FOX – the **FO**rest gap e**X**periment

Background, motivation and objectives

Over the first ten years of research in the forests of the Biodiversity-Exploratories, it turned out that differences between unmanaged beech-dominated forest and managed forests did generally explain quite little variation in observed biodiversity or ecosystem function measures, whereas measures of forest structure (especially dominant tree species, canopy openness and amount of deadwood) explained more of this variation (Felipe-Lucia et al. 2018, Schall et al. 2018, Penone et al. 2019). To provide more mechanistic insights we established an experiment addressing the effect of forest manipulations of forest openness and deadwood amount in 29 forests differing in management, biodiversity and ecosystem functions, i.e. we established a multi-site full-factorial experiment exploring the effects of creating gaps with and without deadwood removal in early spring 2020.

The main objective was to improve our mechanistic understanding on the relationship between land use and biodiversity, following the central questions of the Biodiversity Exploratories. More specifically, the experiment aims at disentangling the effects of two important factors related to forest management: the change of abiotic conditions by opening the canopy and the availability of biotic resources depending on logging.

Experimental design

The experiment was designed as a full factorial experiment based on four treatments (Figure 1):

- ***Treatment 1***: Gap only, i.e. creating a gap with a diameter of around 30 m (see below) and removal of all felled trees **(Abbreviation EP#-G, for example SEW 17-G)**
- ***Treatment 2***: Gap and deadwood. i.e. creating a gap with a diameter of around 30 m and leaving a certain amount of deadwood (see below) **(Abbreviation EP#-GD, for example SEW 17-GD)**
- ***Treatment 3***: Deadwood enrichment; i.e.no gap but placing a certain amount of deadwood (see below) **(Abbreviation EP#-D, for example SEW 17-D)**
- ***Treatment 0***: No gap and no additional deadwood. The plots are the regular Experimental plots (EPs) **(Abbreviation EP#, for example SEW 17)**

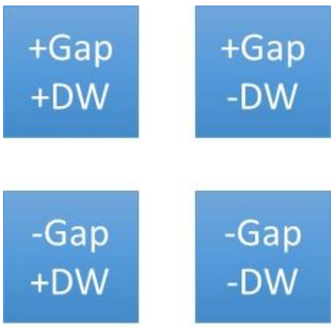

Fig. 1: The four treatments of the forest experiment (+Gap: gap creation, +DW: leaving deadwood on the plot)

Study sites and on-site arrangement of treatments

The experiment had to be restricted to a subset of sites for several reasons. First, heavy cutting such as creating gaps could only be applied in mature stands because such interventions are not appropriate in younger stages due to economic reasons. Second, the number of new plots to be surveyed in the up-coming years beside the existing 150 experimental plots had to be restricted. Third, new plots could only be established in larger stands that show the same species composition and forest structure than the EP. Based on these constrains the following sites, covering the most important forest types of the Biodiversity Exploratories, were selected:

- ***Schorfheide***
  Scots pine (*Pinus sylvestris*) stands: SEW03, SEW17, SEW18
  European beech (*Fagus sylvatica*) stands: SEW35, SEW36, SEW49
  Scots pine-European beech stands: SEW04, SEW31, SEW33
  Oak (*Quercus petraea* and *robur*) stands Eichenbestände: SEW24, SEW25, SEW27

- ***Hainich***
  European beech age-class forests:HEW05, HEW06, HEW19, HEW21, HEW47
  European uneven-aged forests (“Plenter forests”): HEW29, HEW30, HEW32, HEW48

- ***Schwäbische Alb***
  Norway spruce (*Picea abies*) stands: AEW03, AEW33, AEW34
  European beech stands: AEW22, AEW39, AEW42
  European beech mixed with other deciduous tree species: AEW28, AEW47, AEW48

At each study site, the plots were arranged by taking the local conditions into account while keeping minimum distances between the treatments (Figure 2).

