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775 words

Climate change and Conservation Biology

With the global temperature continuing to rise, it has become imperative to understand how temperature changes, precipitation, and other weather events are going to shape health and status of a variety of ecosystems as well as the organisms that occupy them. In addition to observation and in lab experiments, genetic analyses have become a popular method for studying which organisms are better suited for the inevitable changes to come as well as: 1) which areas of the genome are changing, 2) how they are changing, 3) why are certain genes changing, etc.

In one study, scientists examined how genomic signals of selection can predict population declines in the yellow warbler as a result of climate change. They used genomic vulnerability, or the mismatch between current and predicted future genomic variation based on genotype-environment relationships, to help determine which populations were at risk for selection. They found that areas with the highest genomic vulnerability ranged from Alaska to the Rocky Mountains. They found that precipitation and temperature were most closely associated with local adaptation. They then found that one of the strongest genetic associations was upstream of genes known to function in behavior and migration specific to birds. This specific SNP was upstream of two genes that accounted for dispersal and novelty-seeking behavior and had the highest frequencies in areas with highest rainfall. The result of this study is an excellent example of a gene-regulatory network, since this SNP is associated with precipitation and the activation of this SNP could activate the downstream genes associated with dispersal. And it appears the allele frequency of this SNP is going to increase with increasing precipitation. This could be good for birds in these climates since increasing dispersal will reduce the effects of fragmentation due to deforestation and development. In addition, they may adapt to the changing climate easier by migrating further to more suitable habitats. This acts as an excellent predictor for determining declines in populations in different areas. According to this study, populations are most likely going to decline in the western US, where allele frequencies of this SNP are low, most likely due to the lack of precipitation.

The other study examines similar variables, however, they focused on a species of tree in Australia known as *Eucalyptus*. They found that precipitation and temperature had the highest number of adaptive SNPs and used these relationships to create a linear model to determine the change in allele frequency that would be required under a given climate projection. This approach allows conservation groups determine which plants have the best chances of adaption and channeling resources to those groups, some of which could be umbrella species which can cascade to help preserve other species. This study also found that allele frequency varied widely across locations and between SNPs. As a result, they emphasized the importance of genetic diversity and ultimately concluded that seed sourcing from one particular population was not appropriate. Conservation should focus on sourcing from multiple populations since the climate variables, especially precipitation, tended to vary by site. In conclusion, like most things in biology and the sciences, there isn’t a silver bullet. In order to effectively help these organisms to adapt to these changing conditions, we will have to help maintain genetic diversity and monitor them as they make their adaptions.

This is similar to the yellow warbler study in that they both use climate-SNP relationships to help predict which organisms or which populations of organisms have the best chance of adaption given the frequency of particular alleles. Both of these studies emphasize the concept of maintaining genetic diversity. This diversity helps the species maintain some flexibility in the case the environment shifts and is no longer suitable. This could be crucial especially since, while overall global warming is occurring, we are experiencing extremes in our weather and climate and the differences in these extremes appear to be growing. Both of these studies are also novel in that they found a clear link between climate and the ability to adapt. This could be the first step in targeted restoration and conservation strategies that can be more efficient as well as more effective. And finally, both indicated the value of combining environmental, demographic, and genomic data in an effort to predict and understand how the future variability in climate will affect these organisms over the next several decades. The next step will be to determine how quickly these frequencies can change in quickly changing environments to see if adaption can keep up.