USGS/SHWG Stressor summary project update

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U.S. Geological Survey
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Project goal and scope

Question: Which stressors are most affecting stream health in freshwater ecosystems in the Chesapeake Bay watershed?

Stream health = measures of benthic community composition, function, or other response

Stressor = A local factor that can directly affect patterns in stream health

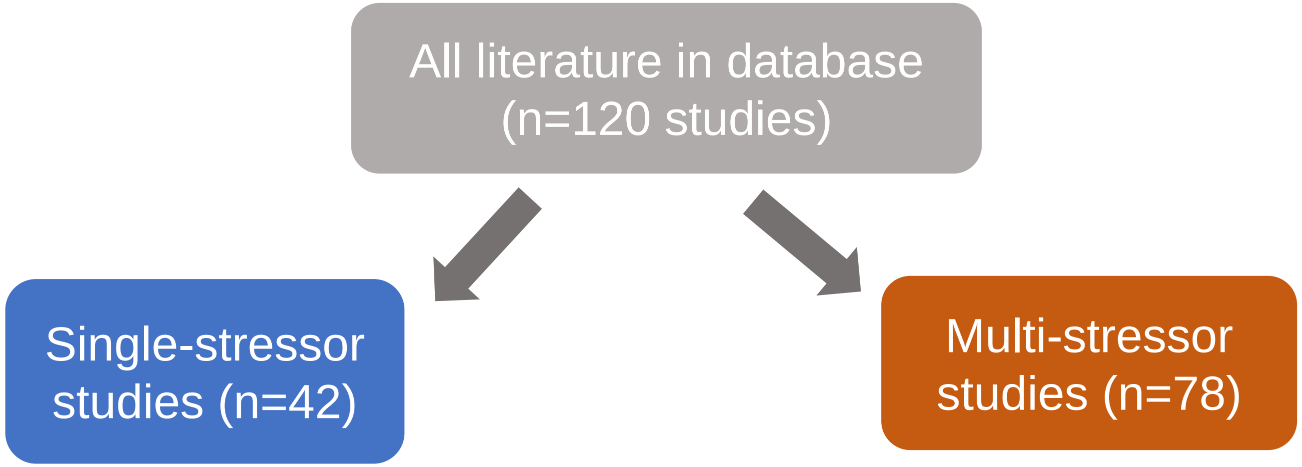
Drivers = Factors that cause changes in stressor conditions or levels

- Use existing information to summarize current understanding of the dominant stressors in different landscape settings/originating from different drivers
- Summarize two types of sources:
  - **Scientific literature**
  - Jurisdictional 303d lists

Extracting key information from selected literature

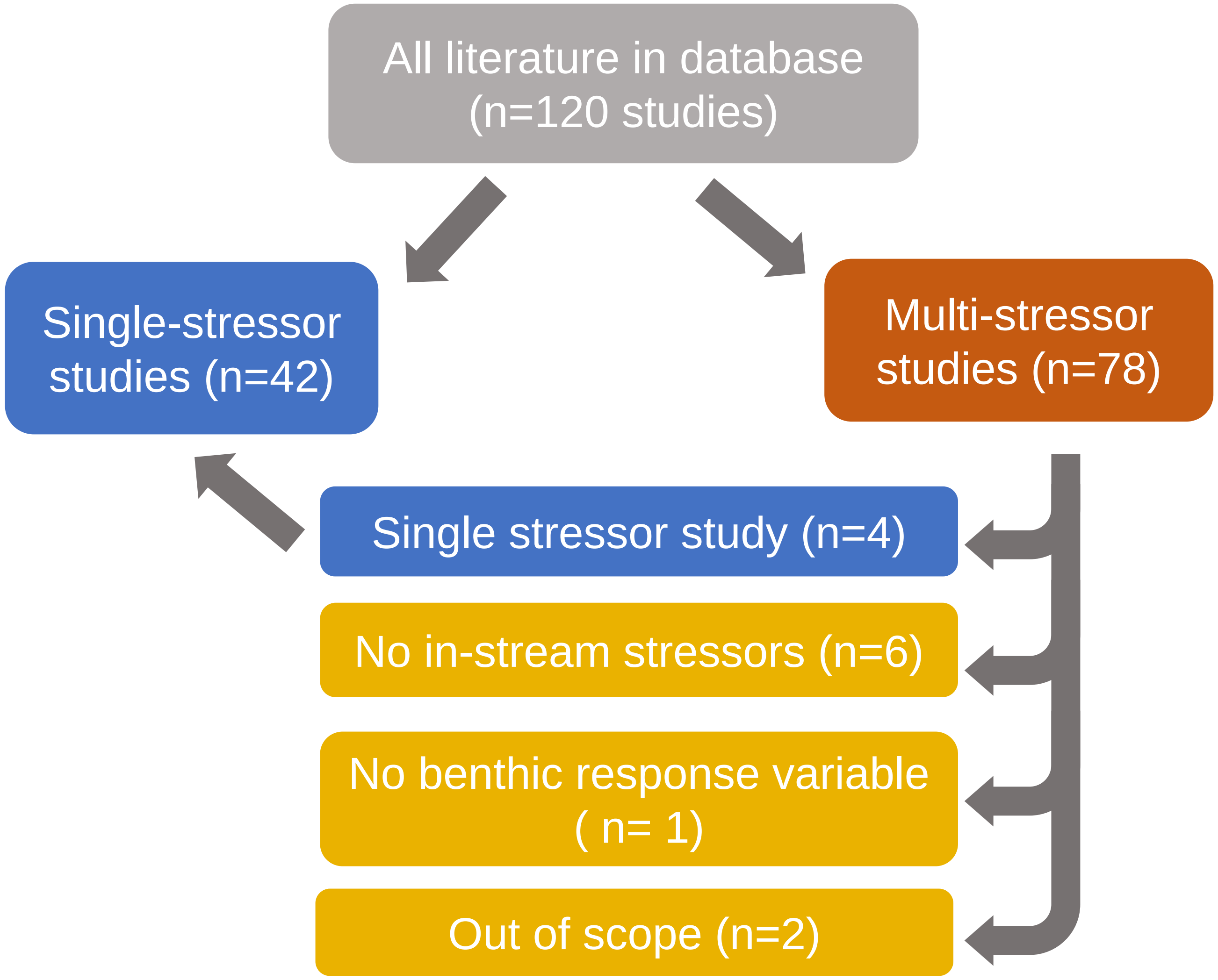
- **General literature search using key words**
- **General study characteristics**
  - Drivers examined in the study
    - Agriculture, urbanization, wastewater, industrial point sources, energy extraction (mining, hydropower), atmospheric deposition, climate change
  - Stressors measured in the study
  - Study design (setting, number of obs. units, etc.)
- **Methodology**
  - How stream health was measured (IBI, drift rates)
  - How stressor(s) were quantified
- **Key conclusions**
  - Information on stressor importance (rank)
  - Thresholds for detectable changes in stream health
  - Interactions between stressors

Literature review workflow



Provisional results, for feedback only

Literature review workflow



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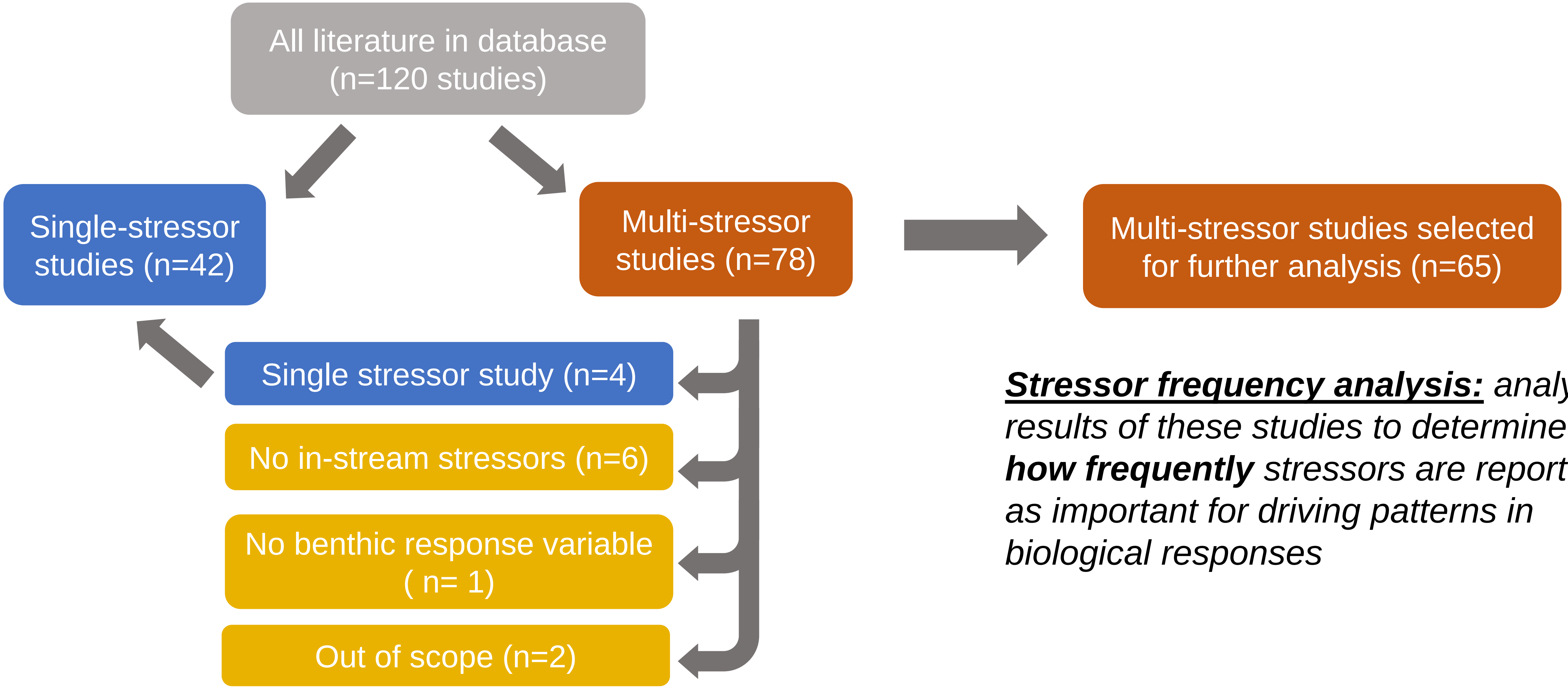