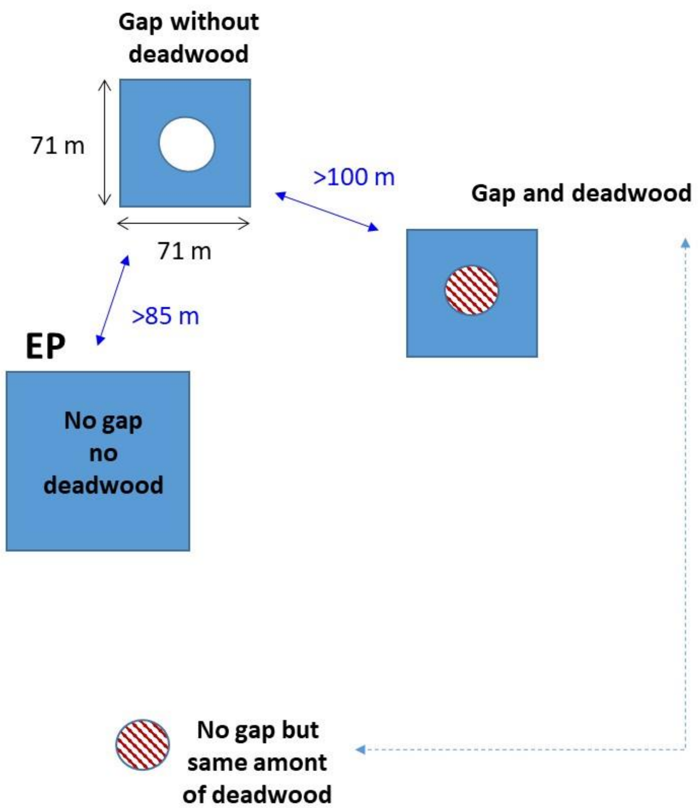

Fig. 2: Arrangement of treatments at a given study site

Treatments

- ***Gaps***

Before creating a gap all trees were inventoried (Figure 3) on an area of 0.5 ha (71 x 71 m). In the center of these new plots all trees except one tree in the gap center were felled. Gap diameter was defined by mean top stand height, i.e. between 25 m (AEW39) and 37 m (HEW06, HEW21). The crown of the remaining tree was cut in a height of around 12 to 15 m. This tree is to be used for instrumentation purposes (sensors, traps etc.)

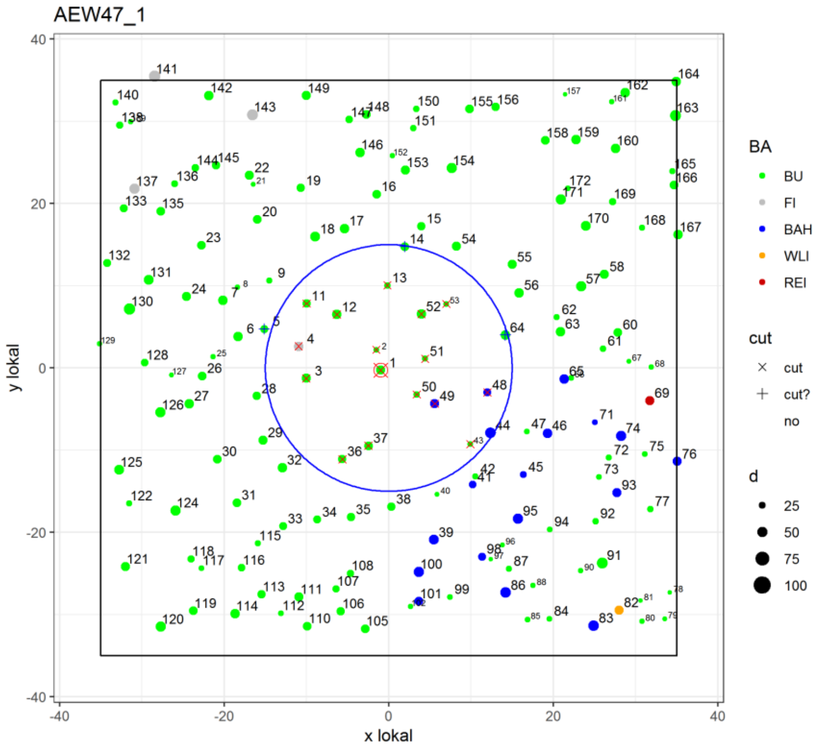

Fig. 3: Example of a plot with a gap prior to cutting. All trees marked by a "x" were selected for cutting, some of the trees marked with "+" were additionally cut depending on the local conditions in order to achieve the inner width of the target gap diameter (BA = tree species; BU = European beech (*Fagus sylvatica*), Fi = Norway spruce (*Picea abies*), BAH = sycamore maple (*Acer pseudoplatanus*), WLI = small-leaved lime (*Tilia cordata*), REI = Red oak (*Quercus rubra*).

