May 9th 2024

Assessing Risks to Biodiversity from Exposure to Chemicals: Findings of an ECETOC Task Force on Biodiversity Definitions, Metrics, and Methodologies

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European Green Deal initiatives (e.g., Farm to Fork Strategy, Zero Pollution Action Plan, Biodiversity Strategy for 2030) identify pollutants as a main driver of biodiversity decline

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Chemical manufacturers and applicators are facing increasing regulatory demands to mediate and mitigate this decline

Regulators and researchers are calling for more holistic and operational assessment of how biodiversity is affected by chemical exposure

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However, “biodiversity” is poorly defined

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Biological diversity: “the **variability** among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.”

– *United Nations Convention on Biological Diversity, 1992*

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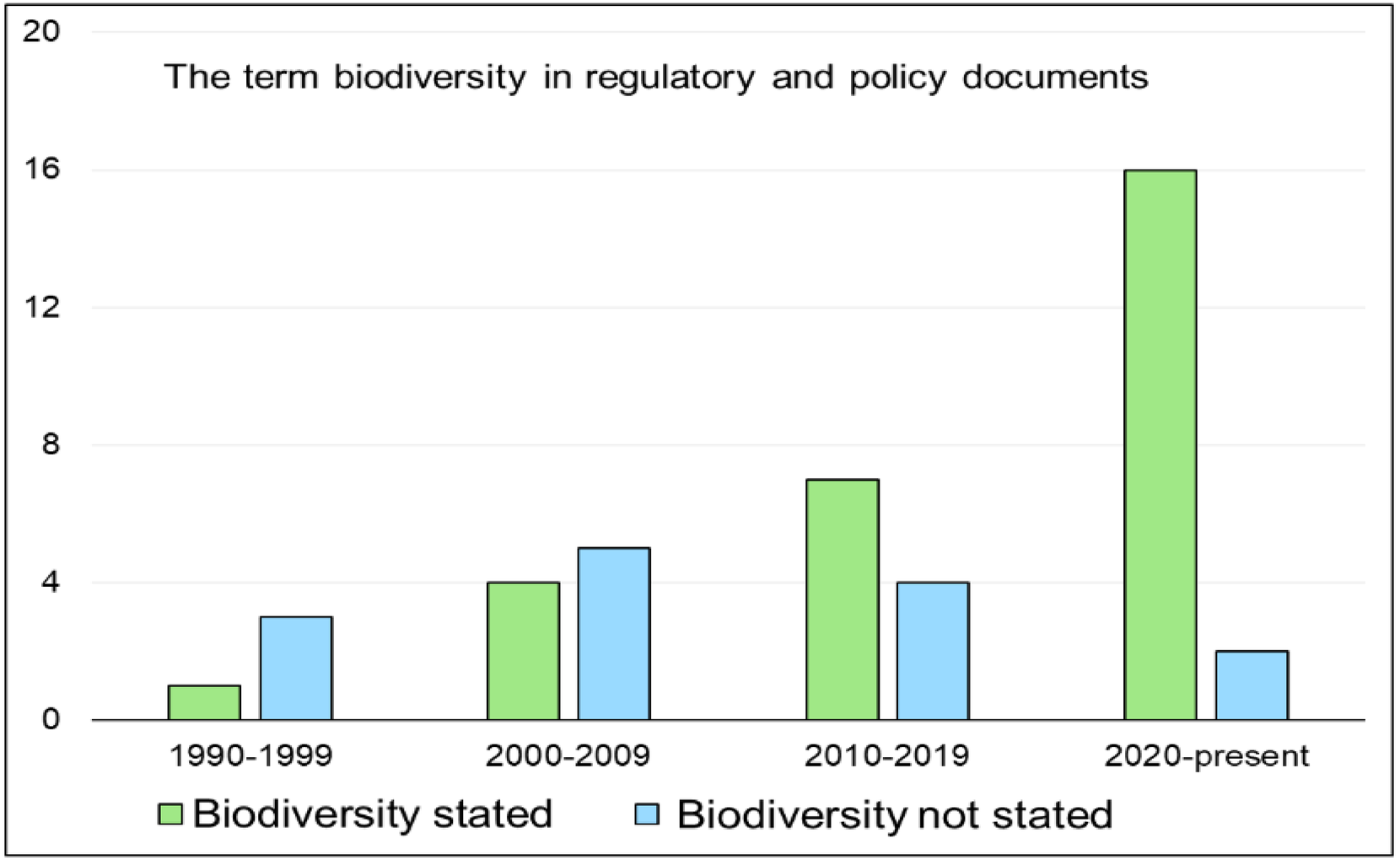
Findings of subgroup #1 (Poster – 4.02.P.Th443):

Lack of definition is reflected in EU regulation

Scope of subgroup:

- Identify coverage, definitions, and metrics of biodiversity in EU-relevant legal documents
- Screened 42 documents



