ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 64 69 Number 2, 2016
http://dx.doi.org/10.11118/actaun201664020579

# WILD BOAR IMPACT TO THE NATURAL REGENERATION OF OAK AND ACORN IMPORTANCE IN ITS DIET

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## Abstract

ZEMAN JAROSLAV, HRBEK JAN, DRIMAJ JAKUB, PLHAL RADIM, KAMLER JIŘÍ, ADAMEC ZDENĚK, HEROLDOVÁ MARTA. 2016. Wild Boar Impact to the Natural Regeneration of Oak and Acorn Importance in its Diet. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 64(2): 579–585.

In this study, the impact of wild boar on the natural regeneration of oak and importance of acorns in the wild boar diet were surveyed. The data were collected near Moravian Krumlov (Czech Republic) in three types of oak stands differing in the canopy density: fully-stocked stand (1), open-canopy stand (2) and the forest stand in a conversion to the coppice forest (3). Within each stand 150 m long lines were set out. Seed traps to collect acorn harvest and control plots were installed on these lines. The plots were inspected at weekly intervals. After the end of acorn fall the average amount of fallen acorns was evaluated. The quantity of metabolizable energy in acorns was assessed and daily survival dose of energy for average weight of wild boar was counted. In spring 2014 the number of seedlings was counted at the same plots. Production of acorns per hectare and basic energy needs for one individual wild boar per day were evaluated for each chosen stand type. The found seedling density amounted to 29,600, 32,000 and 14,000 ind./ha in the first, second and third stand under study, respectively. Wild boar is a major consumer of acorns. In the studied area the production of acorns sufficiently supplied the local wild boar population during winter. Necessary amount of acorns remained for the natural regeneration.

Keywords: oak tree seed trap, oak fully-stocked stand, open-canopy forest stand, forest stand in a conversion to coppice forest, oak seedlings, wild boar daily survival dose

## INTRODUCTION

Natural regeneration has become a more acceptable method of forest establishment and under current guidelines it is the preferred method for restocking semi-natural woodlands (Harmer and Gill, 2000). Under certain circumstances natural regeneration may be more desirable than planting, as it can conserve local genotypes and create more structural diversity within the site. Under natural conditions of the Czech Republic all main economically important forest tree species have potential to naturally regenerate. The importance of this regeneration way is highly preferred, however it meets with high impact of wildlife (birds, rodents and ungulates) either on tree seeds or on their seedlings and saplings (Reimoser and Gossow, 1996; Reimoser and Reimoser, 1997; Den Ouden *et al.*, 2005; Katona *et al.*, 2014). One of the most harmful effect is caused by wild boar; its damage is often evaluated as to agricultural crops (Geisser, 1998; Brauer *et al.*, 2006; Herrero *et al.*, 2006; Acevedo *et al.*, 2007). However, wild boar prefers woodland and other natural or semi-natural habitats as safe resting sites (Spitz and Janeau, 1990; Gérard, *et al.*, 1991; Boitani, *et al.*, 1994). The dietary composition

of wild boar inhabiting farmland-forest mosaic is significantly different from that of wild boar living in a large solid forest complex. The quality of wild boar diet is higher in the farmland – forest mosaic environment (Merta *et al*., 2014).

The species' distribution ranges from Western Europe to the Far East, including many islands such as Japan and Taiwan (Spitz, 1999). Wild boar native to Eurasia are now present throughout all continents except Antarctica and some oceanic islands (Long, 2003), which makes boar one of the most widely distributed mammals in the world (Massei and Genov, 2004). The Western European population of wild boar has increased within its range in the course of several past decades (Fennoscandia: Erkinaro *et al*., 1982; France: Gérard *et al*., 1991; Germany: Feichtner, 1998; Krüger, 1998; Italy: Blasetti *et al*., 1987; Apollonio, Randi and Toso, 1988; Luxembourg: Schley *et al*., 1998b; Schley, 2000; Spain: Sáez- Royuela and Tellería, 1985; Switzerland: Baettig, 1995; Geisser, 2000; for a review see Sáez-Royuela and Tellería, 1986) and it is clear that the species can thrive in areas that are heavily influenced by human activity (Genov, 1981a; Geisser and Bürgin, 1998). Population growth of the wild boar is also associated with increased frequency of the good harvest mast years and it has increased mast consumption (Schley and Roper, 2003).

