In natural environments, large carnivores have important effects on their ungulate prey species which can influence the vegetation as well. On the one hand they can directly influence the number of prey by predation, releasing the grazing pressure from the vegetation. On the other hand, carnivores can indirectly influence the vegetation by influencing the behavior or spatial distribution of ungulates. Several recent studies showed that these indirect effects of carnivores are very important, or even more important than the direct influences.

Much research has been done on how wolves influence the foraging behavior of deer in Yellowstone National Park, USA . These studies showed that deer avoid areas with highest predation risk, and in these areas trees can regenerate better. The presence of wolves therefore affects the vegetation at a landscape scale. In Europe, large carnivores (especially wolves) are increasing in numbers and are recolonizing more and more areas. However, knowledge on how wolves can influence deer behavior or can indirectly affect the vegetation is virtually absent. As European landscapes look very different from the large-scale and natural environment from well-studied systems as Yellowstone National Park (YNP), studies filling this gap of knowledge are highly needed. Important factors that likely modify the predator-prey interactions and the (in)direct influence on the vegetation in European landscapes are among others; smaller size of national parks, higher presence of humans (roads, settlements), more impact of humans on natural processes (hunting, forestry) and lower landscape heterogeneity. Therefore it is the question whether and how carnivores influence ungulates and how this affects the vegetation.

In the present project we aim to study wolf-deer-tree interactions in a completely different type of landscape (as compared to YNP); the closed Białowieża Primeval Forest (BPF) in Poland. This area is interesting as a complete guild of five ungulate species (red deer, wild boar, European bison, moose and roe deer) is present with their natural predators (wolf and lynx). Due to its relatively small size (c. 600 km2) and relative homogeneity of landscape (95% is covered by closed forest), wolves are present everywhere. Four wolf packs (each consisting of 4-5 individuals) occupy the entire area, and ungulates cannot move to predator free areas as they can in YNP. Recent studies from the BPF showed that ungulates anyway react to carnivore presence but at a fine-scale. Deer avoid places with an intensive smell of carnivores (scats of wolf or lynx) or reduce the amount of foraging. Also locations close to large fallen trees logs are perceived as risky by ungulates. These tree logs can block the view for approaching predators, or can prevent quick escape from them. As a result, red deer avoid locations close to tree logs and forage less on tree saplings which are growing there, especially when these tree logs are inside the core of a wolf territory. The long-term impact these behavioral changes of red deer have on the regeneration of trees is unknown and will be studied in this project.

We will perform a series of descriptive and experimental field studies to assess how both the presence of tree logs and presence of wolves affect ungulate foraging behavior and determine the regeneration and composition of tree species. We predict that highly preferred tree species by red deer will profit most from the combined presence of tree logs and wolves, while low preferred species will be able to regenerate without their protective effects. To test this we will use two main approaches. We will survey transects and plots inside and outside the centre of wolf territories (wolf core areas) and assess the survival, growth and browsing intensity of naturally established tree saplings and compare the performance of preferred tree species (f.e. *Carpinus betulus, Tilia cordata, Acer platanoides*) and less preferred species (f.e. *Pinus sylvestris, Picea abies, Alnus glutinosa*) and determine their association with tree logs. In addition, we will perform a large-scale experiment in which we plant tree saplings from eight different species, ranging from highly preferred species to less preferred species by red deer. Experimental plots will be established at different distances from the centre of wolf core areas and on half of the plots we will add ourselves a structure that is blocking the view or escape routes (mimicking the effect of a tree log). Camera traps will give us information of how many and which ungulates are visiting these plots and what behavior they have. Detailed tree measurements will be done to give insight in the effects on growth of trees. The experiment is aimed to test for the interactive effects of tree logs and wolf presence on the browsing intensity and growth of tree species differing in preference for red deer. Both the survey of transects and the experiment should improve our understanding of how wolves in combination with fine-scale environmental factors (tree logs) can affect the regeneration of trees in closed-canopy forests.

Additionally, we planned two pilot studies to test whether the studied predation risk factors, operate in other forest systems in Europe. In intensively managed (forestry, hunting) forest systems in Sweden, we test whether wolf presence significantly reduces ungulate browsing intensity of forest plantations. In the Netherlands, we test whether tree logs are still perceived as a risk factor and affect red deer browsing intensity in predator-free forest.