

# Transformation of Forest Humus Forms in Northwest Germany Across Three Decades

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## Background:

- Soil acidification in the 1970s and 1980 dramatically effected forest soil chemistry, tree vitality and nutrient cycling
- Classification of humus forms is a valuable diagnostic instrument to evaluate the state of forest ecosystems and to monitor changes in ecological processes (e.g. organic matter mineralization and C sequestration)
- Humus forms provide valuable information on how anthropogenic influences have affected (1) nutrient cycling, (2) microbial activity, and (3) the overall health of the forest soil

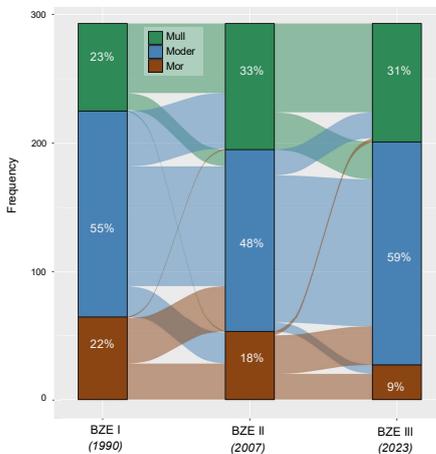


## Methods:

- Humus forms were determined at 465 sampling points as part of the German National Forest Soil Inventory (BZE; see **Box 1**) during the last three BZE inventories (BZE I in 1990, BZE II in 2007 and BZE III 2023)
- Humus forms were identified using the German classification system (see **Box 2**)
- Humus forms were classified at 10 soil monoliths at each BZE point
- Slight differences in the humus form nomenclature (due to developments in the classification system) were harmonized and translated

## Results:

- General improvement in humus forms observed
- Mor humus forms are disappearing (from 22% in BZE I to only 9% in BZE III)
- Presence of Mull humus forms increased between BZE I (23%) and BZE II (33%), but stabilized in BZE III (31%)



Sankey plot showing the trajectory of humus forms over the last 30 years summarized at the "Type" level  
\*This analysis only includes all BZE points that were included in all three BZE inventories, n = 293

- Improvements reflect external factors that have promoted organic matter mineralization rates
- This has led to:
  - a reduction in forest floor layer thickness
  - improved nutrient cycling rates

### Box 1: German National Forest Soil Inventory (Bodenzustandserhebung im Wald, BZE)

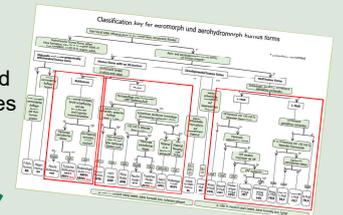
- Quantification of changes in forest soil chemistry, soil nutrient status, ground vegetation (herbs, shrubs and mosses), tree vitality, stands and forest nutrition
- Systematic sampling grid: 8 × 8 km raster
- Germany-wide ~1900 sampling points
- In northwest Germany there are 465 sampling points



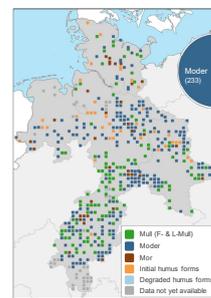
BZE sampling locations in NW Germany

### Box 2: German humus form classification system

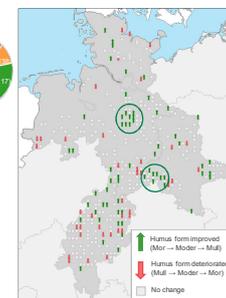
- A morphogenetic systematic approach
- Utilizes diagnostic horizons and properties to infer the processes and pathways involved in its origin and development
- A classification key to guide decision making
- Systematic hierarchical structure: Division → Class → Type → Subtype → Variety
- Developed by the DBG working group on humus forms
- Newest iteration (2022) includes "initial" and "degradation" humus forms



www.humus-form.eu/



Humus forms in the BZE III n=427



Changes in humus forms in the last 15 years (from BZE II to BZE III) n=375

- Random pattern
- Only in the Lüneburg Heathlands and the Harz mountains were there larger clusters where humus forms improved

### Possible drivers:

- Sustained high nitrogen deposition
- Decreased acid deposition
- Increasing temperatures
- Forest liming activities
- Shift from coniferous to deciduous forests (= improved litter quality)
- More light reaching the forest floor
- More natural regeneration