Pilot Study –
Updating Empirical Critical Loads

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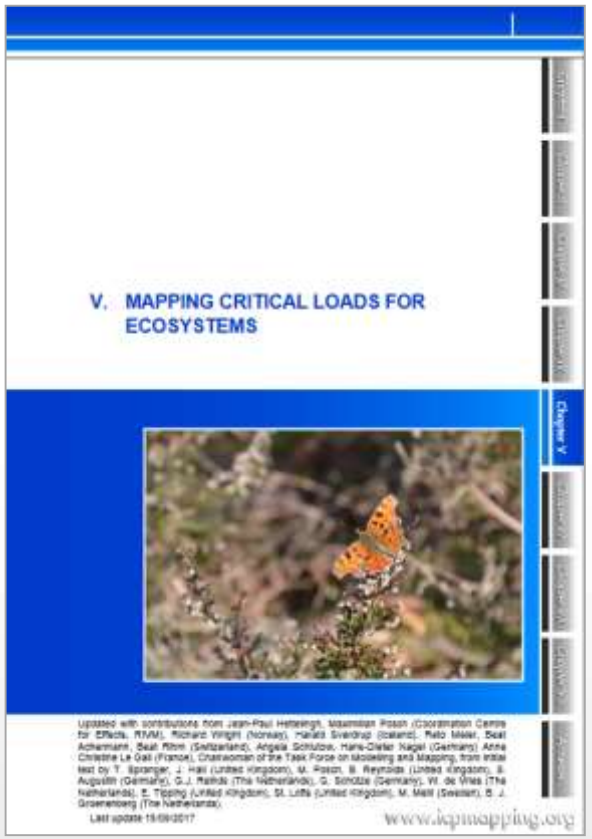
Critical Loads

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)

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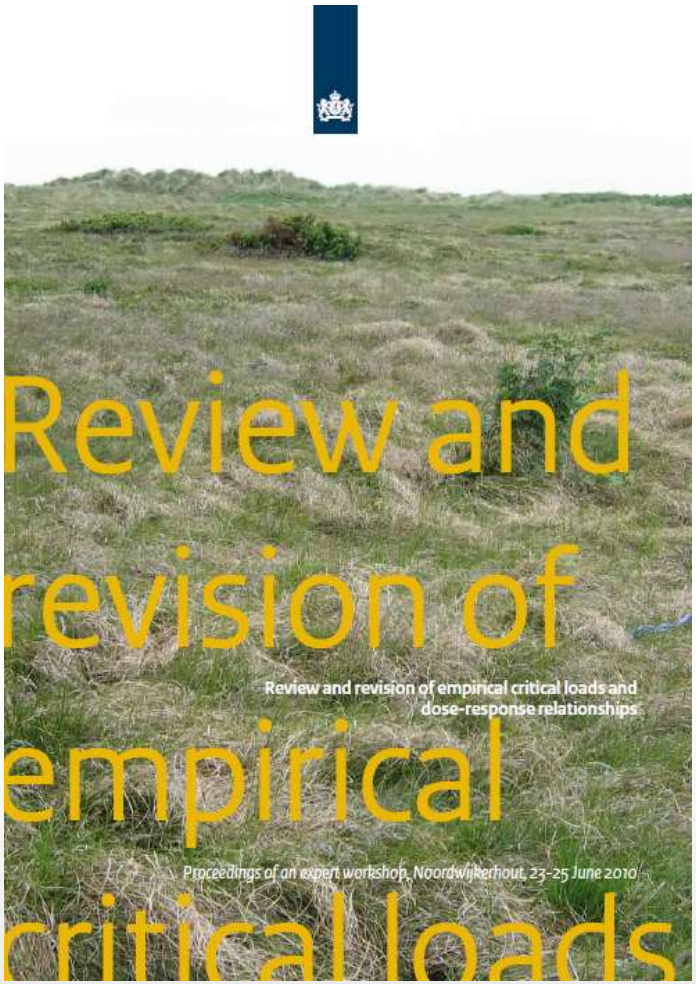
Empirical Critical Loads

Bobbink & Hetteling (2011):

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

Table 1 Overview of empirical critical loads of nitrogen deposition (kg N ha^{-1} 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 kg N ha^{-1} yr^{-1} and reliability	2010 kg N ha^{-1} 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[b]	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[c]	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



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EUNIS habitat classification

EUNIS - **Eu**ropean **N**ature **I**nformation **S**ystem

European Environment Agency

- pan-European
- builds upon the previous initiatives of the CORINE Habitat classification and on the Palaearctic 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

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EUNIS habitat classification

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. **Heathlan** willow (inc
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.