Stressor frequency analysis: *analyze results of these studies to determine* ***how frequently*** *stressors are reported as important for driving patterns in biological responses*

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Stressor frequency analysis methods

Multi-stressor studies (n=78) → Multi-stressor studies selected for further analysis (n=65)

- Examined each study's statistical analysis
- Determined study was eligible if:
  1. Stressor-bio relationships were quantified
  2. Appropriate statistical approaches were applied and reported
     - Examples = multiple linear regression, multivariate analysis, machine learning techniques (BRT)
     - Correlations were included if alpha and/or p-values were reported

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Did not relate stressor to biological response (n=20)

Insufficient statistical analysis or reported stats (n=10)

Sufficient stats for use in frequency analysis (n=35)

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Stressor frequency analysis methods

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NARRATIVE SUMMARY

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All studies are being incorporated into the narrative summary when possible

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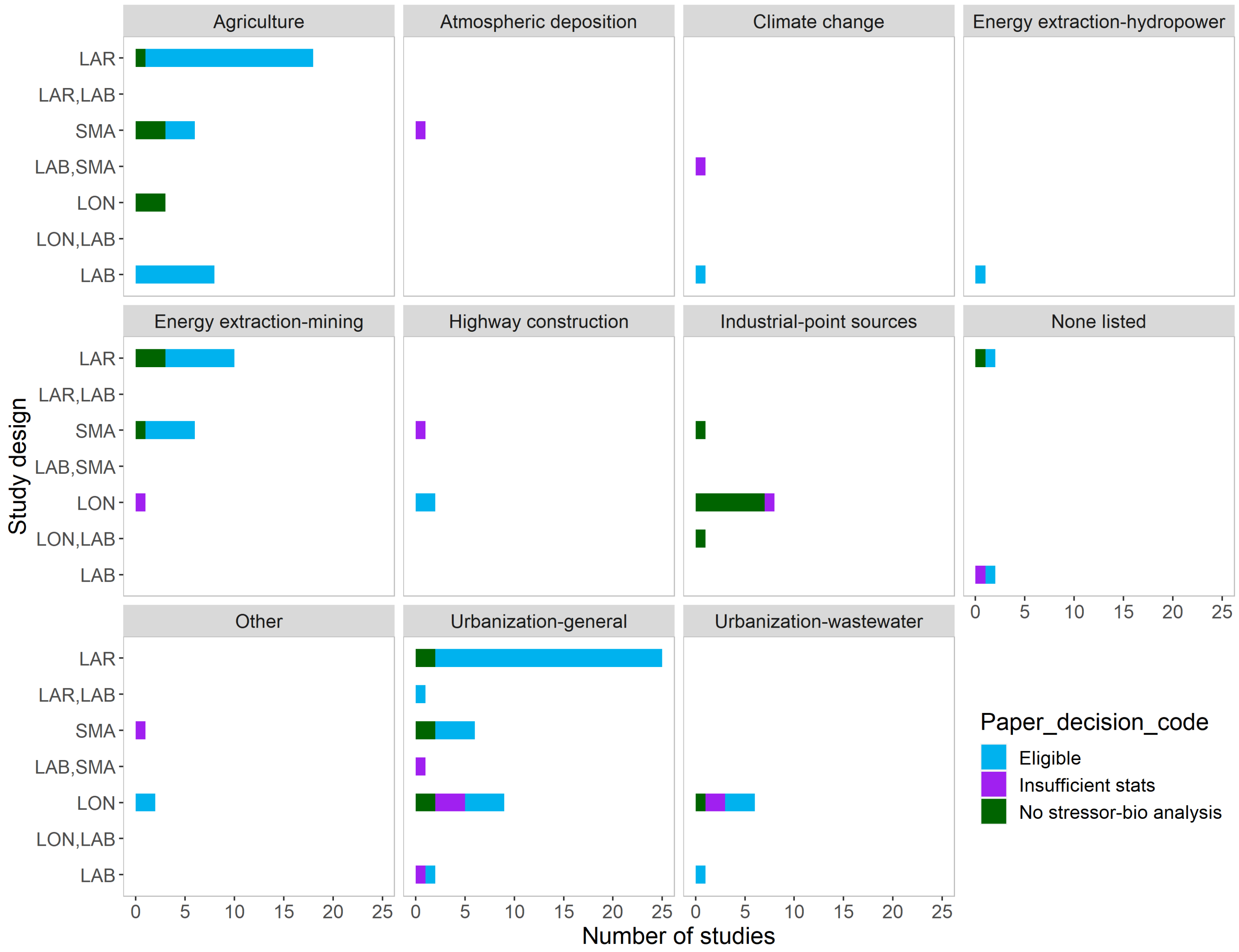
Study eligibility for frequency analysis



Study design definitions

LAR = Large study (15+ observations units)
SMA = Small study (<15 observations units)
LON = Longitudinal study along one stream
LAB = Laboratory, flume, or mesocosm study

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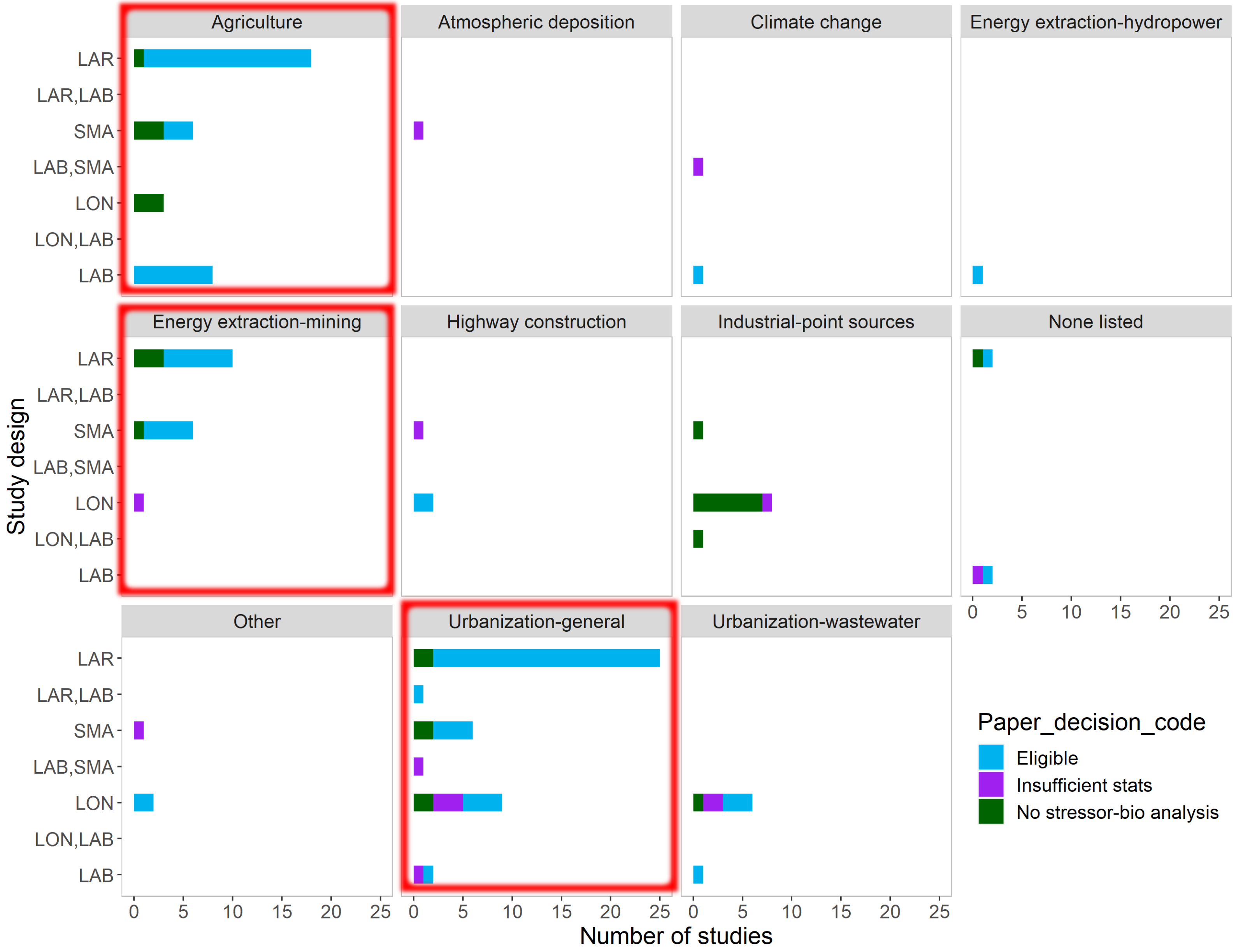
Study eligibility for frequency analysis

Which studies were eligible?

- Most large studies
- Most studies that focus on agriculture, urbanization, and mining



