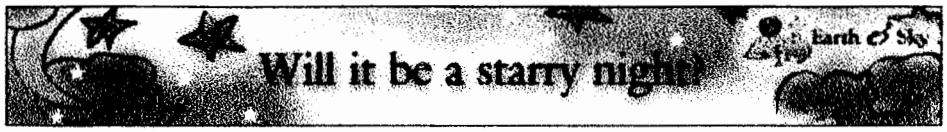

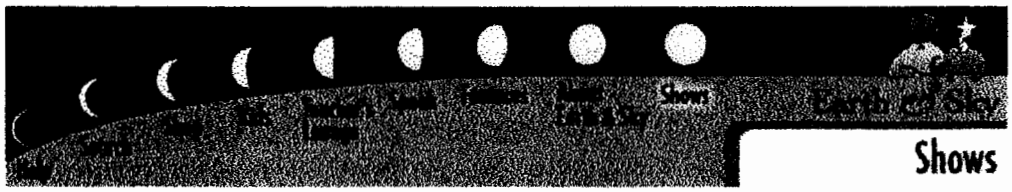

Fragile Ecosystems

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Mountain pine beetles are ubiquitous throughout western pine forests. But for now, they can only survive to a certain elevation above sea level. What happens in the coming years if temperatures rise -- after this on Earth and Sky.

Tuesday, November 7, 2000

DB: This is Earth and Sky, on the delicate relationship between the temperature in a western pine forest -- and a beetle that's damaging to pine.

JB: We talked to U.S. Forest Service researchers -- Drs. Barbara Bentz and Jesse Logan -- at the Rocky Mountain Research Station in Logan, Utah. They've studied the mountain pine beetle at various elevations -- and found that the beetles are successful throughout much of their range -- but that they can't tolerate the colder temperatures at higher elevations. So high elevation trees are safe from the beetles for now.

DB: But the researchers have made mathematical predictions of what could happen if the global climate warmed in the coming century. They looked at a possible warming of 2 degrees Celsius -- an amount consistent with internationally respected climate models. At that rate of warming, the beetles would suddenly find higher altitude habitats to be quite hospitable. That could mean outbreaks in habitats not typically invaded by the beetles. Trees here include the five-needle pines like white bark and bristle cone pine. Some bristle cone pines are the oldest known living organisms on Earth -- and they're not adapted to surviving a mountain pine beetle outbreak.

JB: That's our show -- and we're having our annual Young Producers Contest again this year for students in grades K-12 -- deadline December 15. For information, see our web site at earthsky.com. We're

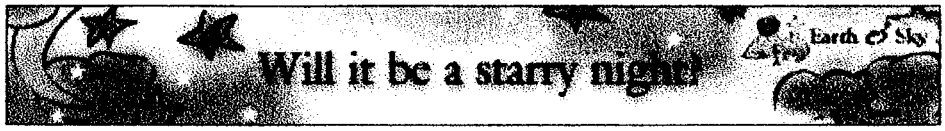
Block and Byrd for Earth and Sky.

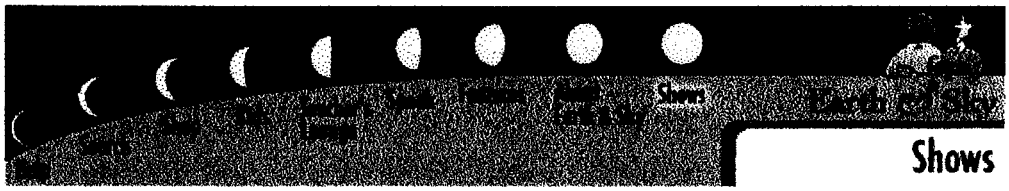
Author(s): Rachel Clark

- More information about this topic

Monday November 6, 2000 | Wednesday November 8, 2000

Let us know what you think!





More Information on "Fragile Ecosystems"

Our thanks to the following individuals and institutions who assisted in the preparation of this script:

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For more information visit the following Web sites:

<http://www.usu.edu/beetle/>http://www.usu.edu/beetle/

The following papers were used in the preparation of this script:

Logan, J.A., and B.J. Bentz, 1999. Model Analysis of Mountain Pine Beetle Coleoptera: Scolytidae Seasonality. Environmental Entomology. Vol.28, no. 6. pp. 924-934.

Logan, J.A., and J.A. Powell submitted. Evaluating the Potential for Climate Change Induced Bark Beetle Invasion of High Elevation Ecosystems. American Entomologist.