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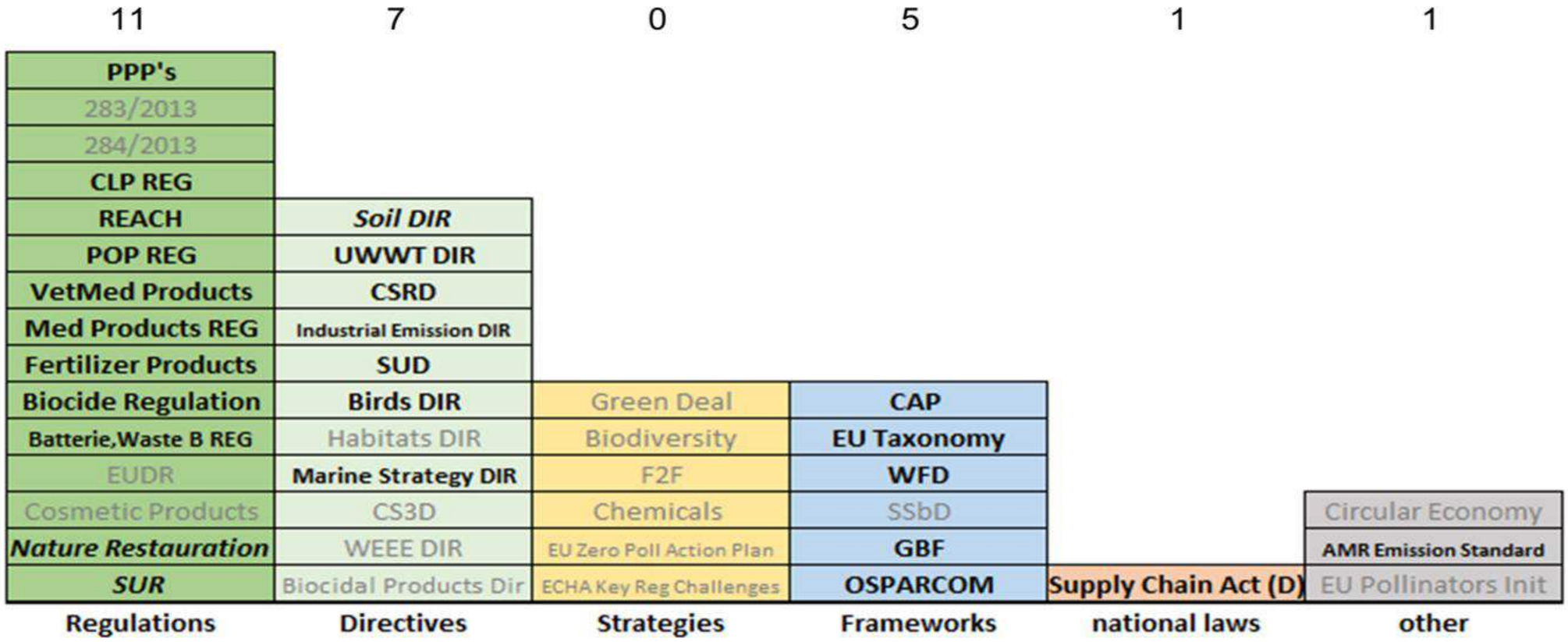
Scope of subgroup:

- Identify coverage, definitions, and metrics of biodiversity in EU-relevant legal documents
- Screened 42 documents → reduced to 25 in “deep dive” (excluded strategy documents)



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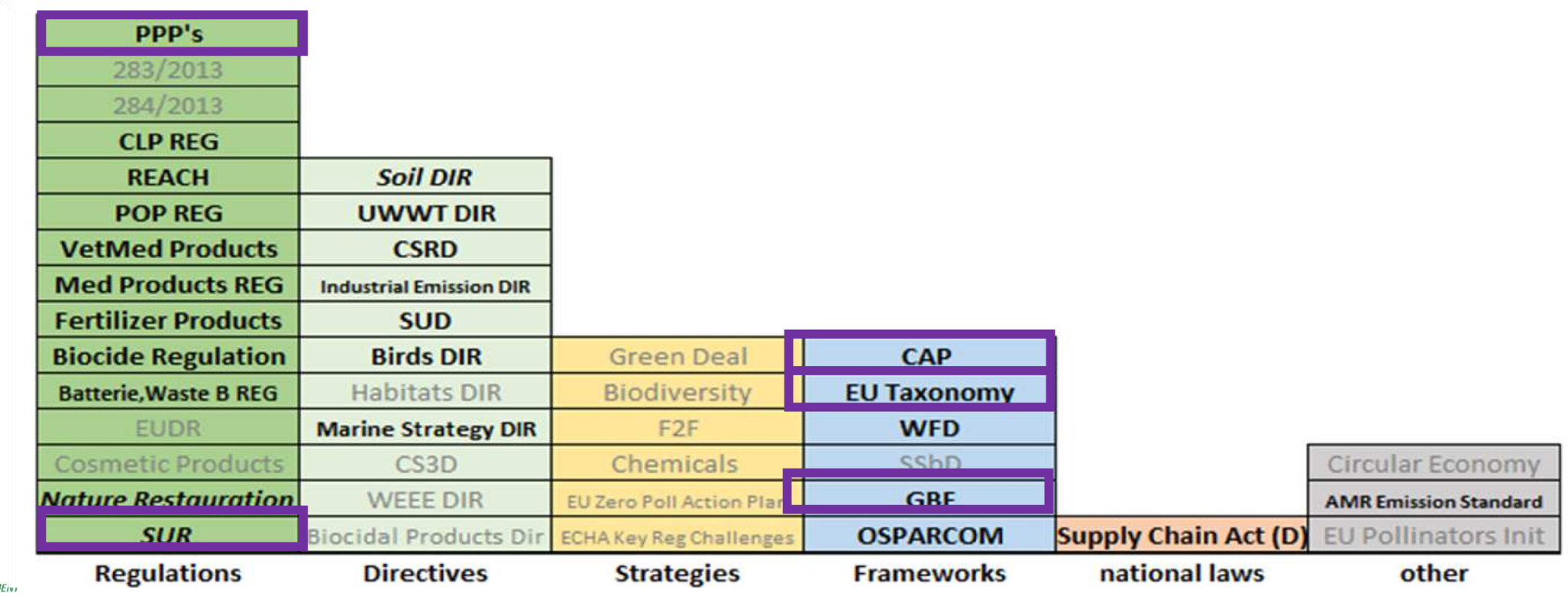
Findings of subgroup #1 (Poster – 4.02.P.Th443):

Lack of definition is reflected in EU regulation

- Biodiversity is defined in only 5 documents, largely following CBD 1992
- Of papers that discussed biodiversity or “the environment,” only 9 documents provide metrics
- Metrics vary in specificity (e.g., populations of surrogate species, habitat conditions, political indices, or just “good conditions)



