Supplementary Information

**Table S1: Input data used in the calculation of net annual nutrient balances.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Net Annual Nutrient Balance Component | Element | Unit | Grazing | Mowing | Burning | Choppering | Sod-Cutting |
| Management Frequency (MF) |  | yr | 1 | 10 | 10 | 15 | 30 |
| Time till *status quo ante* (*sqa*) |  | yr | 1 | 5 | 5 | 10 | 15 |
|  |  |  |  |  |  |  |  |
| Atmospheric Deposition (Datm) | N | kg ha-1 yr-1 | 22.8 | 20.5 | 25 | 23.6 | 21.9 |
| P | kg ha-1 yr-1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |
| K | kg ha-1 yr-1 | 3.6 | 3.3 | 3.5 | 3.6 | 3.4 |
| Ca | kg ha-1 yr-1 | 5.1 | 4.1 | 4.8 | 4.8 | 4.4 |
| Mg | kg ha-1 yr-1 | 2.8 | 1.9 | 2.8 | 2.6 | 2.3 |
|  |  |  |  |  |  |  |  |
| Excrements from Sheep (Esheep) | N | kg ha-1 yr-1 | 3.5 | 0 | 0 | 0 | 0 |
| P | kg ha-1 yr-1 | 0.2 | 0 | 0 | 0 | 0 |
| K | kg ha-1 yr-1 | 1.5 | 0 | 0 | 0 | 0 |
| Ca | kg ha-1 yr-1 | 0.7 | 0 | 0 | 0 | 0 |
| Mg | kg ha-1 yr-1 | 0.3 | 0 | 0 | 0 | 0 |
|  |  |  |  |  |  |  |  |
| Deposition of Ash (Dash) | N | kg ha-1 yr-1 | 0 | 0 | -5.3 | 0 | 0 |
| P | kg ha-1 yr-1 | 0 | 0 | 3.4 | 0 | 0 |
| K | kg ha-1 yr-1 | 0 | 0 | 19.1 | 0 | 0 |
| Ca | kg ha-1 yr-1 | 0 | 0 | 26 | 0 | 0 |
| Mg | kg ha-1 yr-1 | 0 | 0 | 9 | 0 | 0 |
|  |  |  |  |  |  |  |  |
| Removal of Soil and/or Biomass (R) | N | kg ha-1 | 25.6 | 96.8 | 85.5 | 988 | 1679 |
| P | kg ha-1 | 1.9 | 7.1 | 4.4 | 41.6 | 72 |
| K | kg ha-1 | 8.4 | 37.1 | 26.1 | 63 | 164.4 |
| Ca | kg ha-1 | 11.1 | 29.4 | 32.8 | 125.7 | 190.7 |
| Mg | kg ha-1 | 3.8 | 8.5 | 9.3 | 34 | 55.7 |
|  |  |  |  |  |  |  |  |
| Increase in Leaching due to Management (∆Ltrt) | N | kg ha-1 | 0 | 3.1 | 8.8 | 20.0 | 33.2 |
| P | kg ha-1 | 0 | 0.3 | 0.1 | 0.6 | 0.8 |
| K | kg ha-1 | 0 | 3.1 | 12.3 | 7.2 | 12.2 |
| Ca | kg ha-1 | 0 | 3.2 | 3.8 | 9.8 | 1.5 |
| Mg | kg ha-1 | 0 | 3.3 | 1.6 | 1.7 | 4.9 |

