

Problems related to oak regeneration in Central-Europe: from acorn production to wild boar rooting

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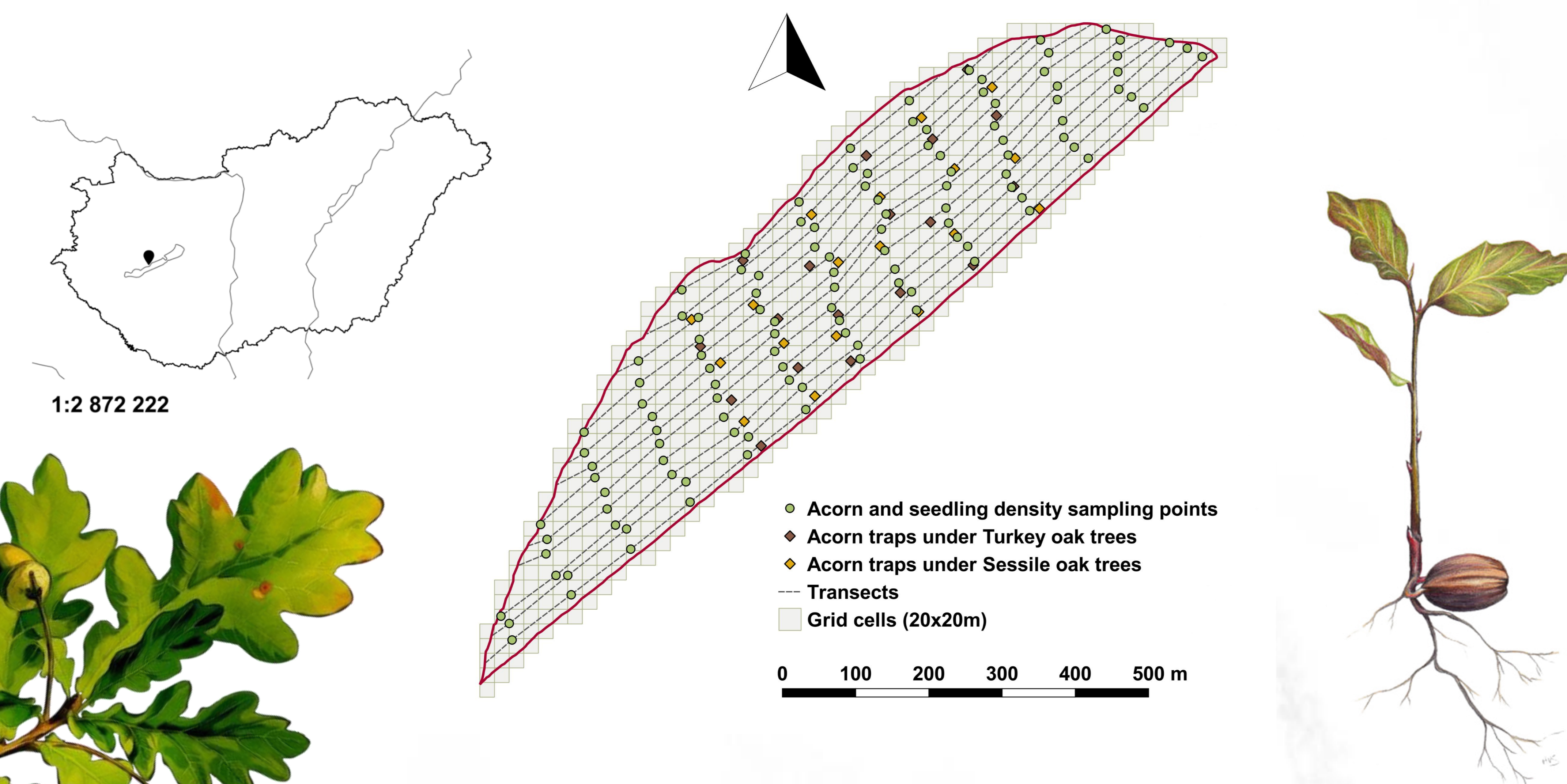


