Supplementary material for Ambarli et al. “Animal-mediated ecosystem process rates in forests and grasslands are affected by climatic conditions and land-use intensity”

Authors: Didem Ambarli*, Nadja K. Simons, Katja Wehner, Wiebke Kämper, Martin M. Gossner, Thomas Nauss, Felix Neff, Sebastian Seibold, Wolfgang Weisser, Nico Blüthgen

*Corresponding author; e-mail: didem.ambarli@gmail.com, phone: +49.8161.71.4861

Table of contents

S1: Relation of seed removal rate with short-term precipitation

S2: Details of herbivory measurements

S3: Details of processing explanatory data

S4: GLMM results in detail

S5: Comparison of the mean effect sizes of short-term vs. medium-term land-use variables in grasslands

S6: Process rates in detail

S7: Effects of the vegetation structure on process rates

S8: Linear correlations between the process rates

S9: Within-plot variation of the process rates
SUPPLEMENTARY MATERIAL S1 Relation of seed removal rate with short-term precipitation

**Figure S1** Scatterplot of mean seed removal rate per plot (original data) versus total precipitation in the survey periods in grasslands and forests. Complete removal after 30 mm precipitation implies removal due to wash-away. Therefore data from plots with higher than 30 mm total precipitation were excluded from the analyses.
SUPPLEMENTARY MATERIAL S2 Details of herbivory measurements

A. Quantifying herbivory in grasslands

In grasslands, herbivory assessments were based on biomass samples that were taken from a temporarily fenced area where early vertebrate grazing and mowing were excluded. A metal frame of 10 cm × 45 cm × 2 cm was placed randomly at two sampling locations in the fenced area. The vegetation was cut at the edge of the frame above 2 cm. In the lab, the proportion of grasses and stems or leaves of herbaceous plants were estimated visually to account for differences in herbivory between plant functional groups. Then an overall subset of 100 leaves was randomly picked from the two groups (herbs and grasses) according to their proportion in the biomass. Leaf damage was estimated as damaged surface area of each leaf in mm² by comparing the damaged areas in the leaves with circular and square templates ranging in size from 1 to 500 mm² (see Gossner and others, 2014). For each leaf, the total damaged area from different damage types (sucking, scraping, mining, chewing etc.) were summed per leave to get one value for damaged area per leaf. We reported regularly shaped, whitish points, which were often clearly visible against the light, as sucking damage caused by sap-sucking insects. Though this method may fail to include all sucking damage especially by small auchenorrhynchns, it captures the majority and is therefore used commonly in insect herbivory studies (Loranger and others, 2014). Leaf damage at the edges was estimated by reconstructing the removed area based on leaf shape. The remaining leaf area was measured with a leaf-area-meter (LI-COR area meter (LI-3100C, Lincoln (NE) USA)). Herbivory rates were calculated as the total damaged area divided by the total leaf area, i.e. damaged and remaining. We accounted for the damage types also measured by leaf-area-meter so included in the remaining area, i.e. sucking, scraping, mining and galling, by subtracting the total area of those damages from the measured area to find the remaining area.
B. Quantifying herbivory

In forests, herbivory rate was estimated on the 10 (in ALB and HAI regions) and 8 (in SCH region) most abundant plant species of all forest layers in terms of percent cover. This also included geophyte species sampled in spring, which were excluded from the subsequent analyses to enable use of the climatic data in the short-term timescale. We selected those species based on plant survey data from former years (Boch and others, 2013, D.Prati, pers. comm). The leaf material was collected along the outer border of the plots in summer (from mid-June (ALB) to mid-August (SCH)). Leaves from the tree layer were collected using elongated lopping shears (max. height: 7 m) to cut branches from the shaded canopy of at least three trees. Where shears were not long enough, branches were collected using shooting and/or climbing. When individuals of the tree species were present in the shrub layer, leaves were collected from that layer as well in an amount approximately representing the distribution of tree and shrub layer within the plot. When a species could not be found on the plot margin or when sampling was not possible out of other reasons, this species was replaced by the next abundant species on the species list. All plant material was collected in plastic bags containing a moist cloth to prevent the leaves from drying out and transferred to a fridge until further processing. In the lab, leaf material was further processed. A total of 12 to 200 randomly picked leaves per species per plot were processed (depending on leaf size and composition, Table S1). For each single leaf, the area was measured using a LI-COR area meter (LI-3000C, Lincoln (NE) USA). For coniferous trees (Abies, Picea, Pinus sp.), sets of 10 leaves were measured together and average values were taken for a single leaf area for better accuracy. For grass species with needle-shaped leaves (Deschampsia flexuosa), no reliable area measurements were possible using the leaf area meter. Thus, leaf length was measured using a ruler and the approximate area was determined by multiplying the length by an estimated leaf width of 1 mm. As for grassland herbivory, the total damaged area from different damage types (sucking, scraping, mining, chewing, etc.) was determined for each leaf using circular and square templates ranging in size from 1 to 500 mm² (see Gossner and others, 2014). Damage types were summed and herbivory rate per leaf was calculated as the proportion of herbivory-affected leaf
area compared to the corrected total area of the leaf (i.e., the sum of measured leaf area and chewing damage). From those leaf-level herbivory rates, we calculated mean herbivory rates per plant species and plot. To determine community-level herbivory rates per plot, we used plant cover values obtained from plot core areas by vegetation surveys, the same data as used for the selection of the most abundant plant species. Plant-species herbivory rates were weighted by their relative contribution to the total cover of assessed plants to calculate community-level herbivory rates per plot.

**Table S1** Number of leaves measured for different taxa in forest plots

| Number of leaves | Sampled plant species                                                                 |
|------------------|---------------------------------------------------------------------------------------|
| 12               | *Pteridium aquilinum*                                                                  |
| 20               | *Actaea spicata, Aegopodium podagraria, Aesculus hippocastanum, Allium ursinum, Arum maculatum, Athyrium filix-femina, Cardamine bulbifera, Dryopteris carthusiana, Dryopteris dilatata, Dryopteris filix-mas, Fraxinus excelsior, Gymnocarpium dryopteris, Mercurialis perennis (part.), Paris quadrifolia, Robinia pseudoacacia, Sorbus aucuparia* |
| 40               | *Calamagrostis epigejos*                                                               |
| 50               | *Rubus fruticosus corylifolius agg., Rubus idaeus, Sambucus nigra, Sambucus racemosa* |
| 80               | *Agrostis capillaris, Agrostis stolonifera, Anthoxanthum odoratum, Brachypodium pinnatum, Brachypodium sylvaticum, Calamagrostis arundinacea, Carex montana, Carex pilulifera, Carex remota, Carex sylvatica, Dactylis glomerata, Dactylis polygama, Deschampsia cespitosa, Deschampsia flexuosa, Festuca gigantea, Hordelymus europaeus, Juncus effusus, Melica uniflora, Milium effusum, Poa chaixii, Poa nemoralis, Poa trivialis, Stellaria holostea* |
| 100              | *Acer campestre, Acer platanoides, Acer pseudoplatanus, Alliaria petiolata, Anemone nemorosa, Anemone ranunculoides, Asarum europaeum, Betula pendula, Carpinus betulus, Circaea lutetiana agg., Conyza canadensis, Corylus avellana, Crataegus sp., Euphorbia amygdaloides, Fagus sylvatica, Fragaria vesca, Frangula alnus, Galeopsis pubescens, Galium aparine, Galium odoratum, Galium rotundifolium, Galium sylvaticum, Geranium robertianum, Hedera helix, Hypericum perforatum, Impatiens noli-tangere, Impatiens parviflora, Lamium galeobdolon agg., Lonicera xylosteum, Melampyrum pratense, Mercurialis perennis (part.), Moehringia trinervia, Mycelis muralis, Oxalis acetosella, Polygonatum multiflorum, Polygonatum verticillatum, Populus tremula, Primula elatior veris agg., Prunella vulgaris, Prunus avium, Prunus serotina, Prunus spinosa, Quercus sp., Ranunculus ficaria, Ranunculus repens, Rumex acetosella, Salix caprea, Sanicula europaea, Senecio ovatus, Stachys sylvatica, Tilia cordata, Tilia europaea, Tilia platyphyllos, Ulmus glabra, Ulmus laevis, Urtica dioica, Vaccinium myrtillus, Veronica officinalis, Viola reichenbachiana riviniana agg.* |
| 200              | *Abies alba, Picea abies, Pinus sylvestris*                                             |
SUPPLEMENTARY MATERIAL S3 Details of processing explanatory data

A. Descriptions

To quantify short-term climatic conditions, we used precipitation sum and the mean or maximum of daily temperature (°C) of the survey period, depending on the process in question. To quantify medium-term effects, we focused on warm and cold periods separately. For the warm period (springs and summers) in 2016 and 2017, we used precipitation sum, mean of the maximum daily temperature reflecting warm conditions, and number of cool days, i.e. with maximum temperature < 10°C of air temperature. For the cold period, we used the minimum of the daily minimum temperature of September and overall winter. The start and end dates of those periods were as follows: 26 March to 19 Sept 2016 for warm season of 2016, 20 Sept 2016 to 28 March 2017 for cold season and from 29 March to starting date of the surveys for warm season of 2017 for each plot. We set those days based on the start or end of successive frost days (a day with an hourly temperature below 0°C). This approach is similar to the general April/September division but more detailed on a daily basis.

