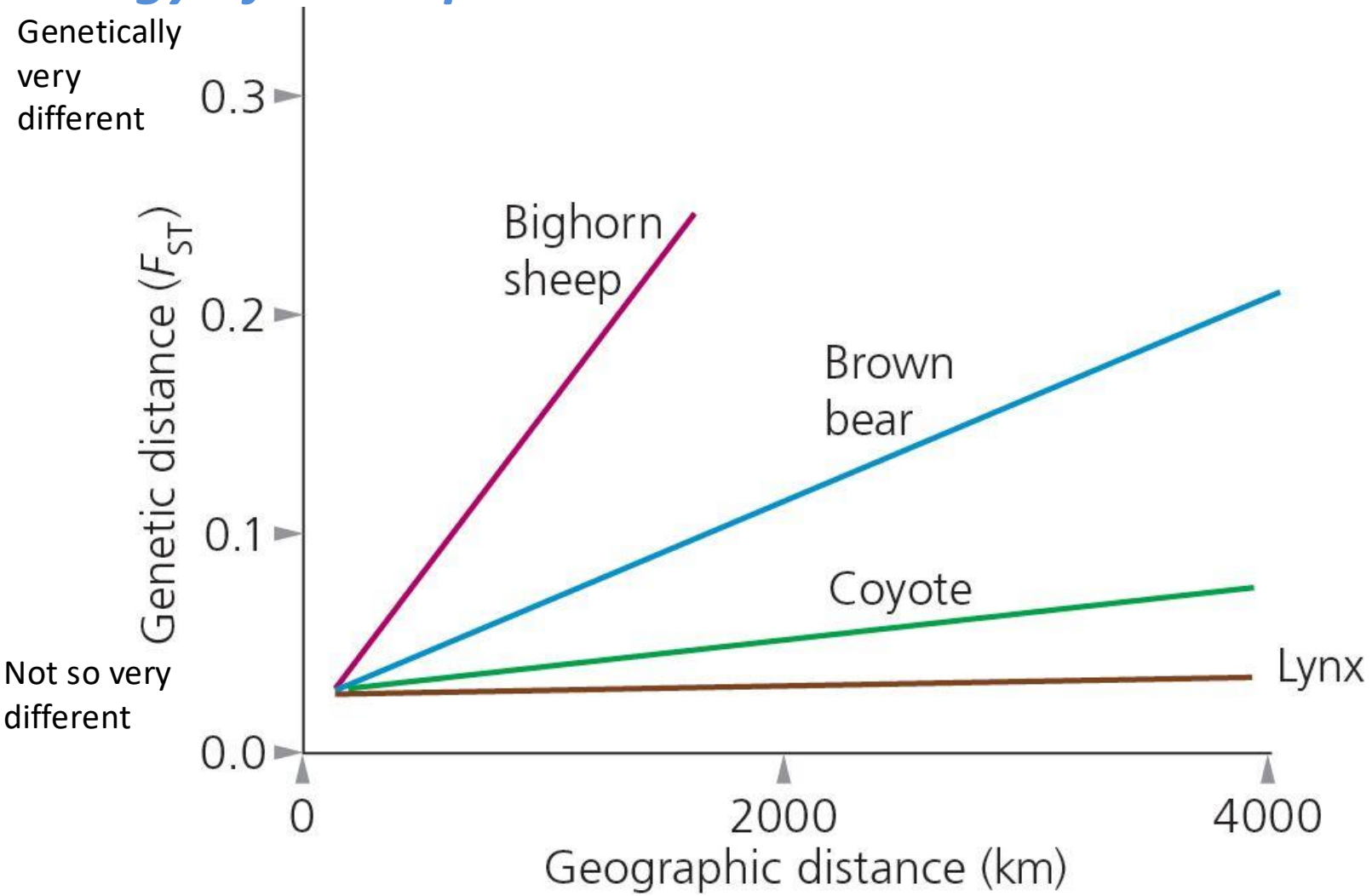
https://www.pri.org/stories/2016-06-18/real-life-incredible-journey-one-3-year-old-mountain-lion

https://www.americanscientist.org/article/americas-cat-is-on-the-comeback



Amount of gene flow varies with the biology of the organism. (Don't worry about how they calculate Fst)