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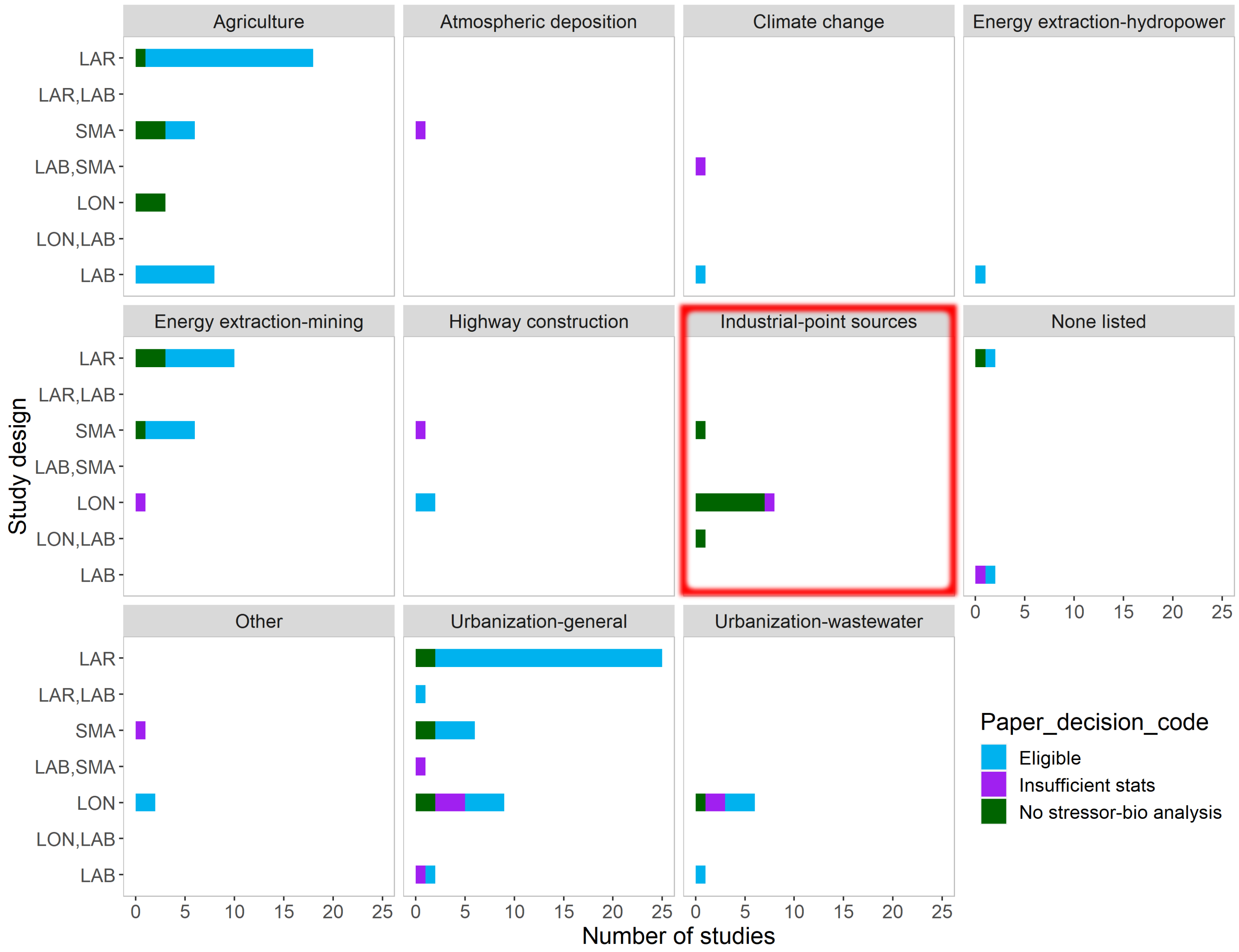
Study eligibility for frequency analysis

Which studies were eligible?

- Most large studies
- Most studies that focus on agriculture, urbanization, and mining

Which studies were not?

- Many longitudinal studies
- Point source studies
- Some smaller studies



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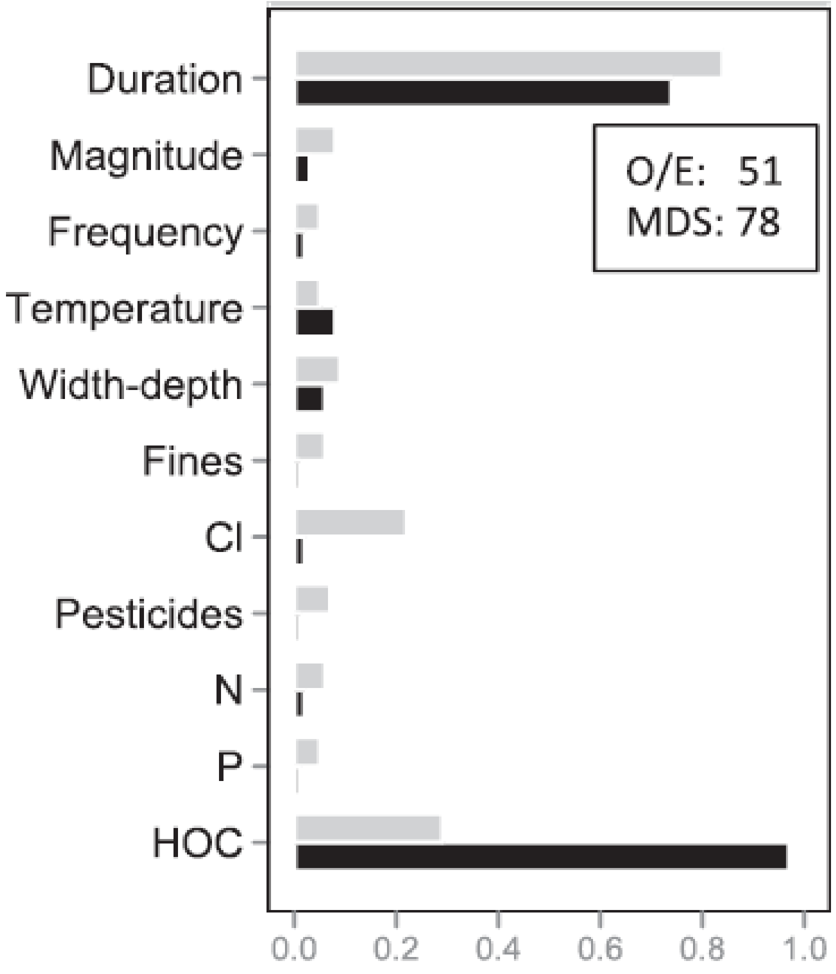
Stressor frequency analysis methods

- Extracted stressor measurements that were found to be significant/important based on study's statistical analysis
- Reported additional response variables separately
- Coarsened stressor measurements into general categories
  - In-stream: Acidity, DO, flow, habitat, nutrients, salinity or major ions, sediment, temperature, toxics-Hg, toxics-metals, toxics-pesticides, toxics-other (e.g., organic contaminants)
  - Out-of-channel "stressors": three types
    - Riparian: riparian buffer width, riparian land use, etc.
    - Physical: catchment area, watershed slope, etc.
    - Landscape: land use (percent urbanization, impervious cover, agriculture, percent mining)
  - Compared list of stressors reported as important to stressors measured



Bryant and Carlisle, 2012

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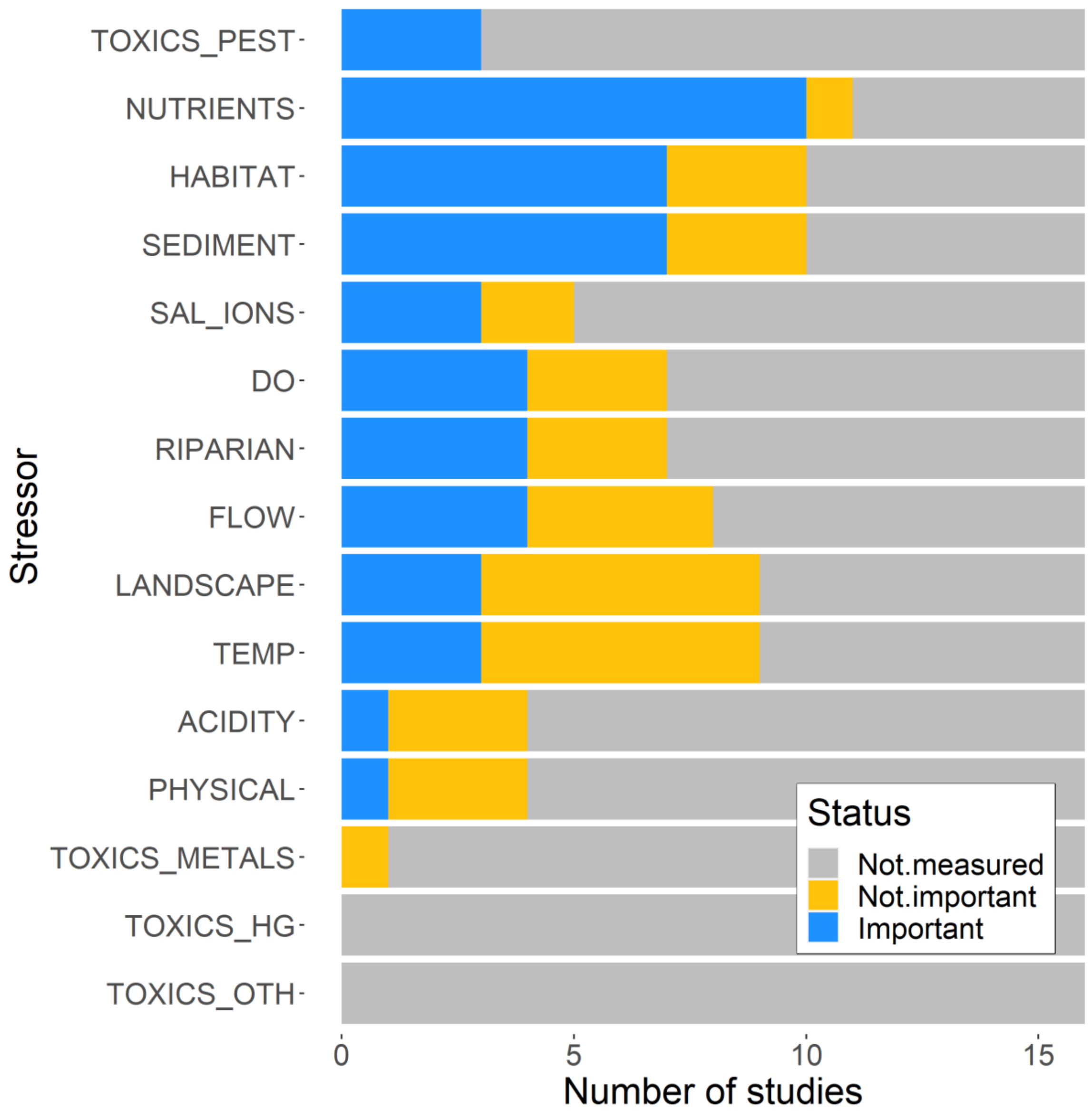
Stressor frequency analysis results

Agriculture studies (n = 16)



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Stressor frequency analysis results

