Long Term Oak monitoring in Ramat Hanadiv

2009-2015

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Background

In ten of the last eleven years, the annual rainfall in Ramat Hanadiv was low, with highest amounts reaching up to only the mean annual precipitation (534 mm, 1996-2015). In 2014, an extreme drought and heat event occurred, when the annual rainfall was 50% of the mean annual precipitation and winter temperatures were exceptionally high (daily maximum temperatures in January and February were >2°C higher than the average during those months). Then, 2015 was the only wet winter in the past eleven years, with almost 40%, or 200 mm, more rainfall (735 mm) than during an average year. Oaks (*Quercus calliprinos*) grow only at a few suitable sites in Ramat Hanadiv and, hence, might be vulnerable even to small changes in the growing conditions. In recent years, massive desiccation was observed among those oak trees, and consequently, a monitoring program was developed to follow the status of oaks in non-grazed plots of the nature park.

Objectives

The overarching objective of the oak monitoring project in Ramat Hanadiv is to follow quantitatively the state of the trees in view of the extensive, potentially climate change-related drought.

Methods

Monitoring started in 2009 with an ordinal scale at low resolution for evaluation of tree status (e.g., sparse vs. dense canopy). The project involved 440 trees in three plots, including a stand of oaks grazed by cattle. Since 2011, we know which trees have no green leaves, and in 2013, a continuous scale of tree evaluation was introduced, according to the practice of crown monitoring in European forests (see e.g. CEC-UN/ECE 1994 and Dobbertin et al. 2009). In the same year, the project was limited to the two ungrazed plots, in which 240 trees were renumbered by permanent labels. Today, the following visually assessed continuous variables (in percent) are monitored at the end of the dry season (October-November): crown density, level of dry leaves, and cover by climbers. In addition, the level of acorn presence is recorded as an ordinal value, and level and location of resprouting is noted. Sometimes additional variables are recorded, such as the presence of galls on leaves in 2014.

Results

As part of the desiccation process in oak trees, the density of foliage in the crown decreased, and in extreme cases, the entire foliage was lost. In 2011 and 2013, about 20% of the trees were without green leaves, though it was not clear when they desiccated. Since oak trees resprout from buds, die-off of the entire tree could be assumed only after several years without foliage. In 2014, more trees desiccated, such that about 30% out of the 240 monitored individuals were without green foliage.

Many of the living oak trees showed signs of stress, and only few of them had a full canopy and did not have any dry leaves. Half of the trees monitored in 2013 showed a moderately to extremely sparse crown (<65% crown density). Beside direct drought effects on the foliage in the crown, climbers might negatively affect trees. In 2013, climbers covered about 50% of tree crowns on average. After the extremely dry and hot winter 2014, >70% of individuals lost green leaves and showed a lower crown density than a year before, with some of them losing all their leaves (Fig. 1). At the same time, the cover of dry leaves in the crown increased drastically (from 15% to 40%). In addition, climber cover of the crown increased by 5% on average. In 2015, only partial monitoring was conducted, which included 160 trees. Following the wet winter 2015, foliage showed a plastic response, as >70% of the trees increased their crown density (Fig. 1) and the cover of dry leaves decreased to 10%. However, none of the about 20 trees that desiccated in 2014 resprouted (some trees could not be retrieved, most probably because they did not recover and were grown over, and sometimes were broken, by massive climber biomass).

