Governor's Council on Climate Change (GC3) Working and Natural Lands Working Group
Forests Sub-Group

Outline for talk on the effects of climate change on forests, April 21, 2020

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1. I was asked to discuss the impact of climate change on forest ecosystems. My own field research focuses on the ecology of birds in forests and early successional habitats, but I discussed the effects of climate change in a book I wrote on ecology and conservation of deciduous forests.
2. A major theme of the book was that one can only understand the ecology of forests by understanding their geological and human history. For understanding Connecticut's forests, a good place to begin is 18,000 years ago, when there were no forests. The state was covered with a mile-deep layer of ice filled with boulders, pebbles and sand.
3. The vegetation south of the ice sheet has been worked out by analyzing sediments from lakes and bogs where pollen has been raining down for thousands of years. Immediately south of the ice sheet the pollen record shows that there were a mix of plant species that are characteristic of arctic tundra. Farther south there was coniferous forest or savanna dominated by boreal-forest conifers such as jack pine, fir and spruce. Even farther south there were mixed oak and southern pine woodlands. Until the 1980s it was not known where the many species of trees that characterize the mixed deciduous forest survived. Hazel and Paul Delcourt discovered that they were largely restricted to small refuges (technically referred to as "refugia"). The refugia were primarily located along river floodplains on the Gulf Coast and southeastern Atlantic coast, and probably extended out onto what is now the continental shelf.
4. You can visit one of these refugia in the Apalachicola River valley in the panhandle of Florida. The river valley sustains impressive floodplain forests, and is still a refugium for several species that are restricted to southeastern floodplain forests, such as Ashe's magnolia and Florida torreya.
5. 14,000 years ago – trees began to move northward out of the refugia as the glaciers receded. Different species moved northward at different rates. Connecticut forests were slowly assembled over a period of 12,000 years, with the last major tree species (American chestnut) arriving only about 2000 years ago. This was one of as many as 18 glacial cycles that trees have survived during the past million and a half years.
6. Implication – Trees may survive current climate change by moving northward. Numerous models have been developed to predict how tree distributions will change as the climate becomes warmer. Projections are based on the current climate limits of particular tree species.
7. The northward shift in geographical is best documented for birds. Many species of birds have already expanded their ranges northward from the Southeast into New England in response to climate change. Examples include Northern Cardinal, Tufted Titmouse, Red-bellied Woodpecker and Black Vulture.

8. A wide variety of other animal groups have expanded northward during the past few decades. This is well documented for butterflies in Europe and for a wide variety of animal species in Britain.
9. Trees are not as mobile as animals, of course. Will trees be able to migrate fast enough to keep up with climate change? Are there too many new barriers to dispersal such as major metropolitan and agricultural areas? Should we aid the northward dispersal of particular species of trees by planting them north of their current range ("assisted dispersal") so that they can keep up with the pace of climate change?
10. Woodall et al. (2009) – analyzed Forest Inventory and Analysis data to determine whether mean latitude of trees seedlings differed from mean latitude of mature trees. Numerous species of northeastern trees had higher latitudes for seedlings than adults, indicating a northward shift. Trees appeared to be shifting their distributions in response to a warming climate.
11. Woodall et al. (2018) – used data from the original 2002 – 2007 inventory and data from a second inventory about ten years later – also used more refined analysis to exam frequency of seedlings at northern edge of the range of each species – In contrast to the earlier study, they found no evidence that seedlings had spread farther north than adults.
12. What caused this "failure to migrate" as climate warmed? Woodall et al. (2018) hypothesized that this was due to the generally low survival of seedlings of many tree species, a problem that is familiar to foresters and forest ecologists in Connecticut.
13. The low survival of seedlings may be due to competition with invasive species in forest openings, severe browsing by dense deer populations because of the loss of top predators, and the lack of conditions needed for oak regeneration (sunny ground layer and periodic ground fires) due to suppression of natural disturbances. The best way to facilitate accommodation of trees to climate change is to address these basic problems with low reproductive rates for many tree species to increase the resiliency of forest ecosystems.

References

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