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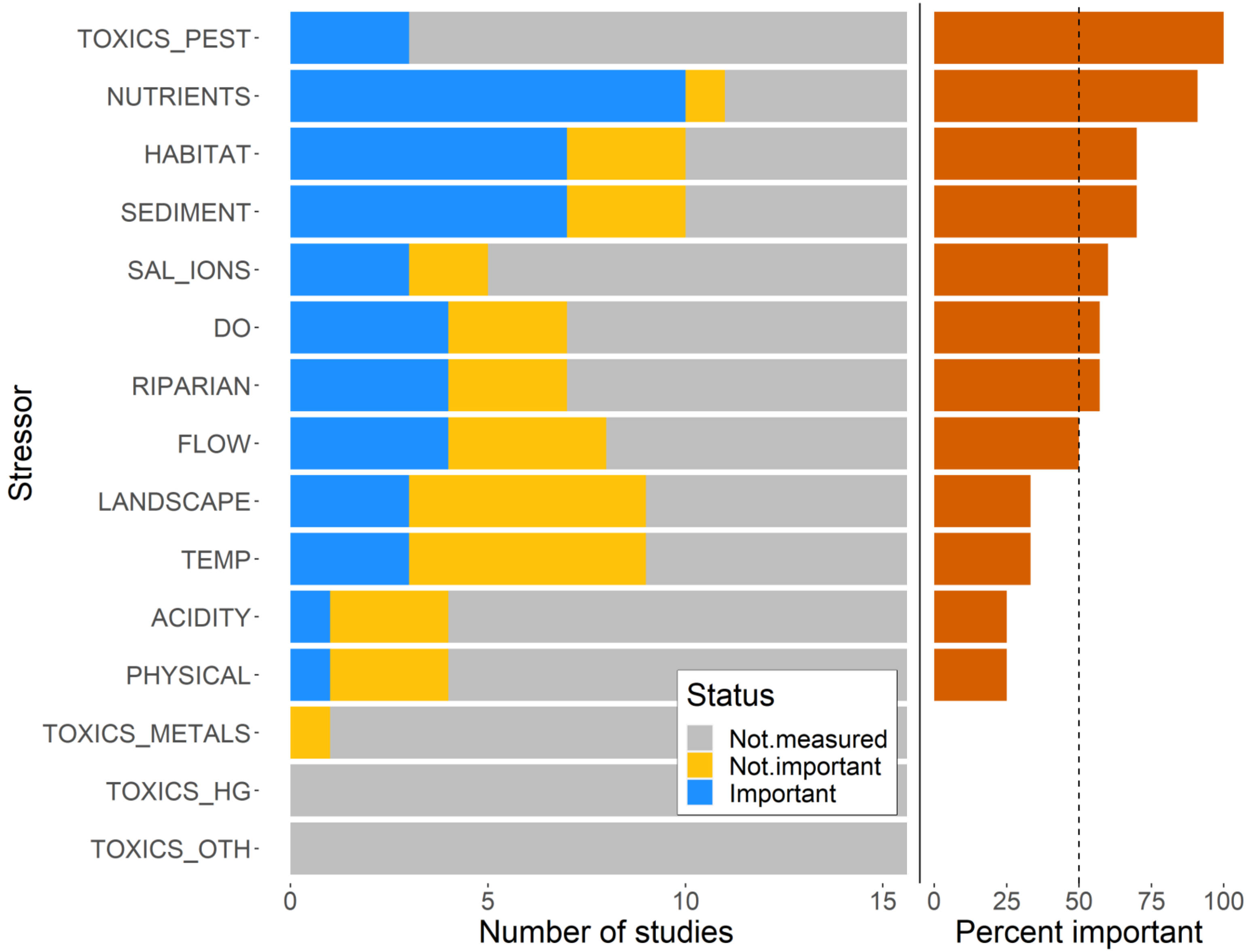

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Stressor frequency analysis results

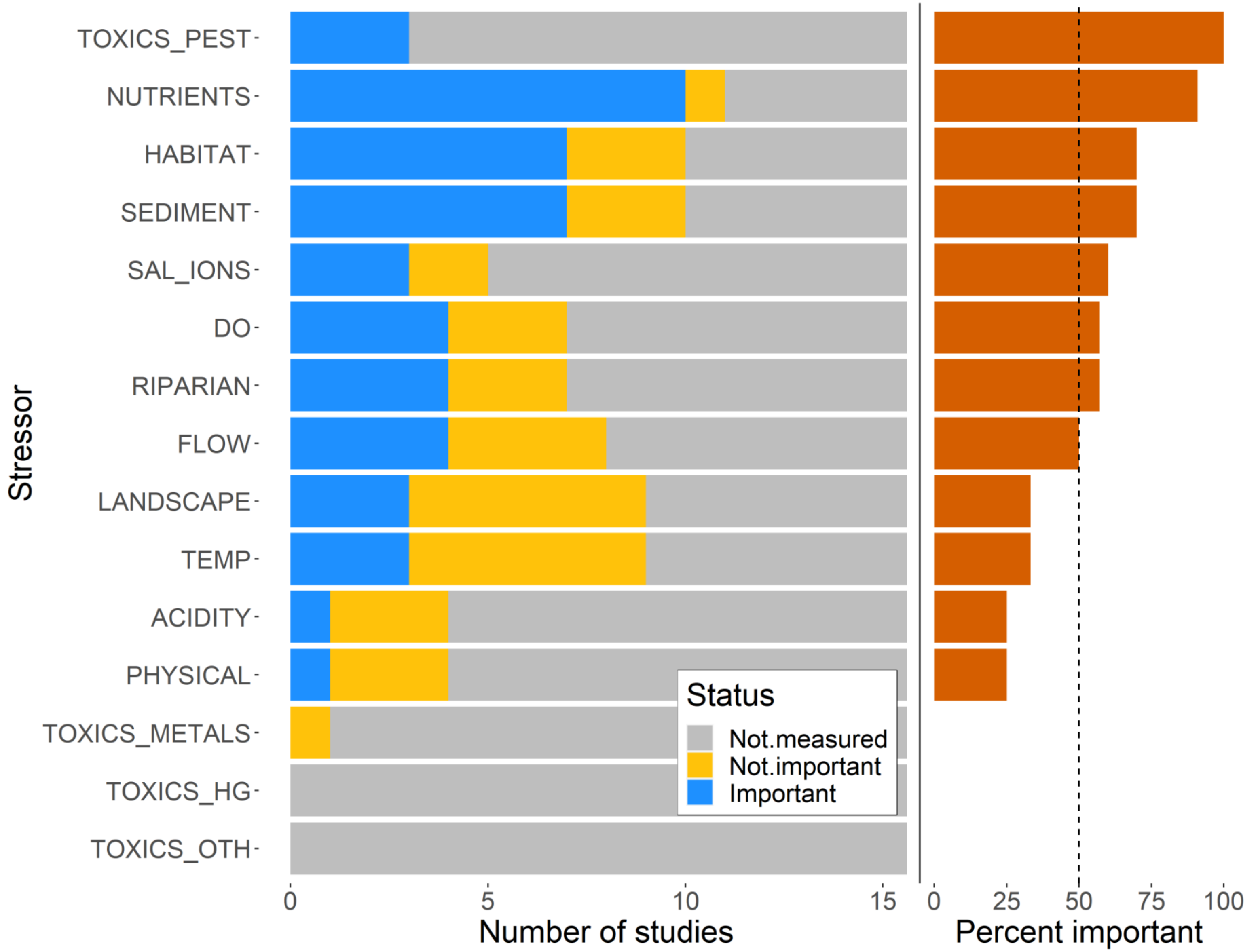
Agriculture studies (n = 16)

Key findings

1. Nutrients, habitat, and sediment were most often measured and most often reported as important

2. Pesticides were measured less frequently but were important in all studies in which they were measured

3. Temperature and flow found to be important in fewer studies



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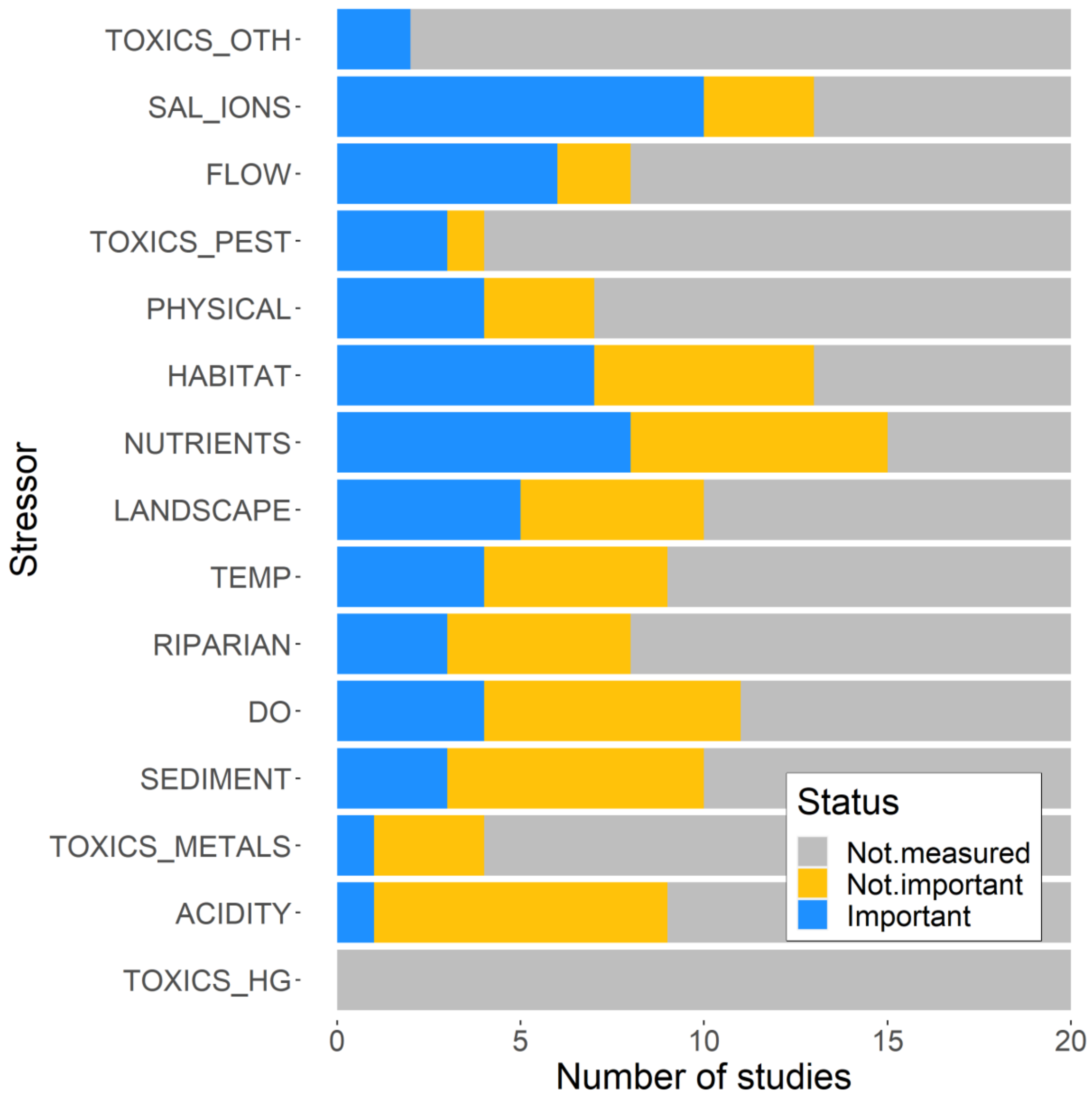
Stressor frequency analysis results

