

Pilot Study – Updating Empirical Critical Loads

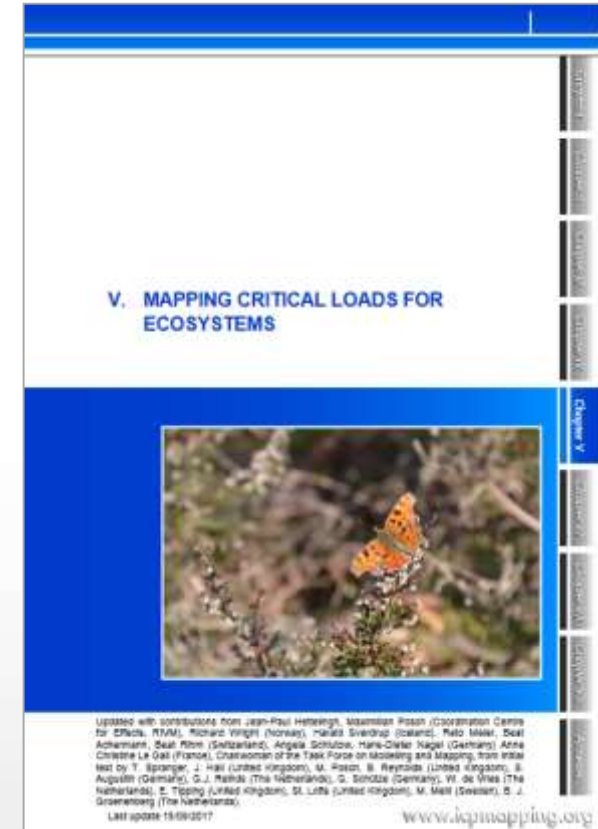
Anne-Katrin Prescher, Nicole Wellbrock
Thünen Institute of Forest Ecosystems, Germany



The critical load is defined as the **level** of a pollutant **below** which **no harmful ecological effect** occurs over the long term” (Pardo et al, 2011)

The different methods to determine Critical loads are described in the **Manual of ICP Modelling & Mapping**.

Empirical critical loads are based on **field observations** and experiments with the aim to establish **dose-response relationships** between the input (deposition) of a pollutant and ecosystem impacts. (CLRTAP, 2017)

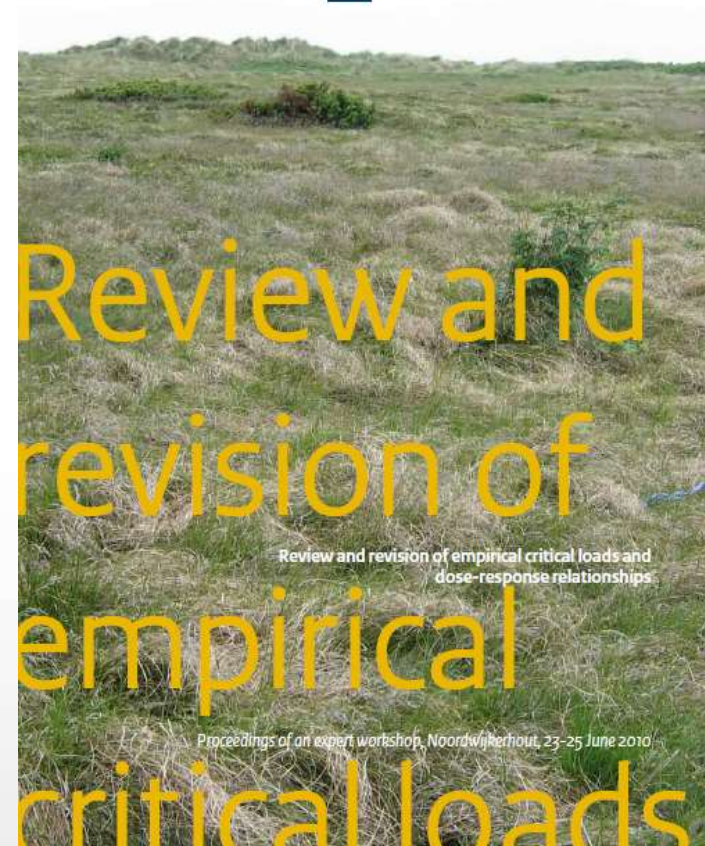


Bobbink & Hetteling (2011):

Review and revision of empirical critical loads and dose response relationships.

Table 1 Overview of empirical critical loads of nitrogen deposition ($\text{kg N ha}^{-1} \text{ yr}^{-1}$) to natural and semi-natural ecosystems (column 1), classified according to EUNIS (column 2), as originally established in 2003 (column 3), and as revised in 2010 (column 4). The reliability is qualitatively indicated by ## reliable; # quite reliable and (#) expert judgement (column 5). Column 6 provides a selection of effects that can occur when critical loads are exceeded. Finally, changes with respect to 2003 values are indicated in bold.

Ecosystem type	EUNIS code	2003 $\text{kg N ha}^{-1} \text{ yr}^{-1}$ and reliability	2010 $\text{kg N ha}^{-1} \text{ yr}^{-1}$	2010 reliability	Indication of exceedance
Marine habitats (A)					
Mid-upper salt marshes	A2.53		20-30	(#)	Increase in dominance of graminoids
Pioneer and low-mid salt marshes	A2.54 and A2.55	30-40 (#)	20-30	(#)	Increase in late-successional species, increase in productivity
Coastal habitats (B)					
Shifting coastal dunes	B1.3	10-20 (#)	10-20	(#)	Biomass increase, increased N leaching
Coastal stable dune grasslands (grey dunes)	B1.4 ^a	10-20 #	8-15	#	Increase in tall graminoids, decrease in prostrate plants, increased N leaching, soil acidification, loss of typical lichen species
Coastal dune heaths	B1.5	10-20 (#)	10-20	(#)	Increase in plant production, increased N leaching, accelerated succession
Moist to wet dune slacks	B1.8 ^a	10-25 (#)	10-20	(#)	Increased biomass of tall graminoids
Inland surface water habitats (C)^a					
Permanent oligotrophic lakes, ponds and pools (including soft-water lakes)	C1.1 ^a	5-10 ##	3-10	##	Change in the species composition of macrophyte communities, increased algal productivity and a shift in nutrient limitation of phytoplankton from N to P
Dune slack pools (permanent oligotrophic waters)	C1.16	10-20 (#)	10-20	(#)	Increased biomass and rate of succession
Permanent dystrophic lakes, ponds and pools	C1.4 ^a		3-10	(#)	Increased algal productivity and a shift in nutrient limitation of phytoplankton from N to P



EUNIS - European Nature Information System



- pan-European
- builds upon the previous initiatives of the CORINE Habitat classification and on the Palaeartic Habitats Classification
- based on general vegetation science with additions of a series of non-vegetated landscape elements, which are important animal habitats or form the basis for colonisation of vegetation
- Marine elements, whether or not colonised by plants or animals