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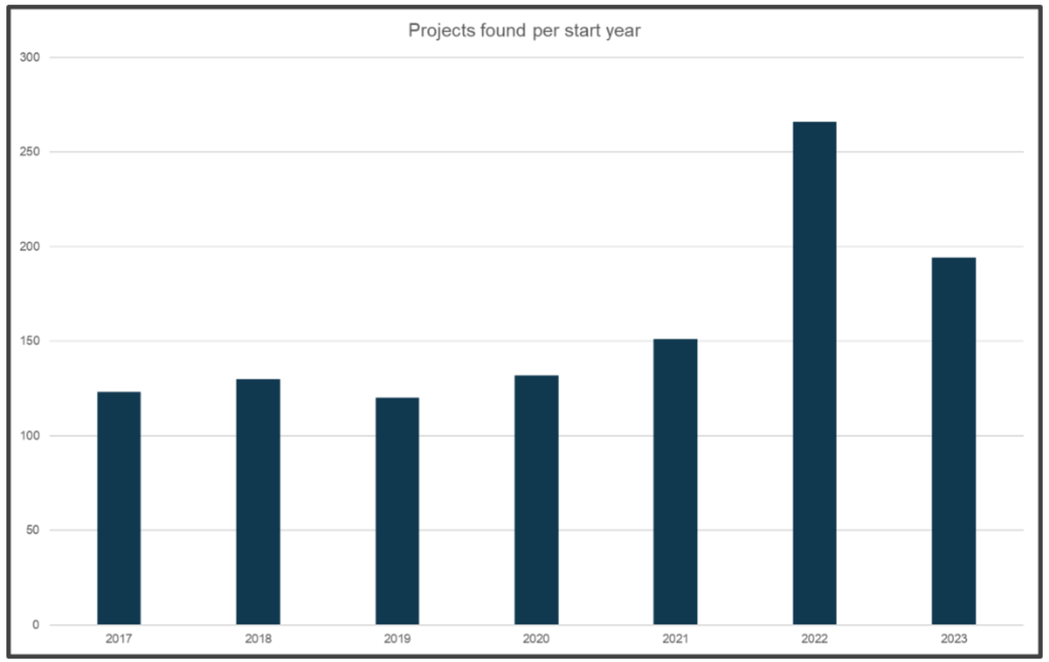
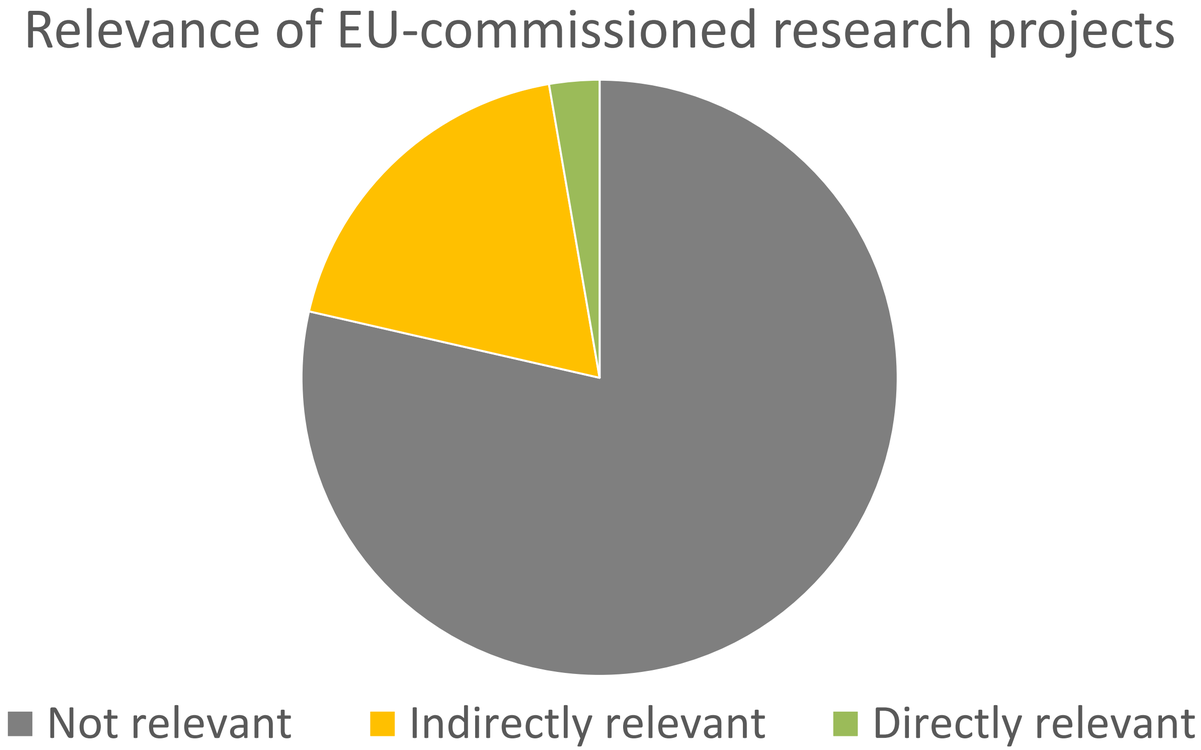
Findings of subgroup #2 (Poster – 4.02.P.Th444):

Biodiversity research often fails to translate into actionable recommendations

- Projects on “biodiversity” and “chemicals” in CORDIS have increased from 2017-2023
- 1116 EU-commissioned research projects; only 34 (~3%) that are directly relevant to chemical regulation





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Findings of subgroup #2 (Poster – 4.02.P.Th444):

Biodiversity research often fails to translate into actionable recommendations

- Research landscape still scattered; focus is habitat-specific (instead of landscape- or system-level approaches)
- Current regulatory concepts and data requirements for chemicals not often reflected in research
- Biodiversity is a heavily researched topic, but still not appropriately leveraged for regulatory purposes.

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Subgroup #3:
How is biodiversity being measured?