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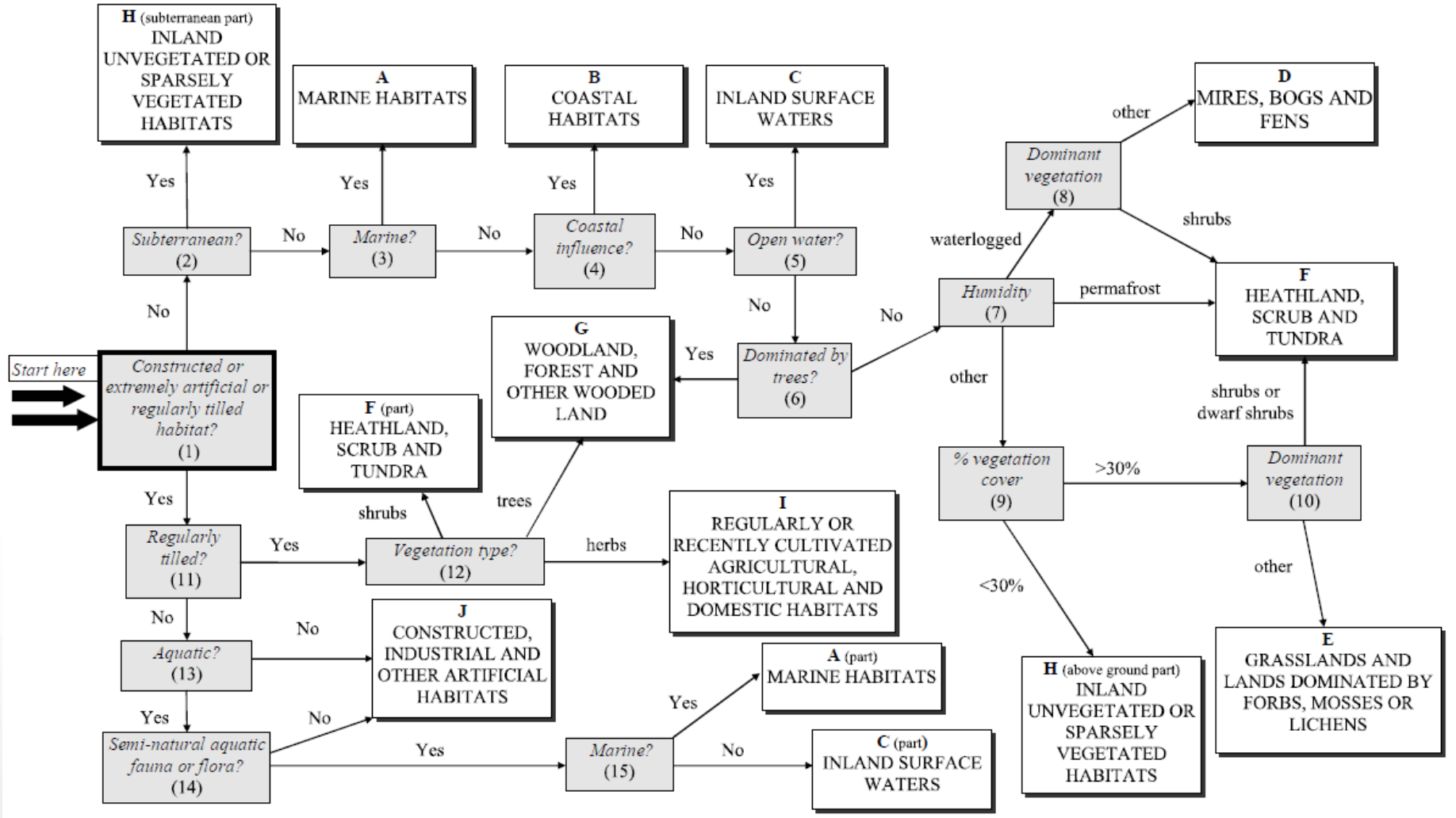
EUNIS habitat classification



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

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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 kgN ha^{-1} a^{-1}, lowest level should not exceed critical load

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Literature Review

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!

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Literature Review

WorldCat

Clarivate Analytics
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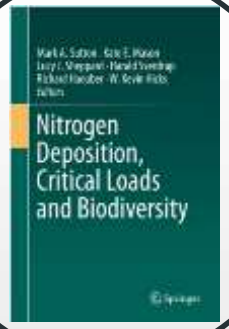

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Using **title and abstracts**, publications were screened and sorted:

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**

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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*)

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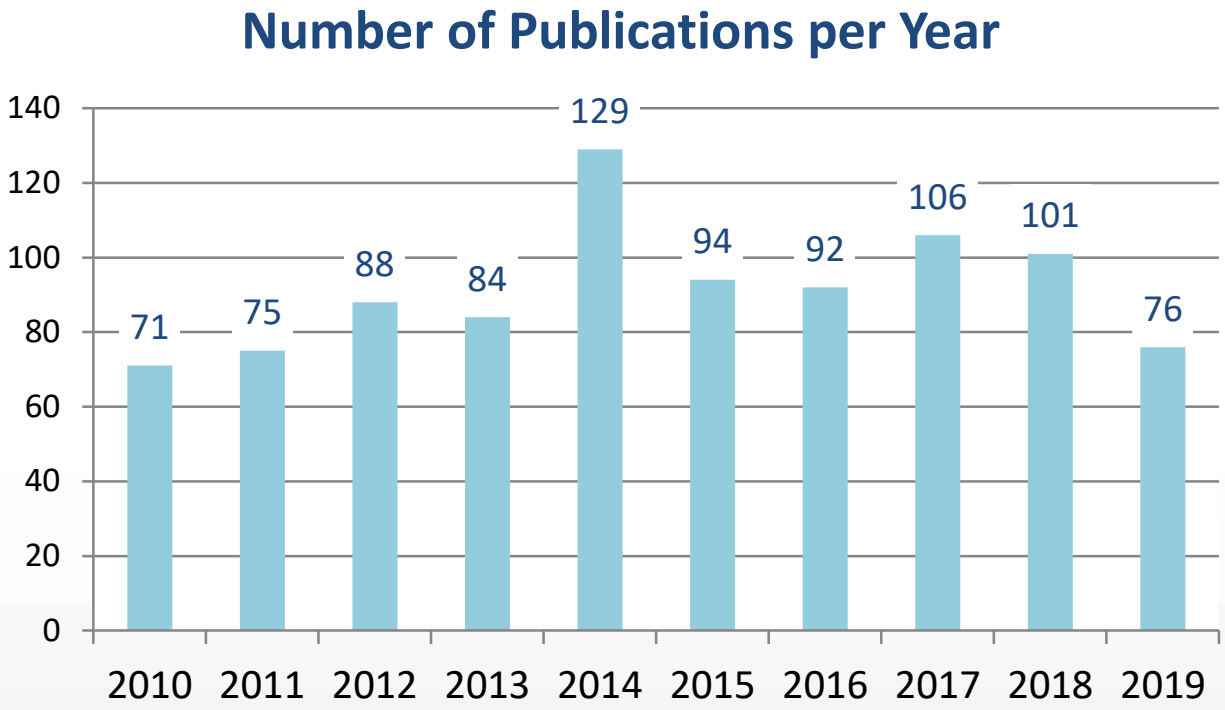
Results