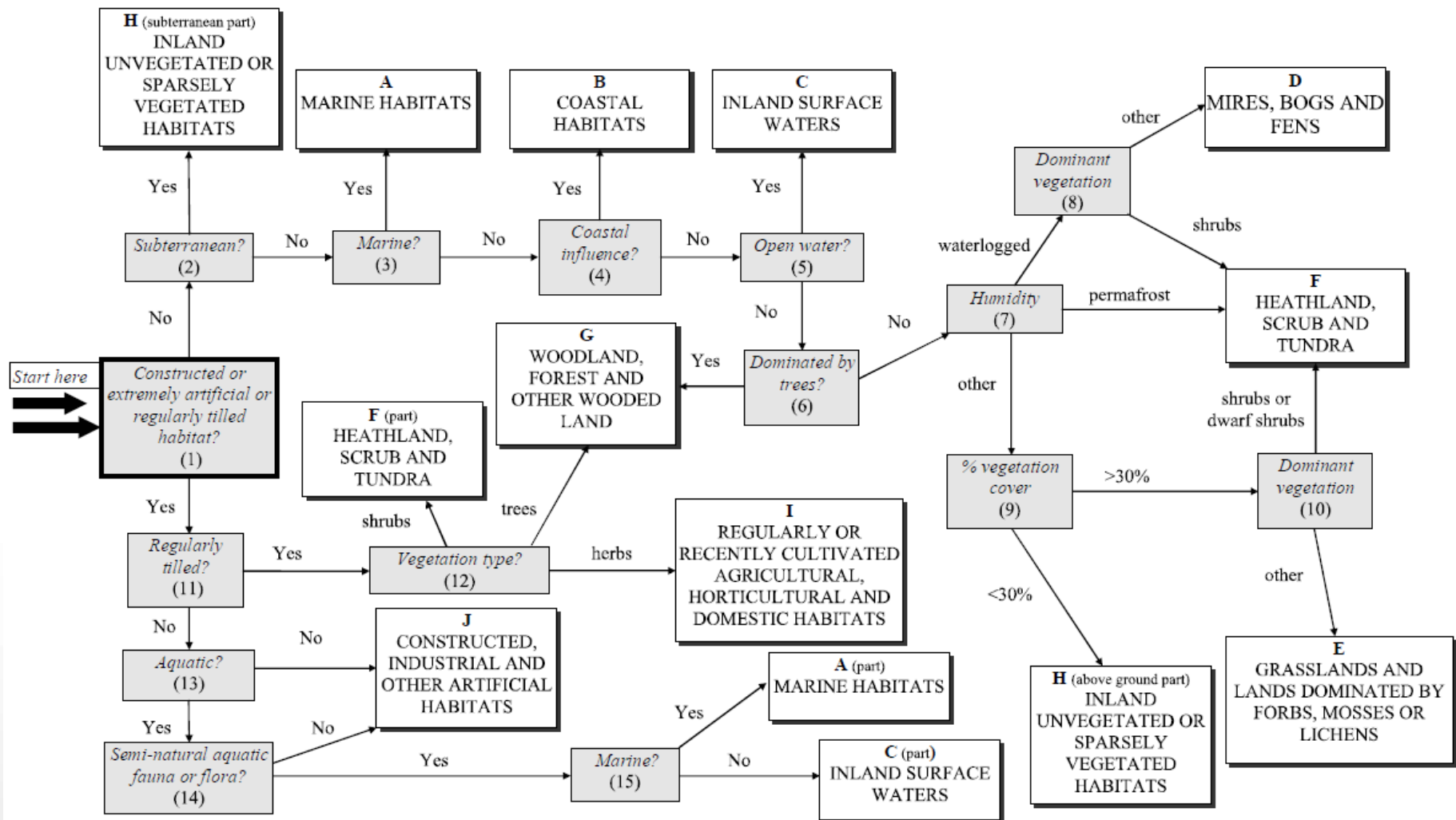
- is hierarchical with a variable number of levels

11 categories for level 1

7 categories of interest

- A. Marine habitats** [includes saltmarshes]
 - B. Coastal habitats** [dunes, shingle, rock/cliffs]
 - C. Inland surface waters** [standing waters; running waters including springs; swamps]
 - D. Mires, bogs and fens** [bogs, fens/flushes]
 - E. Grasslands and lands dominated by forbs, mosses or lichens** [dry and wet grasslands parkland]
 - F. Heathland, scrub and tundra**
 - G. Woodland, forest and other wooded land** [broad-leaved and conifer woodland and plantations; excludes parkland (E) and some scrub types (F)]
 - H. Inland unvegetated or sparsely vegetated habitats** [rock/cliffs, scree, caves]
 - I. Regularly or recently cultivated agricultural, horticultural and domestic habitats**
 - J. Constructed, industrial and other artificial habitats**
 - X. Habitat complexes**
- S. Heathland, scrub and tundra**
- T. Woodland, forest and other wooded land**
- Revised in 2017**

Notes from: Strachan, I.M. 2017. Manual of terrestrial EUNIS habitats in Scotland.



From Davies et al (2004) EUNIS Habitat classification revised 2004

Gaps in Knowledge and research needs (Bobbink, 2011)

1. More research on: **steppe, Mediterranean vegetation types, swamp forests, mires, fens, coastal habitats**
2. More research on: **habitat types with expert judgement or only few studies**
3. More research on: **freshwater and shallow marine ecosystems**
4. Additional effort in allocation of N effects to **appropriate EUNIS forest habitat** subtypes
5. More **rigorous guidelines** for evaluation of new studies (estimation of deposition, confounding factors, statistics)
6. Possible differential effects of **oxidised and reduced nitrogen**
7. **Long-term experiments** with $5 - 50 \text{ kgN ha}^{-1} \text{ a}^{-1}$, lowest level should not exceed critical load



Literature Review

Timespan: 2010 – 2019

Key words for searching:

- nitrogen/ ammonium/ nitrate/ nutrient
- critical load/ limit/ level/ threshold
- deposition/ air pollution/ immission
- experiment/ observation/ simulation/ trial
- fertilization/ addition/ treatment/ application
- ecosystem/ habitat
- ...

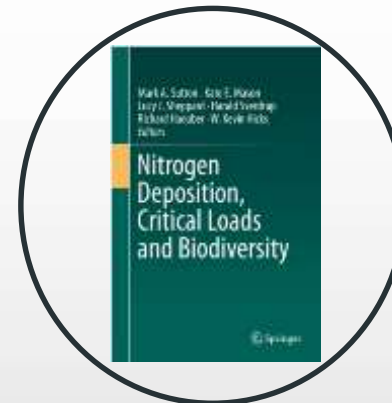
Geographical Boundaries: UNECE region



No studies conducted in
China/ Asia:
~ **35%** less publications!