Urban studies (n = 20)

Includes general urban and wastewater studies



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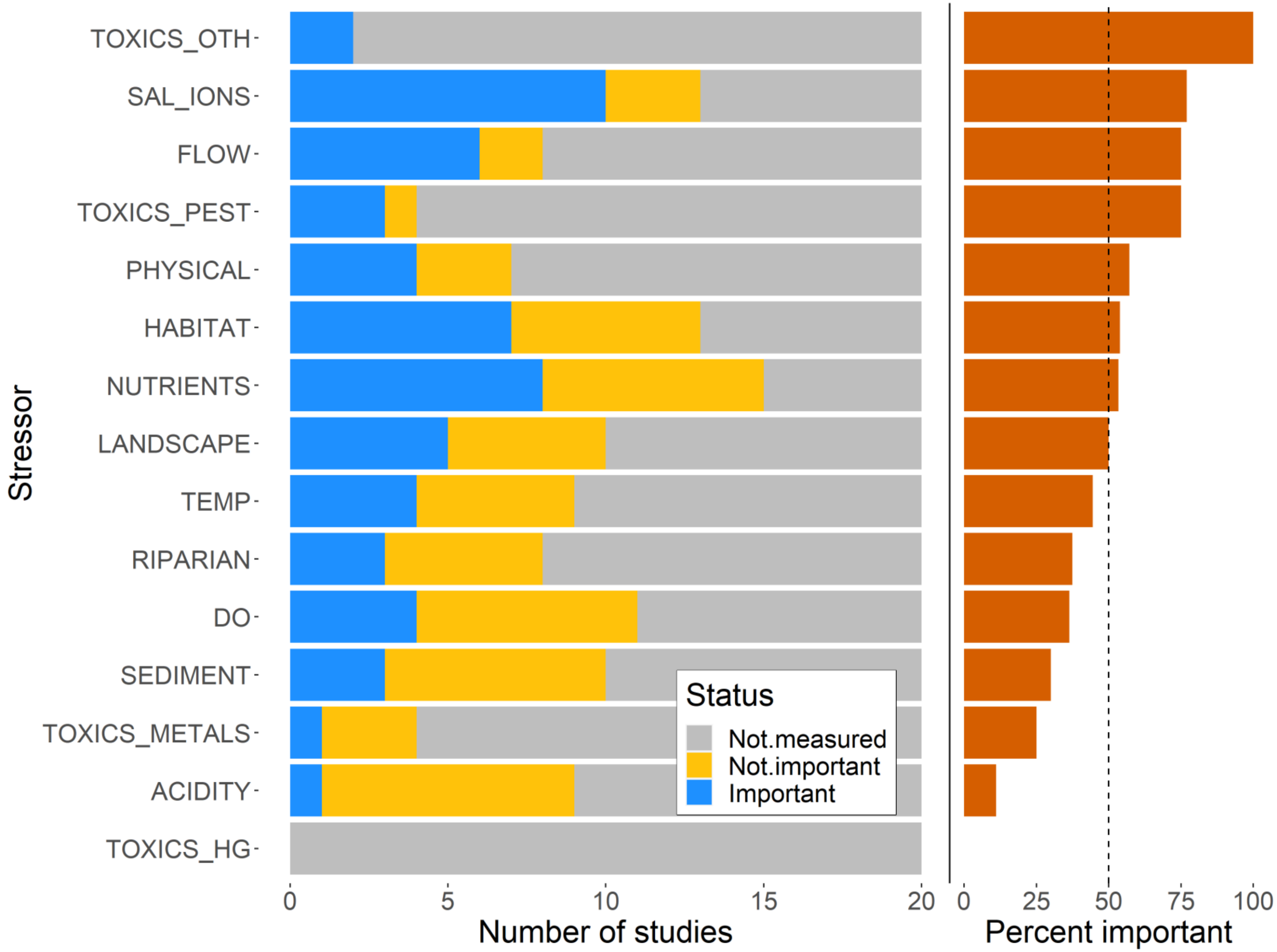

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Stressor frequency analysis results

Urban studies (n = 20)

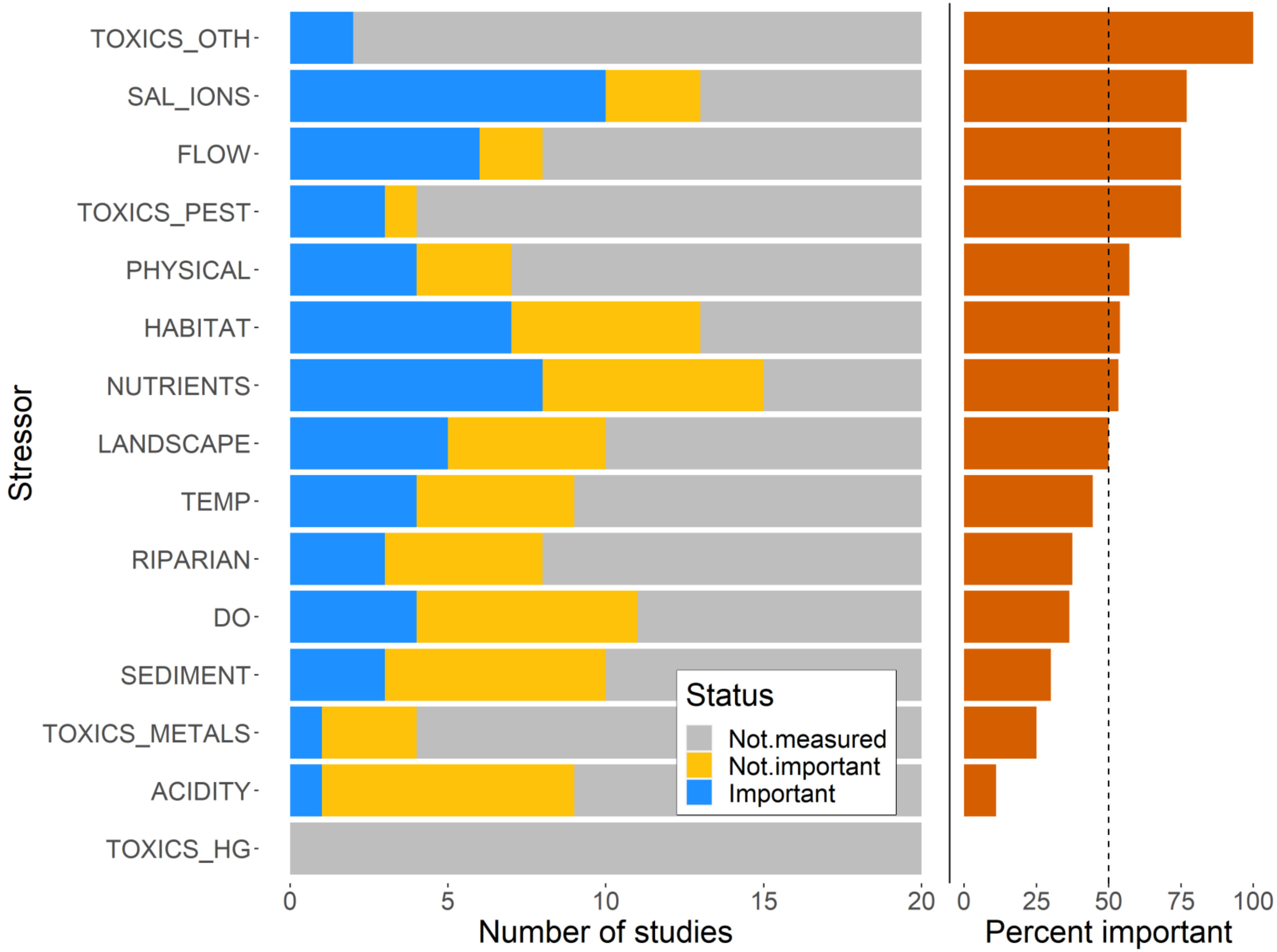
Includes general urban and wastewater studies

