

Appendix 1

Formula for the calculation of the percentages of cattle observations in each vegetation type.

The data used in each calculation were:

n_i = number of observations in cell i on a certain date of observation ($i = 1-94$)

a_{iv} = fraction of the area of cell i that is occupied by vegetation type v

First, the numbers of observations per cell (n_i) were converted into percentages of observations in each cell (p_i):

$$p_i = \frac{100 \cdot n_i}{\sum_i n_i}$$

Second, an approximate utilisation coefficient for each vegetation type (c_v) was calculated as the weighted average percentage of observations in each cell, with the fraction of cell area occupied by the vegetation type (a_{iv}) as weight:

$$c_v = \frac{\sum_i (p_i \cdot a_{iv})}{\sum_i a_{iv}}$$

Third, these utilisation coefficients were used to determine the fraction f_{iv} of all observations in cell i that could be attributed to vegetation type v : the fraction of area occupied by v (a_{iv}) was multiplied by the utilisation coefficient of v (c_v) and standardised so that the sum of the fractions would be 1 for each cell:

$$f_{iv} = \frac{c_v \cdot a_{iv}}{\sum_v (c_v \cdot a_{iv})}$$

The second step was then repeated, i.e. new approximate utilisation coefficients (c'_v) were calculated as the sumproduct of the percentages of observations in each cell and the fractions f_{iv} of the observations attributed to each vegetation type, divided by the fraction of total area occupied by the vegetation types.

$$c'_v = \frac{\sum_i (p_i \cdot f_{iv})}{\sum_i a_{iv}}$$

The third step was then repeated, i.e. the fraction of all observations in cell i that could be attributed to vegetation type v was recalculated (f'_{iv}) using the utilisation coefficients c'_v instead of c_v :

$$f'_{iv} = \frac{c'_v \cdot a_{iv}}{\sum_v (c'_v \cdot a_{iv})}$$

The second step was repeated again using the fractions f'_{iv} instead of f_{iv} so as to determine new utilisation coefficients again (c''_v), from which (third step) new fractions of observations attributed to vegetation type v (f''_{iv}) were calculated.

Finally, the percentages of observations in each vegetation type (p_v) were calculated as the weighted sum of the percentages of observations in each cell, with the fractions f_{iv} , f'_{iv} , and f''_{iv} as weights:

$$p_v = \sum_i (p_i \cdot f_{iv}); \quad p'_v = \sum_i (p_i \cdot f'_{iv}); \quad p''_v = \sum_i (p_i \cdot f''_{iv})$$

The percentages calculated after the third iteration (p''_v) differed from those calculated after the second iteration (p'_v) by only $0.33\% \pm 0.45\%$ (mean \pm SD). They were therefore regarded as sufficiently precise for use in Figure 2 and further calculations.