928



Using **title and abstracts**, publications were screened and sorted:

1. clear indication for determination of dose-response relationships/ empirical critical load; the effects of different N deposition levels/ N dose on ecosystems/ biodiversity
2. review articles that comprise N effects on ecosystems/ biodiversity
3. modelling of critical loads
4. others

➡ **Further sorted to appropriate EUNIS class**

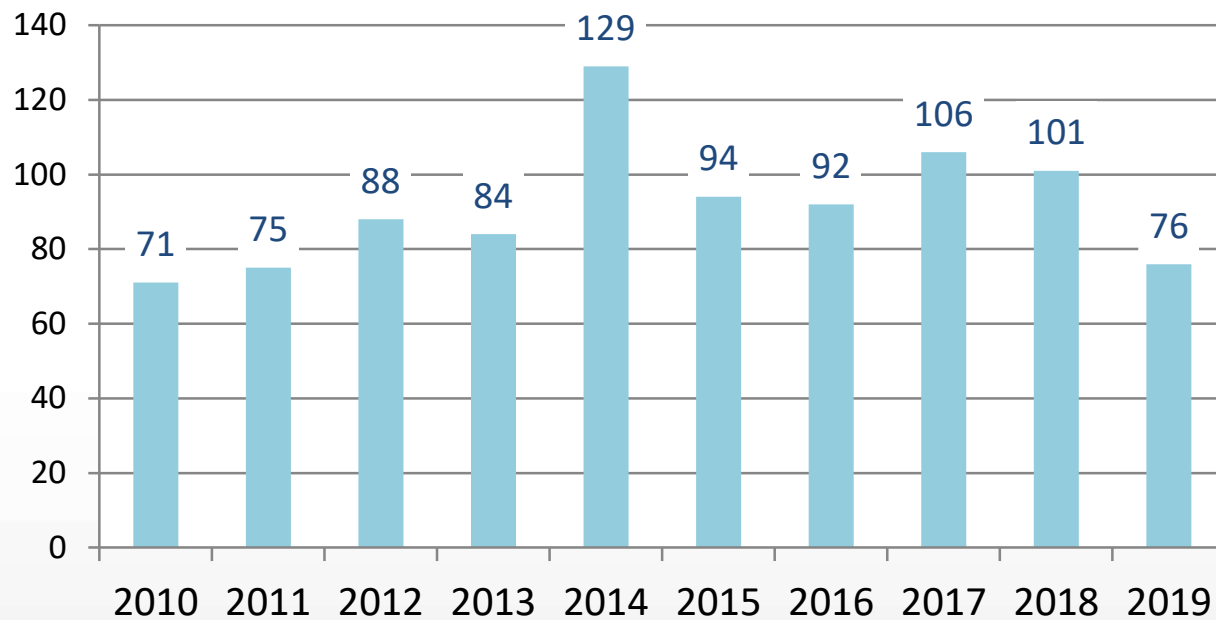
Publications of category 1

Using full papers, publications were screened and sorted

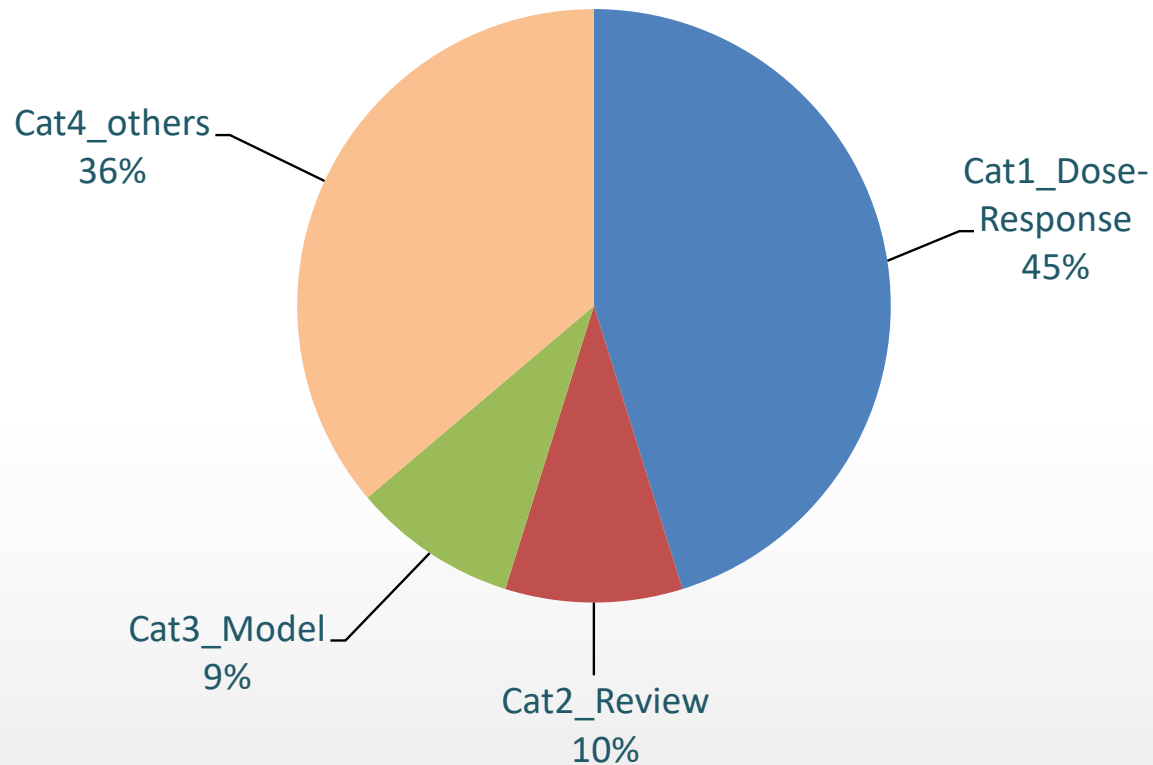
- Country (*country*)
- Experimental set up (*exp_setup*)
- Response variable (*response_var*)
- Additional influencing factors (*add_factors*)
- Determined critical load/ threshold (*threshold_determined*)
- used statistics (*statistics*)