Survey the peer-reviewed literature to better understand definitions, metrics, and methodology

10 biomes:

- Marine
- Forest
- Freshwater
- Soil / Agriculture / Cropland
- Coral
- Grassland
- Coastal / Estuary
- Desert
- Urban
- Tundra / Taiga / Arctic

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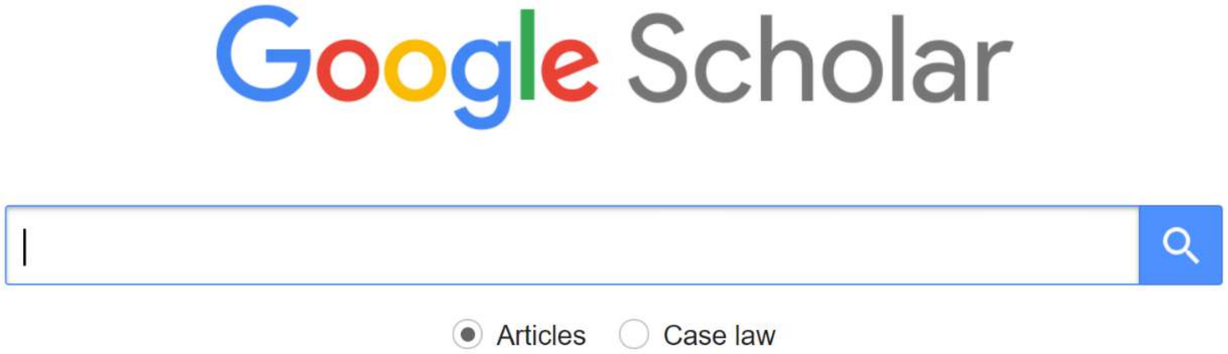
Text-mining approach:

Query Scholar for highest ranked search results `[ecosystem] biodiversity review* OR perspective* OR synthesi* OR "meta-analysis" OR "meta analysis" monitor* OR measur*`



- Scholar searches *full* corpus
- Excluded papers exclusively focused on application / restoration
- Compared Web of Science and Scholar;

Scholar returned a greater percentage of review papers

- Limited search to 2014-2024

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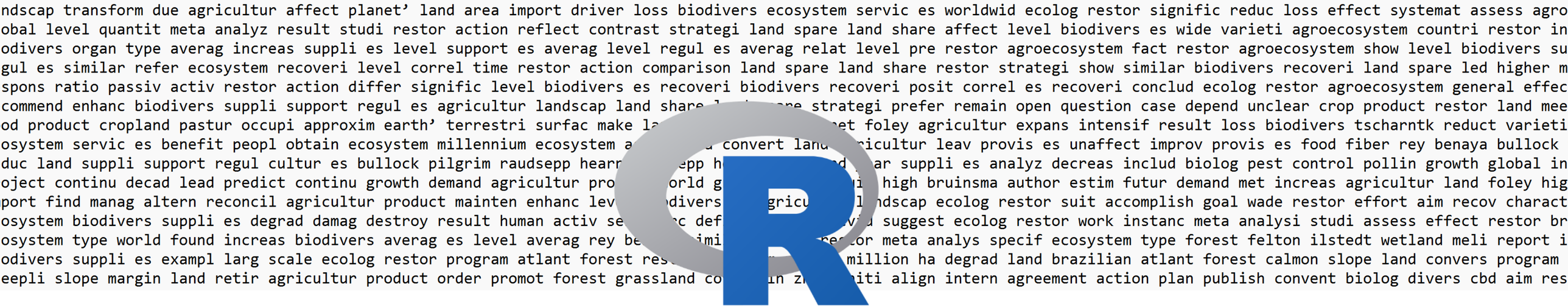
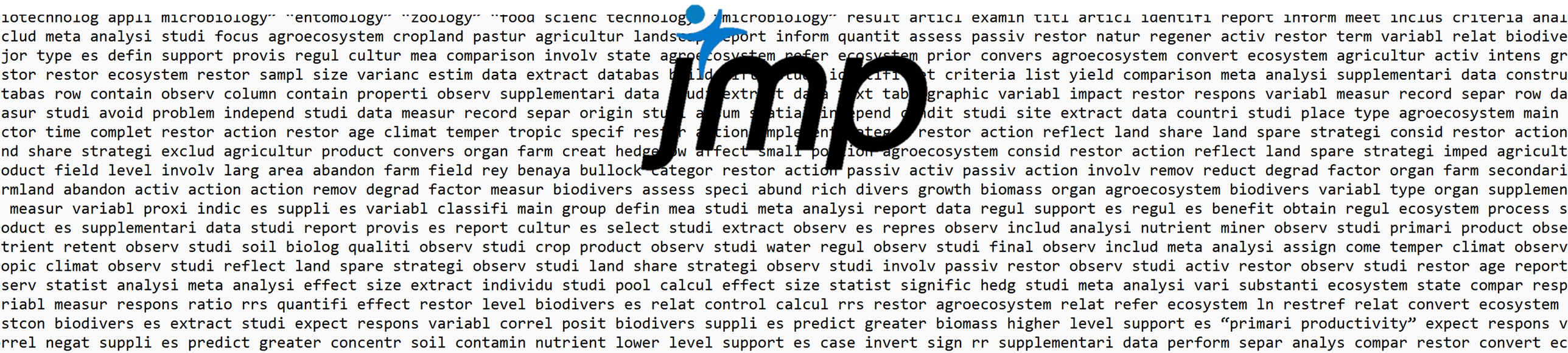
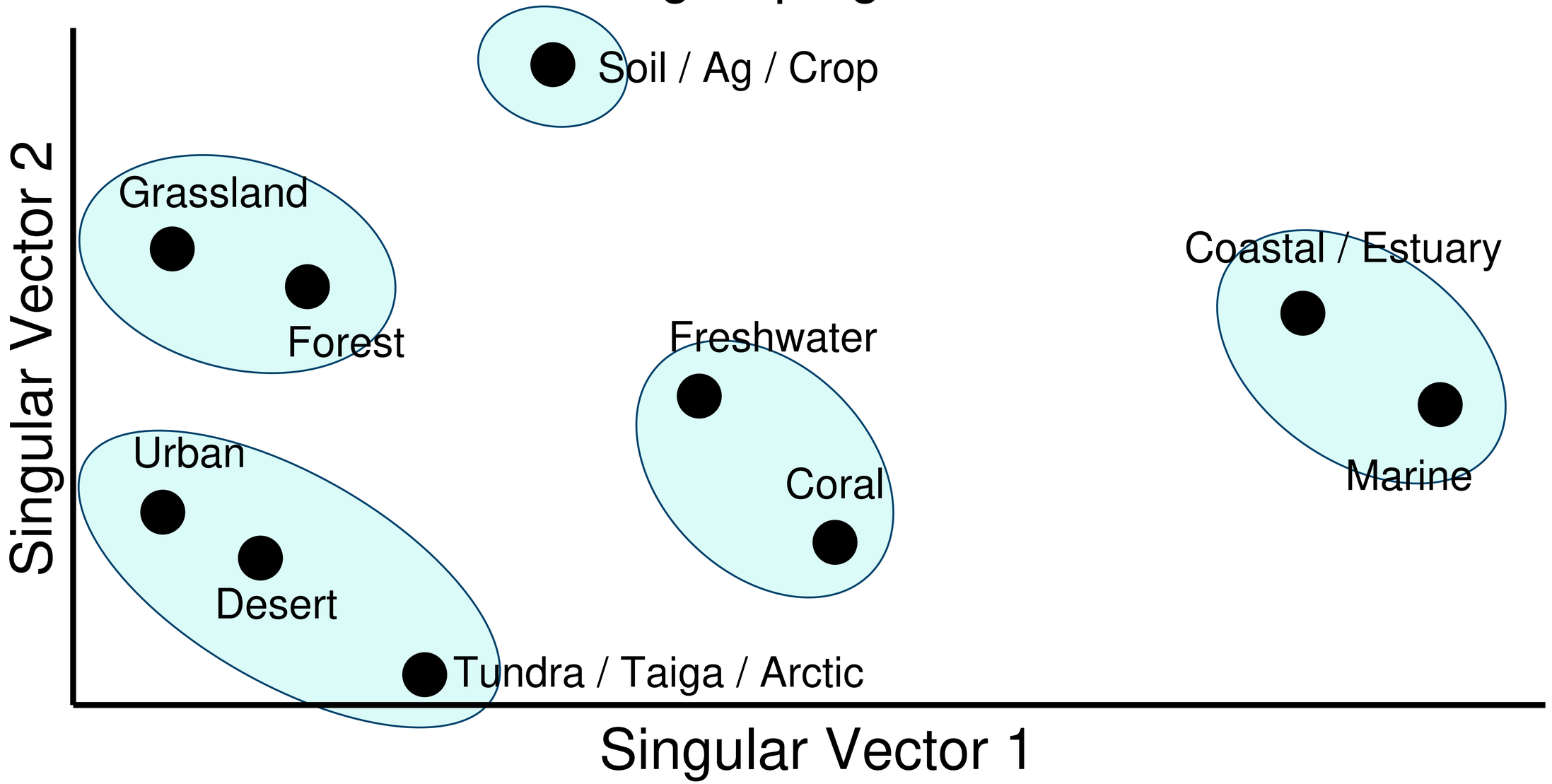


