Using the past to predict the future—climate change impacts on the sagebrush sea

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Scientists from Utah State University developed a new way to use long-term population data to model how species could respond to climate change in the future.

Using thousands of observations of big sagebrush (*Artemisia tridentata*) growth from Arizona to Washington, Andy Kleinhesselink and Peter Adler showed that sagebrush populations at cold sites increased after warmer than average years, whereas populations at hot sites decreased after warmer than average years. In a rapidly warming climate, this pattern suggests that sagebrush populations may decline in the future at the hot edge of this species range, whereas populations may increase in colder areas. These changes may have important effects on wildlife such as the Greater Sage-Grouse (*Centrocercus urophasianus*) which depends on sagebrush for habitat and food.

The novelty and strength of this new research is in combining measurements made over many decades from many hundreds of locations. The study includes 8175 observations of year-to-year change in sagebrush abundance from 131 monitoring sites across western North America (see map). The growth of sagebrush at each site was compared with temperature and precipitation records to determine how year-to-year variation in weather affected sagebrush growth.

The key insight of the study is that the effect of weather on sagebrush growth changes across the species' geographic range. Warm years help sagebrush at cold, high elevation sites, but hurt sagebrush at hot, low

elevation sites. This pattern is consistent with results from previous studies based only on patterns of sagebrush occurrences. However, because the current study combines long-term data with occurrence records, it forges a more direct link between climate and species distribution and abundance.

One of the key benefits of taking this approach for sagebrush, and for other species, is that it allows for ecologists to produce short-term quantitative forecasts for how species populations will respond to annual climate variation. Because these forecasts can be made for the effects of short-term climate variation (1-10 years) they in theory can be tested relatively quickly. This will lead to a cycle of model testing and refinement that ultimately could improve our long-term forecasts, and build confidence in the predictions ecologists are making.

While species distribution models for sagebrush have predicted that global warming could lead to more sagebrush in cold regions and less in hot regions, the new work uses an entirely new modeling approach and an independent set of data. However, the study also showed that sagebrush may be less responsive to precipitation than expected: sagebrush in dry locations did not grow more after wet years than sagebrush in wet locations. Overall, the results suggest that long-term changes in temperature may be more important for the future of sagebrush than changes in precipitation.

More information: Andrew R. Kleinhesselink et al, The response of big sagebrush (Artemisia tridentata) to interannual climate variation changes across its range, *Ecology* (2018). DOI: 10.1002/ECY.2191

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