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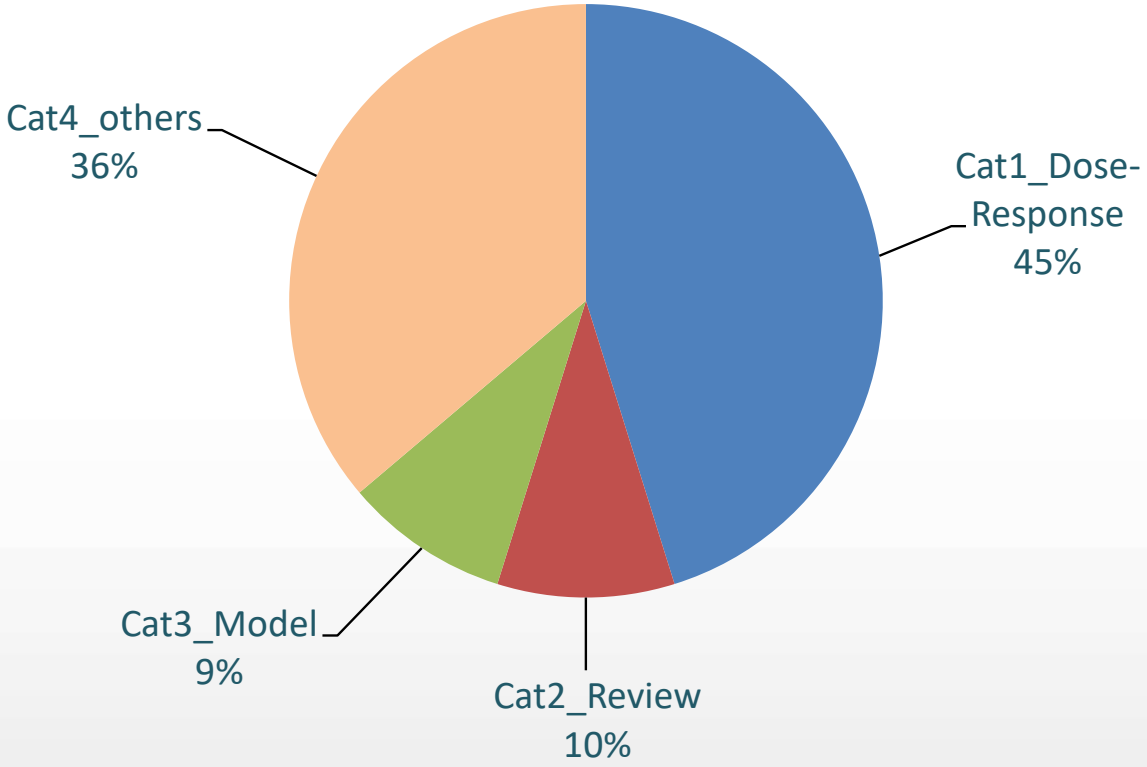
Publications per sorting category



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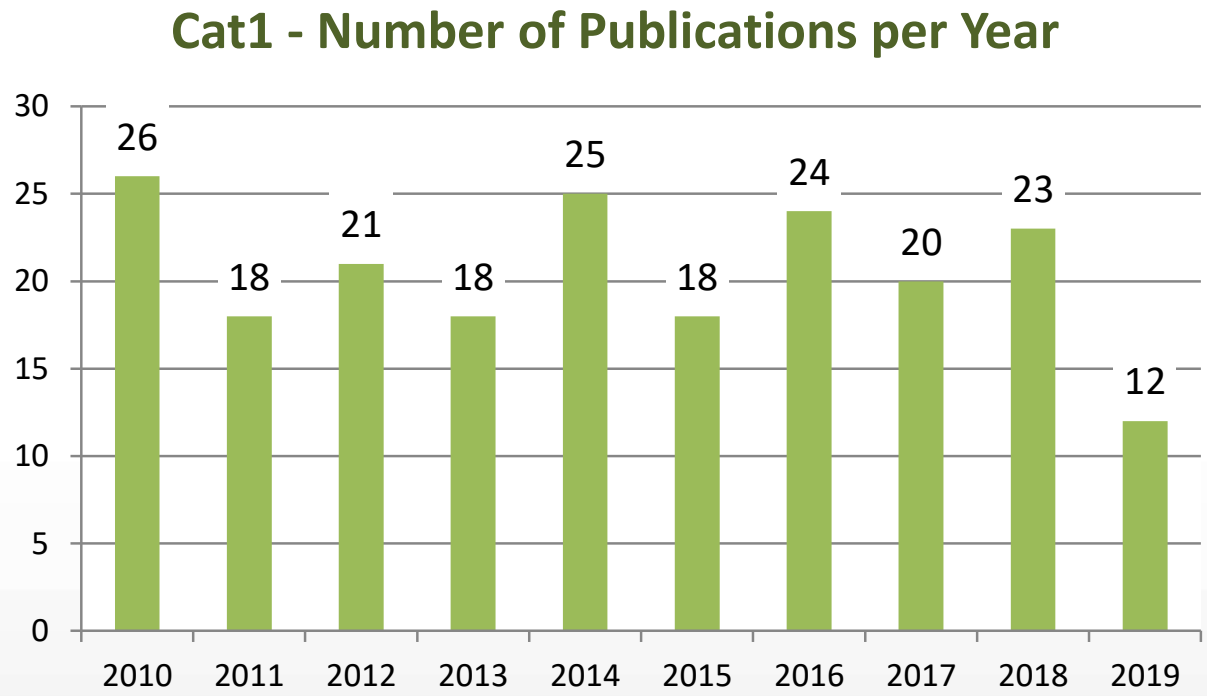