“Unstructured data”



Biomes exhibit distinct groupings of metrics and methods



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SV 1&2 = ~45% variation

What elements of biodiversity are being measured in each system?

What are the elements of biodiversity?

Essential Biodiversity Variables offer a mechanism to unify measurements across ecosystems, but they are still in development

Genetic composition

Genetic diversity
Genetic differentiation
Effective population size
Inbreeding

Species populations

Species distributions
Species abundances

Species traits

Morphology
Physiology
Phenology
Movement
Reproduction

Community composition

Community abundance
Taxonomic / phylogenetic diversity
Trait diversity
Interaction diversity

Ecosystem functioning

Primary productivity
Phenology
Disturbances

Ecosystem structure

Live cover fraction
Ecosystem distribution
Vertical profile

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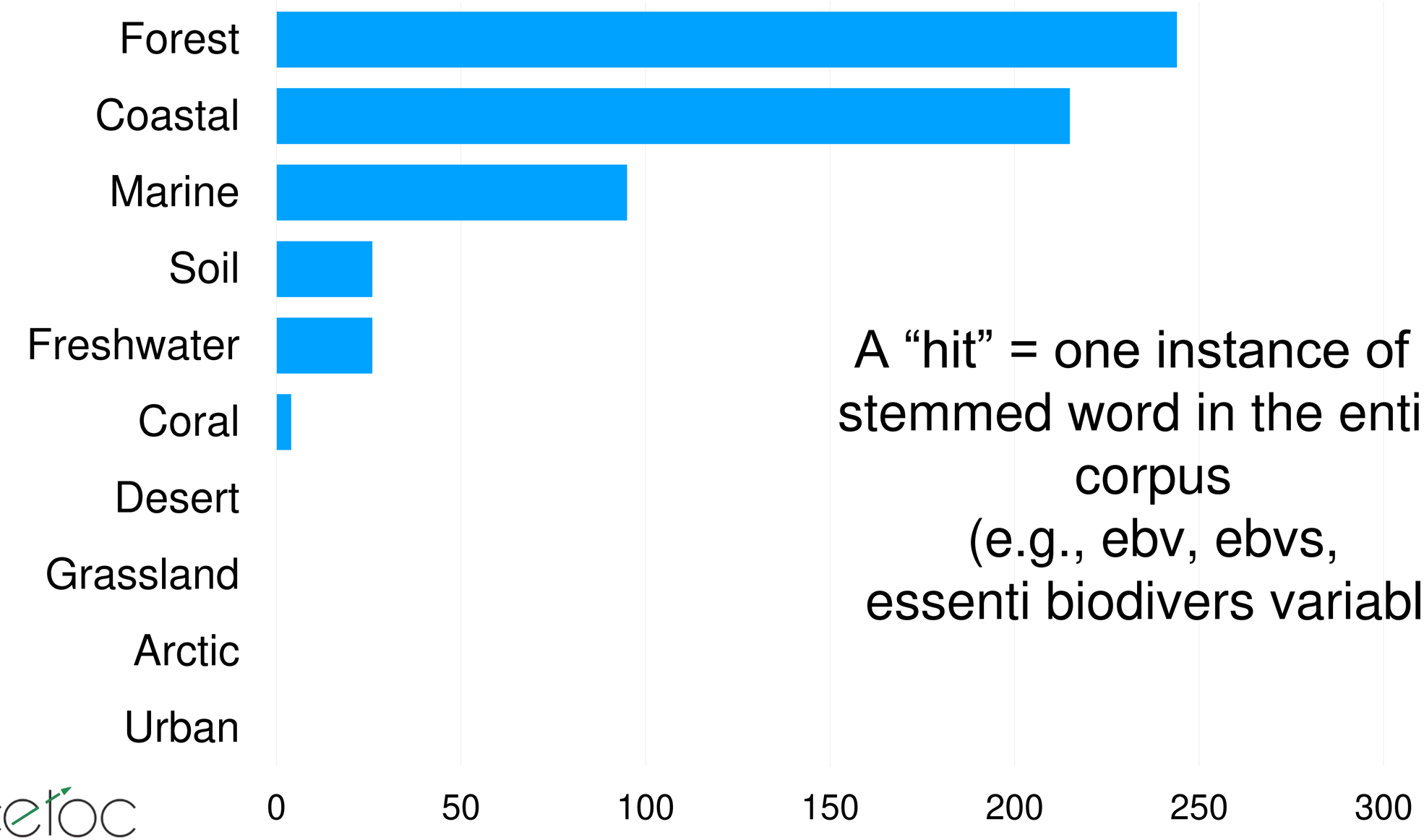
Mention of EBV (hits for EBV-related terms)



