Last Time...

Why do mosquitoes bite some people more than others?

Blood type, metabolism, exercise, shirt color and even drinking beer can make individuals especially delicious to mosquitoes.

• Type O is more attractive than A
• Larger people (and pregnant ladies) exhale more CO$_2$ – get bit more than children
• Attracted to lactic acid/high body temp (exercise)
• Colors that stand out (black, dark blue, red) make you easier to find

Thanks Anna and Paul!
Climate change will affect the following factors

- Carbon Dioxide levels
- Temperature
- Precipitation
- Salinity
- pH (acid level)

These factors all have important effects on Life!
Climate change will affect the following factors

– Carbon Dioxide levels
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Temperature

Average global temperatures have warmed about 0.6°C over the last 150 years

Likely to warm an additional 2° to 6°C by the end of this century
Temperature patterns have changed: increased nighttime minimum temperatures.

Frost defines the growing season for some plants.
Temperature

• Temperatures below 10°C severely inhibit tomato growth
• Temperatures below 6°C render crops inedible
• Increased temperature = longer growing season!

Hurray for climate change!
Temperature

• Grapes: high temp during fruit ripening decreases wine quality
• Ideal growing locations will shift to higher latitudes and from inland to costal areas
• Total premium wine grape production in the United States might decline by up to 81%
Today is Groundhog Day!

• Today’s prediction – early spring
• Since 1993, the U.S. national temperature has been above normal 11 times, below normal 6 times, and near normal 6 times in February.
Timing of Seasons have changed: spring events occurring an average of 2.3 to 5.1 days earlier each decade

- arrival times of migrant Species
- peak flight date
- nesting
- egg laying
Flowering

Budburst
Shift in spring events for the past 50 years, 694 species
Autumn events delayed by 0.3 to 1.6 days per decade

- leaf fall
- hibernation
- departure times of migrants
Effect on species ranges

– Heat and drought at mid-latitudes
– Expanded growing seasons at higher latitudes

Species have migrated 16.9 km closer to the poles each decade
• Audubon Society, 2014: 314 species will lose more than 50 percent of their current climatic range by 2080

• Based on 40 years of “citizen science” and climate change models
Spending winter farther north

As the temperature across the U.S. has gotten warmer from 1966 to 2005, many bird species are spending their winters farther north.

Change in winter destination, 20 species with the most movement

- Winter 1966-67
- Winter 2005-06

Wild Turkey, 408 miles
Purple Finch, 433 miles

Sources: Audubon Society; NOAA
Yellow Billed Magpie

- Exists only in CA
- Will lose 75% of range under high emission scenario
- Will lose 9% of range if pollution is reduced significantly
Emission scenarios

The graph shows the range loss (%) for different bird species under low, medium, and high emission scenarios. The species include:
- Yellow-billed Magpie
- California Gnatcatcher
- Grasshopper Sparrow
- Gray-crowned Rosy-Finch
- Chestnut-backed Chickadee

Each bar represents the range loss for a specific species under a particular emission scenario.
Effect on species ranges

- Expanded growing seasons at higher altitudes

Species have migrated 11.0 meters higher in elevation each decade
Alpine species move higher up the mountain
Revisiting the past to foretell the future: summer temperature and habitat area predict pika extirpations in California

Stewart et al., Journal of Biogeography, 2015.

- Surveyed 67 locations with historical records of pikas. Disappeared from 15 percent of the sites surveyed.
- Pika populations were most likely to go locally extinct at sites with high summer temperatures and low habitat area.
- When summer temperatures are too high, pikas are forced to stay underground to avoid overheating. Less time spent foraging means they don't have as much food to eat, which increases the likelihood of local extinction.
Using GCMs to predict future pika range

• 34 different GCM outputs, based on different levels of human emissions of GHGs
• If only modest action is taken, the model predicts that pikas will disappear from about 75% of sites by 2070 (51 to 88 percent, depending on the global climate model used)
• With aggressive action to reduce GHGs, the model predicts that only about 51% of sites will suffer local extinction (39 to 79 percent, depending on the global climate model)
Alpine Plants

- Adapted to cold, windy environment
- Grow low to the ground
- Plants from lower altitudes move up the mountain, compete for sunlight and nutrients
Effects on Species Range

Grizzly bears moving north to forage
Coming into contact with Polar Bears

– Competition for resources
– Hybridization?

2006. Polar bear mother, grizzly bear father
Polar Bears and Temperature Change

• Hunt seals from ice, unsuccessful at hunting in the water
• Swim south to give birth on land
• Melting ice means longer swims
  —Some Bears are drowning.
When on Land, They Scavenge

- Competition with other polar bears
- Competition with grizzly bears
- Contact with humans
Polar Bears and Temperature Change

- IUCN Red List: **International Union for Conservation of Nature and Natural Resources**
- Listed as **Vulnerable**
- Based on a suspected population reduction of >30% within three generations (45 years)
- Justification for the status is climate change.
2008: US Government Listed Polar Bears as Threatened Under the Endangered Species Act

- Major threat: sea ice habitat is shrinking and is likely to continue to do so over the next several decades
- “Interior Secretary Dirk Kempthorne, however, made clear several times during a press conference announcing the department's decision that, despite his acknowledgement that the polar bear's sea ice habitat is melting due to global warming, the ESA will not be used as a tool for trying to regulate the greenhouse gas emissions blamed for creating climate change.”
Penguins and Temperature Change

Adélie penguin

Emperor penguins
Depend on sea ice for breeding

Adélie populations shifting to colder sites
Emperor populations declining

Extent of sea ice at breeding site has declined by 66% over the past 50 years

— Krill, a food source for penguins, rely on sea ice

Reduced quantity and accessibility of food
Krill: shrimp-like marine invertebrates
Baleen Whales

14 Species

Humpback whale

Blue whale
filter feed through fine-combed structures called baleen
Coral Reefs Temperature Change

• Marine invertebrate animals a few millimeters in diameter.

• Symbiotic relationship with algae
Symbiosis: both benefit

— Algae supply carbohydrates, photosynthetic pigments give the coral color.
— Coral provides a stable environment, CO$_2$ and nutrients.
— Together, they secrete calcium carbonate that forms the hard structure.
— Provides habitat for many animal species.
• Approximately 500 million people worldwide depend upon reefs. 30 million are virtually totally dependent upon reefs.
• source of food
• protect coastlines from storms and erosion
• provide habitat, spawning and nursery grounds for economically important fish species
• provide jobs and income to local economies from fishing, recreation, and tourism
• are a source of new medicines, and are hotspots of marine biodiversity

Contribute $29.8 billion to world economies/year
Coral Reefs and Temperature Change

Seas warming by 1° or 2°C can cause bleaching

- Corals become stressed and expel algae
- Corals die
- Also affected by pH
- Climate change may cause irreparable damage nearly ALL reefs during the next few decades
Coral Bleaching
Amphibians and Temperature Change

Rely on both aquatic and terrestrial systems
Moist permeable skin functions as a respiratory organ

Pathogenic fungus infections
Warm temps = happy fungus