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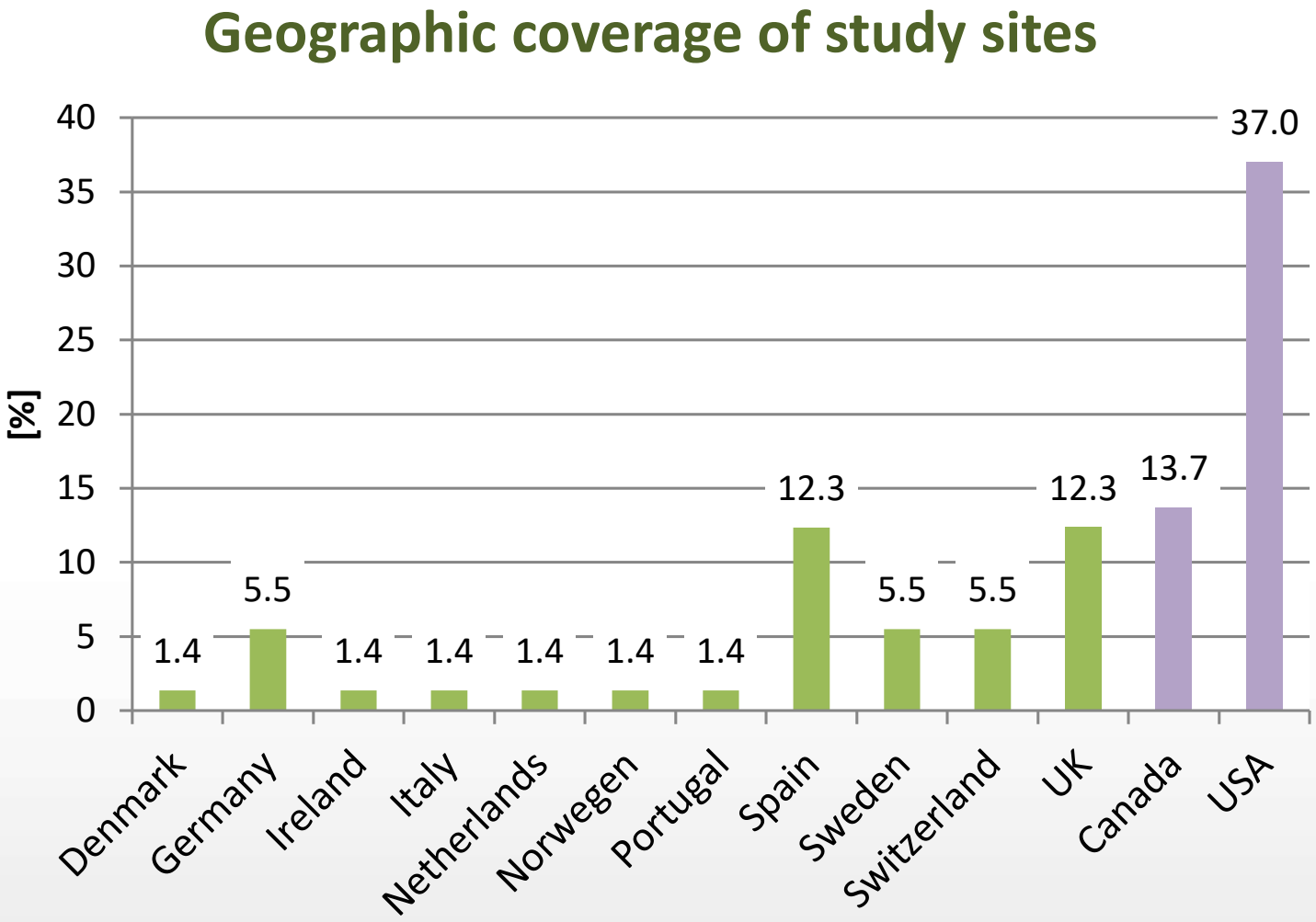
Geographic coverage



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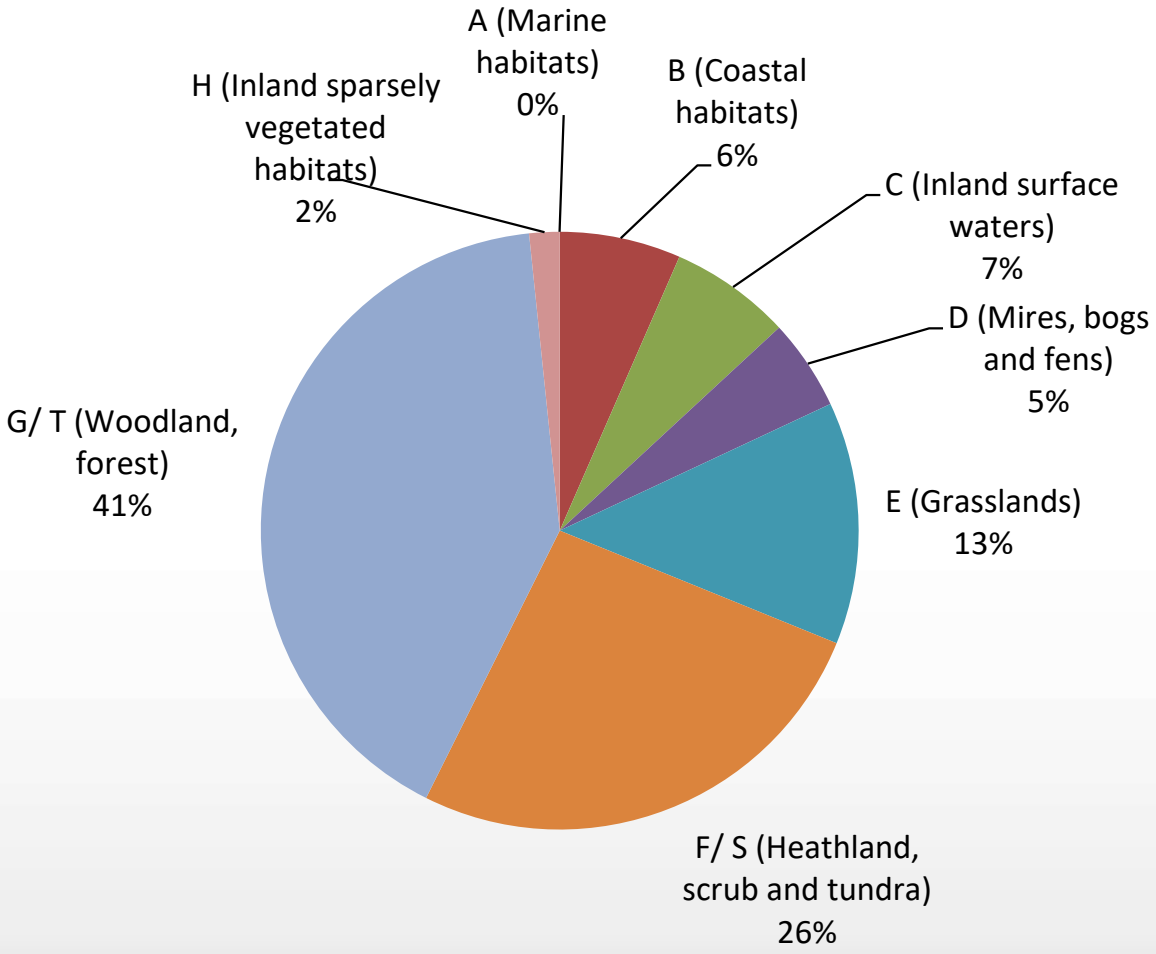
Coverage of EUNIS habitat classes