Key findings

1. Nutrients, habitat, and salinity most frequently measured

2. Toxics, salinity/ions, and flow were most important

3. pH, sediment, and DO were not frequently reported as important



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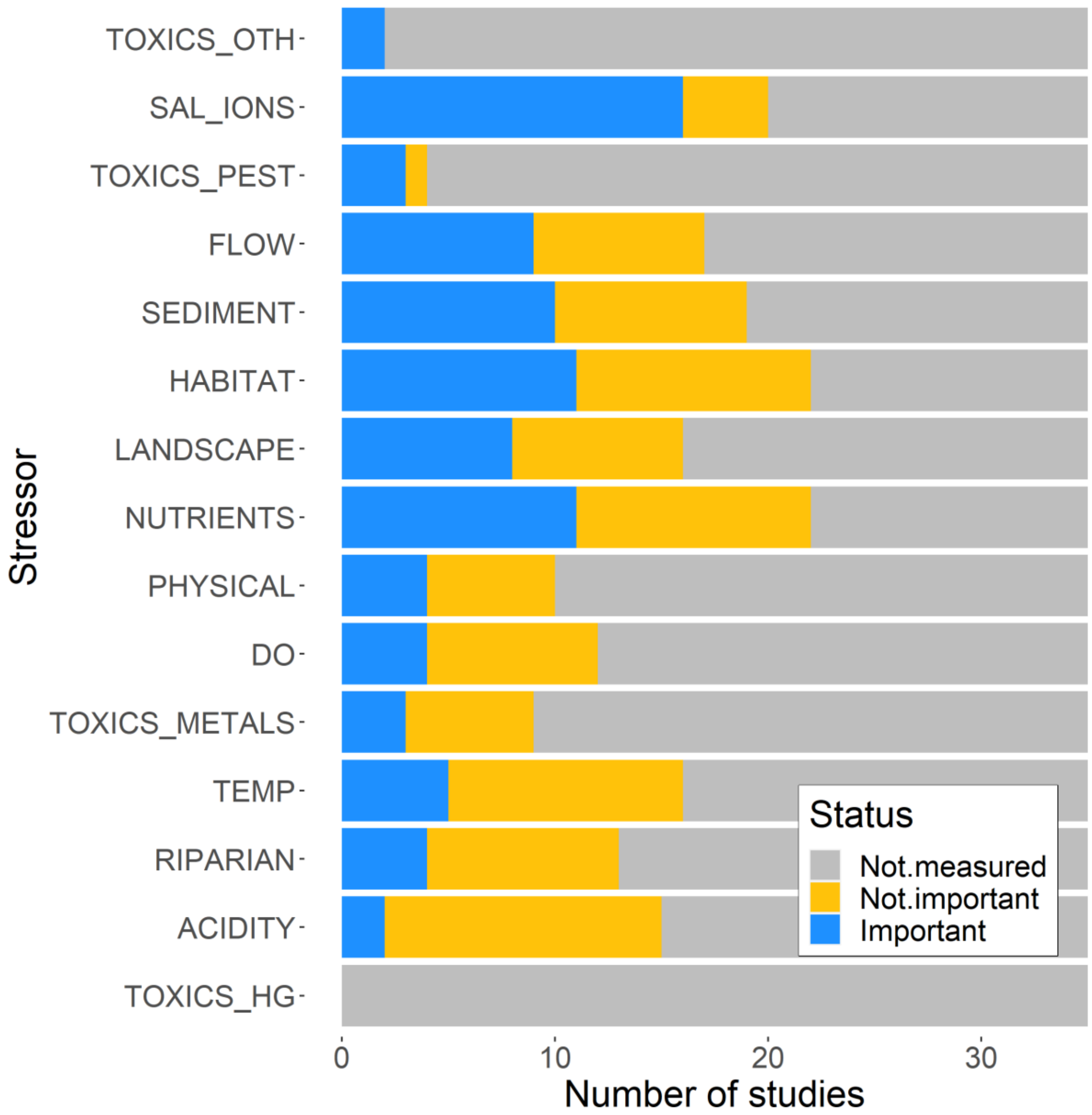
Stressor frequency analysis results

All eligible studies (n = 35)
Includes all drivers



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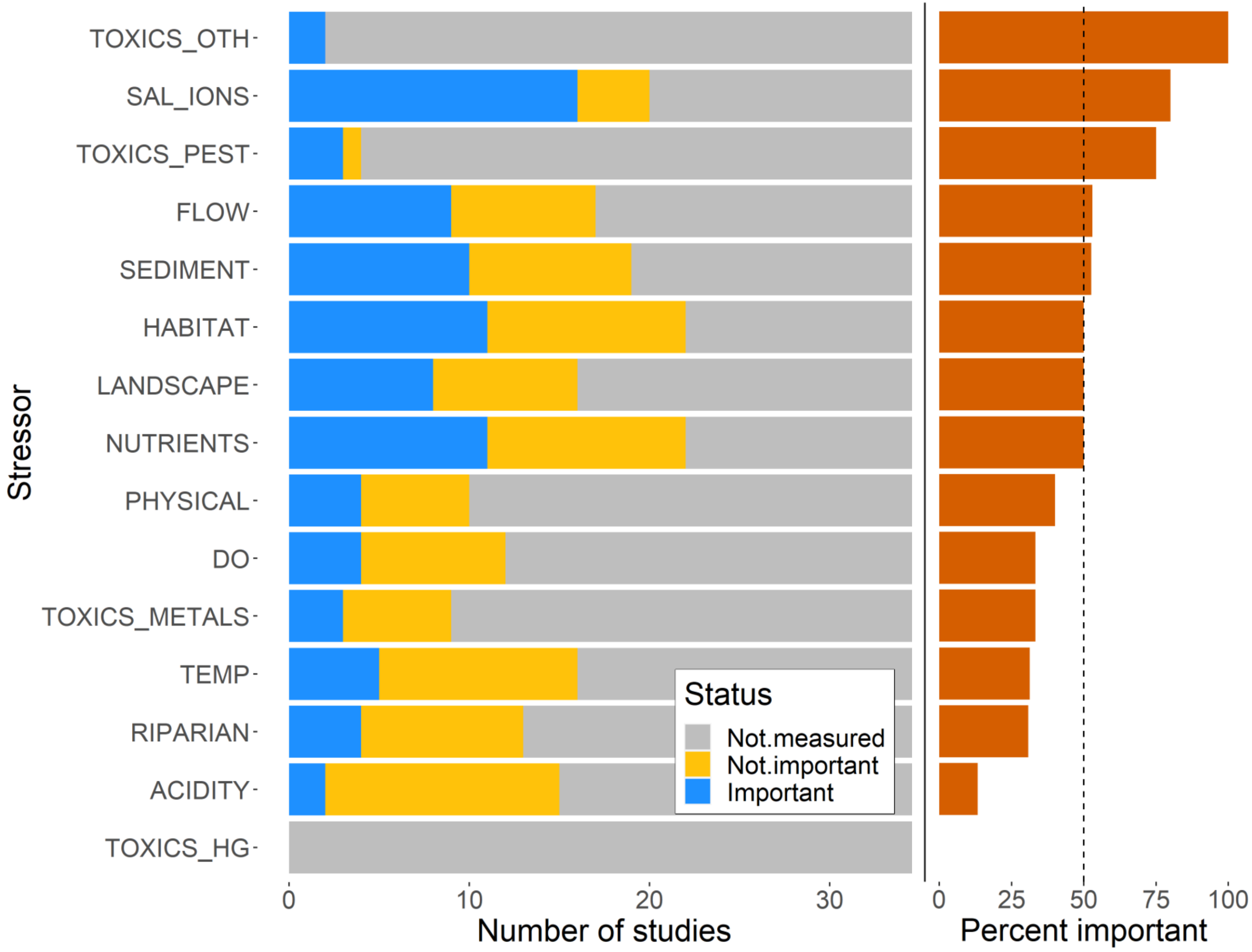

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Stressor frequency analysis results

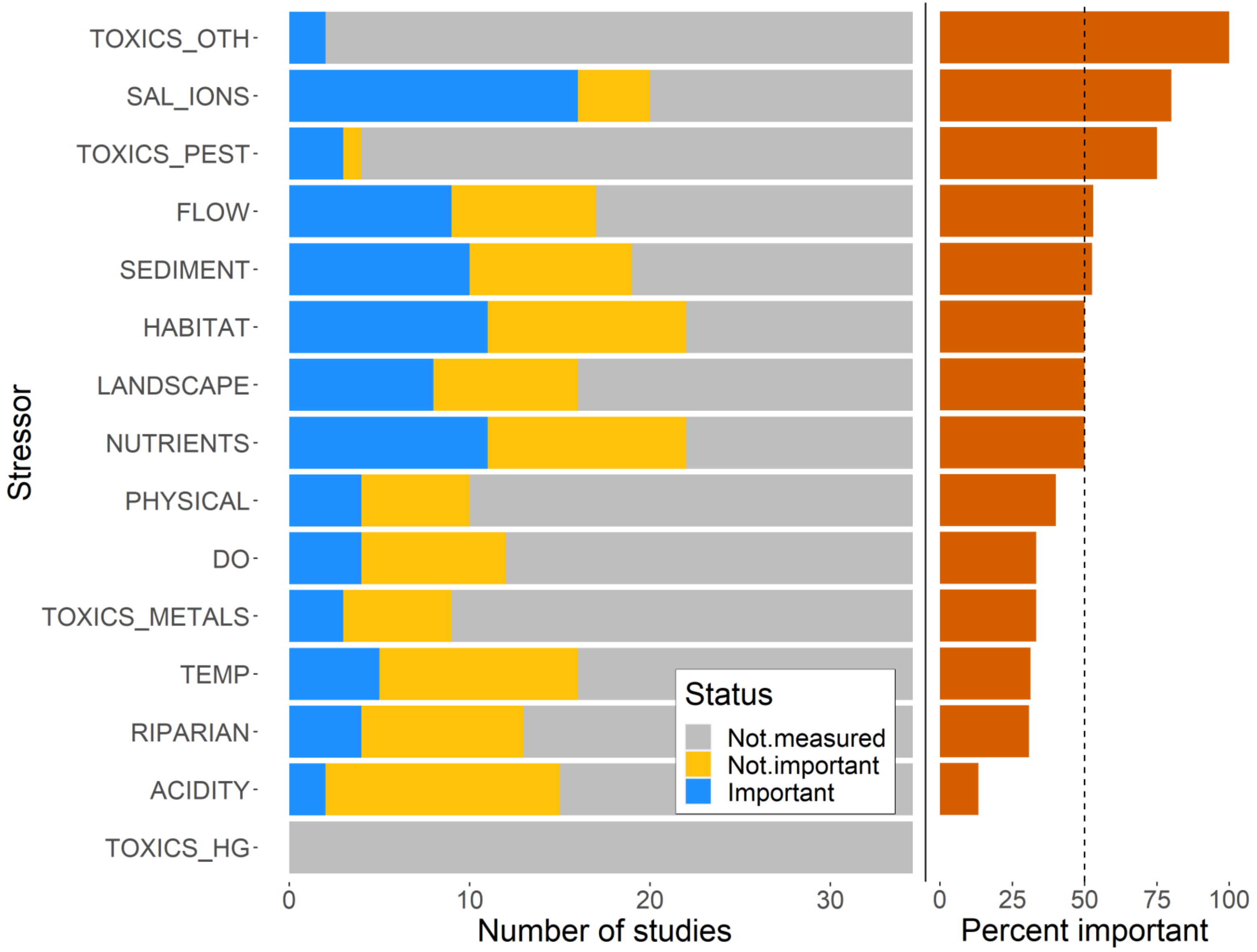
All eligible studies (n = 35)
Includes all drivers

