Can changes in nitrogen deposition be detected in vegetation composition using Ellenberg indicator values?
A study using ten years of data from the National Monitoring Network Flora for Environmental Quality

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Abstract
On global, European and national scales biodiversity is declining. A loss in biodiversity can result in a loss of ecosystem services and make an area more vulnerable to natural disasters. In the Netherlands biodiversity loss is caused by habitat fragmentation, acidification, drought and nitrification. Although a decline of nitrogen deposition has been reported in The Netherlands, it still reaches levels above the critical load for many ecosystems. The National Monitoring Network Flora monitors vegetation composition and its relation to environmental pressures in 10,000 permanent relevées. The Network contains vegetation data collected between 1999 and 2009 in The Netherlands. Data from this network will be used in this study. It will be determined whether changes in nitrogen deposition are detectable in vegetation composition with the use of Ellenberg indicator values and whether areas that are more sensitive to nitrification and acidification are more affected by a changing nitrogen deposition. Nitrogen deposition data and Ellenberg indicator values (nitrogen and pH) are being analyzed for differences between 1999 and 2009. Areas expected to be more affected by acidification and nitrification (sandy areas) are being compared to areas with less expected effect. Preliminary results indicate that throughout The Netherlands several areas show a decline in nitrogen deposition. Some areas susceptible to nitrification and acidification (relatively nutrient-poor areas on sandy soil) show slightly declining trends in nitrogen Ellenberg values. However, areas with the highest deposition changes do not show a declining trend in nitrogen Ellenberg values. Significance has yet to be determined.

1. Introduction
On global, European and national scales biodiversity is declining. A loss in biodiversity can result in a loss of ecosystem services and make an area more vulnerable to natural disasters (European Commission 2008).

In the Netherlands biodiversity loss is caused by habitat fragmentation, acidification, drought and nitrification. With increased nitrogen deposition, nutrient availability increases. Plants that are able to profit more from the higher nutrient availability can increase while less productive plants decrease due to competition. An increase of nitrogen (ammonia) deposition can result in a decline in soil pH. Plants that are vulnerable to acidification will decrease in abundance (Bobbink, Hornung et al. 1998; Bobbink, Hicks et al. 2010). Nitrification and acidification can therefore influence the vegetation composition.

Agriculture is one of the most important sources of nitrogen deposition in the Netherlands (Nature Balance 2009). Although a decline of nitrogen deposition has been reported, it still reaches levels above the critical load for many ecosystems (700-1400 mol/ha/yr) (Environmental Data Compendium April 8th 2010 (version 09)).
To determine the effect of environmental pressures on biodiversity, knowledge is needed on the flora and fauna composition in relation to environmental pressures. The National Monitoring Network Flora monitors vegetation composition and its relation to environmental pressures in 10,000 permanent relevées. The relevées are located in different landscape types (Figure 1). The landscape types are stratified based on vegetation type (e.g., heath), soil type (e.g., sandy soils) and their susceptibility to environmental changes. Several of these areas (mainly nutrient poor sandy soils) are more susceptible than others to nitrification and acidification. Vegetation composition in these areas might respond differently to nitrogen deposition changes and differences in responses can be compared (Alkemade, Latour et al. 1999). Between 1999 and 2009, 8091 relevées were sampled three times. The dataset contains Ellenberg indicator values per relevée. Although the Ellenberg indicator values were originally determined for Central Europe, several studies indicate that these values can be used for Dutch vegetation (Ertsen, Alkemade et al. 1998; Schaffers and Sýkora 2000).

Figure 1. Relevées are distributed throughout the different landscape types in The Netherlands. For simplicity no distinction is made between the different types in this figure (hilly area, sandy area, peat area, riverine area, fen area, see clay area, polder, coastal zone, lakes and seas).
Up to this point, the total dataset with three repeated measures has not been analyzed for vegetation composition changes. It will be determined whether:

changes in nitrogen deposition are also detectable in vegetation composition with the use of Ellenberg indicator values?
areas that are more sensitive to nitrification and acidification are more affected by a changing nitrogen deposition?

2. Method
The Netherlands Environmental Assessment Agency calculates nitrogen deposition in The Netherlands. To determine whether there is a decrease in nitrogen deposition in areas throughout the Netherlands between 1999 and 2009, nitrogen deposition calculations will be analyzed. To determine whether possible differences in nitrogen deposition are also detectable in vegetation composition changes, data of The National Monitoring Network Flora will be used. Vegetation data is collected between 1999 and 2009 in The Netherlands. Average Ellenberg indicator values for nitrogen and pH will be analyzed for differences between 1999 and 2009. To determine whether the effect of deposition change is different for different ecosystems, areas expected to be more affected by acidification and nitrification (sandy areas) will be compared to areas with less expected effect.

3. Preliminary results
Analysis of the data has yet to be conducted but preliminary results can be presented based on superficial analysis of the database. Throughout The Netherlands, several areas show a decline in nitrogen deposition (Figure 2). Some areas susceptible to nitrification and acidification (relatively nutrient-poor areas on sandy soil) show slightly declining trends in nitrogen Ellenberg values. However, areas with the highest deposition changes (between -620 up to -2650 mol/ha/yr) do not show declining trends in nitrogen Ellenberg values. Significance has yet to be determined.
Figure 2. Calculated deposition data from 1995 is subtracted from calculated data from 2005. A low number (more grey) indicates a bigger change between 1995 and 2005 in which 2005 has a lower nitrogen deposition than 1995.

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5. Literature