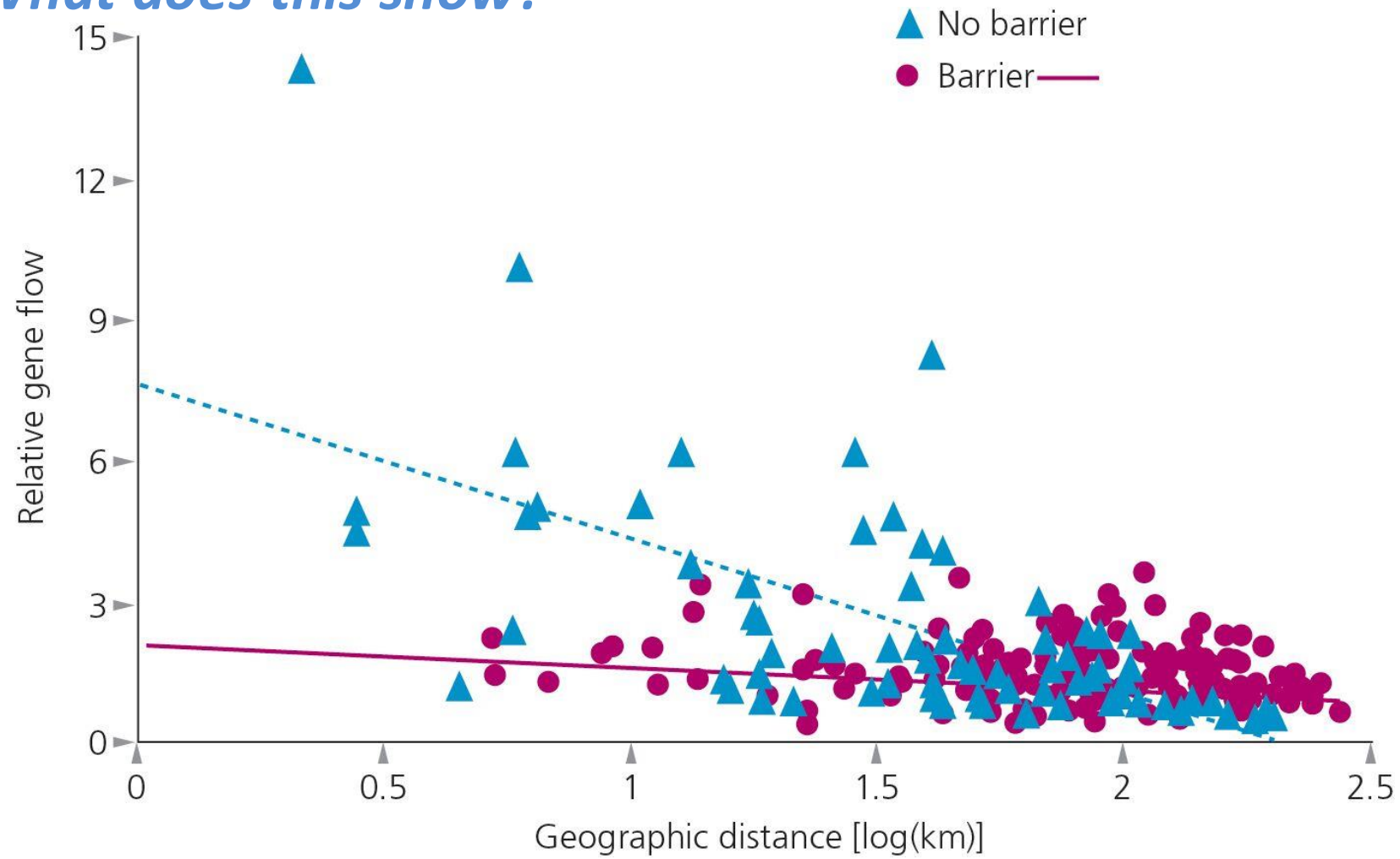
What does this show? How does it relate to the basic biology of each species?



