Using Virtual Birds to Predict the Sounds of Tomorrow

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Waking up early in the morning we've all heard this:

This is the dawn chorus, a collective of multiple birds providing the soundtrack to the start of our days. This background sound is so engrained in our daily lives that we pay no second thought to it, it's just what it is, another part of life.

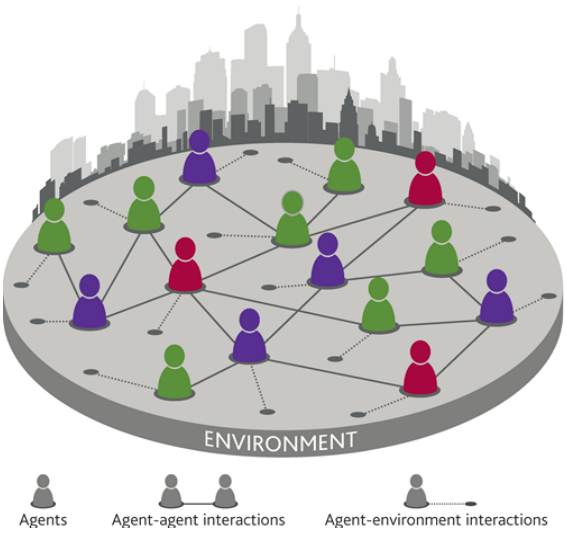
However, with a constantly changing world in the face of climate change, things that seem so concrete are at an increased risk every day. Birdsong diversity is not immune to these changes and if we continue down the path we're heading, we're likely to experience changes in one of the most commonplace facets of our lives.

Soundscape ecology has been around since 1978 and it's a field that isn't too heavily explored. However, when it comes to analyzing bird diversity, it can prove to be very beneficial. Since birdsong can tell us a lot about the health of an ecosystem by simply listening to it.

By analyzing audio, we can hear how diverse a bird community is and we can easily parse out individual songs. In addition, when it comes to a bird singing, the main benefits are attracting mates and defending their territory. If a bird's song is unable to be heard, then it can be very detrimental to their future as they attempt to communicate for a variety of reasons.

The Modeling

Obviously, it's impossible to look into the future and see specifically how climate is going to affect our environment and see how that would influence birds. Since it's not possible to create this environment now, researchers Meely M. Pandit, Eli S. Bridge, and Jeremy D. Ross all from the University of Oklahoma designed an Agent Based Model (ABM) to see how dry arid climate affects virtual bird behavior.



ABM Concept Visualization

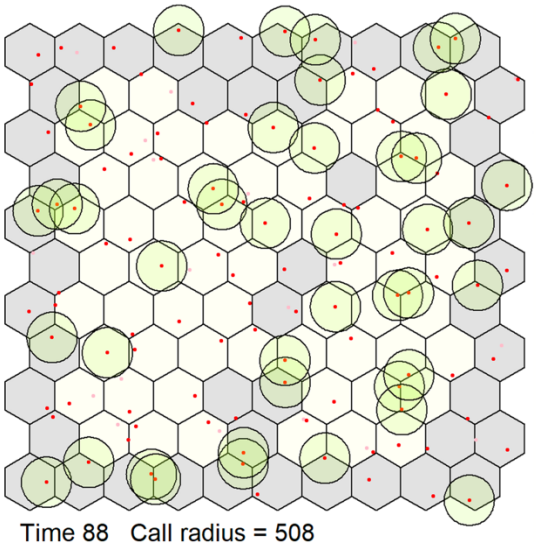
Think of an ABM as a video game, to create a vibrant world in the game the designer puts in AI characters (or NPC's) that walk around and interact with each other and their environment. The same idea applies to the bird model the researchers used in 2022. However, unlike a video game which some may use as respite from reality, simulations like this shine a light on possible futures we're heading towards.

In this model, time steps occurred every minute and birds had the option to either: sing, move, or rest. To influence the bird actions, the model was simulated in western Oklahoma conditions which has seen increasingly dry conditions. For the model the team used 7 total weather environments: current weather (as a baseline), a drought in our current environment, and then climate change conditions that ranged from medium to worst. The medium to worst conditions were simulated from projections to the year 2070 in the area.

These climate conditions have a huge effect on sound attenuation which is how well sound travels through the air. Sound is just waves traveling through the air, so rapidly increasing aridity reduces the capability of sound traveling through it.

In addition to aridity having a negative effect on song transmission, evaporative water loss (EWL) was included or omitted in the tests to see how it affected the birds. As the climate gets dryer, it's harder for birds to retain water so they will experience EWL which is basically just them losing water in their bodies. Once a bird has lost too much water in the simulation, it will have no other option but to rest, further reducing chances of song transmission.

As a measure of success, the research team looked at the number of completed contacts between birds, out in nature this contact can be critical for attracting mates or other forms of communication such as maintaining territories.



Hexagonal grid of the ABM each hexagon is a territory, the red dots are birds, and the green circles are bird song cover radius.

Analysis of Birds Singing

Birds sing in various frequencies so 4,8, and 12 kHz were measured in the model environments. Four kHz saw the most contact while 12 saw the lowest. Eight kHz was the one that was affected the most by drought and arid conditions. Across all environments contact severely dropped when moving from 4 to 8 kHz but the most extreme drop was seen under drought conditions when contact rates dropped by 69%.

Some birds have been known to adapt their frequencies to their environments, however some can't. Those that can adapt exhibit what's known as plasticity which is how flexible species can be with their environment, but after an extended time of being plastic, species can end up permanently adapting the traits.

This permanent adaptation can lead to a widespread homogenization of bird songs, if only certain frequencies work then that may end up being the only thing we hear rather than a rich varied soundscape. Unfortunately for those that cannot adapt, it likely results in them moving to new areas or experiencing extinction as a result of being unable to adapt or find a new habitat.

Another observation was that higher frequency songs were already seeing very low contact but when EWL was added into the mix, every frequency of birdsong saw a reduction in contact rate. The absence of EWL in real life is not realistic since animals will always lose water, so the inclusion of that metric is the most sensical.

While the projection goes out to the year 2070 and that may seem like a long time from now, dry conditions are increasing in parts of the world, and it affects bird songs in two ways: it reduces sound attenuation, and it reduces activity in birds.

Why Should We Care?

Research like this ABM model can provide great insight into what the future has in store, and while they are simulations, they should be heeded with caution. Climate change can run rampant and affect big picture facets of our lives but there's many other smaller things it can affect that we may not notice.

A big question is: why do these bird songs matter so much? When we start letting things happen and passing them off as no big deal, it can result in a cascading effect of apathy. If our rich bird song soundscape becomes so degraded and we let it pass by then what's next? It's little details like our soundscapes that add so much to our earth and once it's gone, it's something the entire planet will dearly miss.