A “hit” = one instance of a stemmed word in the entire corpus
(e.g., ebv, ebvs, essenti biodivers variabl)

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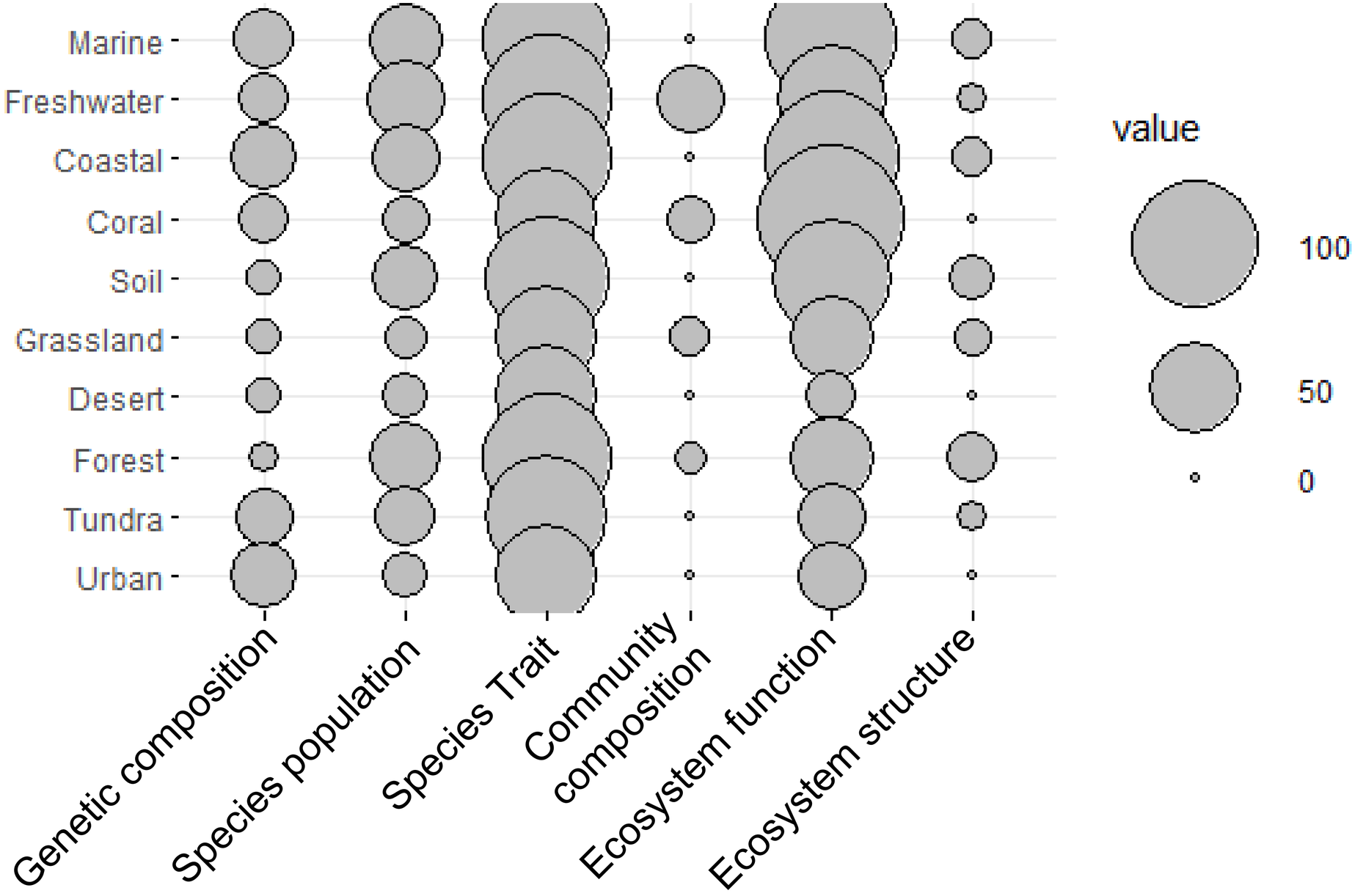
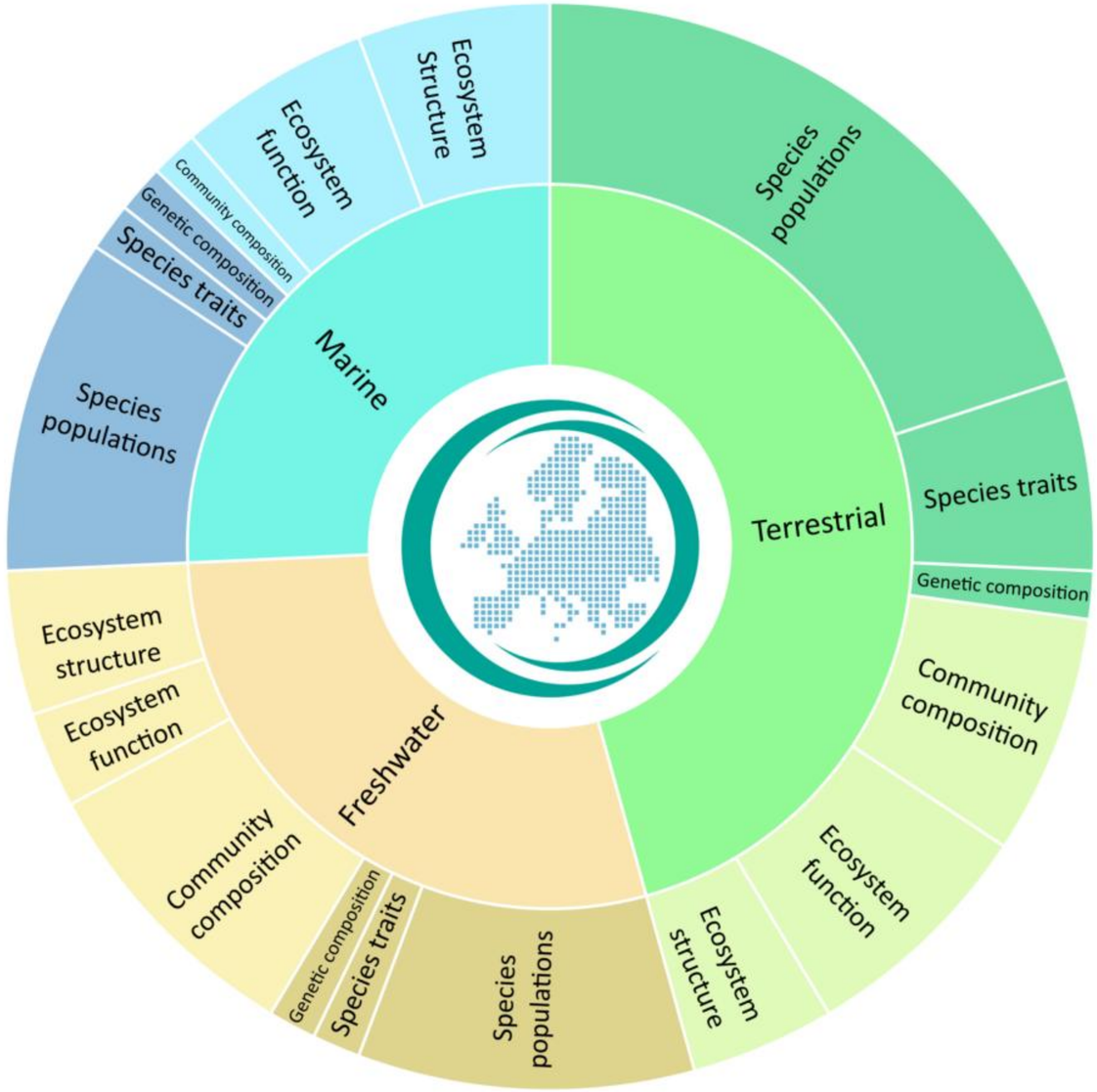
Hits of EBV classes by ecosystem type



EuropaBON's Essential Biodiversity Variables = 84 variables split between marine, terrestrial, and freshwater