Table S2 Description of the climatic variables

| Name                  | Abbreviation | Description                                                                                     | Unit  |
|-----------------------|--------------|-----------------------------------------------------------------------------------------------|-------|
| Cool days             | CoolD        | Days with maximum temperature < 10°C of air temperature                                        | d (day) |
| Maximum temperature   | TempMax      | Maximum of daily temperature of the air at 2 meters above ground                              | °C    |
| Mean temperature      | TempMean     | Mean of daily temperature of the air at 2 meters above ground                                 | °C    |
| Precipitation         | Prec         | Daily Precipitation based on RADOLAN product                                                  | mm    |
| Minimum temperature in September | September_Tmin | Minimum of air temperature recorded in September 2016                                          | °C    |
| Minimum temperature in winter | Winter_Tmin | Minimum of air temperature recorded in winter 2016                                             | °C    |

Climate data were measured by climate stations installed at each plot (https://www.bexis.uni-jena.de/).

When data were missing for specific dates of a plot, we substituted it with the mean value of the specific habitat of the region for that date. Other parameters that might affect the processes rates, specifically mean wind velocity and sunshine duration, were not used because of the high number of missing data in
the dataset. We did not use the number of frost days in summer periods, as in each summer, there was only one plot with frost days.

Figure S2 Correlations between the medium-term climatic variables used in the dung removal, seed removal and predation analyses. Numbers indicate Pearson correlation coefficients. Blue color indicates a positive correlation whereas red color indicates a negative correlation. Correlations smaller than 0.01 appear white. PrecSum: Precipitation sum, TmaxMean: Mean of the maximum temperature, CoolDaysSum: Total number of cool days for the indicated period, S2016: spring+summer 2016, S2017: spring+summer 2017. TminSept and TminWinter are minimum temperatures for September 2016 and winter 2016, respectively.
B. Principal component analysis (PCA) of climatic data

**Figure S3** Ordination of the first two axis of PCA on medium-term climatic variables used in the dung removal, seed removal and predation analyses. PCA was conducted with “factoextra” package (Kassambara and Mundt, 2017) and plotted with ggbiplot package in R. Tmax: Maximum temperature, CoolD: number of cool days in that period, Prec: Precipitation. S2016 and S2017 indicate variables for spring and summer seasons of 2016 and 2017, respectively. September_Tmin and Wnt_Tmin indicate minimum temperatures in September 2016 and across winter between 2016 and 2017, respectively. Letters “c” and “m” at the end of each variable indicate cumulative or mean of that variable for that period, respectively. Plots of each region are colored and indicated in the legend as A: Schwäbische Alb in red, H: Hainich-Dün in green, and S: Schorfheide-Chorin in blue.
Table S3 Contributions of the medium-term climatic variables to dimensions of the PCA in Fig S3 above. Variables are sorted according to the contribution to the first dimension. S2016: spring and summer of 2016, S2017: spring and summer of 2017

| Medium-term climatic variables          | Dim.1 | Dim.2 | Dim.3 | Dim.4 | Dim.5 | Dim.6 | Dim.7 | Dim.8 |
|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Number of cool days in S2016            | 21.3  | 0.9   | 0.0   | 5.9   | 11.9  | 26.5  | 29.4  | 4.1   |
| Mean of maximum temperatures of S2016   | 19.7  | 5.2   | 0.2   | 0.9   | 5.2   | 20.2  | 39.2  | 9.4   |
| Number of cool days in S2017            | 18.1  | 2.1   | 0.1   | 18.5  | 40.0  | 16.1  | 2.3   | 2.9   |
| Precipitation sum of S2016              | 15.9  | 9.7   | 5.8   | 4.9   | 10.2  | 12.4  | 12.1  | 29.1  |
| Mean of maximum temperatures of S2017   | 11.0  | 10.8  | 25.5  | 10.8  | 28.0  | 2.6   | 4.8   | 6.5   |
| Minimum temperature of winter 2016      | 7.6   | 20.1  | 15.4  | 23.8  | 0.9   | 6.5   | 10.7  | 15.0  |
| Precipitation sum of S2017              | 6.0   | 20.5  | 26.0  | 22.0  | 3.3   | 1.3   | 0.9   | 20.1  |
| Minimum temperature of September 2016   | 0.6   | 30.8  | 27.0  | 13.2  | 0.5   | 14.4  | 0.5   | 13.0  |
| Cumulative explained variance           | 50.6  | 79.8  | 87.9  | 92.8  | 96.6  | 98.2  | 99.2  | 100   |

Table S4 Correlations of the medium-term climatic variables to dimensions of the PCA in Fig S3. Variables are sorted according to the correlation coefficients for the first dimension. S2016: spring and summer of 2016, S2017: spring and summer of 2017

| Medium-term climatic variables          | Dim.1 | Dim.2 | Dim.3 | Dim.4 | Dim.5 | Dim.6 | Dim.7 | Dim.8 |
|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Mean of maximum temperatures of S2016   | 0.89  | 0.35  | 0.04  | -0.06 | 0.13  | 0.16  | -0.18 | -0.08 |
| Mean of maximum temperatures of S2017   | 0.67  | 0.50  | -0.40 | 0.21  | 0.29  | -0.06 | 0.06  | 0.06  |
| Minimum temperature of winter 2016      | 0.55  | -0.69 | -0.31 | -0.31 | -0.05 | -0.09 | -0.09 | 0.10  |
| Minimum temperature of September 2016   | -0.16 | -0.85 | -0.42 | 0.23  | -0.04 | 0.14  | 0.02  | -0.09 |
| Precipitation sum of S2017              | -0.49 | 0.69  | -0.41 | -0.30 | -0.10 | -0.04 | 0.03  | -0.11 |
| Precipitation sum of S2016              | -0.80 | 0.48  | -0.19 | 0.14  | -0.18 | 0.13  | -0.10 | 0.14  |
| Number of cool days in S2017            | -0.86 | -0.22 | 0.03  | -0.27 | 0.35  | 0.14  | 0.04  | 0.04  |
| Number of cool days in S2016            | -0.93 | -0.14 | -0.01 | 0.15  | 0.19  | -0.18 | -0.15 | -0.05 |
Table S5 Descriptive statistics for the climatic variables used in the dung removal, seed removal and predation analyses (temperature in °C and precipitation in mm). Note: Surveys took place over a 48 h period.

| Variables                                                              | Min. | 1st Qu. | Median | Mean  | 3rd Qu. | Max.  |
|------------------------------------------------------------------------|------|---------|--------|-------|---------|-------|
| Precipitation sum of survey period                                     | 0.0  | 0.8     | 3.5    | 7.2   | 8.2     | 58.9  |
| Mean temperature of survey period                                      | 12.6 | 15.8    | 17.1   | 17.4  | 18.6    | 24.8  |
| Max temperature of survey period                                       | 13.5 | 17.6    | 18.9   | 19.1  | 20.6    | 25.7  |
| Precipitation sum of spring+summer 2016                               | 188.5| 250.4   | 325.7  | 424.1 | 653.7   | 806.2 |
| Precipitation sum of spring+summer 2017                               | 68.0 | 95.2    | 127.6  | 132.5 | 169.5   | 226.6 |
| Mean of maximum daily temperatures in spring+summer 2016              | 16.4 | 18.2    | 19.8   | 19.7  | 20.7    | 24.3  |
| Mean of maximum daily temperatures in spring+summer 2017              | 13.7 | 16.1    | 16.8   | 16.8  | 17.6    | 19.7  |
| Number of cool days in spring+summer 2016                            | 2    | 7       | 13     | 10.9  | 14      | 28    |
| Number of cool days in spring+summer 2017                            | 4.0  | 9.0     | 12.0   | 11.9  | 14      | 23    |
| Minimum temperature in September 2016                                 | -1.5 | 3.2     | 5.1    | 4.6   | 6.53    | 8.8   |
| Minimum temperature in winter                                          | -25.9| -15.5   | -14.2  | -14.6 | -12.2   | -9.5  |
Figure S4 Ordination of the first two axes of PCA on medium-term climatic variables used in the herbivory analyses. It was conducted with “factoextra” package (Kassambara and Mundt, 2017) and plotted with ggbiplot package (Vu, 2011) in R. Tmax: Maximum temperature, CoolD: number of cool days in that period, Prec: Precipitation. S2016 indicates variables for the spring and summer of 2016. September_Tmin and Wnt_Tmin indicate minimum temperatures in September 2016 and across winter between 2016 and 2017, respectively. Letters “c” and “m” at the end of each variable indicate cumulative or mean of that variable for that period, respectively. Plots of each region are colored and indicated in the legend as A: Schwäbische Alb in red, H: Hainich-Dün in green, and S: Schorfheide-Chorin in blue.
Table S6 Contributions of the medium-term climatic variables to dimensions of the PCA for the herbivory analyses in Fig S4. Variables are sorted according to the contribution to the first dimension. S2016 indicates spring and summer of 2016.

| Medium-term climatic variables                          | Dim.1 | Dim.2 | Dim.3 | Dim.4 | Dim.5 |
|--------------------------------------------------------|-------|-------|-------|-------|-------|
| Number of cool days in S2016                           | 30.6  | 2.5   | 19.6  | 0.6   | 46.7  |
| Mean of maximum temperatures of S2016                  | 26.8  | 9.6   | 9.0   | 13.4  | 41.3  |
| Precipitation sum of S2016                            | 26.8  | 5.8   | 53.9  | 11.3  | 2.3   |
| Minimum temperature of winter 2016                     | 14.4  | 30.5  | 0.6   | 45.1  | 9.4   |
| Minimum temperature of September 2016                 | 1.4   | 51.6  | 16.9  | 29.7  | 0.4   |
| **Cumulative explained variance**                      | 56.2  | 89.9  | 94.8  | 97.9  | 100   |

Table S7 Correlations of the medium-term climatic variables to dimensions of the PCA for the herbivory analysis in Fig S4. Variables are sorted according to the correlation coefficients for the first dimension. S2016 indicates spring and summer of 2016.