Key findings

1. Toxics, salinity/major ions, flow, and sediment were important in > 50% of studies

2. Toxics (pesticides, organics) were rarely measured

3. Habitat and nutrients often measured but reported important only 50% of the time



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Preliminary study findings

Results from frequency analysis

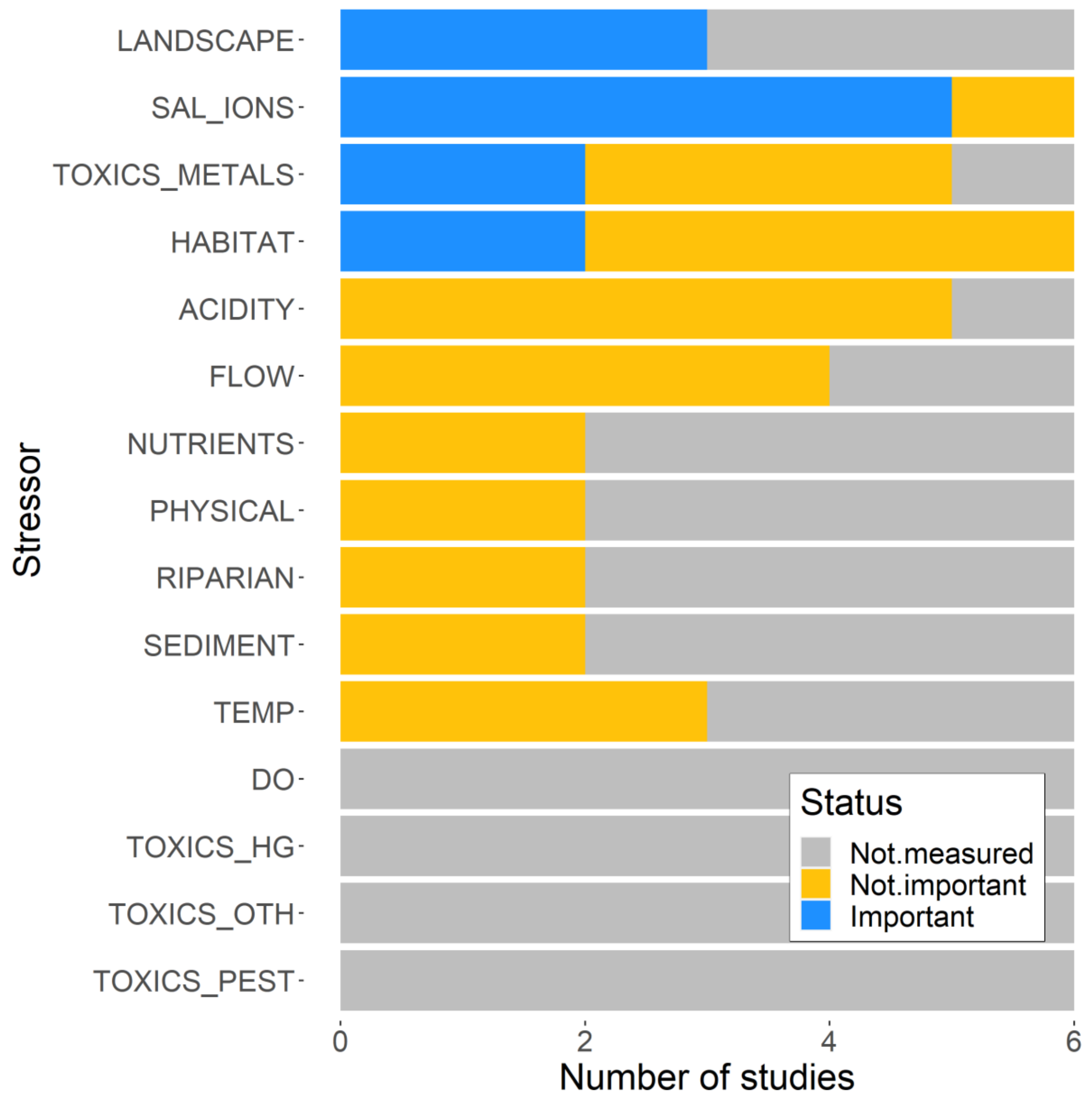
- Frequency analysis focused on certain drivers/landscape settings
- Difficulty in cross-study comparison due to variability in study design and statistical analyses used
  - **General:** Toxics*, salinity/major ions, flow, and sediment
  - **Agricultural settings:** Nutrients, habitat, sediment, and pesticides*
  - **Urban settings:** Toxics*, salinity/major ions, and flow
- Results change based on what response variables are measured

Next steps for report

- Continue summarizing studies in narrative sections
- Short analysis comparing in-stream vs. out-of-channel stressors
- Extract info on thresholds for select stressors
- Draft results from 303d analysis and finish comparison

Stressor frequency analysis results

Mining studies (n = 6)



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Stressor frequency analysis results

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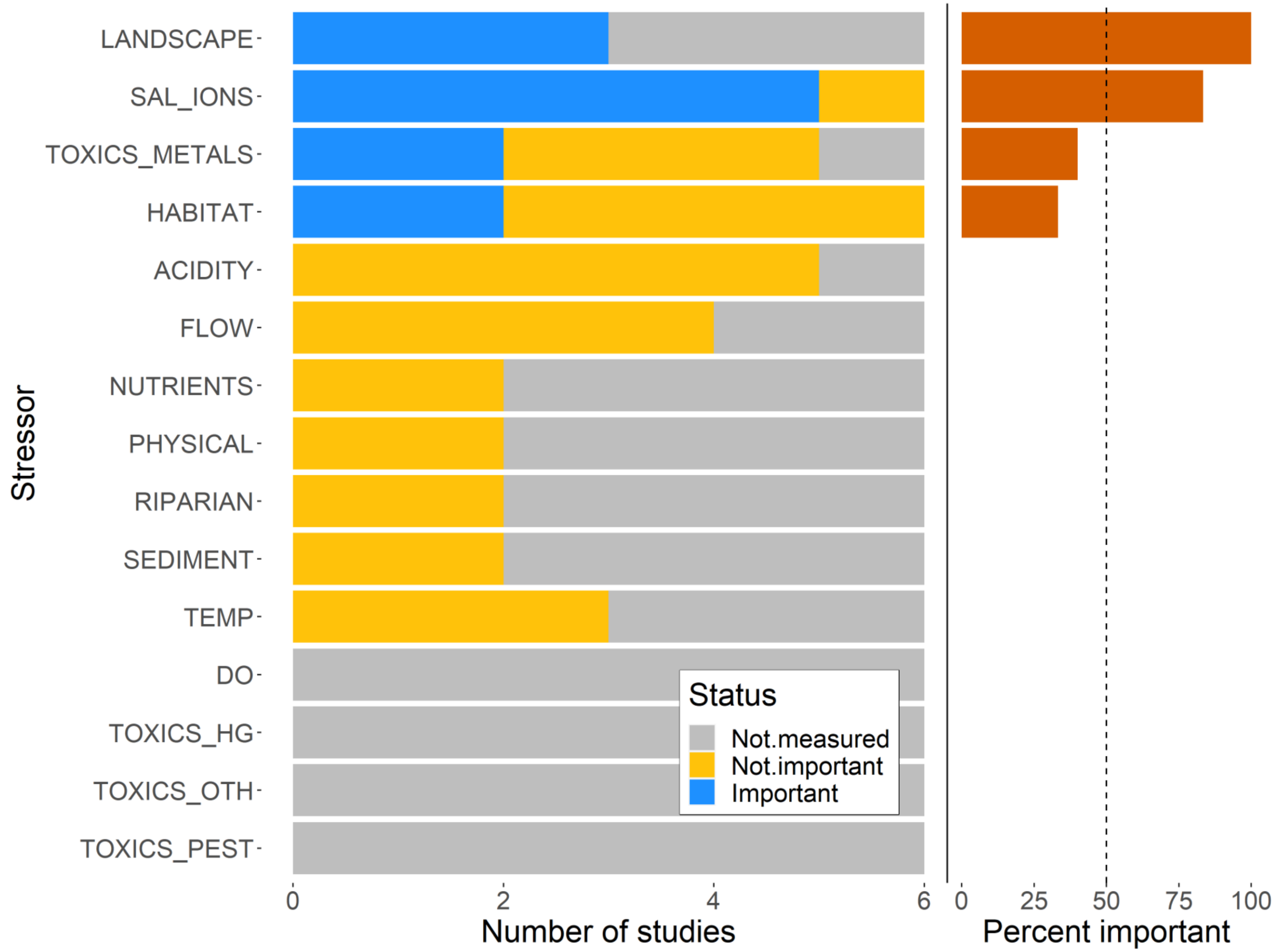

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Stressor frequency analysis results

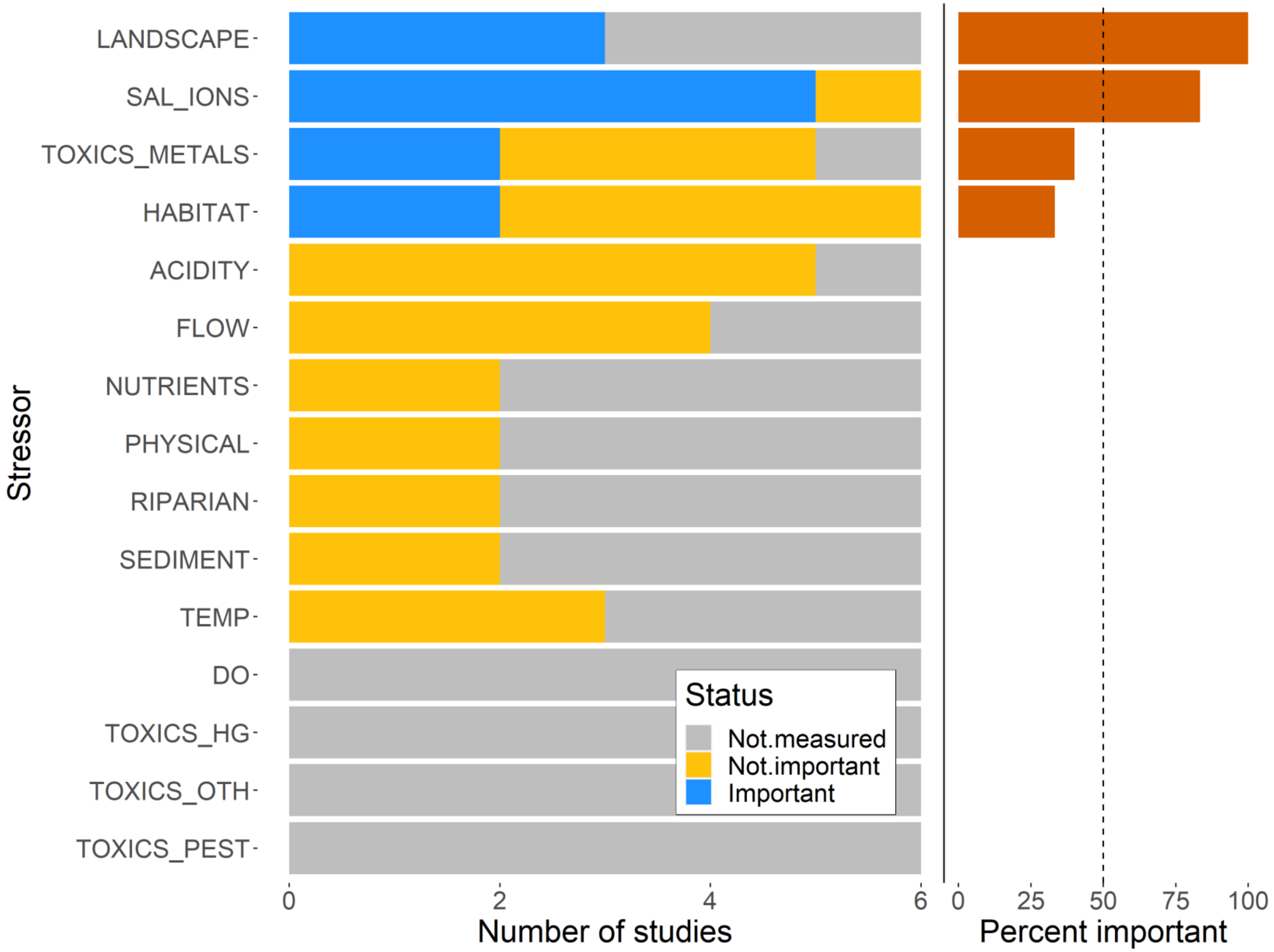
Mining studies (n = 6)

