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Insect range shifts in response to climate change.

What is a "Range Shift"?

"Range shift" refers to the phenomenon of a species' geographical location, or range, changing in response to changes in conditions.

Why does it happen?

The range of a species is typically defined by climate and resources. The critical climate factors are temperature, seasonality, and precipitation. These factors interact in important ways. For example, as average temperatures rise, precipitation patterns change, causing some areas to become wetter, others drier, while creating a mix of wetter AND drier in some areas as a year's worth of rain falls in just a handful of powerful storms, with drought between.

At the same time, higher temperatures mean that species which previously died during cold winters can now colonize new territories.

Is it happening now?

Because of their high mobility, both under their own power, and as "hitch hikers" on humans and human vehicles, there have always been individuals that are outliers, spotted beyond the edge of recognized ranges. For this reason, it can be difficult to know for certain whether a new sighting is due to a range shift, or merely a lost individual that has not yet succumbed to inhospitable conditions.

There *are*, however, certain indications of change around the world. Studies have shown that dragonfly species in Britain are shifting northward, while the Frosted Elfin (*Callophrys irus*), a butterfly commonly restricted to areas south of New England with a small number in Massachusetts, has seen a 1000% increase in its Massachusetts population. Cities like Nairobi, Kenya, which have historically been too cold for malaria mosquitoes are showing an increasing number of malaria cases as the

nights get warmer, and here in New England, the Asian Tiger mosquito (*Aedes albopictus*), which was first introduced to the U.S. in Texas, has been seen at the northern edge of its range earlier in the season, and has been seen *north* of its established range.

Why is this a concern?

Insects are responsible for carrying more human diseases than any other group of animals. Throughout all of human history, warmer climates have meant insect-born diseases ranging from acute and lethal, to chronic illness lasting a lifetime. Of all the biological changes expected from climate change, this is the one that has generated the most worry.

Moreover, there are some important forest diseases that are insect-caused or insect-borne. Asian long-horn beetles (*Anoplophora glabripennis)* and the hemlock-killing wooly adelgid (*Adelges tsugae*) are moving north as winter temperatures moderate and growing seasons lengthen. Fungal pathogens that are facilitated by insects, such as the beech bark disease (caused by a fungus *Nectria*, carried by the beech scale insect *Cryptococcus fagisuga*), can spread more freely as well

There can be other problems as well. For example, some bird species require particular insects for food at important moments in their life cycle, for example when they are first feeding their nestlings. Changes in the prey insect's behavior and range could affect the bird's reproductive success. At the same time, if the springtime phenology of plant life is triggered by day length rather than temperature, insects emerging earlier due to warmer weather may find themselves without food, and plants may later find themselves without pollinators. The study of such ecological disconnects is only in its early stages, but this asynchrony has already been observed in several places around the world.

What's the outlook?

We are in for big changes, and some may be very unpleasant for humans. Asynchronies in seasonal behavior are expected to increase, with potentially devastating effects on ecosystems. Malaria, dengue fever, Chagas disease, and many other illnesses are expected to spread to new territories as the hosts that bear them spread. At the same time, species notorious for less direct damage, like bark beetles and various ant species are expected to move northwards as well. How

fast the spread occurs depends on a variety of factors ranging from warmth, to water availability, to transportation, but the spread *is* expected to happen.