| Medium-term climatic variables                          | Dim.1 | Dim.2 | Dim.3 | Dim.4 | Dim.5 |
|--------------------------------------------------------|-------|-------|-------|-------|-------|
| Number of cool days in S2016                           | -0.93 | 0.2   | -0.22 | -0.03 | 0.22  |
| Precipitation sum of S2016                            | -0.87 | -0.31 | 0.36  | 0.13  | 0.05  |
| Minimum temperature of September 2016                 | -0.2  | 0.93  | 0.2   | -0.21 | -0.02 |
| Minimum temperature of winter 2016                    | 0.64  | 0.72  | 0.04  | 0.26  | 0.1   |
| Mean of maximum temperatures of S2016                  | 0.87  | -0.4  | 0.15  | -0.14 | 0.21  |
C. Histograms of the climate variables

Figure S5 Histogram of the climatic conditions during the short-term timescale in grasslands (used for the analyses of the dung removal, seed removal and predation)

Figure S6 Histogram of the climatic conditions during the short-term timescale in forests (used for the analyses of the dung removal, seed removal and predation)
Figure S7 Histogram of the climatic conditions during the medium-term timescale in grasslands (used for the analyses of the dung removal, seed removal and predation)

Figure S8 Histogram of the climatic conditions during the medium-term timescale in forests (used for the analyses of the dung removal, seed removal and predation)
Figure S9 Histograms of the climate variables used for the herbivory in grasslands

Figure S10 Histograms of the climate variables used for herbivory in forests
D. Coefficient of variation (CV) of the climate variables

**Table S8** CV of climate variables that were used in the analyses of the dung removal, seed removal and predation

| Habitat | Timescale | Variable                                    | CV % |
|---------|-----------|---------------------------------------------|------|
| Forest  | Short-term| Precipitation sum                           | 154  |
| Forest  | Short-term| Temperature - mean                          | 13   |
| Forest  | Short-term| Temperature – max                           | 11   |
| Forest  | Medium-term| Precipitation sum for spring+summer 2016 | 46   |
| Forest  | Medium-term| Precipitation sum for spring+summer 2017  | 32   |
| Forest  | Medium-term| Mean of maximum temperature for spring+summer 2016 | 8   |
| Forest  | Medium-term| Number of cool days in spring+summer 2016 | 39   |
| Forest  | Medium-term| Number of cool days in spring+summer 2017 | 32   |
| Forest  | Medium-term| Minimum temperature in September 2016     | 36   |
| Grassland| Short-term| Precipitation sum                           | 162  |
| Grassland| Short-term| Temperature - mean                          | 15   |
| Grassland| Short-term| Temperature – max                           | 14   |
| Grassland| Medium-term| Precipitation sum for spring+summer 2016 | 46   |
| Grassland| Medium-term| Precipitation sum for spring+summer 2017 | 29   |
| Grassland| Medium-term| Mean of maximum temperature for spring+summer 2016 | 5   |
| Grassland| Medium-term| Mean of maximum temperature for spring+summer 2017 | 5   |
| Grassland| Medium-term| Number of cool days in spring+summer 2016 | 35   |
| Grassland| Medium-term| Number of cool days in spring+summer 2017 | 27   |
| Grassland| Medium-term| Minimum temperature in September 2016     | 70   |
| Grassland| Medium-term| Minimum temperature in winter 2016         | -23  |

**Table S9** CV of climate variables that were used in the analyses of the herbivory

| Habitat | Timescale | Variable                                    | CV % |
|---------|-----------|---------------------------------------------|------|
| Forest  | Short-term| Sum of daily maximum temperature            | 18   |
| Forest  | Medium-term| Precipitation sum for spring+summer 2016 | 46   |
| Forest  | Medium-term| Mean of maximum temperature for spring+summer 2016 | 8   |
| Forest  | Medium-term| Number of cool days in spring+summer 2016 | 40   |
| Forest  | Medium-term| Minimum temperature in September 2016      | 36   |
| Grassland| Short-term| Sum of daily maximum temperature            | 17   |
| Grassland| Medium-term| Precipitation sum for spring+summer 2016 | 48   |
| Grassland| Medium-term| Mean of maximum temperature for spring+summer 2016 | 6   |
| Grassland| Medium-term| Number of cool days in spring+summer 2016 | 37   |
| Grassland| Medium-term| Minimum temperature in September 2016      | 77   |
| Grassland| Medium-term| Minimum temperature in winter 2016         | -22  |
E. Histograms of land-use variables

Figure S11 Histograms of the land-use data used in the dung removal, seed removal and predation analyses. The x-axes of the first row include variables at short-term grazing (livestock unit*days/ha), mowing (number of cuts) and fertilization (kg nitrogen/ha), respectively. The second row has the same variables for the medium-term timescale, standardized relative to its mean within that year, and then calculated the average of two preceding years (2015 and 2016).
F. Correlations among explanatory variables used in the analyses

Figure S12 Correlations among grassland explanatory variables used for the dung removal, seed removal and predation analyses. Numbers indicate correlation coefficients based on Pearson’s test. Blue color indicates a positive correlation whereas red color indicates a negative correlation. Positive correlations which are smaller than 0.25 appear white. ST: short-term variables corresponding to two days of survey period. MT: medium-term. MT variables are represented with the first two axes of the PCA. Short-term precipitation is the sum of daily precipitation of 2 days. Tmean: mean of daily temperature, Tmax: mean of daily maximum temperature.
**Figure S13** Correlations among forest explanatory variables used for dung removal, seed removal and predation analyses. Numbers indicate correlation coefficients based on Pearson test. Blue color indicates a positive correlation whereas red color indicates a negative correlation. Positive correlations smaller than 0.35 appear white. ST: short-term variables corresponding to two days of survey period. MT: medium-term. MT variables are represented with the first two axes of the PCA. Short-term precipitation is the sum of daily precipitation of 2 days. Tmean: mean temperature, Tmax: maximum temperature.
Figure S14 Correlations among grassland explanatory variables considered for the herbivory analyses. Numbers indicate correlation coefficients based on Pearson test. Blue color indicates a positive correlation whereas red color indicates a negative correlation. Correlations that are very close to zero appear white. ST: short-term variables corresponding to two days of survey period. MT: medium-term. MT variables are represented with the first two axes of the PCA. Precipitation is the sum of daily precipitation of the short-term period. Tmean: mean temperature, Tmax: maximum temperature. cum: cumulative.
**Figure S15** Correlations among forest explanatory variables considered for the herbivory analyses. Numbers indicate correlation coefficients based on Pearson test. Blue color indicates a positive correlation whereas red color indicates a negative correlation. ST: short-term variables corresponding to two days of survey period. MT: medium-term. MT variables are represented with the first two axes of the PCA. Precipitation is the sum of daily precipitation of the short-term period. Tmean: mean temperature, Tmax: maximum temperature, cum: sum of daily values over the period.
SUPPLEMENTARY MATERIAL S4 GLMM results in detail

Significance codes indicated in bold are as follows: ("." : p≤0.1, *: p≤0.05,**: p≤0.01,***: p≤ 0.001.

A. Dung removal

Table S10 Dung removal in grasslands

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|----------|
| (Intercept)    | 0.137    | 0.015     | 9.312   | <0.001***|
| ST maximum temperature | 0.031 | 0.018    | 1.788   | 0.074 .  |
| ST precipitation | -0.016  | 0.019     | 0.850   | 0.395    |
| ST temperature: ST precipitation | -0.011 | 0.034   | -0.317  | 0.751    |
| MT climate: Dry summer (PCA axis1) | **0.031** | **0.014** | **2.295** | **0.022*** |
| MT climate: Cold winter (PCA axis2) | -0.014 | 0.013 | -1.094 | 0.274 |
| MT DrySummer: ColdWinter | -0.016 | 0.015 | -1.011 | 0.312 |
| ST grazing | **0.026** | **0.013** | **2.093** | **0.036*** |
| ST Mowing | 0.014    | 0.013     | 1.119   | 0.263    |
| ST Fertilization | -0.007  | 0.013     | -0.584  | 0.559    |

ST: short-term, MT: medium-term

Table S11 Dung removal in forests

| Fixed effects | Estimate | Std.Error | t value | Pr(>|z|) |
|---------------|----------|-----------|---------|----------|
| (Intercept)   | 0.249    | 0.093     | 2.679   | 0.007**  |
| ST maximum temperature | -0.023  | 0.016    | -1.427  | 0.154    |
| **ST precipitation** | **0.039** | **0.019** | **2.041** | **0.041*** |
| ST temperature: ST precipitation | -0.013 | 0.023 | -0.569 | 0.569 |
| MT climate: Dry summer (PCA axis1) | -0.047 | 0.047 | -0.995 | 0.320 |
| MT climate: Cold winter (PCA axis2) | 0.018 | 0.033 | 0.563 | 0.574 |
| MT DrySummer: ColdWinter | 0.010 | 0.022 | 0.436 | 0.663 |
| Wood harvest | -0.029   | 0.019     | -1.547  | 0.122    |
| Non-natural trees | **0.041** | **0.018** | **2.261** | **0.024*** |
| **Anthropogenic deadwood** | **0.039** | **0.017** | **2.331** | **0.020*** |