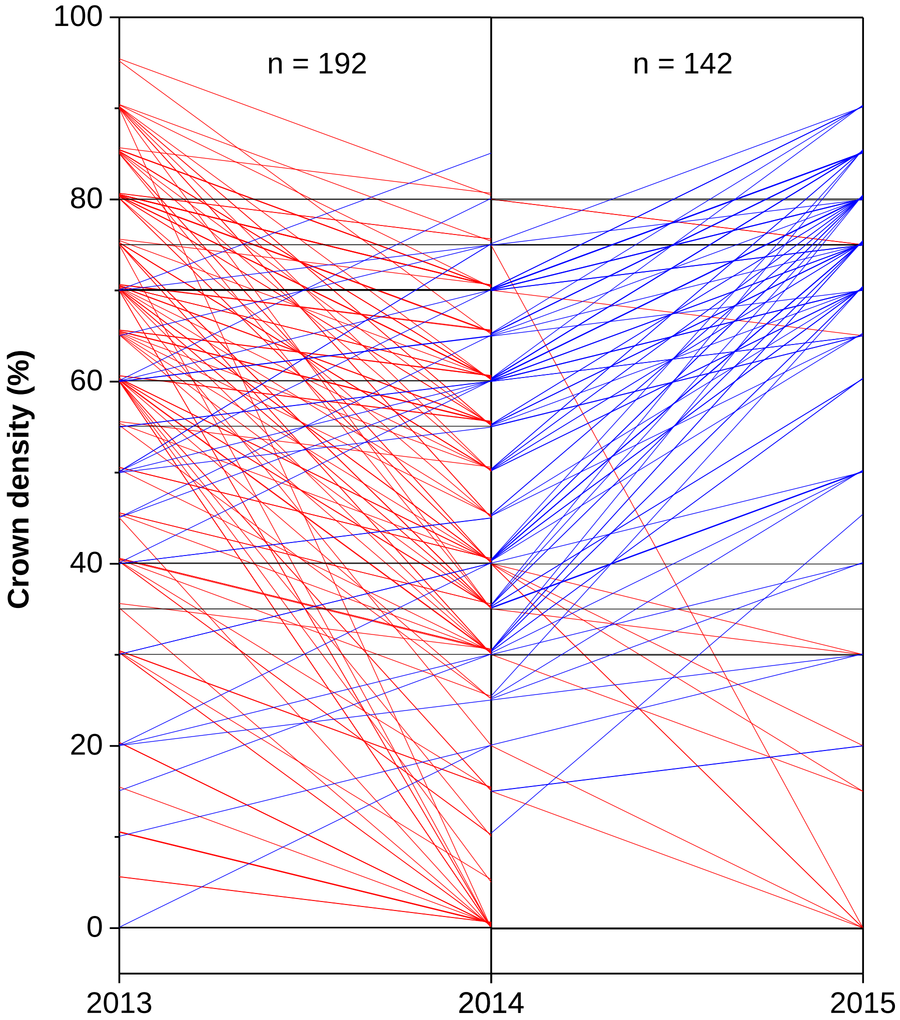

Fig. 1. Change in crown density of oak trees following the dry and hot winter 2014 and following the wet winter 2015. Red lines indicate a decrease in crown density of individual trees between years, blue lines show an increase, and black lines indicate no change in crown density. The wider a line, the more trees underwent the same trajectory between years. Note, that most trees lost leaves between 2013 and 2014, and grew new leaves between 2014 and 2015. Note also that none of the trees that lost all of their leaves (crown density = zero) in 2014 recovered in 2015. Crown density was visually determined at the end of the dry season using a picture scale of crown densities.

Acorn production is an important measure of tree health and recruitment potential. For oak species in California, massive recruitment of new seedlings was restricted to the combination of a mast year followed by a wet winter and spring. Our acorn data are not insightful, since they are on an ordinal scale (none, few, medium, many). Therefore, the California or European continuous acorn monitoring technique should be adopted (e.g., Koenig & Knops 2013).

Conclusions

Oaks provide a unique habitat in Ramat Hanadiv, but drought threatens the existence of this habitat. Drought (and heat) might occur more frequently in the future as part of regional climate change. For example, 2016 was the eleventh dry winter in the last twelve years, with only 457 mm of rainfall (86% of mean annual precipitation). To follow the status of the oaks in Ramat Hanadiv and to improve our understanding of their response to climate variation, monitoring of the full set of 240 trees should be continued at an annual scale. The results from the monitoring effort will also enable assisting the park to develop a strategy for conservation of the trees, if necessary.

References

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