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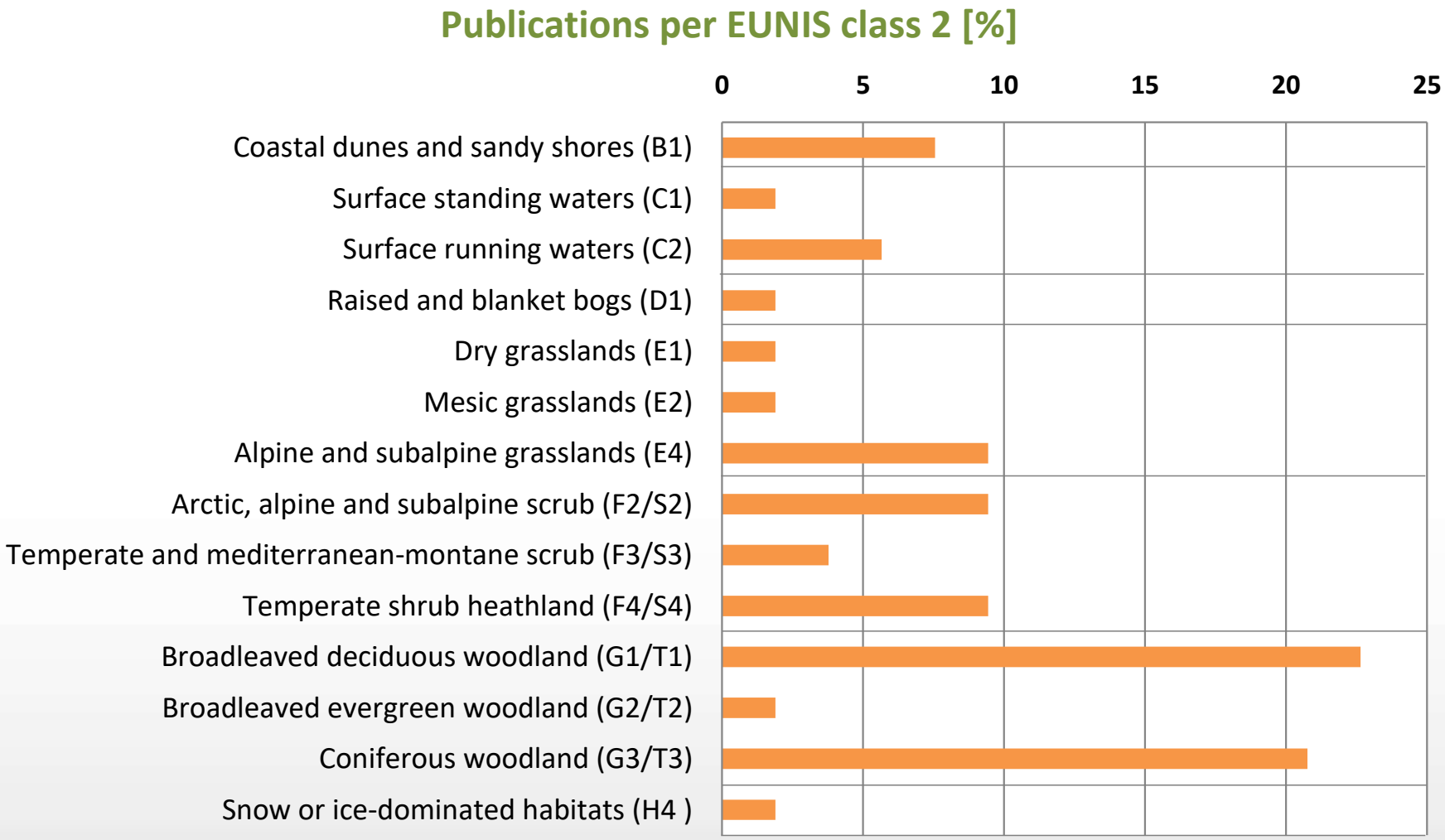

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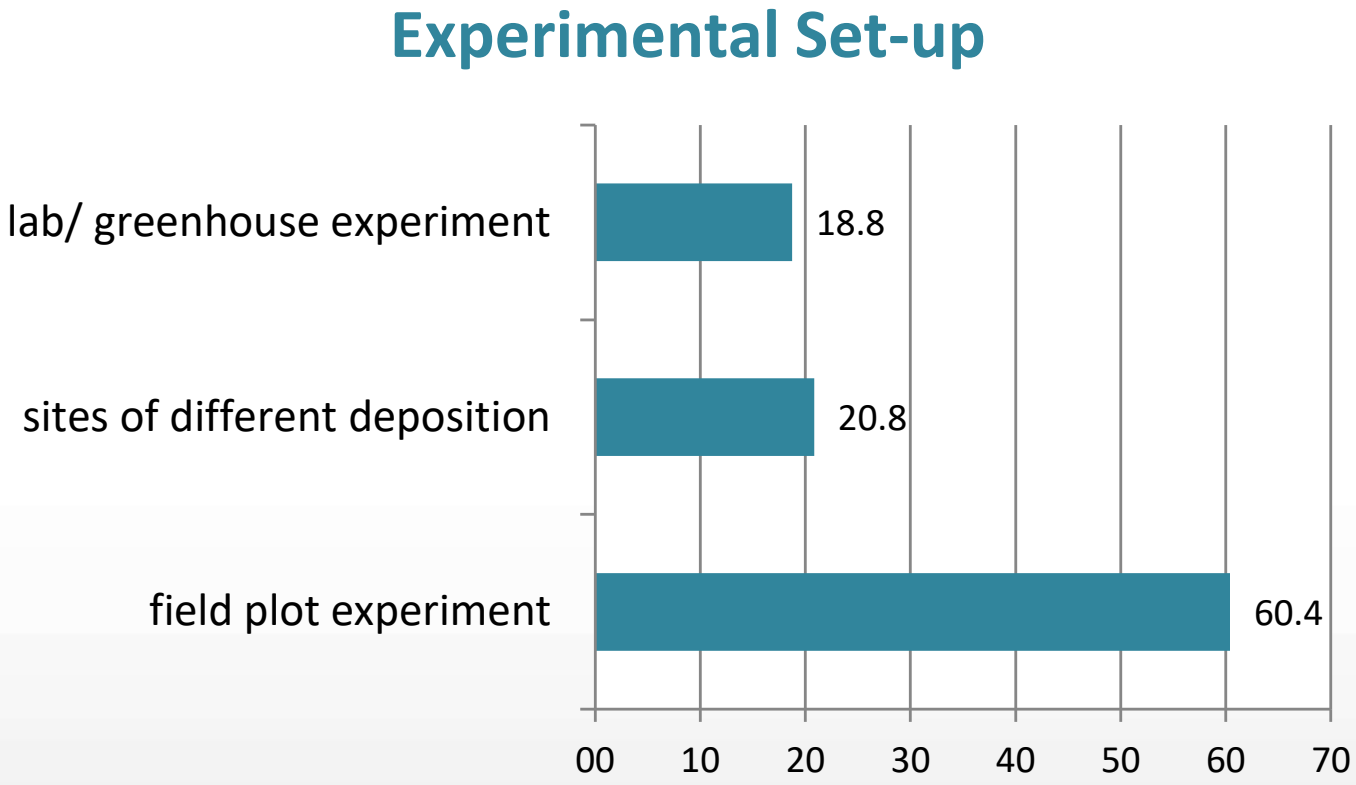