ST: short-term, MT: medium-term
B. Seed removal

**Table S12** Seed removal in grasslands

| GLMM results (657 observations, 134 plots; 3 regions) |
|-----------------------------------------------|
| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
| (Intercept) | 1.662 | 0.236 | 7.043 | <0.001*** |
| ST maximum temperature | -0.008 | 0.247 | -0.032 | 0.974 |
| **ST precipitation** | **0.522** | **0.254** | **2.054** | **0.040*** |
| ST temperature: ST precipitation | 0.472 | 0.377 | 1.251 | 0.211 |
| MT climate: Dry summer (PCA axis1) | 0.304 | 0.244 | 1.247 | 0.212 |
| **MT climate: Cold winter (PCA axis2)** | **0.749** | **0.216** | **3.472** | **<0.001*** |
| MT DrySummer: ColdWinter | **0.919** | **0.258** | **3.564** | **<0.001*** |
| ST grazing | -0.251 | 0.193 | -1.301 | 0.193 |
| ST Mowing | -0.205 | 0.203 | -1.006 | 0.314 |
| ST Fertilization | -0.106 | 0.196 | -0.540 | 0.589 |

ST: short-term, MT: medium-term

**Figure S16** Effects of the interaction between medium-term climatic variables on seed removal in grasslands. Both variables were standardized to mean = 0 and standard deviation = 1.
Table S13 Seed removal in forests

GLMM results (664 observations, 136 plots; 3 regions)

| Fixed effects*          | Estimate | Std.Error | t value | Pr(>|z|) |
|-------------------------|----------|-----------|---------|---------|
| (Intercept)             | 5.441    | 0.502     | 10.844  | <0.001***|
| ST maximum temperature  | -0.395   | 0.393     | -1.003  | 0.316   |
| ST precipitation        | -0.158   | 0.454     | -0.348  | 0.728   |
| ST temperature: ST precipitation | -1.131 | 0.438     | -2.583  | 0.010** |
| MT climate: Dry summer (PCA axis1) | -0.242 | 0.477     | -0.508  | 0.612   |
| MT climate: Cold winter (PCA axis2) | -1.587 | 0.529     | -3.000  | 0.003** |
| MT DrySummer: ColdWinter | -0.127  | 0.490     | -0.258  | 0.796   |
| Wood harvest            | 0.108    | 0.464     | 0.233   | 0.815   |
| Non-natural trees       | -1.312   | 0.436     | -3.010  | 0.003** |
| Anthropogenic deadwood  | 0.712    | 0.437     | 1.632   | 0.103   |

ST: short-term, MT: medium-term

Figure S17 Effects of interaction between the short-term climatic variables on seed removal in forests. Both variables were standardized to mean = 0 and standard deviation = 1.
C. Predation

I. Predation in grasslands

Table S14 Overall predation in grasslands

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|----------|
| (Intercept)    | -1.309   | 0.125     | -10.488 | <0.001***|
| ST mean temperature | -0.257   | 0.161     | -1.597  | 0.110    |
| ST precipitation   | -0.187   | 0.151     | -1.242  | 0.214    |
| ST temperature: ST precipitation | 0.152   | 0.274     | 0.554   | 0.580    |
| MT climate: Dry summer (PCA axis1) | -0.093   | 0.137     | -0.679  | 0.497    |
| MT climate: Cold winter (PCA axis2) | 0.376 | 0.125     | 3.002   | 0.003***|
| MT DrySummer: ColdWinter | -0.230   | 0.150     | -1.534  | 0.125    |
| ST grazing       | -0.264   | 0.120     | -2.194  | 0.028*   |
| ST Mowing        | -0.322   | 0.127     | -2.542  | 0.011*   |
| ST Fertilization | 0.350    | 0.121     | 2.896   | 0.004**  |
| MT Grazing       | -0.246   | 0.116     | -2.126  | 0.034*   |

ST: short-term, MT: medium-term

Table S15 Arthropod predation in grasslands

| Fixed effects | Estimate | Std.Error | t value | Pr(>|z|) |
|---------------|----------|-----------|---------|----------|
| (Intercept)   | -1.639   | 0.135     | -12.110 | <0.001***|
| ST mean temperature | -0.318   | 0.174     | -1.825  | 0.068 .  |
| ST precipitation | -0.199   | 0.164     | -1.211  | 0.226    |
| ST temperature: ST precipitation | 0.172   | 0.297     | 0.578   | 0.563    |
| MT climate: Dry summer (PCA axis1) | -0.102   | 0.149     | -0.686  | 0.493    |
| MT climate: Cold winter (PCA axis2) | 0.363 | 0.135     | 2.683   | 0.007**  |
| MT DrySummer: ColdWinter | -0.263   | 0.162     | -1.622  | 0.105    |
| ST grazing     | -0.104   | 0.130     | -0.798  | 0.425    |
| ST Mowing      | -0.266   | 0.137     | -1.943  | 0.052 .  |
| ST Fertilization | 0.475    | 0.130     | 3.656   | <0.001***|
| MT Grazing     | -0.278   | 0.129     | -2.154  | 0.031*   |

ST: short-term, MT: medium-term
Table S16 Bird predation in grasslands

| Fixed effects                           | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------------------------------|----------|-----------|---------|---------|
| (Intercept)                            | -9.210   | 1.251     | -7.365  | <0.001***|
| ST mean temperature                    | -0.288   | 0.789     | -0.365  | 0.715   |
| ST precipitation                       | -0.223   | 0.667     | -0.334  | 0.738   |
| ST temperature: ST precipitation       | 0.501    | 1.305     | 0.384   | 0.701   |
| MT climate: Dry summer (PCA axis1)     | 0.565    | 0.718     | 0.787   | 0.431   |
| MT climate: Cold winter (PCA axis2)    | 1.191    | 0.632     | 1.884   | 0.060   |
| MT DrySummer: ColdWinter               | -0.628   | 0.765     | -0.820  | 0.412   |
| ST grazing                             | -0.924   | 0.806     | -1.146  | 0.252   |
| ST Mowing                              | 0.483    | 0.550     | 0.878   | 0.380   |
| ST Fertilization                       | -0.900   | 0.828     | -1.086  | 0.277   |

ST: short-term, MT: medium-term

Table S17 Rodent predation in grasslands

| Fixed effects                           | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------------------------------|----------|-----------|---------|---------|
| (Intercept)                            | -4.601   | 0.241     | -19.121 | <0.001***|
| ST mean temperature                    | -0.062   | 0.240     | -0.257  | 0.797   |
| ST precipitation                       | -0.049   | 0.225     | -0.220  | 0.826   |
| ST temperature: ST precipitation       | -0.087   | 0.409     | -0.214  | 0.831   |
| MT climate: Dry summer (PCA axis1)     | -0.624   | 0.205     | -3.045  | 0.002** |
| MT climate: Cold winter (PCA axis2)    | -0.003   | 0.191     | -0.015  | 0.988   |
| MT DrySummer: ColdWinter               | 0.322    | 0.226     | 1.425   | 0.154   |
| ST grazing                             | -0.685   | 0.242     | -2.825  | 0.005** |
| ST Mowing                              | -0.747   | 0.217     | -3.446  | 0.001***|
| ST Fertilization                       | -0.112   | 0.194     | -0.575  | 0.566   |

ST: short-term, MT: medium-term
II. Predation in forests

Table S18 Overall predation in forests

| Fixed effects                                           | Estimate | Std.Error | t value | Pr(>|z|) |
|--------------------------------------------------------|----------|-----------|---------|----------|
| (Intercept)                                            | 0.087    | 0.075     | 1.151   | 0.250    |
| ST mean temperature                                    | -0.029   | 0.090     | -0.319  | 0.749    |
| ST precipitation                                       | 0.006    | 0.098     | 0.066   | 0.947    |
| ST temperature: ST precipitation                       | 0.057    | 0.133     | 0.428   | 0.669    |
| MT climate: Dry summer (PCA axis1)                     | **-0.272** | **0.088** | **-3.098** | **0.002** **
| MT climate: Cold winter (PCA axis2)                    | -0.055   | 0.096     | -0.569  | 0.569    |
| MT DrySummer: ColdWinter                               | 0.004    | 0.108     | 0.041   | 0.967    |
| Wood harvest                                           | 0.023    | 0.090     | 0.250   | 0.803    |
| Non-natural trees                                      | -0.013   | 0.080     | -0.165  | 0.869    |
| Anthropogenic deadwood                                 | 0.017    | 0.083     | 0.209   | 0.835    |

ST: short-term, MT: medium-term
Table S19 Arthropod predation in forests

| Fixed effects                                     | Estimate | Std.Error | t value | Pr(>|z|)  |
|---------------------------------------------------|----------|-----------|---------|-----------|
| (Intercept)                                       | -1.089   | 0.081     | -13.490 | <0.001*** |
| ST mean temperature                               | -0.130   | 0.096     | -1.353  | 0.176     |
| ST precipitation                                  | 0.102    | 0.104     | 0.984   | 0.325     |
| **ST temperature: ST precipitation**              | **0.287**| **0.141** | **2.037**| **0.042***|
| MT climate: Dry summer (PCA axis1)                | -0.103   | 0.093     | -1.102  | 0.270     |
| MT climate: Cold winter (PCA axis2)               | -0.150   | 0.104     | -1.443  | 0.149     |
| MT DrySummer: ColdWinter                          | -0.203   | 0.117     | -1.734  | 0.083     |
| Wood harvest                                      | -0.132   | 0.099     | -1.338  | 0.181     |
| **Nonnative tree species**                        | **0.285**| **0.085** | **3.350**| **0.001***|
| Anthropogenic deadwood                            | -0.098   | 0.089     | -1.112  | 0.266     |