Introduction

Throughout the temperate zone on the Northern Hemisphere oaks (*Quercus spp.*) are among the most important tree species. Many of the red-listed forest species are connected to this genus. However, the adequate regeneration of the oaks has been regularly missing or scarce. So this process is often in the focus of interest of forest and wildlife managers or conservationists. Acorns of the oaks mean the basis of the regeneration, the crop size and germination success have a crucial role in the successful recruitment. Oak acorns have high nutritional value and they are keystone resource for wildlife. But acorns are also often under high parasitic pressure by granivorous insects (*Curculio spp.*) damaging acorns while they are still on the tree, out of reach for post-dispersal seed predators. However, oaks are not completely unarmed against these impacts, they typically show mast seeding (a synchronous intermittent production of large seed crops by population of plants) considered as a defensive strategy. These episodic pulses in acorn availability have crucial and far-reaching effects in these ecosystems. Trophic generalists, like wild boars (*Sus scrofa*) are the ones that most likely respond to these masting events. Besides, wild boars have a profound effect on their environment mainly by their rooting behavior affecting the biodiversity. Then, they are often considered as one of the main obstacles in the oak regeneration. Therefore, we examined the patterns of oak regeneration process and studied these relationships.

Methods

We monitored a forest stand dominated by Turkey (*Q. cerris*) and sessile oak (*Q. petraea*) in Hungary, near the village of Zánka approximately in every month from 2016 October to 2019 December. We recorded every wild boar rooting our transects intercepted, with a GPS device. At the sampling points (1m²) the acorns on the ground were counted and categorized if there were any sign of infestation on them or if they were germinated. On the same sampling points (4m²) we also counted the seedlings which were emerged from the prior acorn fall. In 2017 September, 36 acorn traps were set up, which made us available to measure the acorn production excluding the effects of the large mammals. For the analysis the study interval was divided to different temporal sample units. Acorn fall periods, were normally from September to November, except in 2019 when acorn fall started a month earlier, when we expected the most intense acorn production. Acorn rich periods were from October to April, when acorns were available for the seed predators until they become seedlings in spring. While, seedling rich periods were from April to November, when we were able to detect the individuals. We examined the parasite pressure on acorns from the start of the acorn fall until December. Besides these, we identified germination and seedling peak months. For the rooting analysis the study site was divided to 702 cells of 20x20 m to examine the dynamics of the wild boar rooting by marking the cells which were rooted.