Results

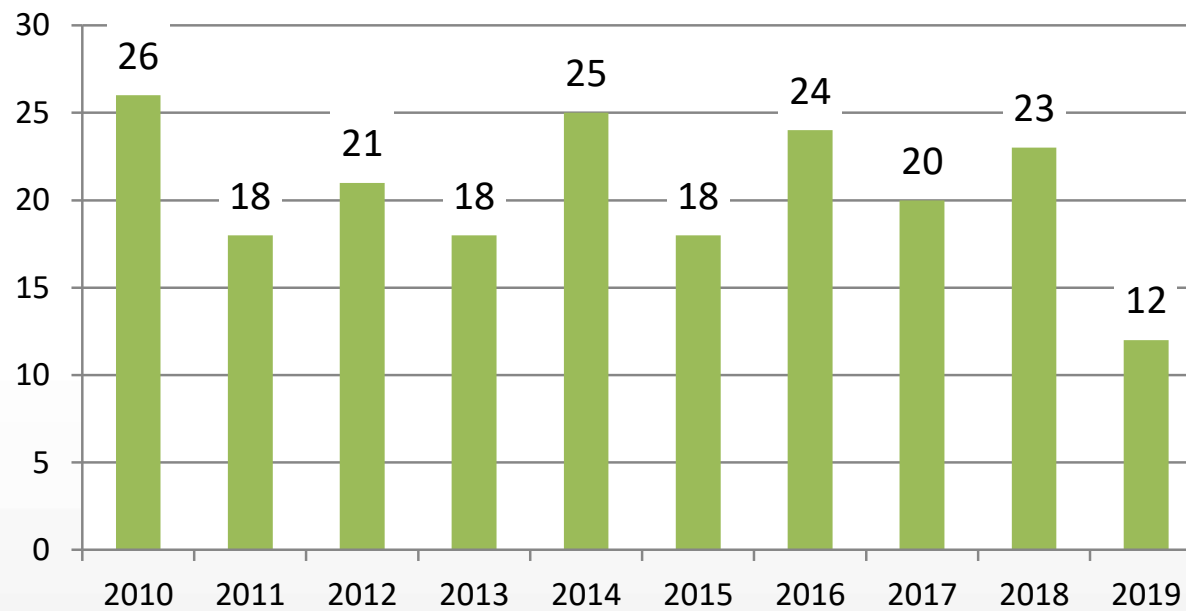
Number of Publications per Year



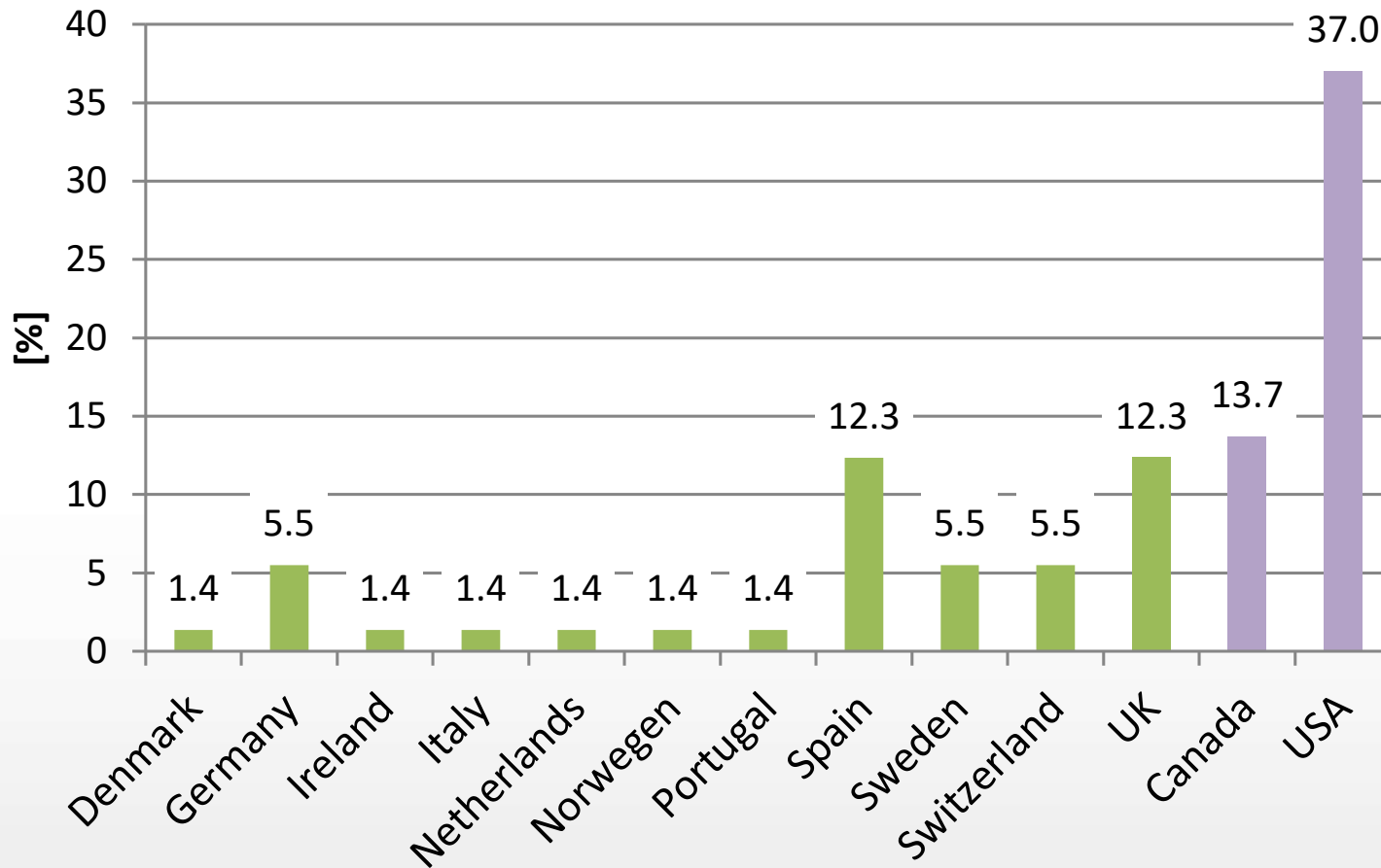
Publications per sorting category