ST: short-term, MT: medium-term

Figure S18 Effects of the interaction between the short-term climatic variables on predation by arthropods in forests. Both variables were standardized to mean = 0 and standard deviation = 1.
### Table S20 Bird predation in forests

| Fixed effects                          | Estimate | Std.Error | t value | Pr(>|z|)   |
|----------------------------------------|----------|-----------|---------|-----------|
| (Intercept)                            | -4.401   | 0.220     | -20.008 | <0.001*** |
| ST mean temperature                    | -0.192   | 0.227     | -0.848  | 0.396     |
| **ST precipitation**                   | **-0.599** | **0.234** | **-2.561** | **0.010*** |
| ST temperature: ST precipitation       | 0.174    | 0.364     | 0.479   | 0.632     |
| **MT climate: Dry summer (PCA axis1)** | **1.077** | **0.199** | **5.403** | **<0.001***** |
| **MT climate: Cold winter (PCA axis2)** | **0.887** | **0.208** | **4.273** | **<0.001***** |
| MT DrySummer: ColdWinter               | 0.017    | 0.217     | 0.079   | 0.937     |
| **Wood harvest**                       | **-0.567** | **0.214** | **-2.650** | **0.008** **** |
| Non-natural trees                      | -0.088   | 0.174     | -0.507  | 0.612     |
| Anthropogenic deadwood                 | -0.017   | 0.180     | -0.094  | 0.925     |

ST: short-term, MT: medium-term

### Table S21 Rodent predation in forests

| Fixed effects                          | Estimate | Std.Error | t value | Pr(>|z|)   |
|----------------------------------------|----------|-----------|---------|-----------|
| (Intercept)                            | -1.690   | 0.446     | -3.792  | <0.001*** |
| ST mean temperature                    | 0.135    | 0.127     | 1.060   | 0.289     |
| ST precipitation                       | 0.093    | 0.140     | 0.665   | 0.506     |
| ST temperature: ST precipitation       | -0.161   | 0.187     | -0.860  | 0.390     |
| **MT climate: Dry summer (PCA axis1)** | **-0.195** | **0.321** | **-0.607** | **0.544** |
| **MT climate: Cold winter (PCA axis2)** | **0.008** | **0.224** | **0.037** | **0.971** |
| MT DrySummer: ColdWinter               | -0.170   | 0.175     | -0.972  | 0.331     |
| Wood harvest                           | 0.117    | 0.135     | 0.867   | 0.386     |
| **Non-natural trees**                  | **-0.306** | **0.131** | **-2.326** | **0.020*** |
| **Anthropogenic deadwood**             | **0.301** | **0.121** | **2.487** | **0.013** **** |

ST: short-term, MT: medium-term
D. Herbivory

Models were conducted at the plot level. Due to collinearity, short-term precipitation and medium-term fertilization were not included in the models. ST: short-term, MT: medium-term.

Table S22 Total herbivory in grasslands

| GLMM results (145 plots, 3 regions) | Estimate | Std.Error | t value | Pr(>|z|) |
|------------------------------------|----------|-----------|---------|---------|
| (Intercept)                        | -4.380   | 0.243     | -18.025 | <0.001*** |
| ST max temperature cumulative      | -0.223   | 0.066     | -3.390  | 0.001*** |
| MT climate: Dry summer (PCA axis1) | 0.056    | 0.198     | 0.284   | 0.776   |
| MT climate: Warm winter (PCA axis2)| -0.086   | 0.059     | -1.445  | 0.148   |
| MT DrySummer:WarmWinter            | -0.026   | 0.052     | -0.496  | 0.620   |
| ST Fertilization                   | -0.143   | 0.093     | -1.537  | 0.124   |
| ST Grazing                         | -0.132   | 0.076     | -1.735  | 0.083   |
| MT Grazing                         | -0.049   | 0.052     | -0.947  | 0.344   |
| MT Mowing                          | -0.001   | 0.064     | -0.013  | 0.990   |

ST: short-term, MT: medium-term

Table S23 Grass herbivory in grasslands

| GLMM results (145 plots, 3 regions) | Estimate | Std.Error | t value | Pr(>|z|) |
|------------------------------------|----------|-----------|---------|---------|
| (Intercept)                        | -5.730   | 1.073     | -5.339  | <0.001*** |
| ST max temperature cumulative      | -1.260   | 0.278     | -4.532  | <0.001*** |
| MT climate: Dry summer (PCA axis1) | -0.371   | 0.507     | -0.733  | 0.464   |
| MT climate: Warm winter (PCA axis2)| -0.261   | 0.171     | -1.528  | 0.127   |
| MT DrySummer:WarmWinter            | 0.076    | 0.144     | 0.528   | 0.598   |
| ST Fertilization                   | -0.034   | 0.108     | -0.317  | 0.751   |
| ST Grazing                         | -0.255   | 0.142     | -1.796  | 0.073   |
| MT Grazing                         | -0.239   | 0.165     | -1.450  | 0.147   |
| MT Mowing                          | -0.367   | 0.108     | -3.414  | 0.001*** |

ST: short-term, MT: medium-term
Table S24 Herbivory in grasslands

| Fixed effects                                      | Estimate | Std.Error | t value | Pr(>|z|) |
|---------------------------------------------------|----------|-----------|---------|---------|
| (Intercept)                                       | -4.222   | 0.234     | -18.025 | <0.001*** |
| ST max temperature cumulative                     | -0.253   | 0.079     | -3.191  | 0.001** |
| MT climate: Dry summer (PCA axis1)                | 0.398    | 0.220     | 1.808   | 0.071.   |
| MT climate: Warm winter (PCA axis2)               | -0.052   | 0.094     | -0.549  | 0.583    |
| MT DrySummer:WarmWinter                           | 0.048    | 0.080     | 0.605   | 0.545    |
| ST Fertilization                                  | -0.164   | 0.130     | -1.265  | 0.206    |
| ST Grazing                                        | -0.304   | 0.152     | -1.997  | 0.046*   |
| MT Grazing                                        | 0.014    | 0.058     | 0.233   | 0.815    |
| MT Mowing                                         | 0.119    | 0.078     | 1.518   | 0.129    |

ST: short-term, MT: medium-term

Table S25 Total herbivory in forests

| Fixed effects                                      | Estimate | Std.Error | t value | Pr(>|z|) |
|---------------------------------------------------|----------|-----------|---------|---------|
| (Intercept)                                       | -3.273   | 0.048     | -67.680 | <0.001*** |
| ST max temperature cumulative                     | -0.139   | 0.054     | -2.548  | 0.011*   |
| MT climate: Dry summer (PCA axis1)                | 0.174    | 0.042     | 4.116   | <0.001*** |
| MT climate: Warm winter (PCA axis2)               | 0.034    | 0.046     | 0.736   | 0.462    |
| MT Dry Summer:Warm Winter                         | -0.017   | 0.038     | -0.443  | 0.658    |
| Wood harvest                                      | -0.100   | 0.047     | -2.113  | 0.035*   |
| Non-natural trees                                 | -0.460   | 0.068     | -6.789  | <0.001*** |
| Anthropogenic deadwood                            | -0.013   | 0.036     | -0.356  | 0.722    |

ST: short-term, MT: medium-term
SUPPLEMENTARY MATERIAL S5 Comparison of the mean effect sizes of short-term vs. medium-term land-use variables in grasslands

This section aims to compare the effect sizes of land-use variables in the short-term vs. medium-term timescales. As those variables were correlated within and among each variable set, we did not analyze them together but we obtained the mean effect sizes from separate models using either short-term or medium-term variables together with the climatic conditions, following the main model structure indicated in the Methods. As we focused on the short-term effects in the main findings, we used the results presented in the Results and the Supplementary material S6 for the short-term effects of dung removal, seed removal, predation by birds or rodents. In case that those results included the medium-term effects such as the case for some predation and herbivory tests, we also run a model only with the short-term effects and then only with the medium-term effects of the corresponding variables. The medium-term variables included grazing and fertilization intensities but not of mowing due to collinearity. The short-term variables included all three land-use components except for herbivory as the subplots that herbivory measurements took place were not mown. We then calculated the mean effect size of land-use variable sets, the absolute of each effect size weighted inversely by its standard error. The results show that the mean effect sizes of short-term land-use variables were higher than that of the medium-term variables for all processes except for the seed removal and the predation by the arthropods (Fig. S19).

Figure S19 Mean effect sizes of short-term (blue bars) vs. medium-term (red bars) land-use components in grasslands. The effect sizes were obtained from the GLMM models and weighted inversely by their standard errors.
Results of the additional GLMMs used to calculate the mean effect sizes of the land-use variables on the process rates in grasslands

Table S26 Dung removal analysis with the climatic and medium-term land-use variables

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|---------|
| (Intercept)    | 0.132    | 0.015     | 8.697   | <0.001  *** |
| ST maximum temperature | -0.011  | 0.019     | -0.590  | 0.555   |
| ST precipitation | 0.037    | 0.017     | 2.103   | 0.035   * |
| ST temperature: ST precipitation | -0.019  | 0.035     | -0.543  | 0.587   |
| MT climate: Dry summer (PCA axis1) | 0.031    | 0.014     | 2.174   | 0.030   * |
| MT climate: Cold winter (PCA axis2) | -0.019   | 0.013     | -1.469  | 0.142   |
| MT DrySummer: ColdWinter | -0.018   | 0.016     | -1.109  | 0.268   |
| MT Grazing     | 0.006    | 0.012     | 0.479   | 0.632   |
| MT Fertilization | -0.010   | 0.013     | -0.768  | 0.442   |

ST: short-term, MT: medium-term

Table S27 Seed removal analysis with the climatic and medium-term land-use variables