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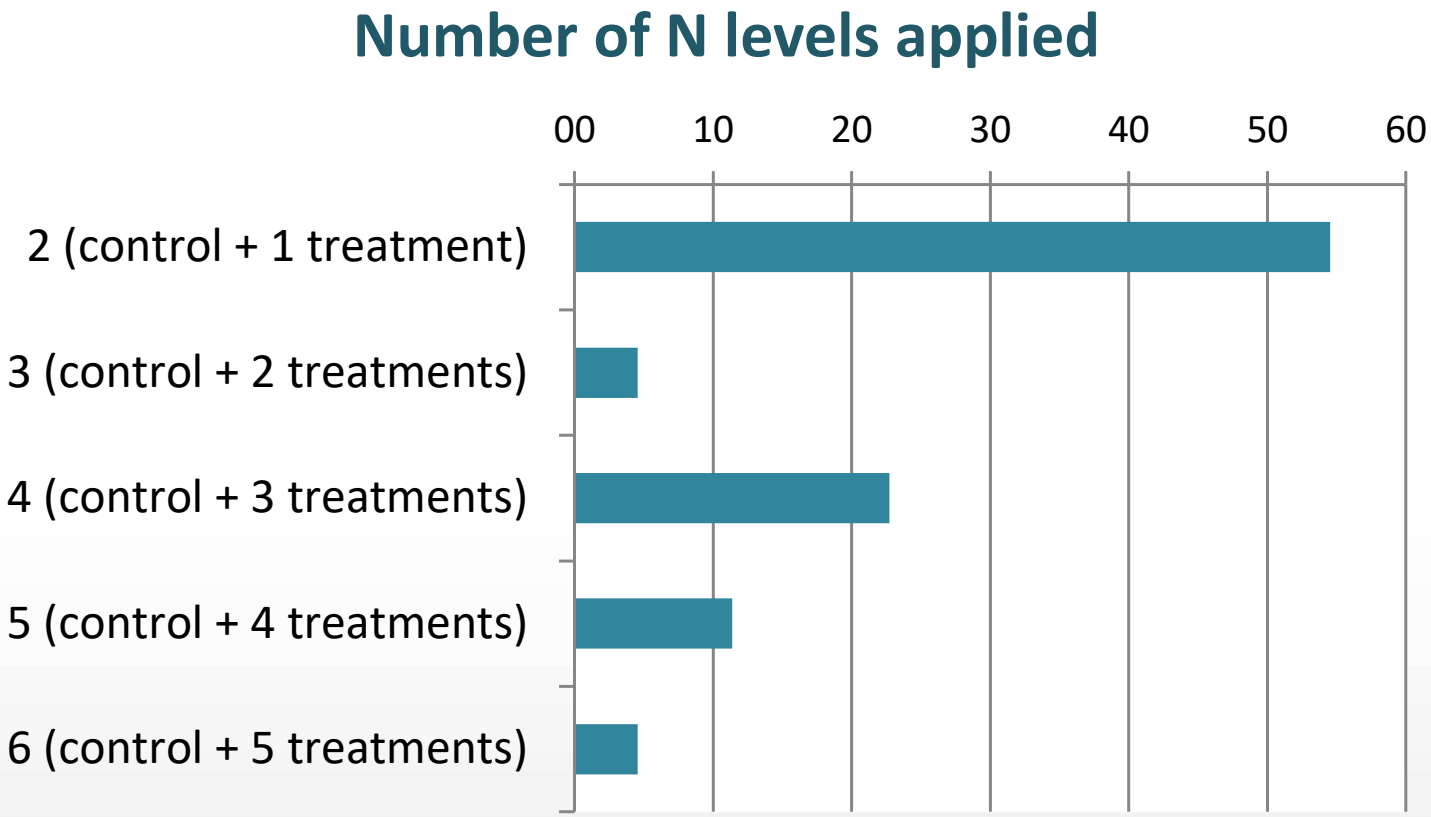

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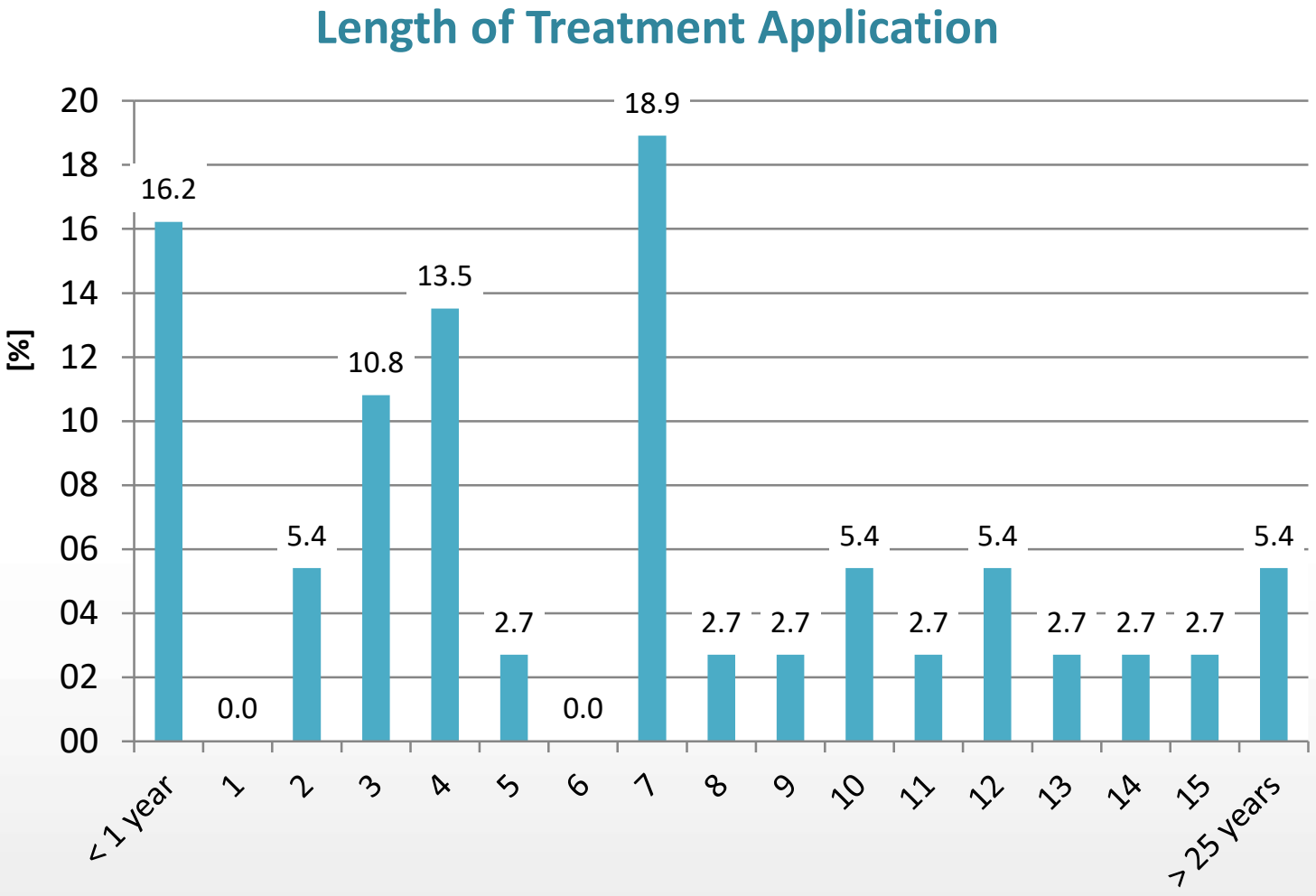