Results

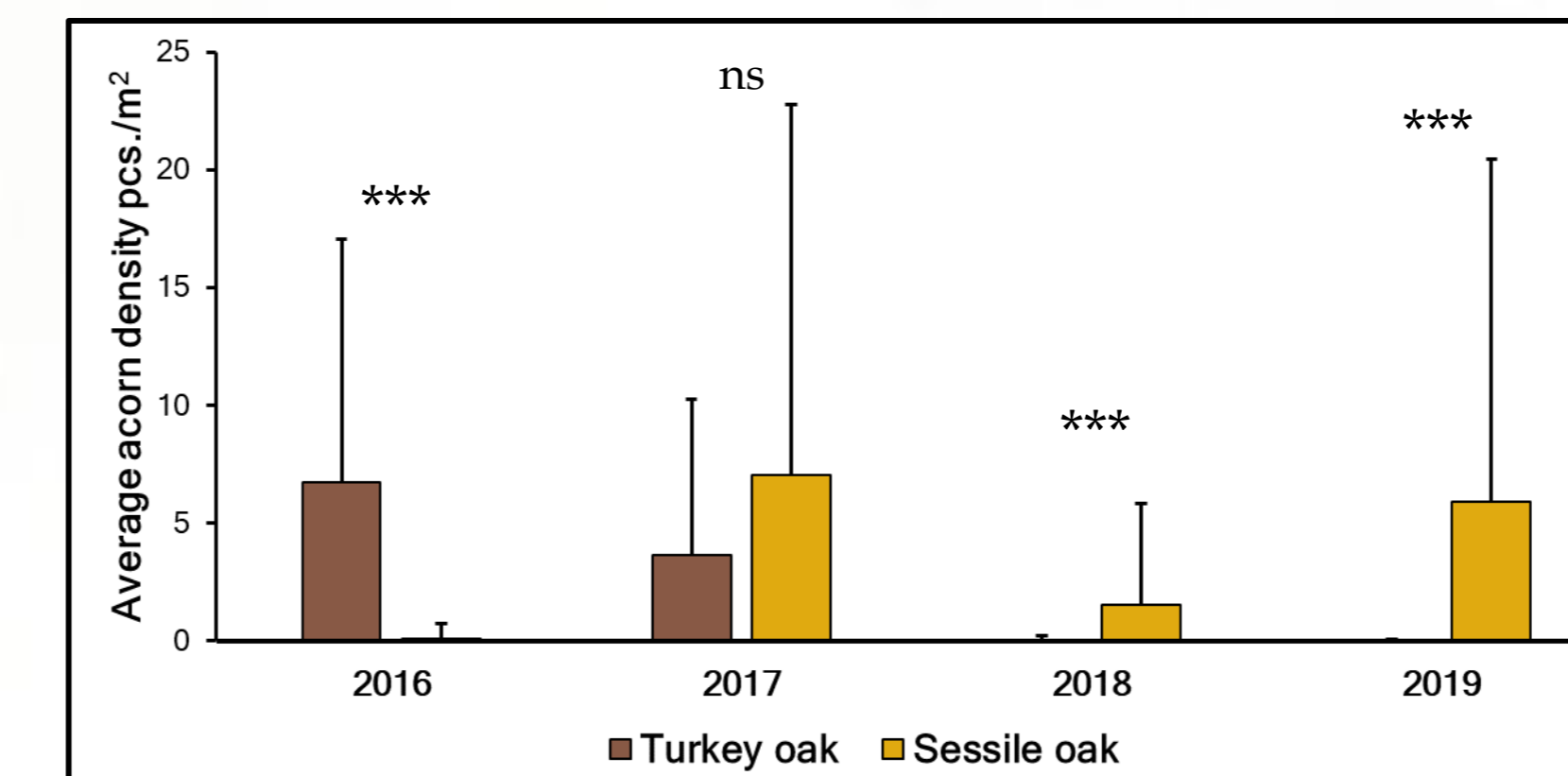


Figure 1. - Average acorn densities during the examined acorn fall periods on the ground. Turkey oak practically produced acorns only in the first two periods, while sessile oak showed a more balanced yield throughout the study. There was no significant difference between the acorn densities of the two species in the 2017 acorn fall period.