Ex. Bighorn sheep again!

Humans can alter the population structure of other species! (barriers here are mostly highways)

What does this show?



Ex. GM crops

How does gene flow differ in plants vs animals?

Google Genetically Modified Crops (GM crops) disadvantages.

Google What genetically modified foods are grown in US?

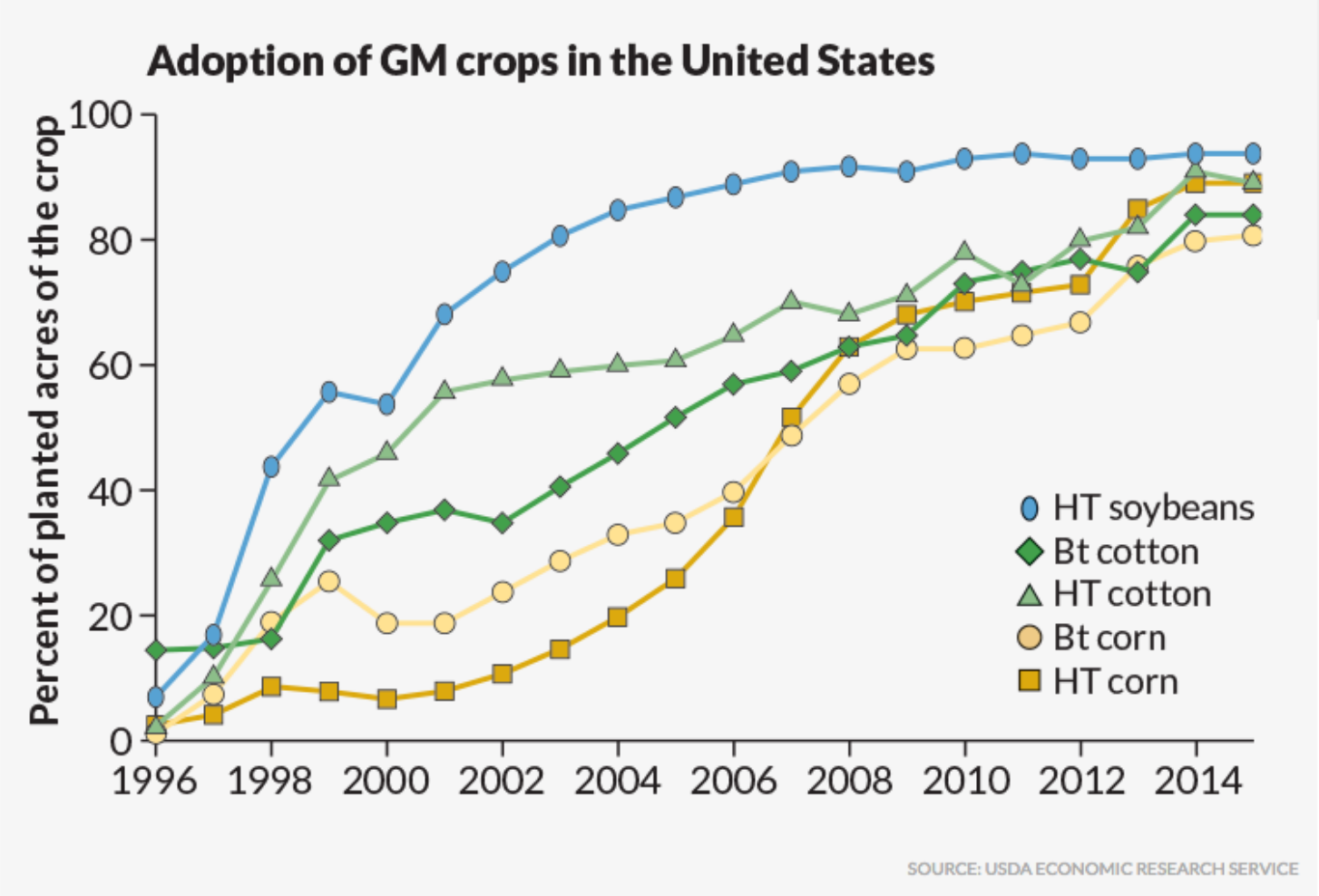
Some of you might worry about eating GM foods but this is generally not something biologists worry about.