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|---------|
| (Intercept)    | 1.586    | 0.231     | 6.869   | <0.001  *** |
| ST maximum temperature | -0.078   | 0.228     | -0.341  | 0.733   |
| ST precipitation | 0.397    | 0.224     | 1.771   | 0.076   |
| ST temperature: ST precipitation | 0.414    | 0.333     | 1.243   | 0.214   |
| MT climate: Dry summer (PCA axis1) | 0.345    | 0.253     | 1.364   | 0.173   |
| MT climate: Cold winter (PCA axis2) | 0.796    | 0.213     | 3.738   | <0.001  *** |
| MT DrySummer: ColdWinter | 0.874    | 0.259     | 3.380   | <0.001  *** |
| MT Grazing     | -0.314   | 0.182     | -1.723  | 0.085   |
| MT Fertilization | -0.147   | 0.186     | -0.790  | 0.429   |

ST: short-term, MT: medium-term

Table S28 Overall predation analysis with the climatic and medium-term land-use variables

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|---------|
| (Intercept)    | -1.285   | 0.130     | -9.924  | <0.001  *** |
| ST mean temperature | -0.330   | 0.164     | -2.017  | 0.044   |
| ST precipitation | -0.285   | 0.153     | -1.871  | 0.061   |
| ST temperature: ST precipitation | 0.285    | 0.290     | 0.981   | 0.326   |
| MT climate: Dry summer (PCA axis1) | -0.151   | 0.140     | -1.076  | 0.282   |
| MT climate: Cold winter (PCA axis2) | 0.390    | 0.127     | 3.085   | 0.002   ** |
| MT DrySummer: ColdWinter | -0.240   | 0.155     | -1.552  | 0.121   |
| MT Grazing     | -0.236   | 0.116     | -2.039  | 0.041   |
| MT Fertilization | 0.328    | 0.120     | 2.721   | 0.007   ** |

ST: short-term, MT: medium-term
### Table S29 Overall predation analysis with the climatic and only short-term land-use variables

#### GLMM results (669 observations, 134 plots, 3 regions)

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|---------|
| (Intercept)    | -1.309   | 0.127     | -10.312 | <0.001  ***|
| ST maximum temperature | -0.273   | 0.163     | -1.670  | 0.095   |
| ST precipitation | -0.181   | 0.153     | -1.185  | 0.236   |
| ST temperature: ST precipitation | 0.120    | 0.278     | 0.433   | 0.665   |
| MT climate: Dry summer (PCA axis1) | -0.147   | 0.137     | -1.076  | 0.282   |
| **MT climate: Cold winter (PCA axis2)** | 0.358    | 0.127     | 2.815   | 0.005   **|
| MT DrySummer: ColdWinter | -0.206   | 0.152     | -1.349  | 0.177   |
| ST Grazing     | -0.315   | 0.120     | -2.625  | 0.009   **|
| ST Mowing      | -0.288   | 0.128     | -2.259  | 0.024   * |

ST: short-term, MT: medium-term

### Table S30 Arthropod predation analysis with the climatic and medium-term land-use variables

#### GLMM results (669 observations, 134 plots, 3 regions)

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|---------|
| (Intercept)    | -1.620   | 0.138     | -11.709 | <0.001  ***|
| ST mean temperature | -0.389   | 0.174     | -2.228  | 0.026   * |
| ST precipitation | -0.290   | 0.164     | -1.776  | 0.076   |
| ST temperature: ST precipitation | 0.283    | 0.310     | 0.911   | 0.362   |
| MT climate: Dry summer (PCA axis1) | -0.164   | 0.149     | -1.099  | 0.272   |
| **MT climate: Cold winter (PCA axis2)** | 0.339    | 0.134     | 2.528   | 0.011   * |
| MT DrySummer: ColdWinter | -0.283   | 0.165     | -1.719  | 0.086   |
| MT Grazing     | -0.240   | 0.126     | -1.899  | 0.058   |
| MT Fertilization | 0.407    | 0.127     | 3.197   | 0.001   **|

ST: short-term, MT: medium-term

### Table S31 Arthropod predation analysis with the climatic and short-term land-use variables

#### GLMM results (669 observations, 134 plots, 3 regions)

| Fixed effects* | Estimate | Std.Error | t value | Pr(>|z|) |
|----------------|----------|-----------|---------|---------|
| (Intercept)    | -1.620   | 0.138     | -11.709 | <0.001  ***|
| ST mean temperature | -0.389   | 0.174     | -2.228  | 0.026   * |
| ST precipitation | -0.290   | 0.164     | -1.776  | 0.076   |
| ST temperature: ST precipitation | 0.283    | 0.310     | 0.911   | 0.362   |
| MT climate: Dry summer (PCA axis1) | -0.164   | 0.149     | -1.099  | 0.272   |
| **MT climate: Cold winter (PCA axis2)** | 0.339    | 0.134     | 2.528   | 0.011   * |
| MT DrySummer: ColdWinter | -0.283   | 0.165     | -1.719  | 0.086   |
| MT Grazing     | -0.240   | 0.126     | -1.899  | 0.058   |
| MT Fertilization | 0.407    | 0.127     | 3.197   | 0.001   **|

ST: short-term, MT: medium-term
Table S32 Bird predation analysis with the climatic and medium-term land-use variables

| Fixed effects*                     | Estimate | Std.Error | t value | Pr(>|z|) |
|-----------------------------------|----------|-----------|---------|----------|
| (Intercept)                       | -9.656   | 1.261     | -7.655  | <0.001   *** |
| ST maximum temperature            | -0.148   | 0.790     | -0.187  | 0.852    |
| ST temperature: ST precipitation  | 0.532    | 1.400     | 0.380   | 0.704    |
| MT climate: Dry summer (PCA axis1)| 0.558    | 0.753     | 0.741   | 0.459    |
| MT climate: Cold winter (PCA axis2)| 1.086    | 0.635     | 1.711   | 0.087    |
| MT DrySummer: ColdWinter          | -0.640   | 0.822     | -0.779  | 0.436    |
| MT Grazing                        | -0.237   | 0.503     |         | 0.638    |
| MT Fertilization                  | -1.479   | 1.511     | -0.979  | 0.328    |

ST: short-term, MT: medium-term

Table S33 Rodent predation analysis with the climatic and medium-term land-use variables

| Fixed effects*                     | Estimate | Std.Error | t value | Pr(>|z|) |
|-----------------------------------|----------|-----------|---------|----------|
| (Intercept)                       | -4.612   | 0.259     | -17.790 | <0.001   *** |
| ST maximum temperature            | -0.152   | 0.268     | -0.567  | 0.571    |
| ST precipitation                  | -0.225   | 0.246     | -0.914  | 0.361    |
| ST temperature: ST precipitation  | 0.011    | 0.464     | 0.023   | 0.982    |
| MT climate: Dry summer (PCA axis1)| -0.626   | 0.225     | -2.788  | 0.005    ** |
| MT climate: Cold winter (PCA axis2)| 0.096    | 0.205     | 0.467   | 0.640    |
| MT DrySummer: ColdWinter          | 0.271    | 0.248     | 1.096   | 0.273    |
| MT Grazing                        | -0.211   | 0.191     | -1.104  | 0.270    |
| MT Fertilization                  | -0.094   | 0.199     | -0.471  | 0.637    |

ST: short-term, MT: medium-term

Table S34 Total herbivory analysis with the climatic and medium-term land-use variables

| Fixed effects*                     | Estimate | Std.Error | t value | Pr(>|z|) |
|-----------------------------------|----------|-----------|---------|----------|
| (Intercept)                       | -4.364   | 0.223     | -19.531 | <0.001   *** |
| ST max temperature cumulative     | -0.223   | 0.063     | -3.513  | <0.001   *** |
| MT climate: Dry summer (PCA axis1)| 0.051    | 0.208     | 0.245   | 0.806    |
| MT climate: Warm winter (PCA axis2)| -0.063   | 0.059     | -1.057  | 0.290    |
| MT DrySummer:WarmWinter           | -0.026   | 0.052     | -0.498  | 0.618    |
| MT Grazing                        | -0.070   | 0.051     | -1.368  | 0.171    |
| MT Fertilization                  | -0.195   | 0.111     | -1.749  | 0.080    |

ST: short-term, MT: medium-term
Table S35 Total herbivory analysis with the climatic and short-term land-use variables

| Fixed effects*          | Estimate | Std.Error | t value | Pr(>|z|) |
|-------------------------|----------|-----------|---------|----------|
| (Intercept)             | -4.376   | 0.246     | -17.760 | <0.001   *** |
| ST max temperature cumulative | -0.215   | 0.065     | -3.286  | 0.001    **  |
| MT climate: Dry summer (PCA axis1) | 0.002     | 0.205     | 0.008   | 0.994    |
| MT climate: Warm winter (PCA axis2) | -0.070   | 0.057     | -1.223  | 0.221    |
| MT DrySummer:WarmWinter | -0.009   | 0.050     | -0.174  | 0.862    |
| ST Fertilization        | -0.144   | 0.088     | -1.631  | 0.103    |
| ST Grazing              | -0.140   | 0.076     | -1.855  | 0.064    |

ST: short-term, MT: medium-term

Table S36 Grass herbivory analysis with the climatic and medium-term land-use variables

| Fixed effects*          | Estimate | Std.Error | t value | Pr(>|z|) |
|-------------------------|----------|-----------|---------|----------|
| (Intercept)             | -5.424   | 1.186     | -4.574  | <0.001   *** |
| ST max temperature cumulative | -0.818   | 0.401     | -2.041  | 0.041    *   |
| MT climate: Dry summer (PCA axis1) | -0.684    | 0.609     | -1.123  | 0.261    |
| MT climate: Warm winter (PCA axis2) | -0.160   | 0.158     | -1.015  | 0.310    |
| MT DrySummer:WarmWinter | 0.131    | 0.167     | 0.787   | 0.431    |
| MT Grazing              | -0.212   | 0.185     | -1.147  | 0.251    |
| MT Fertilization        | -1.500   | 1.151     | -1.303  | 0.193    |