Wild boar is native in the Czech Republic, whose distribution and abundance is thought to have varied significantly throughout the last centuries. These fluctuations are believed to be linked to climatic conditions (Geisser and Reyer, 2005). Today, the growing populations of wild boar cause a serious economic, ecological and social threat not only in the Czech Republic but across central Europe (Frank 2008; Kirschning *et al*., 2008).

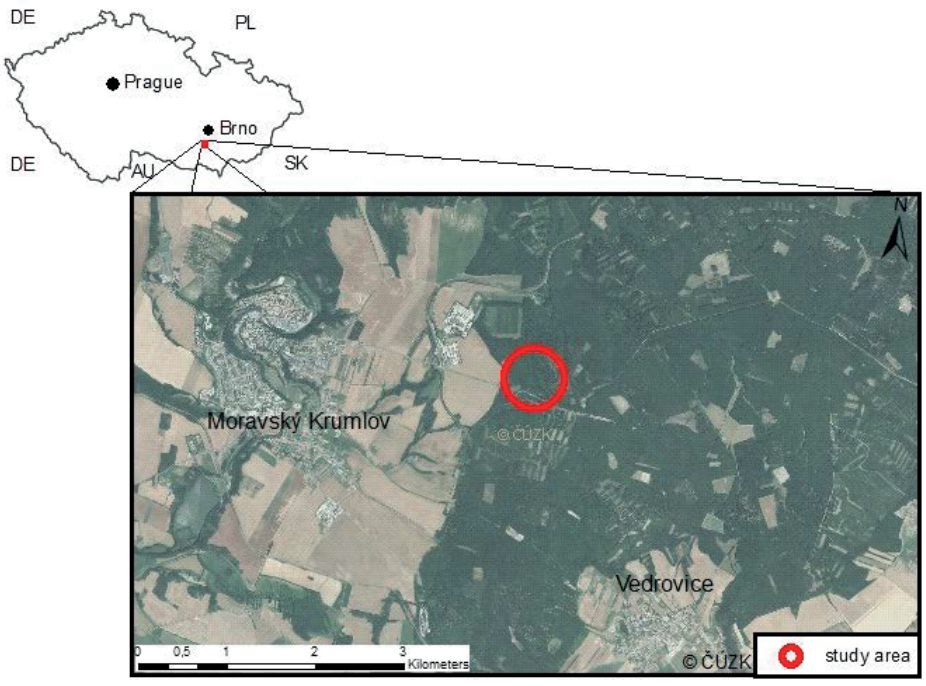
The species shows dramatic population increase throughout Europe partly related to the increase of forested areas. The effect of wild boar on native plant communities and mainly on forest biodiversity and regeneration is very high in many countries. Its root damaging impact and acorn consumption could be a primary factor in preventing oak forest regeneration (Katona *et al*., 2014).

Aim of this study is to evaluate acorn production in three oak forest stands in relation to wild boar food requirement and its impact on the natural regeneration of oak.