One thing some people worry about is gene flow in GM crops!

How are we genetically modifying crops?

- Herbicide tolerance- (”HT or Roundup Ready” corn) Insert a gene (that codes for CP4 ESPS synthase-from a bacterium) that makes corn able to break down the Roundup herbicide.
- Insect resistance- (“Bt corn”) Insert bacterial toxin (Bt) gene into corn so corn codes for this toxin which makes bugs that try to eat it sick.

We also insert these genes into crops like soy and cotton.



HT = herbicide tolerance

Bt = toxin makes insect resistant

"While corn and soy don't have close wild relatives in the United States, **canola**, another widely planted GM crop, does. Herbicide-resistance genes from GM canola have turned up in wild, weedy mustard plants on roadsides in the United States, Canada and elsewhere."

https://www.sciencenews.org/article/gmos-haven%E2%80%99t-delivered-their-promises-%E2%80%94-or-risks

FYI: Canola is a *Brassica* species (sometimes used in lab as a model organism).

Most of the world's major crops naturally hybridize (share pollen) with wild relatives somewhere in the world……

What are the ramifications?

Wikipedia-***Brassica*** *napus*

While corn in US doesn't have wild relatives nearby, corn in Mexico does.

Mexico to start experimental planting of GMO corn

http://www.reuters.com/article/idUSN0424072320090604 2009

MEXICO CITY, June 4 (Reuters) - Mexico, considered the birthplace of corn, is reviewing more than two dozen requests to begin experimental planting of genetically modified crops, the agriculture ministry said on Thursday. He said U.S. biotech food producer Monsanto Co is one of the companies who have applied for a permit to begin planting.

Supporters of GMO food, whose DNA is altered to be resistant to pests, say they boost yields. More than 70 percent of U.S. corn is genetically modified.

But farmers in Mexico's rural south, where corn has been grown for thousands of years, worry GMO corn will cross-pollinate with native species and alter their genetic content.

Corn was first planted in Mexico some 9,000 years ago and the country is now home to more than 10,000 varieties. The grain was adopted by Spanish conquistadors in the early 1500s and eventually spread to the rest of the world.

Under the current rules, GMO corn seeds are not allowed into certain parts of the country that are determined to be "centers of origin" for genetically unique corn strains found only in Mexico.

https://www.nytimes.com/2023/03/06/us/politics/mexico-ban-us-corn.html

The New York Times

U.S. to Challenge Mexican Ban on Genetically Modified Corn

The Biden administration said it would request talks with Mexico over a brewing trade fight.

Mexico bought more than 20 million metric tons of corn from the United States in 2021-22, according to the U.S. Department of Agriculture. Farmers in Mexico grew 27.3 million metric tons last year. Dane Rhys/Reuters


By Ana Swanson and Linda Qiu

March 6, 2023

WASHINGTON — The Biden administration said on Monday that it would take initial steps toward challenging a ban that Mexico has placed on shipments of genetically modified corn from the United States, restrictions that have rankled farmers and threatened a profitable export.

In a statement on Monday, the Mexican Ministry of Economy said its decree was aimed at ensuring that tortillas are made with native Mexican corn varieties, in an effort to ensure the biodiversity of the corn that is grown in the country. It said it would draw on data and evidence to demonstrate that the ban had not had an impact on commerce, and was consistent with the trade agreement.

In the United States, the vast majority of corn planted has been bioengineered to be resistant to herbicides and insects. Bt corn, for example, contains a gene from a soil bacterium that kills the European corn borer, an insect that feeds on maize and other grasses.

Corn can also be modified to be resistant to glyphosate, the most widely used herbicide in agriculture and lawn maintenance in the United States. Glyphosate-based products like Roundup are sprayed on fields, killing weeds and leaving the resistant crops intact.

While the Environmental Protection Agency has said the herbicides pose no risk to human health, overuse can wreak ecological havoc in areas where natural plant species are not resistant to the chemical compound. Environmental groups have warned that glyphosate can be particularly deadly for pollinators like bees and butterflies.