- ***Deadwood***

On the gaps where the trees were removed (treatment_1), the remaining crowns were transported outside the 71 m x 71 m plot, so that no deadwood was on the gap or on the plot. The amount of deadwood on the plots of treatment_2 and treatment_3 was defined based on the standing volume before cutting (Figure 4). By this, a minimum amount of 100 m^3 ha^{-1} was achieved, but extremely high amounts of deadwood were prevented that would not have allowed field work.

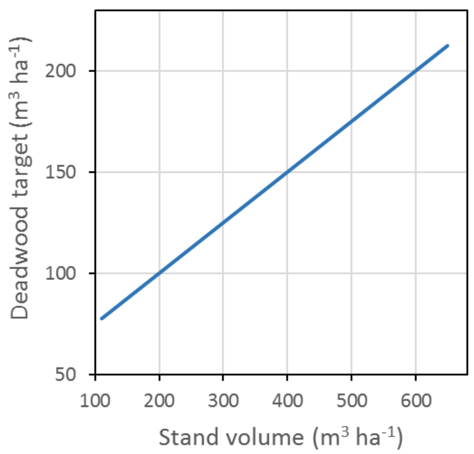

Fig. 4: Relationship between target deadwood per plot and standing stand volume before cutting

On those gaps where deadwood was supposed to remain, the felled trees were cut into pieces of 4 to 5 metres in order to place not only the same amount of deadwood on the gap (in case of treatment_2) and inside the stand (in case of treatment_3), but to prorate each individual stem between gap and stand (Figure 5). By this, the decomposition of each individual tree in the two different surroundings should be traceable. Each log carries a number and is marked. In addition to the stems also the crown material of the felled trees were prorated between gap and related stand.

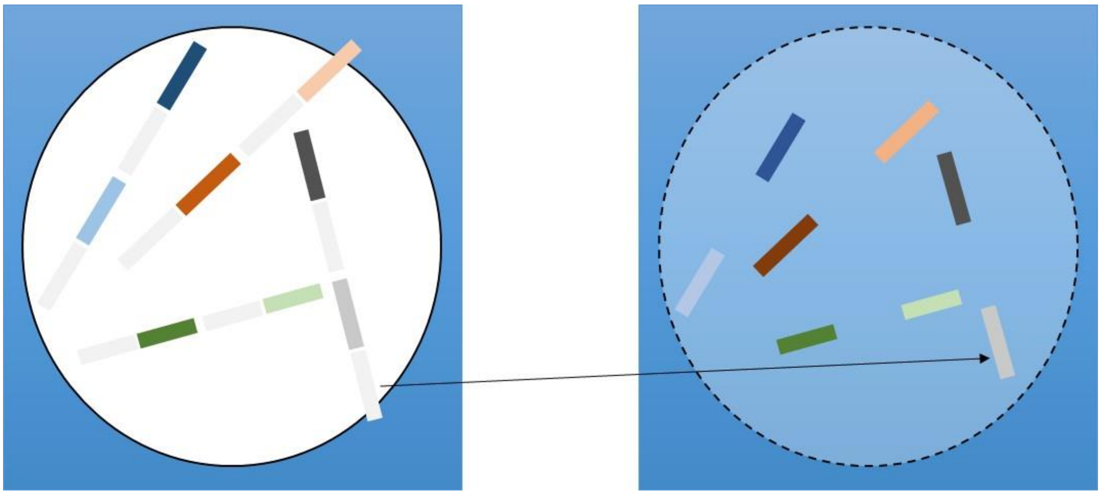

Fig. 5: Scheme of dividing the logs of individual trees between gap (left side, treatment_2) and closed stand (right side, treatment_3)

References

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