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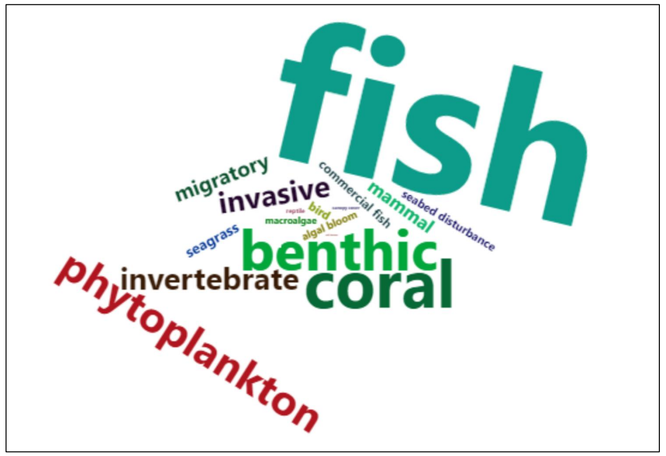
Dominant EuropaBON EBV keywords in each system

Marine



Freshwater

Forest

Tundra / Taiga / Arctic

Coastal / Estuary

Soil / Ag / Crop

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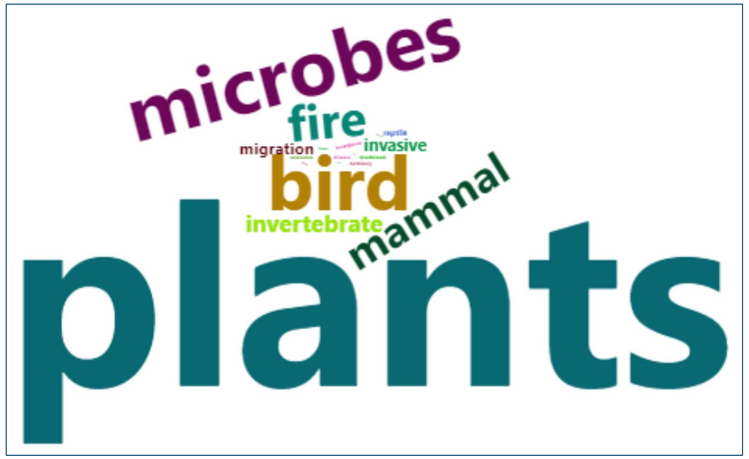
Dominant EuropaBON EBV keywords in each system