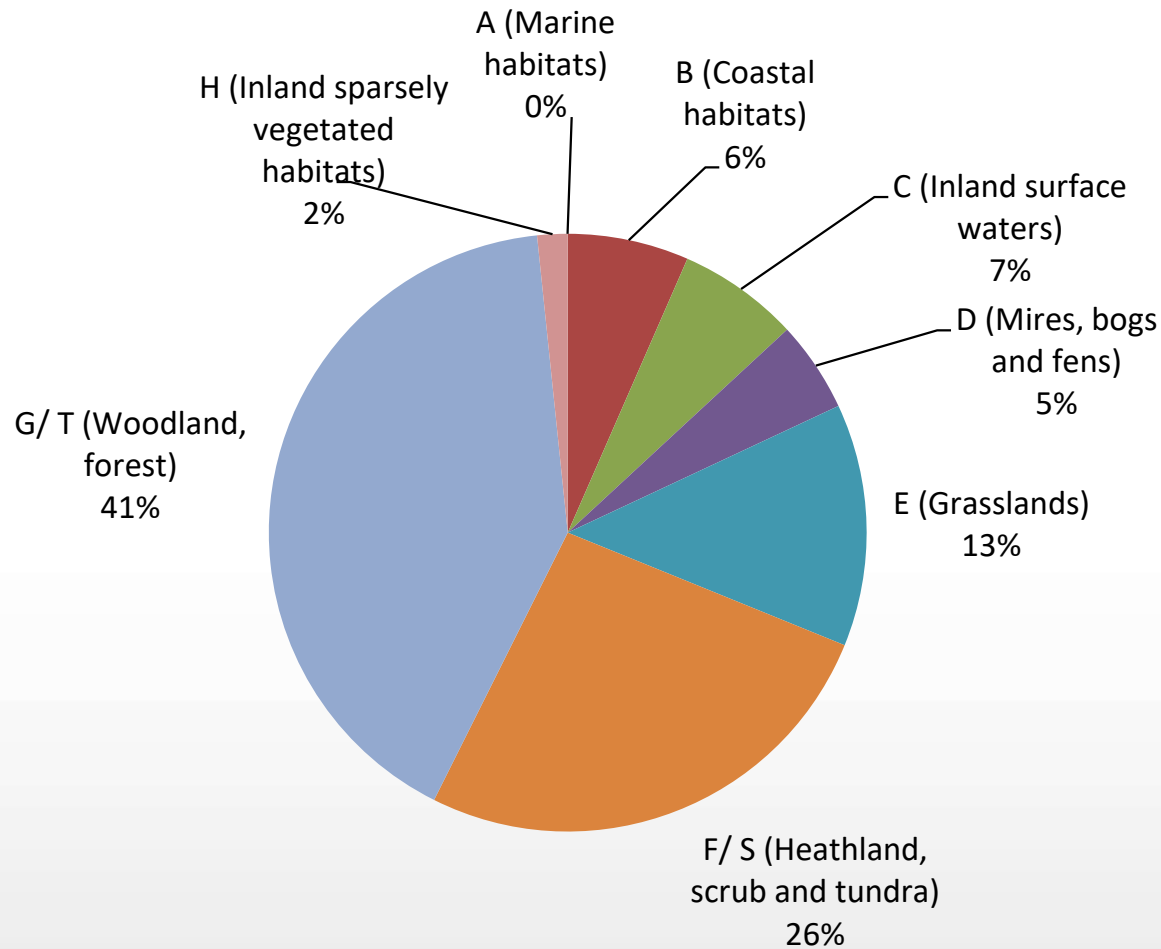


Cat1 - Number of Publications per Year

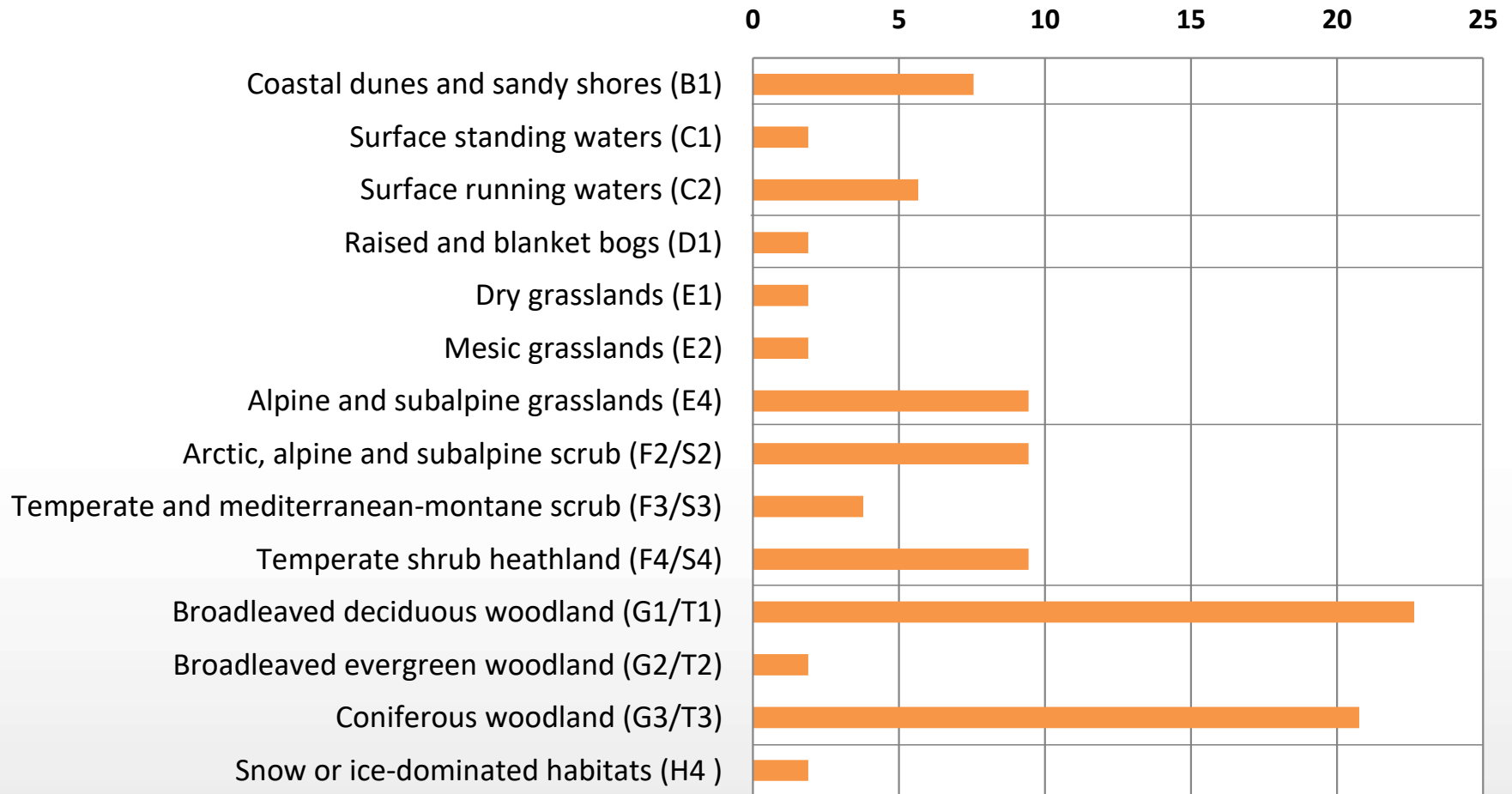