ST: short-term, MT: medium-term

Table S37 Grass herbivory analysis with the climatic and short-term land-use variables

| Fixed effects*          | Estimate | Std.Error | t value | Pr(>|z|) |
|-------------------------|----------|-----------|---------|----------|
| (Intercept)             | -5.308   | 1.230     | -4.316  | 0.000    *** |
| ST max temperature cumulative | -1.124   | 0.299     | -3.755  | 0.000    *** |
| MT climate: Dry summer (PCA axis1) | -1.112    | 0.570     | -1.951  | 0.051    |
| MT climate: Warm winter (PCA axis2) | -0.268   | 0.158     | -1.691  | 0.091    |
| MT DrySummer:WarmWinter | 0.270    | 0.154     | 1.752   | 0.080    |
| ST Fertilization        | -0.200   | 0.100     | -1.997  | 0.046    *   |
| ST Grazing              | -0.199   | 0.127     | -1.568  | 0.117    |

ST: short-term, MT: medium-term
Table S38 Herb herbivory analysis with the climatic and medium-term land-use variables

| Fixed effects*                      | Estimate | Std.Error | t value | Pr(>|z|) |
|-------------------------------------|----------|-----------|---------|----------|
| (Intercept)                         | -4.148   | 0.174     | -23.832 | < 0.001  *** |
| ST max temperature cumulative       | -0.242   | 0.076     | -3.173  | 0.002    **  |
| MT climate: Dry summer (PCA axis1)  | 0.303    | 0.164     | 1.849   | 0.064    .    |
| MT climate: Warm winter (PCA axis2) | 0.024    | 0.097     | 0.251   | 0.802    .    |
| MT DrySummer:WarmWinter             | 0.089    | 0.085     | 1.050   | 0.294    .    |
| MT Grazing                          | -0.046   | 0.065     | -0.707  | 0.479    .    |
| MT Fertilization                    | -0.186   | 0.171     | -1.090  | 0.276    .    |

ST: short-term, MT: medium-term

Table S39 Herb herbivory analysis with climatic and short-term land-use variables

| Fixed effects*                      | Estimate | Std.Error | t value | Pr(>|z|) |
|-------------------------------------|----------|-----------|---------|----------|
| (Intercept)                         | -4.202   | 0.223     | -18.866 | < 2e-16  *** |
| ST max temperature cumulative       | -0.243   | 0.078     | -3.119  | 0.002    **  |
| MT climate: Dry summer (PCA axis1)  | 0.349    | 0.195     | 1.789   | 0.074    .    |
| MT climate: Warm winter (PCA axis2) | -0.024   | 0.089     | -0.267  | 0.789    .    |
| MT DrySummer:WarmWinter             | 0.054    | 0.079     | 0.690   | 0.490    .    |
| ST Fertilization                    | -0.115   | 0.118     | -0.972  | 0.331    .    |
| ST Grazing                          | -0.324   | 0.150     | -2.157  | 0.031    *    |

ST: short-term, MT: medium-term
SUPPLEMENTARY MATERIAL S6 Process rates in detail

**Figure S20** Boxplots showing plot-level mean rates of major processes in forests and grasslands. G: Grassland, F: Forest.

**Figure S21** Boxplots of plot-level predation rates by each predator group in two habitats. Predation by each group was calculated as the proportion of caterpillars with at least one predation mark by each group. G: Grassland, F: Forest.
Figure S22 Boxplots of plot-level herbivory rates on two plant groups in grasslands.

Table S40 Results of ANOVA tests on the plot-level process rates between forests and grasslands. Df: degrees of freedom, Sum Sq: sum of squares, Mean Sq: Mean squares. Herbivory on grasses and on herbs are not included as they were measured only in grasslands.

| Processes               | Df  | Sum Sq | Mean Sq | F value | Pr(>F)   |
|-------------------------|-----|--------|---------|---------|----------|
| Dung removal            | Habitat | 1 | 3.956 | 3.956 | 79.57 | <2e-16 |
|                         | Residuals | 281 | 13.972 | 0.05 | 281 | 13.972 | 0.05 |
| Seed removal            | Habitat | 1 | 3.646 | 3.646 | 61.35 | 1.22e-13 |
|                         | Residuals | 260 | 15.453 | 0.059 | 260 | 15.453 | 0.059 |
| Predation - overall     | Habitat | 1 | 3.72 | 3.720 | 81.2 | <2e-16 |
|                         | Residuals | 281 | 12.87 | 0.046 | 281 | 12.87 | 0.046 |
| Predation by arthropods | Habitat | 1 | 0.081 | 0.081 | 2.002 | 0.158 |
|                         | Residuals | 281 | 11.389 | 0.041 | 281 | 11.389 | 0.041 |
| Predation by birds      | Habitat | 1 | 0.0358 | 0.036 | 5.526 | 0.0194 |
|                         | Residuals | 281 | 1.819 | 0.007 | 281 | 1.819 | 0.007 |
| Predation by rodents    | Habitat | 1 | 3.44 | 3.44 | 125 | <2e-16 |
|                         | Residuals | 281 | 7.734 | 0.028 | 281 | 7.734 | 0.028 |
| Herbivory               | Habitat | 1 | 0.05377 | 0.054 | 156.5 | <2e-16 |
|                         | Residuals | 293 | 0.10071 | 0.00034 | 293 | 0.10071 | 0.00034 |
SUPPLEMENTARY MATERIAL S7: Effects of vegetation structure on process rates

We recorded vegetation structure parameters at the subplot level: vegetation height was measured for the majority (90%) of the ground cover in cm. Vegetation cover of ground layer and canopy density were recorded as percentages. Tables S41 & 42 show the results of GLMM analyses for the effect of vegetation on the process rates at the subplot level. We used all vegetation parameters and region (representing environmental differences between the regions) as fixed effects. We included plot as a random effect (1 | Plot). All numerical explanatory variables were standardized. Significance (Sig.) codes: ("." : p≤0.1, *: p≤0.05, **: p≤0.01,**: p≤ 0.001. No vegetation structure data are available from herbivory surveys.

Table S41 Results of GLMM analyses for the effect of vegetation on process rates at subplot level in grasslands

| Processes: | Dung removal | Seed removal | Predation-overall | Predation by arthropods | Predation by birds | Predation by rodents |
|------------|--------------|--------------|-------------------|-------------------------|-------------------|---------------------|
| Intercept  | 0.111 <0.001 *** | 0.449 0.159 | -0.773 <0.001 *** | -1.108 <0.001 *** | -8.595 <0.001 *** | -3.952 <0.001 *** |
| Vegetation height | -0.012 0.192 | 0.269 <0.001 *** | 0.201 0.005 ** | 0.160 0.033 * | -0.120 0.510 | 0.637 <0.001 *** |
| Vegetation cover | 0.009 0.318 | -0.041 0.382 | 0.135 0.059 | 0.131 0.084 | 0.660 0.044 * | 0.039 0.798 |
| Region Hainich | 0.038 0.198 | 0.434 0.314 | -0.649 0.023 * | -0.502 0.100 | -2.579 0.095 | -0.667 0.071 |
| Region Schorfheide | 0.062 0.065 | 2.405 <0.001 *** | -1.070 0.001 *** | -1.246 <0.001 *** | 0.324 0.779 | -1.567 <0.001 *** |

Table S42 Results of GLMM analyses for the effect of vegetation on process rates at subplot level in forests

| Processes: | Dung removal | Seed removal | Predation-overall | Predation by arthropods | Predation by birds | Predation by rodents |
|------------|--------------|--------------|-------------------|-------------------------|-------------------|---------------------|
| Intercept  | 0.274 <0.001 *** | 4.737 <0.001 *** | 0.298 0.011 * | -1.113 <0.001 *** | -4.908 <0.001 *** | -0.783 <0.001 *** |
| Vegetation height | -0.002 0.834 | -0.254 <0.001 *** | 0.075 0.022 * | 0.002 0.968 | -0.072 0.499 | 0.089 0.009 ** |
| Vegetation cover | 0.015 0.184 | 0.538 <0.001 *** | 0.100 0.054 | 0.093 0.114 | 0.137 0.247 | 0.040 0.543 |
| Canopy density | -0.016 0.054 | -0.033 0.549 | 0.094 0.021 * | 0.006 0.904 | 0.178 0.064 | 0.136 0.009 ** |
| Region Hainich | -0.081 0.042 * | 4.484 <0.001 *** | -0.114 0.500 | -0.123 0.550 | -0.865 0.054 | -0.185 0.451 |
| Region Schorfheide | 0.185 <0.001 *** | -1.625 0.090 | -0.620 0.000 *** | 0.074 0.717 | 2.445 <0.001 *** | -2.433 <0.001 *** |
SUPPLEMENTARY MATERIAL S8 Linear correlations between the process rates

Table S43  Linear correlations of the plot-level process rates in grasslands based on Pearson’s correlation. \( r \): correlation coefficient, \( p \): significance level. Correlations between predation by different groups and between different herbivory measures are shown in rectangles for the ease of interpretation.