**Calculation of Net Annual Appreciation**

The information on the appreciation of the individual management practices by visitors to the Lüneburger Heath Nature Reserve was taken from a survey conducted between September 2001 and April 2003 (Müller, 2004). In this study a pre-test revealed that the visitors did not have much specialist knowledge of the different maintenance measures. For this reason, a survey concept was developed in which pictures of several aspects of the measures were shown to the interviewees. There were three sets of pictures, series 1 showing the surface just treated, series 2 the surface two years later, and series 3 the performance of the measures. The interviewees were asked to give marks from 1 (very attractive) to 5 (very unattractive). In the current study we use the responses referring to series 1 and 2 to calculate the impact of management on appreciation over the entire management cycle. We used series 3 (performance of the measures) to determine the “baseline” appreciation, i.e. the situation when the effect of management practice on area surfaces are no longer distinguishable for the interviewees. We did this because this was the only data available for grazing and because a comparison of the results between series 1 and 3 for the other management practices showed identical responses (Fig. 4, Müller et al., 2004). Thus when the median response is equal to that given for grazing directly after management (2 = attractive) we declared there to be no more effect of management practice on visual appreciation (baseline appreciation). We used the mean between series 1 and 3 to estimate the appreciation 1 year after management and assumed a linear increase in appreciation hereafter (only relevant for sod-cutting). We then summed the yearly appreciation values for the 5 years it takes until all management practices are at background values (Table S2).

**Table S2: Calculation of appreciation values until five years after the management practices were performed.** Values are based on an ordinal scale with 1 representing “very attractive” and 5 “very unattractive”. Values in **bold** font represent original data (Müller 2004) whilst those in *italics* are calculated based on linear regression and those underlined are assumed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year after Management | Grazing | Mowing | Burning | Choppering | Sod-Cutting |
| 1 | 2 | **3** | **4** | **4** | **4** |
| 2 | *2* | *2.5* | *3* | *3* | *3.5* |
| 3 | 2 | **2** | 2 | **2** | **3** |
| 4 | 2 | 2 | 2 | 2 | *2.5* |
| 5 | 2 | 2 | 2 | 2 | *2* |
| Sum Years 1-5 | 10 | 11.5 | 13 | 13 | 15 |

For each management practice, we calculated net annual appreciation based on the ordinal scale using equation S1

Equation S1

where *Ai* is the appreciation measured or estimated in the *ith* year after the application of a management practice and *MF* is the management frequency (in years) of the management practice under consideration. For all management practices, the baseline appreciation (i.e., the appreciation 5 years after management) was set to a value of 2.

**Table S3: Trade-Off components prior to standardization.** Negative values represent a loss from the system, i.e. outputs are higher than inputs.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Trade-Off Component** | **Unit** | **Grazing** | **Mowing** | **Burning** | **Choppering** | **Sod-Cutting** |
| Annual N Balance per Management Cycle (Nbal) | kg ha-1 yr-1 | -1.5 | 7.5 | 13.3 | -49.7 | -38.8 |
| Annual P Balance per Management Cycle (Pbal) | kg ha-1 yr-1 | -1.7 | -0.6 | -0.1 | -2.6 | -2.4 |
| Annual Cation Balance per Management Cycle (Cationbal) | kg ha-1 yr-1 | -12.7 | -3.8 | 3.0 | -12.3 | -10.6 |
| Annual Increase in Groundwater Recharge per Management Cycle (GR) | mm yr-1 | 0 | 64 | 61 | 128 | 126 |
| Annual Increase in N leachate per Management Cycle (GQ) | kg N ha-1 yr-1 | 0.00 | 0.31 | 0.88 | 1.33 | 1.11 |
| Annual C removed in biomass and/or soil per Management Cycle (Cstocks) | kg ha-1 yr-1 | 1111 | 420 | 383 | 1748 | 1497 |
| Annual Appreciation per Management Cycle (Appreciation) | Ordinal (1 = Very attractive, 5 = very unattractive) | 2.00 | 2.15 | 2.30 | 2.20 | 2.17 |
| Annual Net costs per Management Cycle (Costs) | Euro ha-1 yr-1 | 210 | 5 | 36 | 223 | 200 |

**References**

Müller, J. (2004). Cost-benefit ratio and empirical examination of the acceptance of heathland maintenance in the Lueneburg heath nature reserve. *J. Environ. Plan. Manag.* 47, 757–771. doi:10.1080/0964056042000274461.