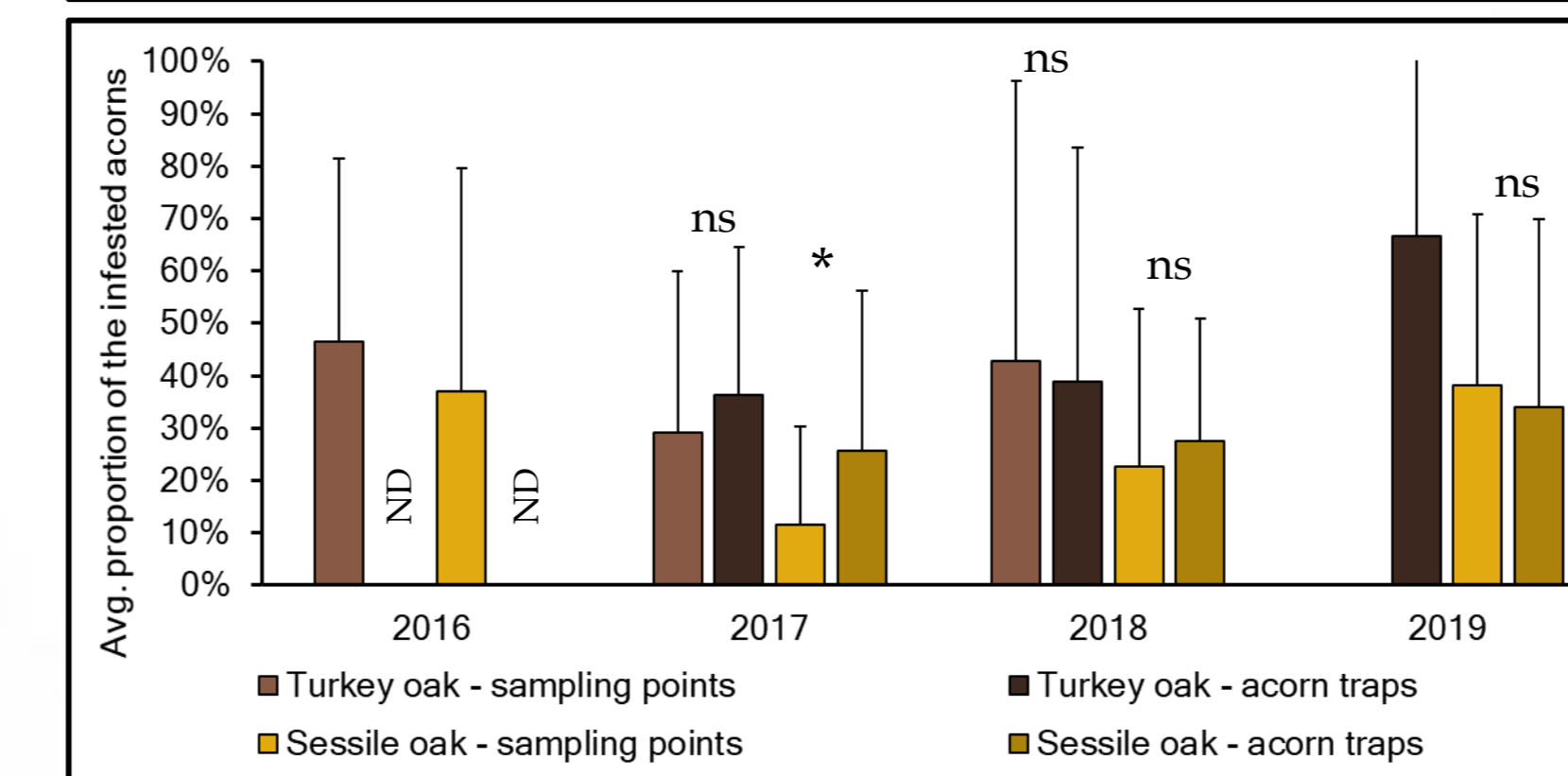


Figure 2. - The proportion of the infested acorns by parasites were typically similar in the acorn traps and on the ground for both oak species, so there we found no sign of selective wild boar foraging. Infested acorns increased after 2016 during the successive years in case of the sessile oak, while there was a slight decrease in case of the Turkey oak from 2016 to 2017 - the only two years, when the species practically produced any acorn.