## MATERIAL AND METHODS

### Study Area

The study area was situated in South Moravia near the town Moravian Krumlov in Czech Republic. Map (Fig. 1) outputs were processed in software ArcGIS 10.1 (ESRI, Redlands, California, USA). Three oak forest stands were chosen as study localities with the elevation ranging between 340 and 380 m a.s.l. The mean annual temperature was 8–9 °C. Data were collected in the following oak stands types: fully-stocked stand (1), open-canopy forest stand (2) and the forest stand in a conversion to the coppice forest (3). All three forests were situated close to each other with the average age of about 80 years. Dominant tree was the sessile oak (*Quercus petraea*). In a fully-stocked stands almost no herb and shrub layer was developed, in other two stands herb layer was present and shrub layer was formed by natural forest regeneration. The




1: *Map of the locality*

main aim of the forest management in this area was oriented towards a production of high-quality oak cut-outs. Forests under research were situated about 200 m in distance from the open agricultural land, and in time of research, with only crop remnants in the fields. Game species, as also wild boar, were concentrated in forests utilizing the diet supply of mast. The forest stands were located in hunting area (5.05 km$^2$) named Bílá Voda. The hunting area borders the wildlife reserve Moravian Krumlov in the north, east and south, with intensive agriculture landscape being mostly on the west side. Wild boar (*Sus scrofa*) density was about 14 individuals per km$^2$. Other present wildlife species were roe deer (*Capreolus capreolus)* and sporadically red deer (*Cervus elaphus*).

## Methods

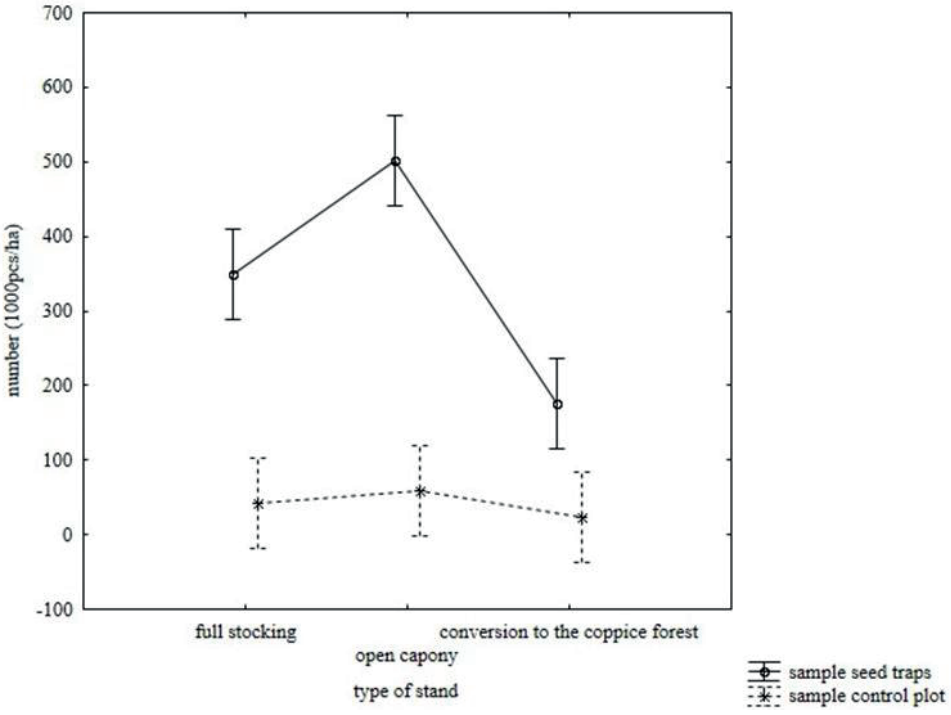
Within each of the three oak stands (1, 2, 3) 15 points were set up on 150 m long line with 10 m spacing. At each of the 15 points, seed traps to collect the falling oak acorns were installed. These were metal traps with storing bags with 0.25 m$^2$ surface. They were situated high enough above the ground with its content not accessible to any acorn predator. In the vicinity of the seed traps the control plots of the same size were established on the ground. Both plots and seed traps were inspected weekly from 10$^{th}$ of September 2013 (the beginning of seed fall) to 9$^{th}$ of November 2013 (the end of seed fall). Acorns from the seed traps were collected, counted, their weight was determined and they were taken to the lab. Acorns on the control plots were only counted and weighted, but always left on the forest ground. It was expected that the amount of oak acorns collected on the control plots would be influenced by consumption of rodents, birds and ungulates. Altogether 8 data sets were collected at each stand, i.e. 24 in all three stands (Fig. 2).