Geographic coverage of study sites

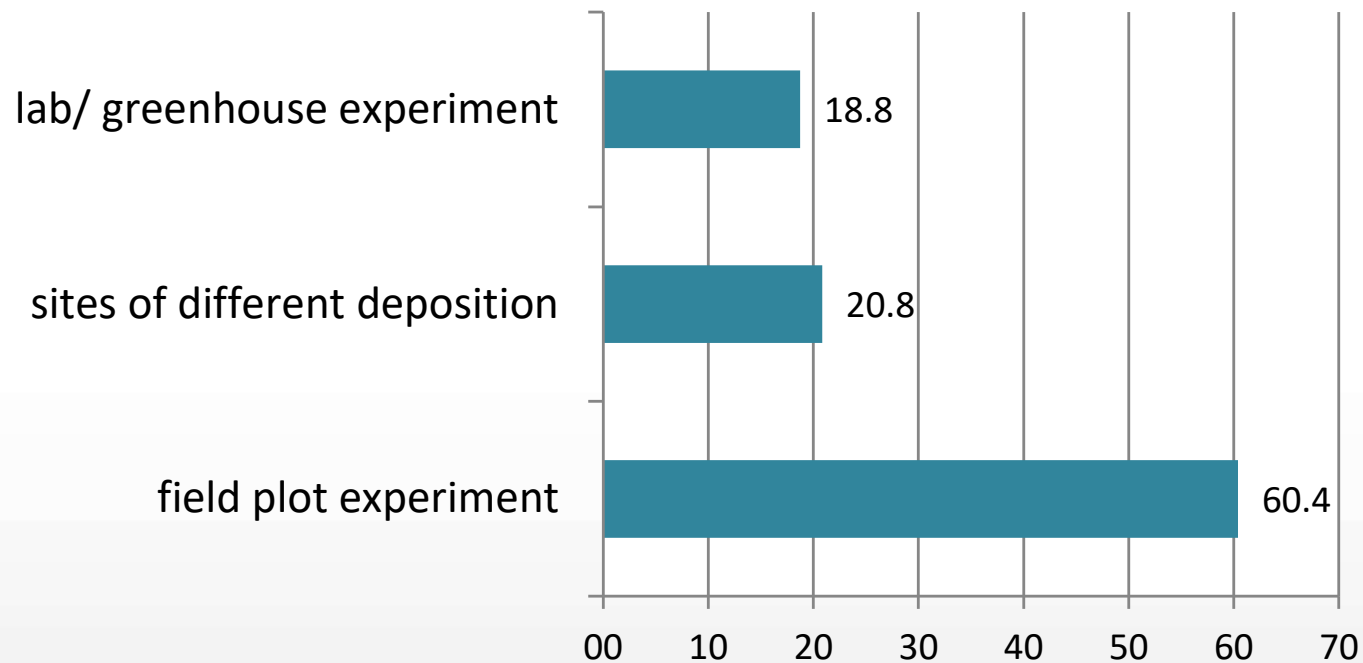




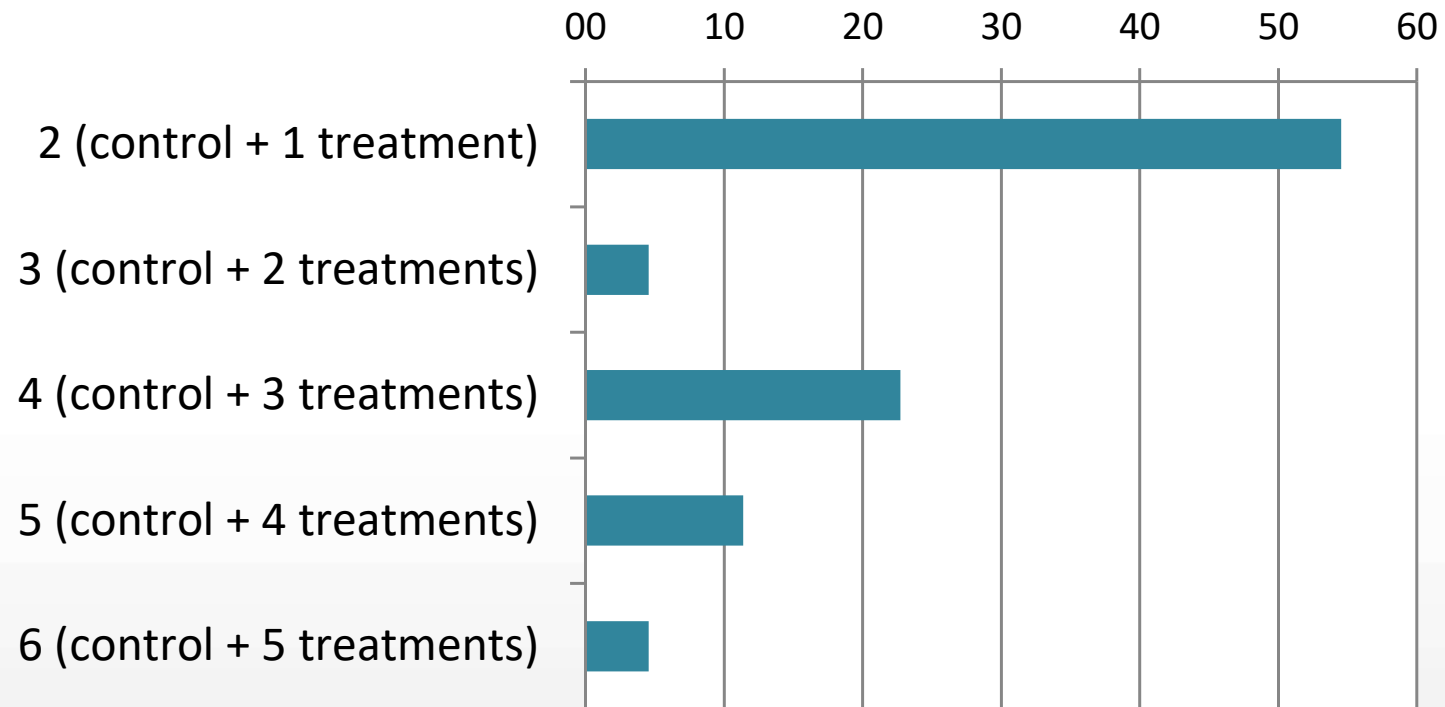
Publications per EUNIS class 2 [%]