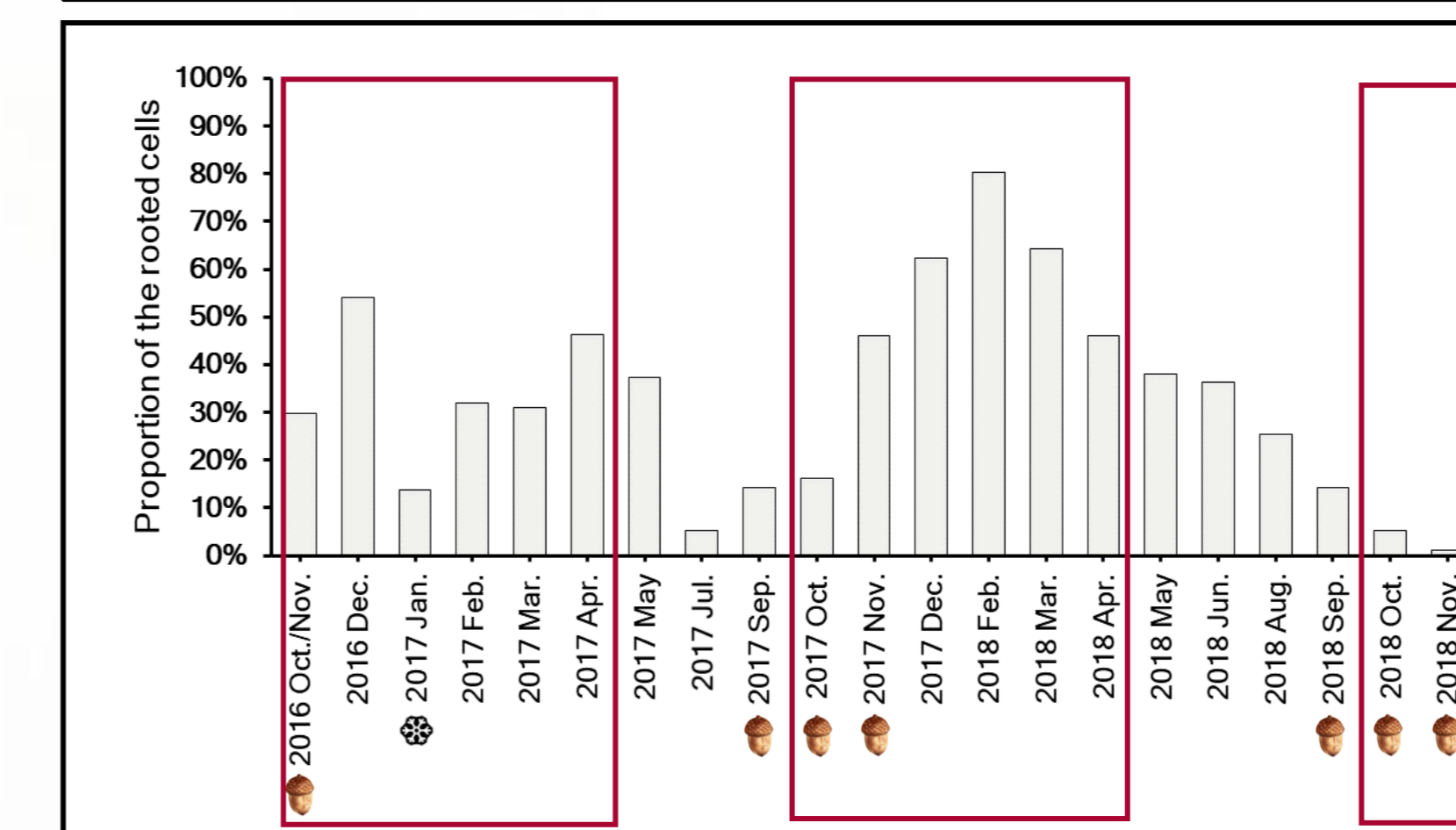


Figure 3. - The interannual changes of the rooting during the acorn rich periods (indicated by the red frames) were similar to the patterns of acorn production as the proportion of the rooted area was much lower in the third acorn rich period. It seems that the availability of the acorns has fundamentally drove the rooting dynamics. (Acorn symbols indicate the acorn fall periods, while the snowflake symbols indicate when the study site was covered by snow during the sampling.)