It is illegal to grow genetically modified corn in Mexico, where maize was first domesticated 8,700 years ago and where white corn is a staple crop. Supporters of Mexico's ban worry that any imports of bioengineered corn would threaten native species, as the varieties can cross-pollinate.

Chapter 6 The ways of change: drift and selection

1. Hardy-Weinberg-how do we use it?
2. Genetic Drift (Drosophila example bottlenecks and founder events)
3. Landscape genetics (Gene Flow, is at end of chapter but I am moving forward)

And finally I have thrown a number of random topics into the heading below ☺

4. Digging around in the field of Population Genetics

- **Measuring fitness** - My take-away from this section is really just that measuring fitness is hard! Do know what **fitness** is! (The number of surviving offspring you produce.)

  We also talk about the fitness of an allele (pop gen simulation).

- **Selection in small populations** - My take-away is that when populations are small odd things can happen in general and especially when selection is taking place. (simulation).

- **French Mosquito** - Example starts chapter and later illustrates **pleiotropy**. My take-away is that you should be familiar with this example and to know what the word pleiotropy means!

- **Experimental Evol in *E. coli*** is kind of cool and famous and was in the news be cause they actually shut down the lab due to covid and froze all their sample for the first time since 1988! (see next slide)

Updated: Labs go quiet as researchers brace for long-term coronavirus disruptions

By Kelly Servick, Adrian Cho, Giorgia Guglielmi, Gretchen Vogel, Jennifer Couzin-Frankel Mar. 16, 2020 , 5:30 PM

Evolutionary biologist Richard Lenski at Michigan State University spends a lot of time thinking about how microbes grow. Since 1988, his team has watched populations of *Escherichia coli* bacteria grow and evolve in the lab through more than 73,000 generations. So when cases of COVID-19, caused by the novel coronavirus SARS-CoV-2, appeared in the United States, he knew to expect exponential growth—these first cases were just a hint of what was to come.

This week, as research institutions around the world brace for a surge in COVID-19 cases and consider their staff and students' roles in slowing the virus' spread, Lenski decided to freeze his bacteria and pause the 32-year experiment. "I didn't want people responsible for doing this daily work [of maintaining the bacteria] to feel a pressure to come in when they might not be feeling well," he says. This is "a tiny perturbation" in the scheme of the experiment, which can simply be resumed by unfreezing the bacteria. But that disruption is itself the tip of an iceberg. Countless labs in a variety of research fields are reconsidering their planned studies—and not all projects can be easily put on ice.

https://www.sciencemag.org/news/2020/03/updated-labs-go-quiet-researchers-brace-long-term-coronavirus-disruptions

- **Allele vs allele** - This section goes over different kinds of relationships between alleles. While we often focus on dominance relationships (where one allele is dominant and the other recessive), there are other kinds of relationships. One of those is an additive relationship.

  Additive relationships are also known as **incomplete dominance** where the heterozygote is intermediate between the two homozygotes.

  (Remember the example we went over? RR= red flowers, Rr=pink flowers, and rr=white flowers)

  This is the one that is kind of like “blending inheritance”!

- Mutation selection balance- (skip for now)
- Selecting diversity (skip for now)

- **Inbreeding**

  Increases chances of bringing together two nasty alleles!

  Imagine the “t” allele is a kind of rare recessive allele that causes a kinked tail and undescended testicles in cougers/pumas.
  Remember the Florida Panthers?
  Now there are California panthers with kinked tails too-https://www.nps.gov/samo/learn/news/first-abnormalities-linked-to-inbreeding-depression.htm
  Imagine you cross a normal individual with a “carrier” of the t allele and then mate those offspring! **TT x Tt cross ---Punnett Square!**

Also Interesting inbreeding historical connections! (Hapsburg-your text!)

Dogs are another great example!!

https://dogagingproject.org/inside-foundation-demystifying-inbreeding

https://www.vetmed.ucdavis.edu/news/most-dog-breeds-highly-inbred

Inbreeding also interacts with **genetic drift** in small populations!

That is it for Chapter 6!