Coral

Grassland

Desert



Urban

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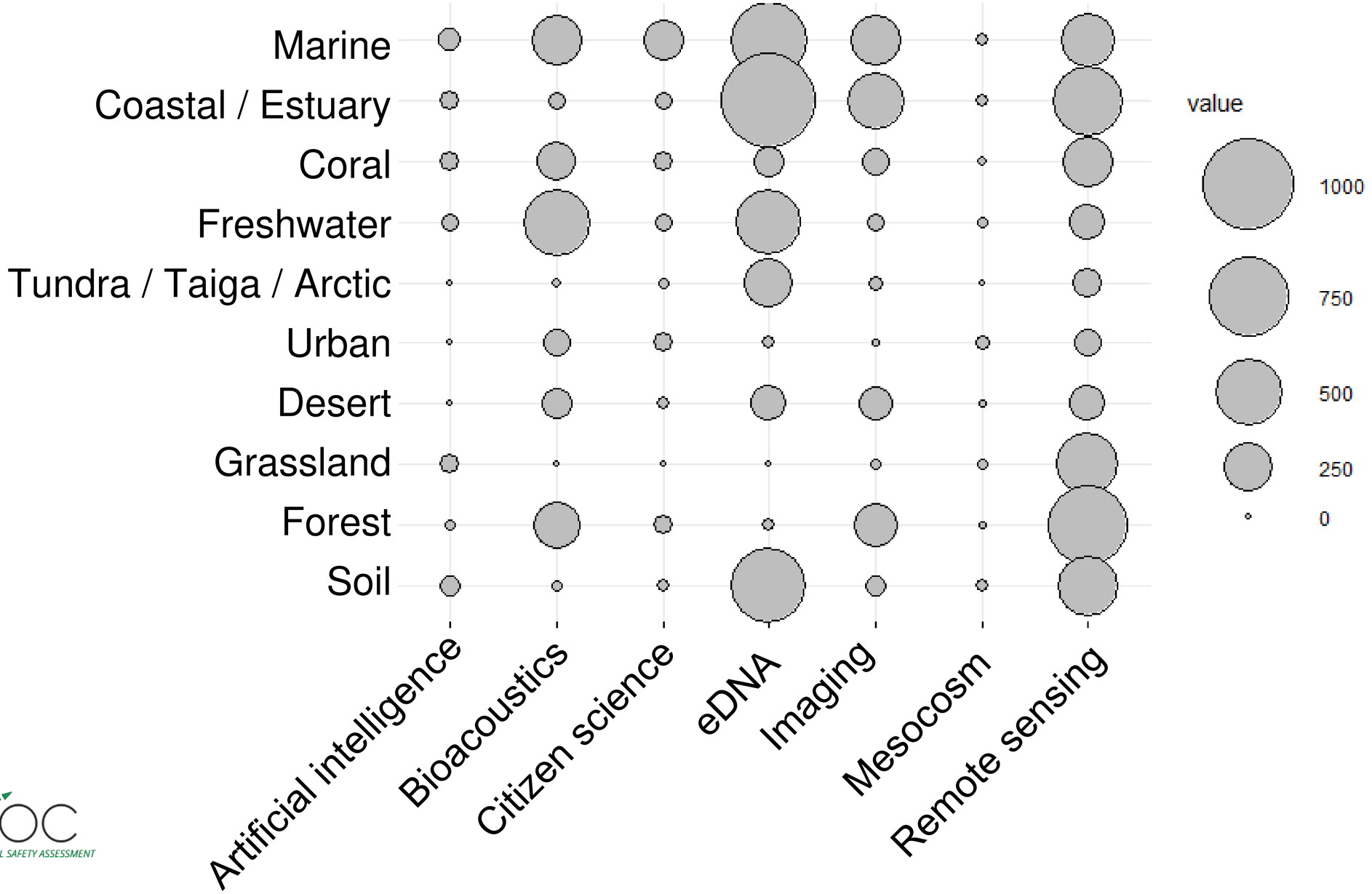
What about methodology?

Need for “boots-on-the-ground” field sampling will persist while next-gen / big data approaches push us beyond “habitat-specific” approaches

Hits of next-gen methods by ecosystem type (based on Dornelas et al. 2022)



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Take-home messages:

- Biodiversity and associated metrics remain poorly defined in chemical regulation and legislation (Poster 443)
- EU-sponsored research on effects of chemicals on biodiversity is growing but lacks transferable knowledge to legislative action (Poster 444)
- Biodiversity metrics and methods vary according to ecosystem
- Among EBV definitions, trait diversity and ecosystem function are the most widely applied definitions
- Next-generation methods including remote sensing and eDNA are among the most prevalent “next-generation” techniques in academic literature

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Recommendations / Future research

- Greater **integration between academic research and regulation** by adoption of research findings into regulatory frameworks / guidance of research activities by regulatory needs
- **Facilitate sharing of data** between fields and sectors
- Do changes in the dominant metrics of biodiversity translate to loss of ecosystem services or stability?
- Go global: utilize **next-generation approaches and machine learning** to integrate habitat-specific studies into large-scale, global datasets that can help understand global patterns
- Formulate **operational definitions of biodiversity** within regulatory contexts that are also consistent with broadly agreed definitions
- Provide **recommendations on methodologies** for chemical risk assessment

Membership

Disclaimer: Logos for presentation purposes only and do not indicate any endorsement of TF activities.


Thank you.
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Interested in joining a workshop on the topic?

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