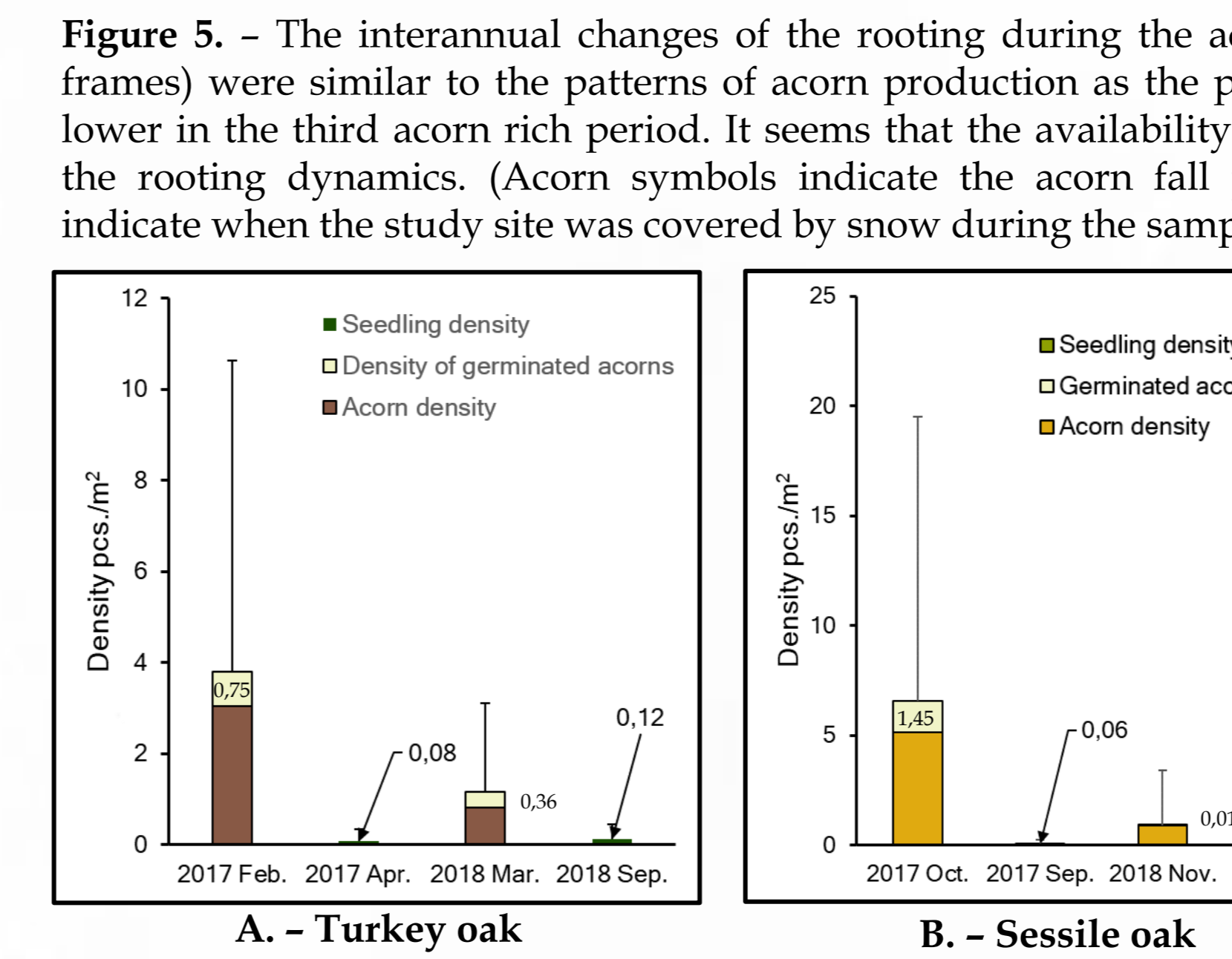


Figure 4. - Acorn densities on the ground during the acorn rich periods showed similar patterns as we saw in the acorn fall periods.