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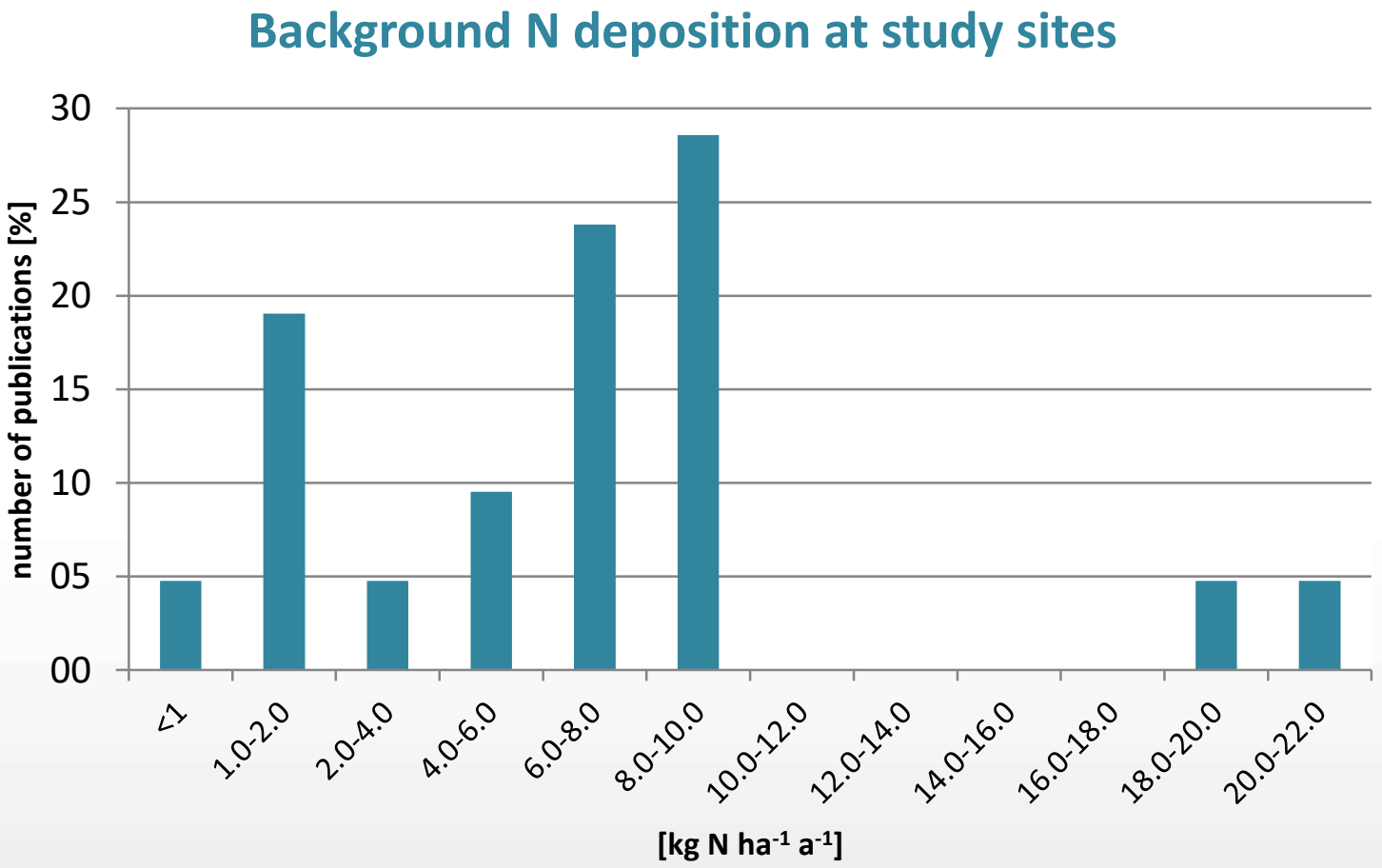
Background N Deposition