| Processes in grasslands | Dung removal | Seed removal | Predation - overall | Predation by arthropods | Predation by birds | Predation by rodents | Herbivory - total | Herbivory on grasses |
|-------------------------|--------------|--------------|---------------------|------------------------|-------------------|---------------------|-------------------|---------------------|
| Dung removal            | r \( p \)    | r \( p \)    | r \( p \)           | r \( p \)              | r \( p \)          | r \( p \)            | r \( p \)          | r \( p \)            |
| Seed removal            | 0.040        | 0.688        |                     |                        |                   |                     |                   |                     |
| Predation - overall     | -0.080       | 0.371        | 0.100               | 0.274                 |                   |                     |                   |                     |
| Predation by arthropods | -0.080       | 0.386        | 0.050               | 0.591                 | 0.950             | <0.001              |                   |                     |
| Predation by birds      | 0.030        | 0.733        | 0.060               | 0.529                 | 0.330             | <0.001              | 0.080             | 0.362               |
| Predation by rodents    | -0.150       | 0.079        | 0.140               | 0.129                 | 0.320             | <0.001              | 0.120             | 0.346               |
| Herbivory - total       | -0.010       | 0.942        | 0.080               | 0.371                 | -0.170            | 0.057               | -0.150            | 0.081               |
| Herbivory on grasses    | -0.010       | 0.880        | -0.110              | 0.215                 | -0.190            | 0.033               | -0.150            | 0.087               |
| Herbivory on herbs      | -0.050       | 0.613        | 0.200               | 0.027                 | -0.070            | 0.408               | -0.110            | 0.230               |

Table S44  Linear correlations of the plot-level process rates in forests based on Pearson’s correlation. \( r \): correlation coefficient, \( p \): significance level. Correlations between predation by different groups are shown in rectangles for the ease of interpretation.

| Processes in forests | Dung removal | Seed removal | Predation - overall | Predation by arthropods | Predation by birds | Predation by rodents |
|----------------------|--------------|--------------|---------------------|------------------------|-------------------|---------------------|
| Dung removal         | r \( p \)    | r \( p \)    | r \( p \)           | r \( p \)              | r \( p \)          | r \( p \)            |
| Seed removal         | -0.260       | 0.002        | 0.320               | <0.001                 |                   |                     |
| Predation - overall  | -0.060       | 0.434        | 0.320               | <0.001                 |                   |                     |
| Predation by arthropods | 0.180       | 0.031        | -0.020              | 0.820                  | 0.480             | <0.001              |
| Predation by birds   | 0.410        | <0.001       | -0.280              | 0.001                  | 0.090             | 0.301               | 0.170             | 0.043               |
| Predation by rodents | -0.320       | <0.001       | 0.440               | <0.001                 | 0.600             | <0.001              | -0.330            | <0.001              | -0.350              | <0.001 |
| Herbivory - total    | -0.110       | 0.182        | 0.090               | 0.280                  | -0.030            | 0.745               | -0.040            | 0.630               | 0.010             | 0.866               | 0.000             | 0.967               |
SUPPLEMENTARY MATERIAL S9: Within-plot variation of the process rates

We used the coefficient of variation (CV) as a measure of variation in the process rates. We focused on the within-plot variation of each process in each habitat and calculated as $CV_{\text{within}} = \text{mean} (CV_{\text{plot}}) = \frac{\text{mean} (SD_{\text{plot}})}{\bar{x}_{\text{plot}} \times 100}$ where SD is the standard deviation and $\bar{x}$ is the mean process rate. We used CV as it is independent of the magnitude of the mean and does not require any assumption on data distribution. Although each process rate was calculated as proportion and varied between 0 and 1 (0-100 in percentage), the histograms of the rates below (Figures S23- S29) did not follow a clear binomial distribution because it is not the random occurrence of a probability but the rate of a natural process affected by various drivers. Our data cover a wide range of means and CVs and the CV decreases as the mean increases, as expected based on the above formula. So there is no drawback in reporting CVs and checking their correlations with land-use intensities as our sample sizes are very large.

Table S45 Percent coefficient of variation of each process rate ($CV_{\text{within}}$) within plots in grasslands and forests. Dung removal, seed removal and predation measurements were based on 5 subplots per plot; herbivory was based on 2 subplots in grasslands, and there were no subplot-level measurements for herbivory in forests. For herbivory in grasslands, mowing did not take place in the short-term timescale, hence LUI includes only grazing and fertilization.

| Processes          | Habitat  | $CV_{\text{within}}$ |
|--------------------|----------|----------------------|
| Dung removal       | Forest   | 69 ± 0.55            |
| Seed removal       | Forest   | 19.5±0.46            |
| Predation – overall| Forest   | 45.8±0.44            |
| Predation by arthropods | Forest | 84±0.56              |
| Predation by birds | Forest   | 130.9±1.01           |
| Predation by rodents| Forest  | 106.9±0.7            |
| Dung removal       | Grassland| 89.7±0.62            |
| Seed removal       | Grassland| 43.9±0.6             |
| Predation – overall| Grassland| 88.46±0.69           |
| Predation by arthropods | Grassland | 94.3±0.7          |
| Predation by birds | Grassland| 143±1.82             |
| Predation by rodents| Grassland| 177.5±1              |
| Herbivory – total  | Grassland| 37.2±0.44            |
| Herbivory – grasses| Grassland| 47.9±0.51            |
| Herbivory – herbs  | Grassland| 56.1±0.52            |
Table S46 Correlations between within-plot level variations of process rates ($CV_{\text{within}}$ in %) and land-use intensities. Correlation coefficients of Pearson correlation tests were given and significant results are indicated in bold with p values in parentheses. For land-use intensity in forests, a compound measure, ForMI (Kahl and Bauhus, 2014), was used which combines harvest intensity, proportion of non-natural trees in the tree composition, and anthropogenic deadwood. For grasslands, a compound measure, LUI (Blüthgen and others, 2012), combining the intensity of livestock grazing, the number of cuts and fertilization was adopted and the dataset was produced based on the short- and medium-terms of the study. Herbivory in forests was measured at the plot level so no $CV_{\text{within}}$ was available.

| $CV_{\text{within}}$ | Correlation with ForMI | Correlation with short-term LUI | Correlation with medium-term LUI |
|----------------------|------------------------|-------------------------------|--------------------------------|
| Dung removal         | -0.072                 | -0.176 ($p = 0.04$)           | 0.095                          |
| Seed removal         | 0.147                  | 0.340 ($p < 0.001$)           | 0.236 ($p = 0.008$)            |
| Predation –overall   | 0.061                  | 0.159                         | -0.135                         |
| Predation by arthropods | 0.053              | 0.124                         | -0.211 ($p = 0.019$)           |
| Predation by birds   | -0.174                 | 0.184                         | 0.262                          |
| Predation by rodents | -0.038                 | 0.250 ($p = 0.058$)           | 0.031                          |
| Herbivory –overall   | NA                     | 0.062                         | 0.117                          |
| Herbivory on grasses | NA                     | 0.139                         | 0.297 ($p = 0.002$)            |
| Herbivory on herbs   | NA                     | 0.150                         | -0.053                         |

Figure S23 Left: histogram showing subplot level dung removal rates; right: scatterplot showing plot level mean rates and CV for grasslands (G) and forests (W).
**Figure S24** Left: histogram showing subplot level seed removal rates; right: scatterplot showing plot level mean rates and CV for grasslands (G) and forests (W).

**Figure S25** Left: histogram showing subplot level overall predation rates; right: scatterplot showing plot level mean rates and CV for grasslands (G) and forests (W).
Figure S26 Left: histogram showing subplot level rates of predation by arthropods; right: scatterplot showing plot level mean rates and CV for grasslands (G) and forests (W).
**Figure S27** On the left: histogram showing subplot level rates of predation by birds; on the right: scatterplot showing plot level mean rates and CV for grasslands (G) and forests (W).

**Figure S28** On the left: histogram showing subplot level rates of rodent predation; on the right: scatterplot showing plot level mean rates and CV for grasslands (G) and forests (W).
Figure S29 top: histograms showing subplot level herbivory rates in grasslands; bottom: scatterplots showing plot level mean rates and CV
Ecosystems

Supplementary material for Ambarli et al.

References

Blüthgen N, Dormann CF, Prati D, Klaus VH, Kleinebecker T, Hölzel N, Alt F, Boch S, Gockel S, Hemp A, Müller J, Nieschulze J, Renner SC, Schöning I, Schumacher U, Socher SA, Wells K, Birkhofer K, Buscot F, Oelmann Y, Rothenwöhrer C, Scherber C, Tscharntke T, Weiner CN, Fischer M, Kalko EKV, Linsenmaier KE, Schulze E-D, Weisser WW. 2012. A quantitative index of land-use intensity in grasslands: Integrating mowing, grazing and fertilization. Basic and Applied Ecology 13: 207-220.

Boch S, Prati D, Müller J, Socher S, Baumbach H, Buscot F, Gockel S, Hemp A, Hessenmöller D, Kalko EK. 2013. High plant species richness indicates management-related disturbances rather than the conservation status of forests. Basic and Applied Ecology 14: 496-505.

Gossner MM, Weisser WW, Meyer ST. 2014. Invertebrate herbivory decreases along a gradient of increasing land-use intensity in German grasslands. Basic and Applied Ecology 15: 347-352.

Kahl T, Bauhus J. 2014. An index of forest management intensity based on assessment of harvested tree volume, tree species composition and dead wood origin. Nature Conservation 7: 15-27.

Kassambara A, Mundt F. 2017. Factoextra: Extract and Visualize the Results of Multivariate Data Analyses. pR package version 1.0.5.

Loranger H, Weisser WW, Ebeling A, Eggers T, De Luca E, Loranger J, Roscher C, Meyer ST. 2014. Invertebrate herbivory increases along an experimental gradient of grassland plant diversity. Oecologia 174: 183-193.

R Core Team R. 2017. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing.

Vu V. 2011. Ggbiplot v.0.55: A ggplot2 based biplot.