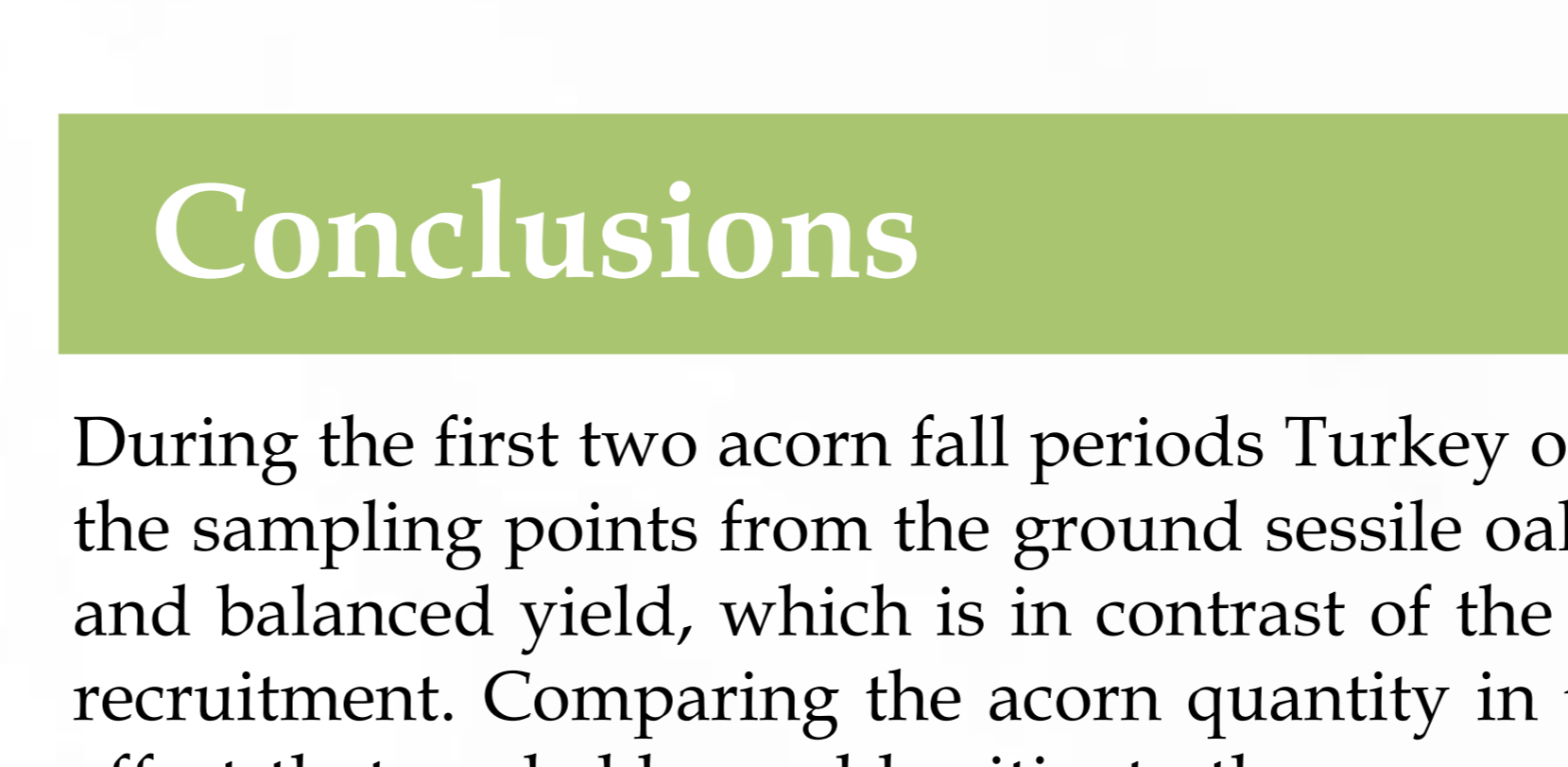


Figure 5. - Germination peak was different for the two species, as in case of the sessile oak (B.) it is not uncommon to germinate as early as falling from the tree if the humidity is high enough. However, the proportion of the germinated acorns were quite low for both species (chronologically 16% and 32% for the Turkey oak (A.); 18% and 2% for the sessile oak). Seedling density during the seedling peak period was relatively low for both species.

Conclusions

During the first two acorn fall periods Turkey oak was masting, but later it produced almost nothing. While based on the data from the sampling points from the ground sessile oak masted in 2017, but based on the data from acorn traps it showed a relatively low and balanced yield, which is in contrast of the masting phenomena and might be a detrimental strategy for the sessile oak in the recruitment. Comparing the acorn quantity in the acorn traps and on the ground, we demonstrated a strong large seed predator effect that probably could mitigate the regeneration of the forest, but it seems that some seedlings still could emerge despite the increased rooting pressure and wild boar presence after the first two acorn fall periods. Although the extent of this rooting pressure and acorn predation may be too severe to deal with from the point of view of forest managers as it slows down heavily the rate of the regeneration. But it seems that wild boar is not the single obstacle of the regeneration, but rather has a strong effect on a system influenced by many factors such as acorn parasites and predators, strategies of the species, weather and site quality.