Collected acorns were peeled and dried in a drier at 60 °C. After drying the acorns were acclimatized for 24 hours at room temperature. After acclimatization the dried acorns were grinded to powder. Prepared samples were sent for laboratory analysis to determine their chemical composition. As the wild boar partly peals the acorns while consuming them, detailed analysis of mass rate between pericarp and cotyledons of acorns was done. Percentage rate of pericarp to cotyledons in original mass was 30% to 70%, as to dry matter 53% to 44%, respectively. Metabolizable energy was subsequently calculated by the following formula:

$$ME\ (MJ) = (0.464 \times H\ 0.75);$$

$$ME\ (MJ/kg) = 0.000210 \times KS\ NL \times NL\ (g/kg) +$$
$$+0.000374 \times KS\ T \times T\ (g/kg) +$$
$$+ 0.000144 \times KS\ VL \times VL\ (g/kg) +$$
$$+ 0.000171 \times KS\ BNLV \times BNLV\ (g/kg).$$

(H – live weight; KS – digestibility coefficient; NL – crude protein; T – fat; VL – fiber, BNLV – nitrogen free extract (Zeman *et al.*, 2006) was used. Energy expenditure in low temperature during the winter was adjusted and increased by 10%. Another adjustment to 30% was considered for movement loss of energy. For average wild boar metabolizable




2: *Comparison of average amount of oak harvest (in 1000pcs/ha) with 95% confidence interval (CI) collected by the two sampling methods (seed traps and controlled plots) in three forest types*

I: *Total diet supply of acorns (dry matter) in details linking to wild boar acorn daily survival dose and number of seedlings remaining for forest regeneration*

| Value | Unit | Forest stands | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Total mass of acorns harvest | kg/ha | 406 | 667 | 182 |
| Total mass of acorn consumption | kg/ha | 371 | 624 | 168 |
| Acorn mass left until spring | kg/ha | 50 | 78 | 25 |
| Total number of acorn harvest | 1000 pcs/ha | 349 | 501 | 176 |
| Total number of acorn consumption | 1000 pcs/ha | 307 | 443 | 152 |
| Number of acorn left until spring | 1000 pcs/ha | 42 | 58 | 24 |
| Number of viable seedlings in spring | 1000 pcs/ha | 29.6 | 32 | 14 |
| Avarage weight of one acorn | g | 2.46 | 2.74 | 2.32 |
| DMR acorns for wild boar (45 kg) in the original mass | kg | 2.68 | 2.60 | 2.84 |
| Days of DMR counted from total acorn food supply | day/ha | 321 | 528 | 144 |
| Days of DMR of consumed acorns | day/ha | 294 | 494 | 133 |

Note: DMR – daily maintanace ratio

energy was 8,062 MJ, without adjustment, after adjusted increase it was higher (11,286 MJ). Quantity of metabolizable energy in acorns was compared with daily survival dose for average wild boar with a live weight of 45 kg (Zeman *et al*., 2006).

At the same forest stands (fully-stocked stand, open-canopy forest stand and that in a conversion to the coppice) oak seedlings were counted in spring 2014 (April) on 100 randomly distributed plots. Size of each plot was the same as in previous acorn collecting (0.25 $m^2$). These plots were placed 0–25 meters from the seed traps line randomly.

### Statistical Evaluation

Comparison of mean number of oak acorns among all three various stands was done during all research periods (10. 9.–9. 11.). Differences were evaluated between amount of oak mast (mean number) collected by two monitoring methods; amount of oak mast in seed traps and on the control plot closed to it on the forest ground. Two-way ANOVA and Tukey HSD test ($\alpha = 0.05$; 95% confidence interval) were applied using STATISTICA 12 (Statsoft, 2013) software.