Key findings

1. Landscape factors (e.g., coal production, % watershed mined) and salinity/ions important in > 50% studies

2. Metals and habitat often measured but not often reported as important

3. pH, flow, temperature, and nutrients not reported as important



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Stressor frequency analysis results

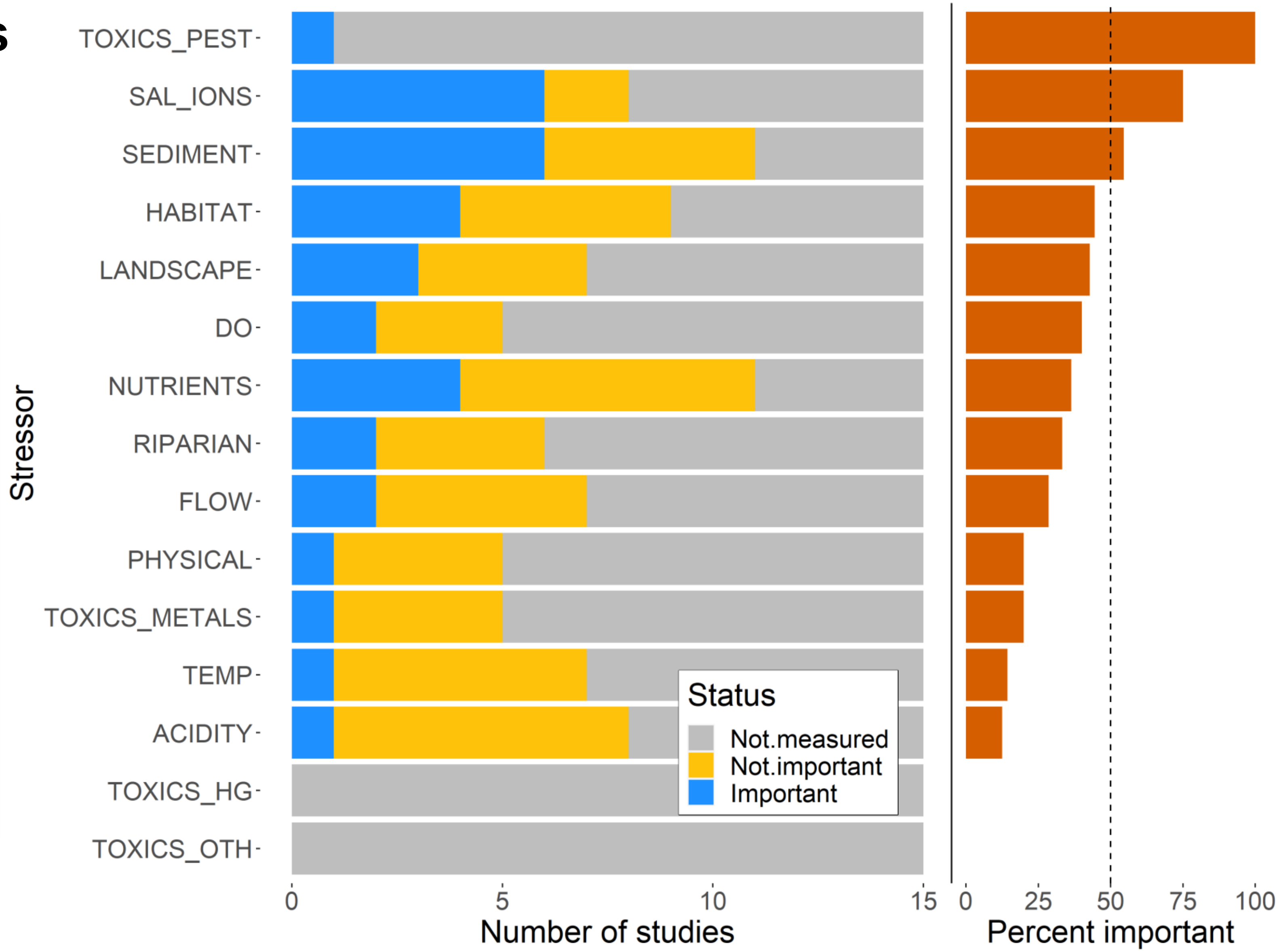
Studies using EPT richness as response variable (n = 15)

Key findings

1. Toxics, salinity/major ions, and sediment were important in > 50% of studies

2. Toxics (pesticides, organics) were rarely measured

3. Temperature, flow and pH were rarely reported as important



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Stressor frequency analysis results

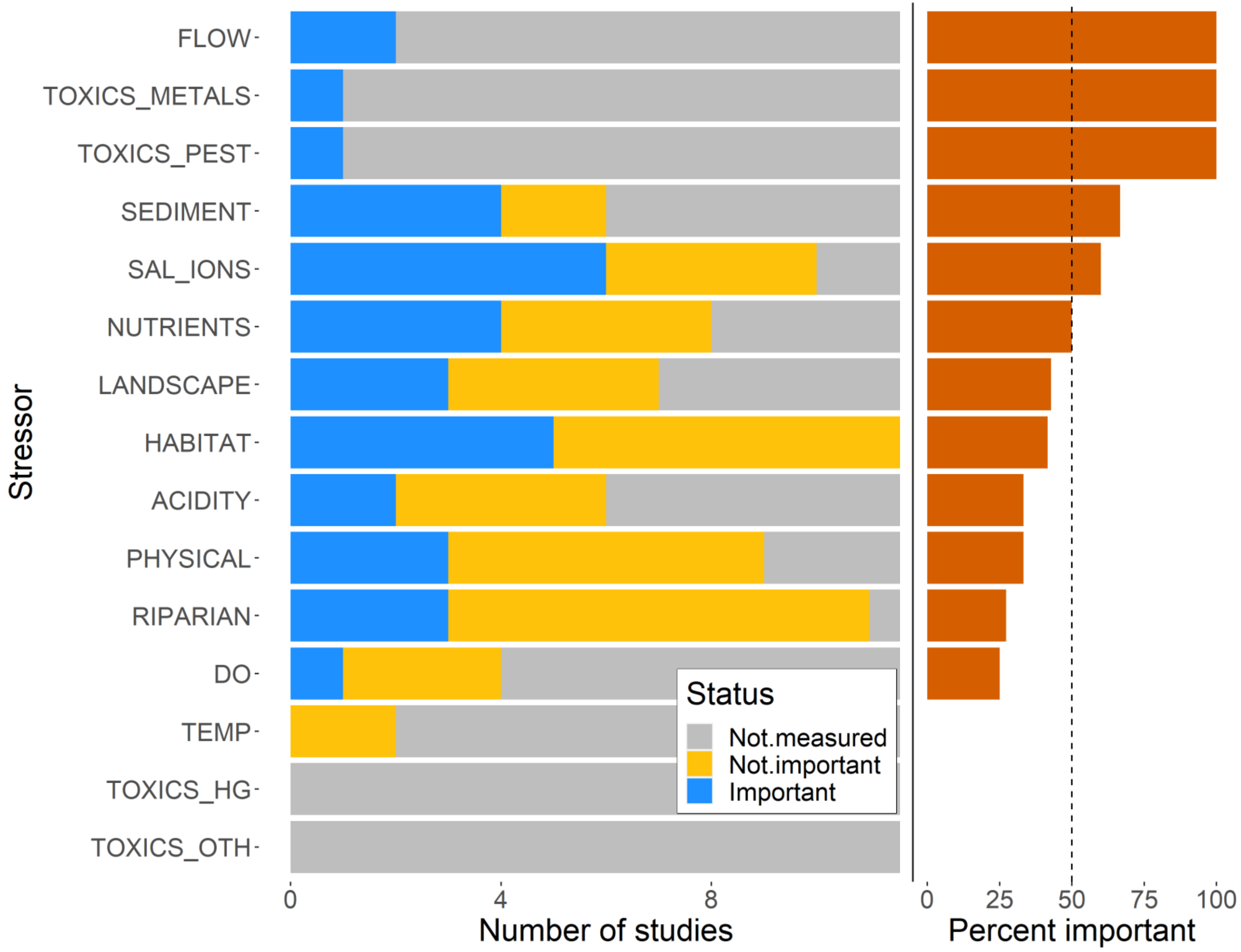
Studies using a multi-metric index as response variable (n = 12)

Key findings

1. Flow, toxics, salinity/major ions, and sediment were important in > 50% of studies

2. Habitat measured in all studies but important in < 50%

3. Watershed and riparian characteristics often measured but rarely important



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