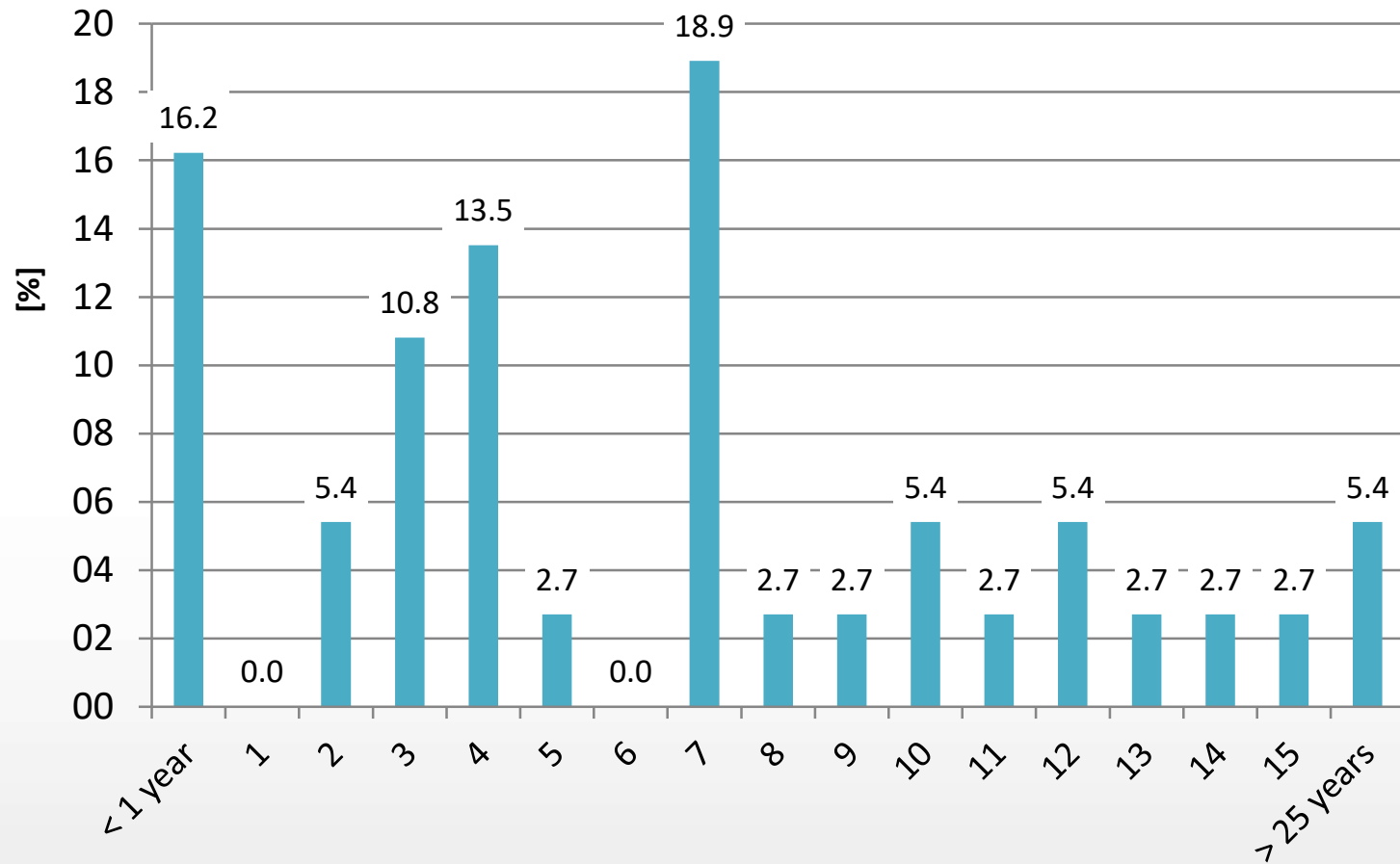
Experimental Set-up



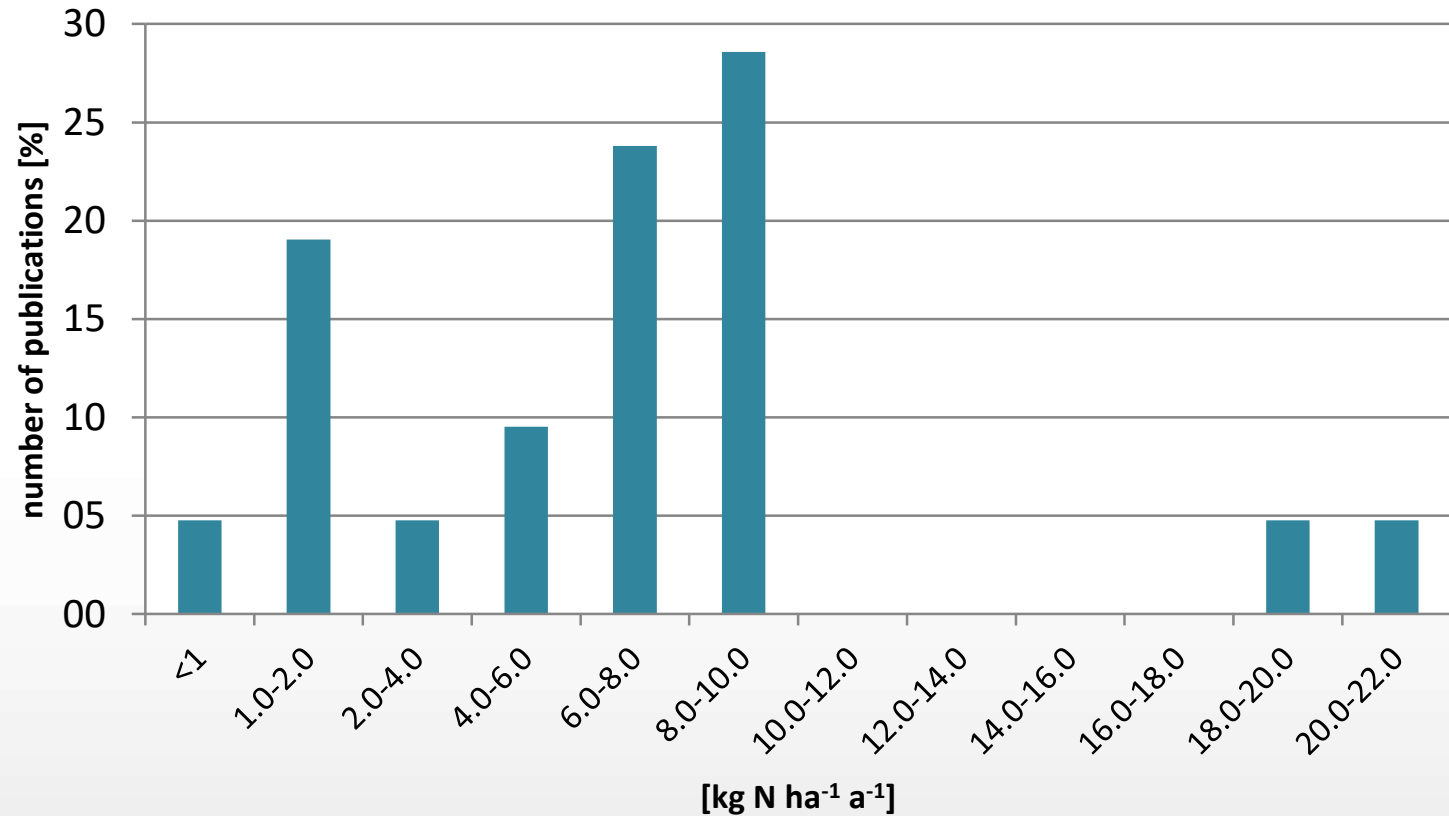
Number of N levels applied



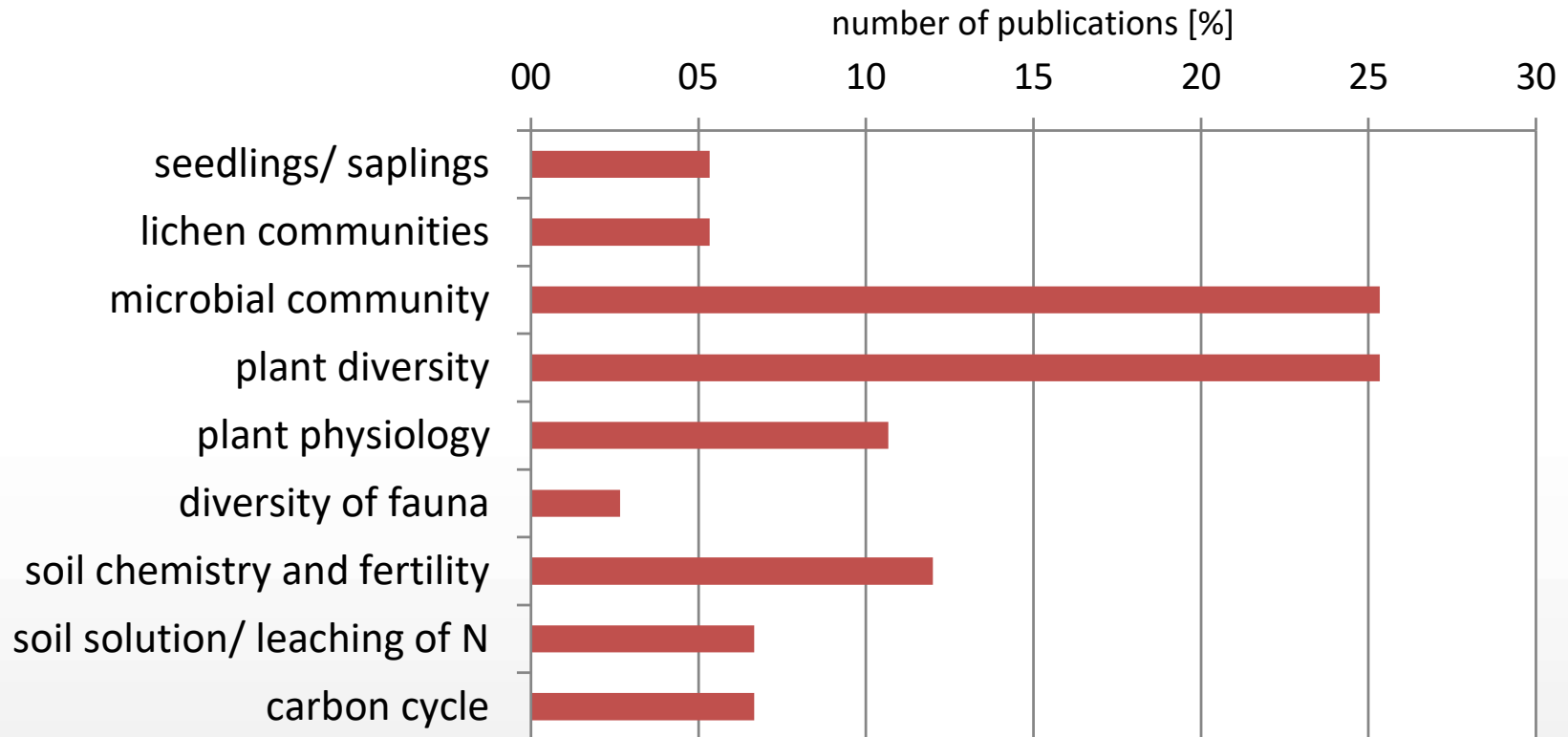
Length of Treatment Application



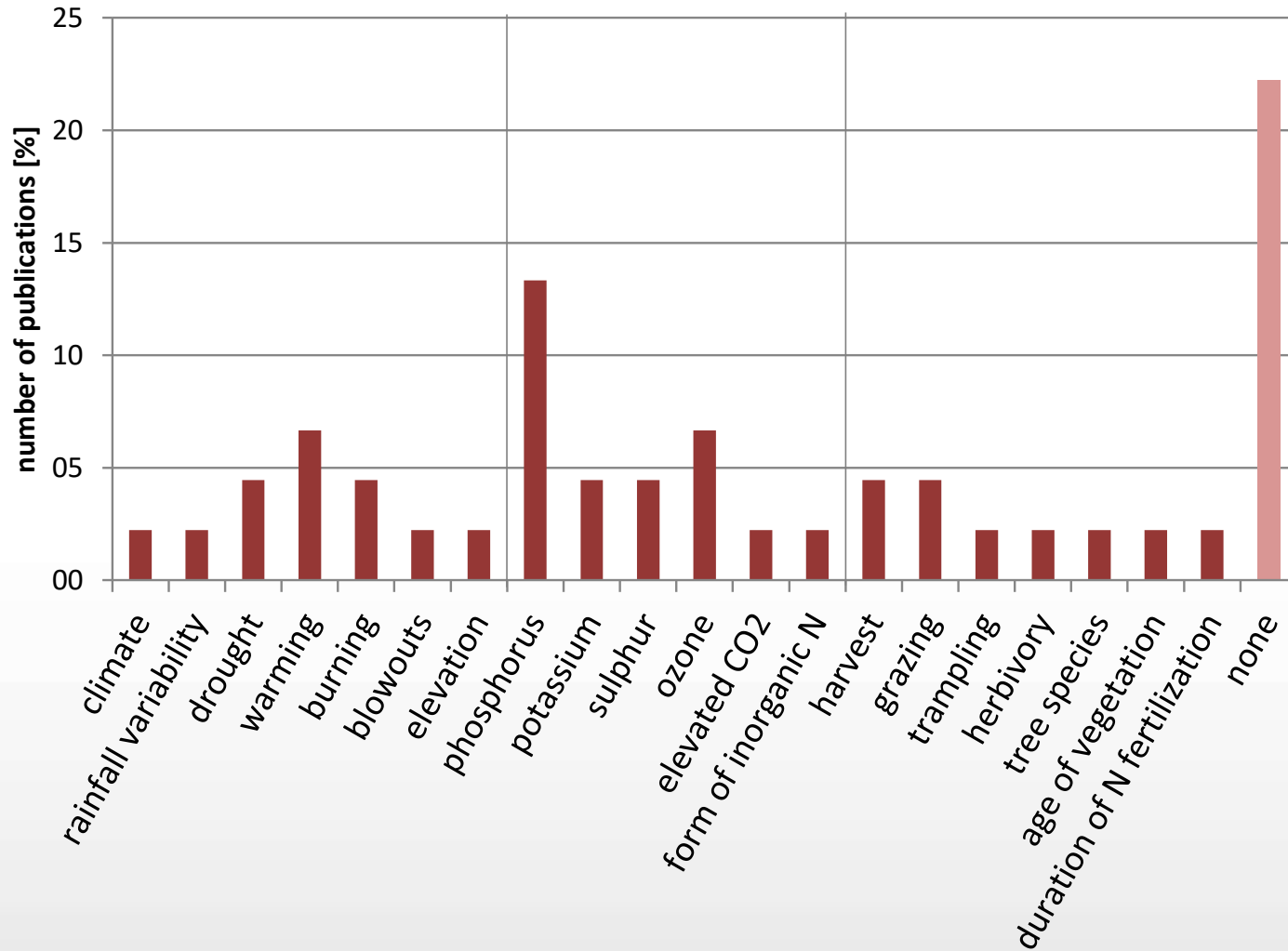
Background N deposition at study sites



Response variable in N addition studies



Additional studied factors



Gaps in Knowledge and research needs (Bobbink, 2011)

1. More research on: **steppe, Mediterranean vegetation types, swamp forests, mires, fens, coastal habitats** → **Some more studies found**
2. More research on: **habitat types with expert judgement or only few studies** → **Some more studies found**
3. More research on: **freshwater and shallow marine ecosystems** → **Some more studies found**
4. Additional effort in allocation of N effects to **appropriate EUNIS forest habitat subtypes** → **Kept to experts/ NEC Directive**
5. More **rigorous guidelines** for evaluation of new studies (estimation of deposition, confounding factors, statistics) → **Set starting point with sorting criteria**
6. Possible differential effects of **oxidised and reduced nitrogen** → **still difficult to judge**
7. **Long-term experiments** with 5 – 50 kgN ha⁻¹ a⁻¹, lowest level should not exceed critical load → **Some more studies found**

Thank you for your attention!