## RESULTS

The production of acorns (average amount of fallen acorns in dry matter) collected by seed traps was significantly influenced by the type of forest ($F(2, 84) = 17.585$; $p < 0.001$) as differences were found among all three forest stands under study (Tab. I, Fig. 2). Sampling technique (seed traps, control plot) also significantly influenced amount of acorns ($F(1, 84) = 146.76$; $p < 0.001$). Interaction of both of these factors (sampling technique and forest type) also significantly influenced the acorn harvest ($F(2, 84) = 11.463$; $p < 0.001$). Small differences (not significant ($F(2, 42) = 0.568$; $p = 0.571$)) were found among samples on the control plots (Fig. 2).

Dynamics of acorns amount during the harvest season is on Fig. 3 (mean number of 15 traps). The highest amount of acorns was in open-canopy stand with also highest average weight of acorns.

The daily survival dose (daily need of maintenance requirement of energy) for average wild boar with a live weight of 45 kg can be compensated by 2.9 kg of acorns without pericarp. This can cover the basic energy need of one individual (Tab. I) for 294 days in fully-stocked stand (1), 494 days in open-canopy stand (2) and 133 days in the forest stand in a transition to the coppice forest (3). The consumption was 91.5%, 93.6% and 92% in the first, second and third forest stand type, respectively.

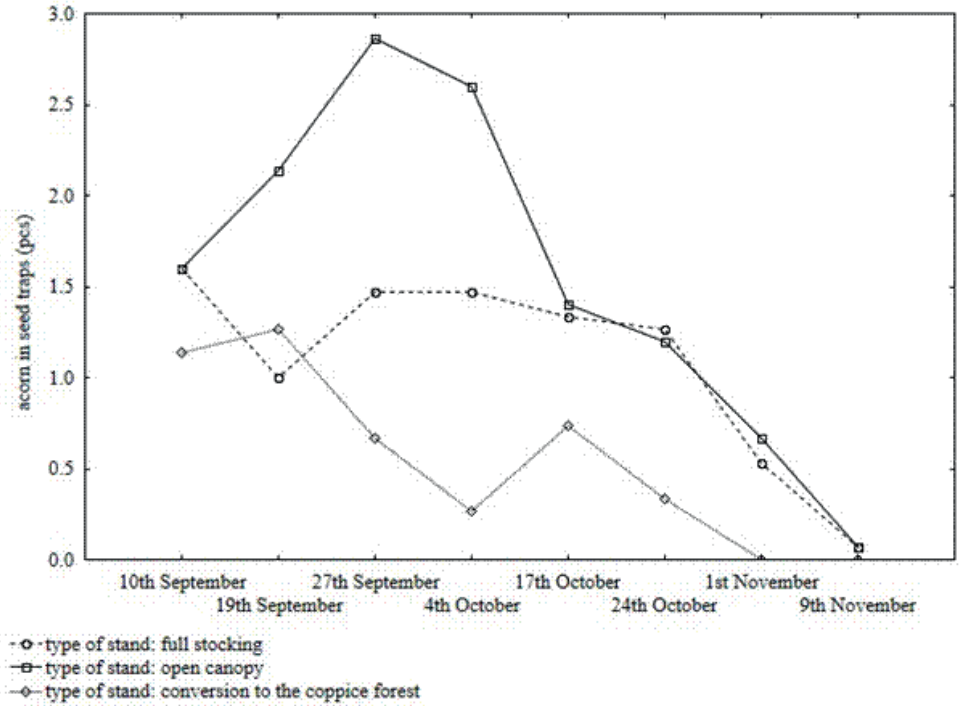
Potential count of total mass and number of acorn of wild boar consumption was 371 kg/ha and 307 pcs/ha in full stocked forest; 624 kg/ha and 443 pcs/ha in open-canoppy forest and 168 kg/ha nad 152 pcs/ha in forest in a conversion to the coppice.

The seedlings density (Tab. I) was 29,600 individuals per hectare in fully-stocked stand, 32,000 ind./ha in open-canopy stand and 14,000 ind./ha in the forest stand in a transition to the coppice forest.