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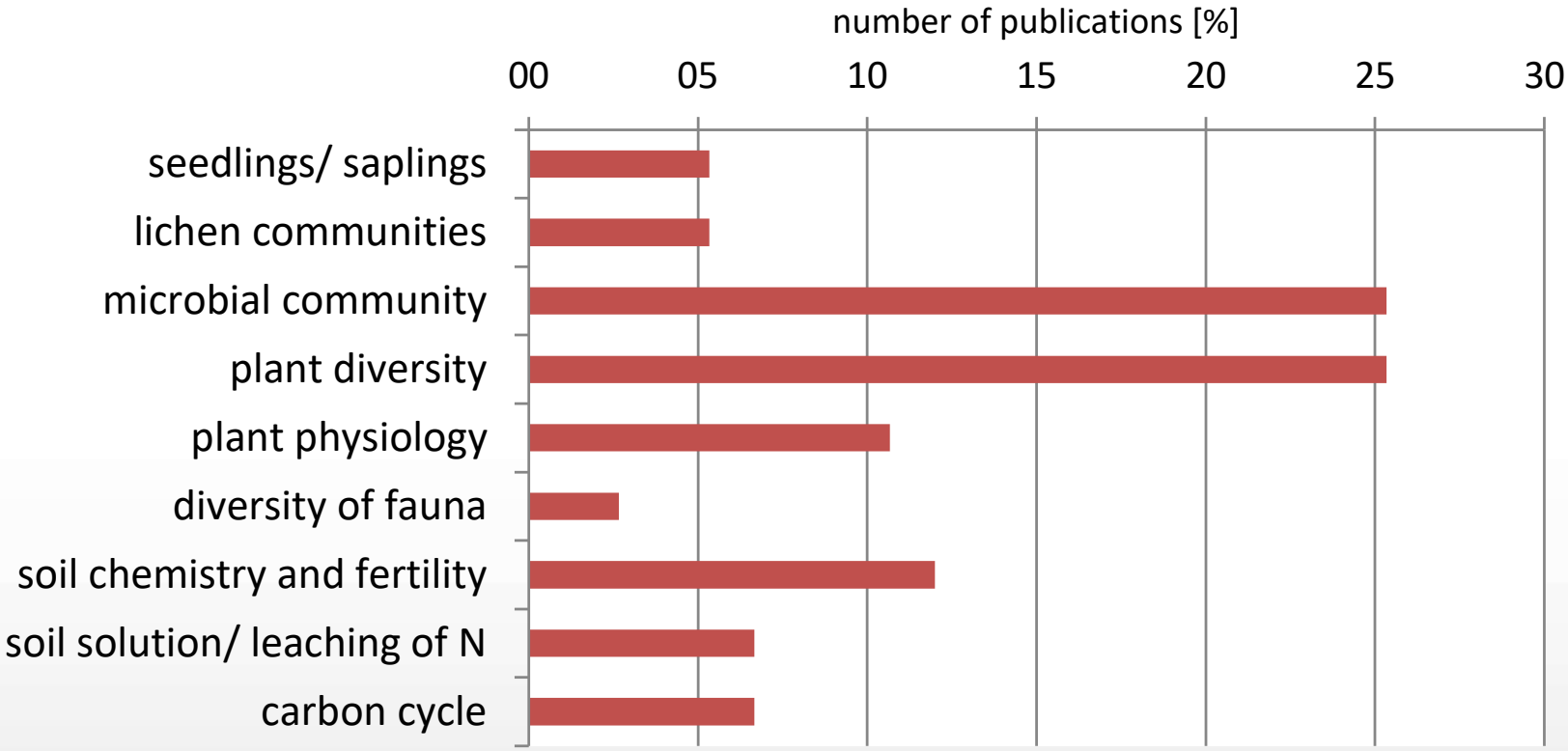
Coverage of response variables

Response variable in N addition studies



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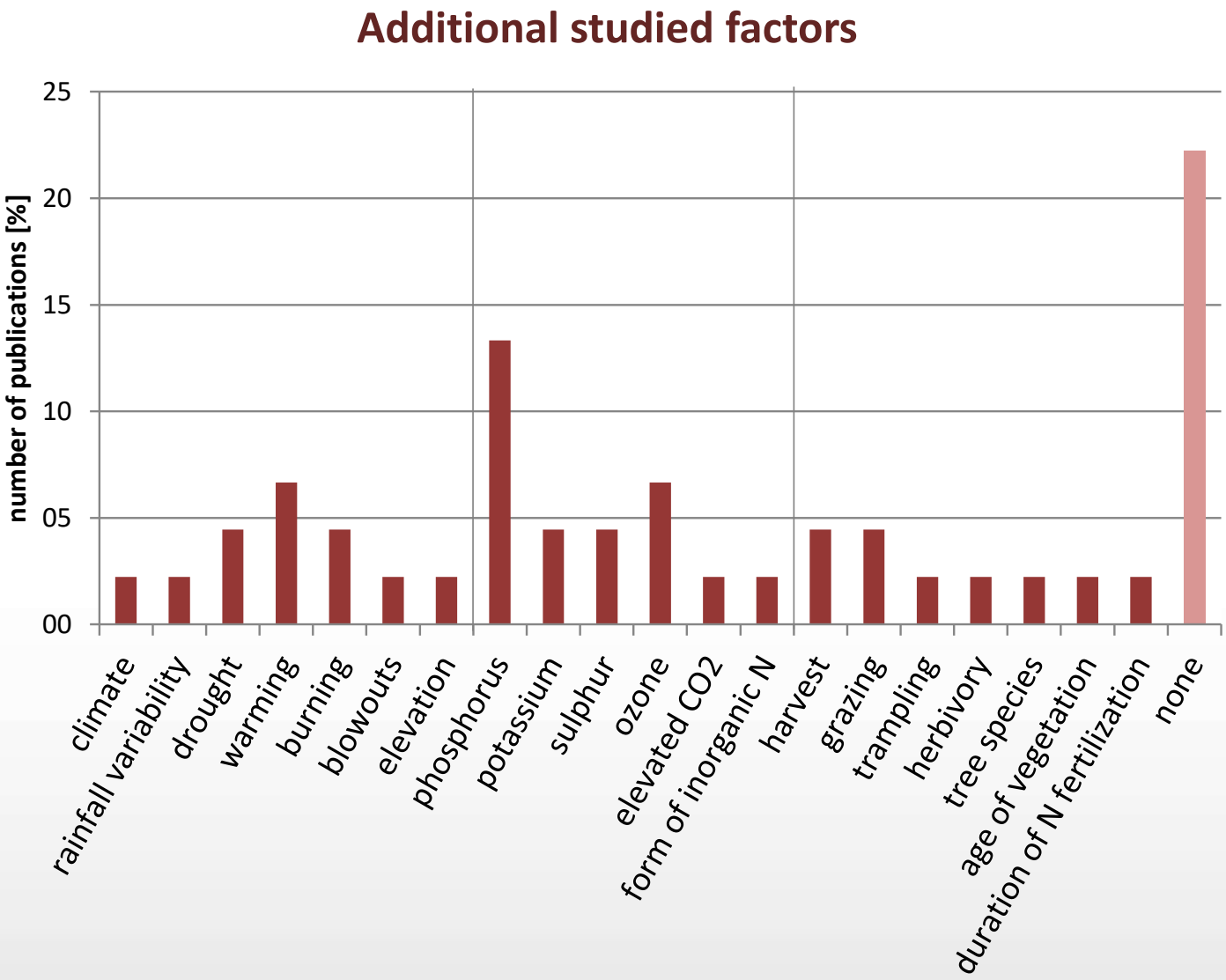
Additional influencing factors



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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**

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Thank you for your attention!