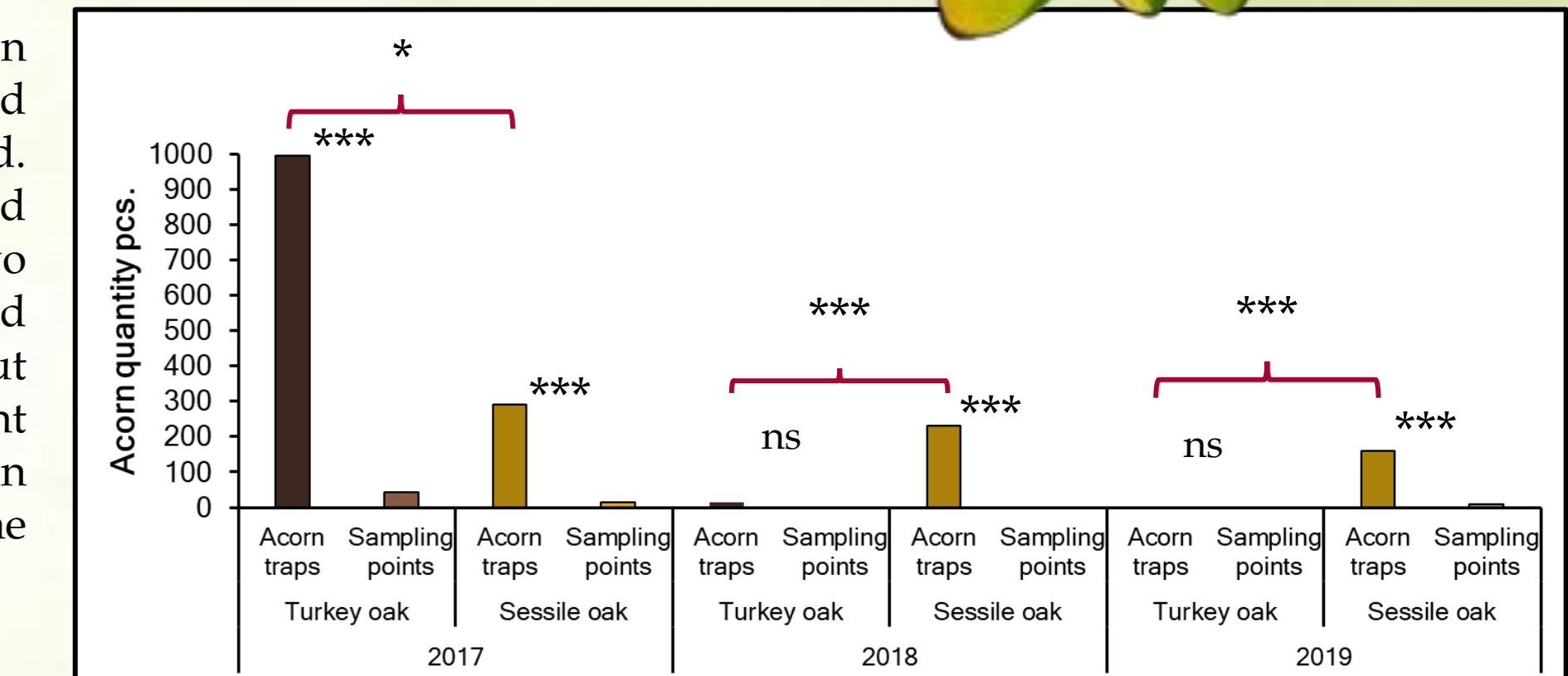


Figure 6. - Acorn densities on the ground during the acorn rich periods showed similar patterns as we saw in the acorn fall periods.

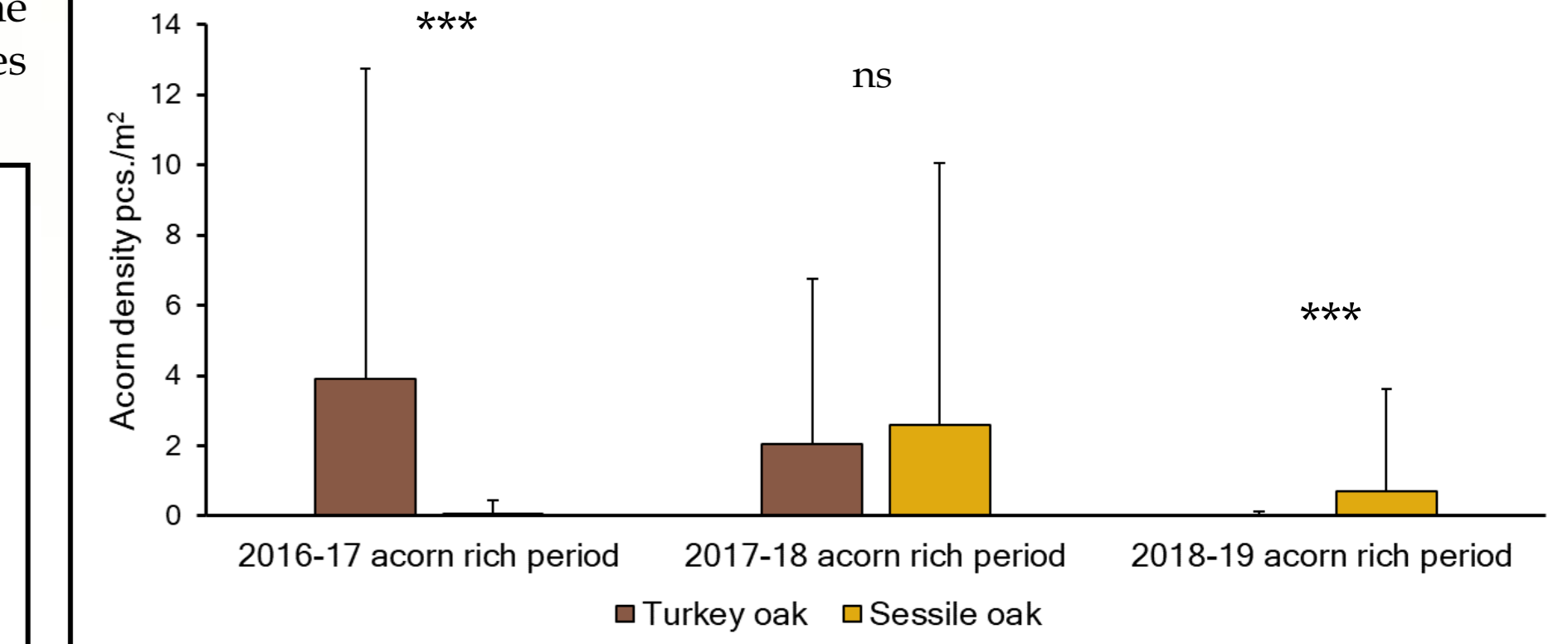


Figure 7. - Seedling densities also followed the pattern of the acorn densities. Turkey oak seems to be the more successful species in the recruitment. But it is interesting that in 2018 we found slightly more Turkey oak seedlings than in 2017 even though that the acorn density of the species was lower in the acorn fall and acorn rich periods than in the same periods earlier. Although it is worth to mention that in 2017 their acorns were less infested and in 2018 germination peak period showed higher germination proportion, which might be enough to compensate for the lower production and density values.