## DISCUSSION

In our study importance of acorn harvest for wild boar and its impact on forest natural regeneration was evaluated. Although the high consumption of acorns was found out, enough seedlings were left out to allow natural regeneration.

According to Katona *et al*. (2014) wild boar can have a substantial effect on oak forest regeneration, but level of its impact related to other factors is not always unequivocal. Investigation of other factors, such as acorn production, acorn germination capability or the effect of other acorn predators could reveal the need of more complex management interventions. Advantage of our study is the complexity of results related to particular area in oak stand and certain population of wild boar in particular seed year.




3: *Dynamics of the mean number (pcs) of collected acorns in 15 traps (collected and counted every week)*

The different composition of forest habitats influences the foraging conditions of wild boar. The potential food resources for wild boar are higher in deciduous and mixed forests than in coniferous forest habitats (Grodziński *et al*., 1984).

The method of seed fall collection using seed traps during the whole oak harvest season is commonly used. This method was completed by harvest evaluation on control plots. Difference between the amount of oak seeds in the seed traps and at the control plots on the forest ground is given by predation of seed-eating vertebrates. Oak acorn as a food supply is consumed not only by wild boar but also by many other animals like deer, squirrels and other rodent species (Jenzen, 1971). Also the birds, e.g. jay, collect the seeds for food (Den Ouden *et al*., 2005).

During mast years, consumption of acorns and beechnuts starts in autumn and continues till spring (or even, in exceptional cases, until August; Briedermann, 1976) of the following year. If mast availability is low, other food items are consumed more frequently and in larger volumes. Massei *et al*. (1996) showed that graminoid consumption was negatively correlated with that of acorns, while others have shown a similar relationship between mast consumption and that of potatoes, cereals and roots (Briedermann, 1976). Since the availability of mast varies from year to year more than any of these other food items, it is reasonable to infer that mast is the preferred diet and that the other foods in question were eaten only when the supply of mast was limited. According to Schley and Roper (2003), based on nine studies on wild boar diet acorn consumption was 45% in average.

In experiments on *Quercus pyrenaica* by Gómez *et al*. (2003), dispersed acorns were also quickly consumed by several species of predators, particularly wild boar (*Sus scrofa*) and wood mouse (*A. sylvaticus*). Less than 4% of the experimental acorns survived to produce seedlings, even when they were buried 4 cm in soil, simulating caches. When there was a low acorn harvest in southern Spain, all acorns were eaten within few months by a variety of vertebrate herbivores (cattle, red deer, fallow deer, wild boar and rabbits).

In the Mediterranean area, where agricultural crops were not available and supplementary food was not provided, acorn and olive production was likely to influence both body weight and reproduction. Following a high production of acorns and olives, wild boar exhibited higher body weight, more breeding females and a larger litter size than in years of poor production of these food components.

Gómez *et al*. (2003), were also monitoring the natural establishment of the oak (*Quercus pyrenaica*) for 3 years in two forest plots and two shrub land plots, by counting seedlings. Around 98% of 1,000 experimental seedlings were killed by herbivores, notably wood mice, wild boar, and domestic and wild ungulates. Seedling survival varied spatially being significantly higher under shrubs (4%). Most of acorns were quickly consumed by several species of predators, particularly wild boar and wood mouse. In case of our study seedling survival was similar and varied between 91.5 to 93.6%.

## CONCLUSION

According to our results the acorns are an important food source for wild boar. The production of acorns in the study area is sufficient as a food supply for local wild boar population during winter. Oak forest is preferable biotope for the local wild boar population in case of good seed harvest. The wild boar concentrates on the acorn utilization as long as this food supply is not exhausted. In spite of that, quantity of acorns which remained for natural forest regeneration was sufficient.

Acknowledgement

The research was realized with the contribution of funds IGA LDF MENDELU, project number [9/2014]

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