Author's Notes:
Could the climate warm by 2 degrees Celsius? The researchers compared their data to two internationally respected climate models, and found that the globe appears to be heading for a warmer climate. The

models predict a warming trend of 1 to 2 degrees Celsius from 2010 to 2039, and a 2-3 degrees Celsius warming from 2040 to 2070.

Interview with Barbara Bentz and Jesse Logan:

Bentz and Logan have spent the last 10-15 years working on a model to use temperature to predict mountain pine beetle phenology development, lifecycle, etc.. To do this, they have measured temperatures in the field at high elevations up to 10,000 feet above sea level and lower elevations about 8,000 feet above sea level, as well as higher latitudes 45N and lower, warmer latitudes 38N. Over this large range, they have recorded the temperature in a variety of forest locations, and have even recorded the temperature inside the phloem of pine trees. Thats because the mountain pine beetles live in the phloem of the trees, under the bark, and emerge as adults at particular temperatures.

The other thing Bentz and Logan study is when and how beetles emerge from under the bark. They've found that its very important for the beetles to synchronize their emergence, because the trees where the beetles make their homes have evolved defenses against the beetles. The trees release a suit of resins, some of which are toxic to beetles, which can expel and kill the beetles. Thus, its important to the beetles to emerge synchronously so that some of them stand a chance of survival. They also found that emergence must by well timed within a season, and that the beetles have approximately a one year life cycle.

The question, then, is: How does temperature influence these three things synchrony, 1 year life cycle, and timing of emergence?

The first thing Bentz and Logan do is look at the actual temperature records across their widespread study sites. They compare the real temperature record with what they record about beetle life history. So, they have a very accurate record of what happens with the relationship with actual temperatures and beetle characteristics. And in higher elevations, where there are trees not adapted to live with the mountain pine bark beetle, they have found that the 3 key beetle factors are off. That is, the beetle just doesn't do well in higher elevations.

To find out what might happen with changes in temperature i.e. a warming climate, the researchers tell their computer model to raise the temperature values incrementally, to see whether this will impact the beetles three key factors. They can add increments of .01 in the model, to see when or if that increase affects the beetles life cycle, its synchrony, or its timing of emergence. Bentz and Logan say nothing happens until the temperature becomes 2C higher than normal. Then, at higher elevations, things become very favorable to the beetles. And the three key factors become good for the beetles--meaning they could potentially successfully invade the trees at higher elevations if the temperature there warmed by 2C. The trees at high elevations include

the five-needle pines e.g. whitebark pine, limber pine, and bristle cone pine.

Even though pine trees at lower elevations have evolved to deal effectively with the mountain pine beetles, the five needle pines at higher elevations have not. Mountain pine beetles that could successfully invade these trees if the temperature warmed by 2C would have the same sorts of impacts as non-native exotic invasive species. Trees like the bristle cone pines are some of the oldest known living organisms on earth. They are not adapted to beetle outbreaks like their lower elevation cousins. Because these high elevation trees function like islands separated from one another, loosing the trees due to beetle outbreaks would make it difficult for recolonization to take place.

In addition, a 2C warming also translates into a possible range expansion of the beetle by 6N in latitude. That could mean the beetle would be able to invade jack pine, a species that has not been in contact with mountain pine beetles before. Jack pines habitat extends through almost all of Canada. Bentz and Logan say this is not a local, North American issue. There are similar species of beetle in Europe, who, they suspect would also make range expansions into more northern latitudes and higher elevations given a warmer temperature.

Another point is that the high elevation trees are important for a variety of reasons. One is that they help conserve and direct scarce western water during the critical winter months when snows are falling. Another is that grizzly bears rely heavily on nut production of the white bark pine tree. When those nuts are scarce, grizzly tend to have more run-ins with humans. If a beetle outbreak in high elevation stands of white bark pines destroyed many of these trees, grizzly bears would have a very difficult time finding enough food to eat.

Could any of this turn out to be true? Could temperatures warm over the next century--setting up a scenario where mountain pine beetles can invade high elevation habitats previously inaccessible to them? Bentz and Logan have compared two internationally respected climate models to their own data, and have found that the globe, indeed, appears to be heading for a warmer climate. They looked at the Hadley Center for Climate Prediction and Research also known as the HADCM2 model from the United Kingdom, and the Canadian Center for Climate Modeling and Analysis also known as the CGCM1 or CGCM2 models. According to the predictions of these global climate models, we can expect to see a global warming trend of 1 to 2C from 2010 to 2039, and a 2-3C warming from 2040 to 2070, and then a 3-4C warming from 2070 onward. The researchers emphasize that these are the conservative estimates--they assume that greenhouse gas emissions are curbed to present day levels immediately.

- Transcript for this show

Let us know what you think!