

# Towards a Core Ontology for Hierarchies of Hypotheses in Invasion Biology

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## Introduction

### Hierarchy-of-Hypotheses (HoH):

- ▶ Invasion biology studies the spread of organisms outside of their native ranges.
- ▶ Many hypotheses have been formulated on why species become invasive, and many case studies have tested specific aspects of these general ideas.
  - The Hierarchy-of-Hypotheses approach [1] suggests modeling these broad, general ideas as hierarchies (Fig. 1).
- ▶ Overarching ideas branch into more precise, better testable hypotheses at lower levels
  - This model, however, has not been rooted in formal semantics.
  - It is thus currently not possible to automatically infer new knowledge.

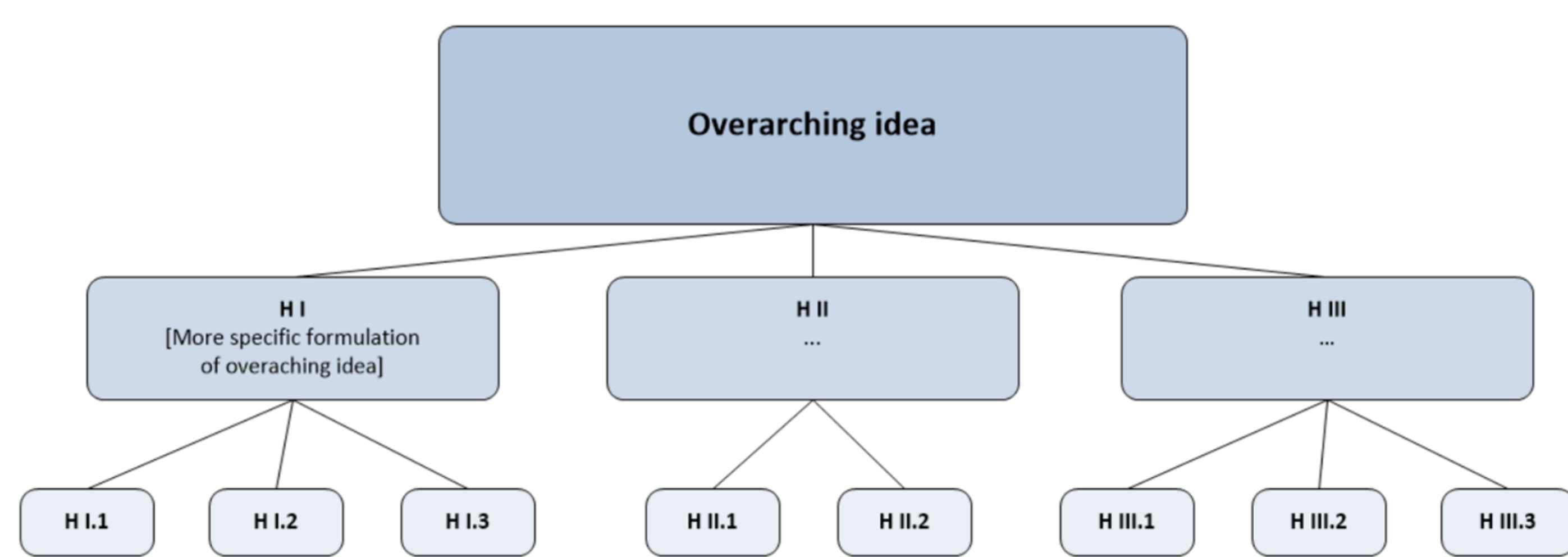


Fig. 1: Basic scheme of HoH

### Objectives:

- ▶ A first step to closing this gap by defining a core ontology for the field.

### Challenges:

- ▶ Analyzing individual hypotheses can not capture their meaning
  - More information is needed to get the correct model
- ▶ The **Biotic Resistance Hypothesis H2**, e.g., states that "An **ecosystem** with high **biodiversity** is more resistant against exotic **species** than an **ecosystem** with lower **biodiversity**".
  - However, lower and higher biodiversity are viewed as either related to the number of observed species, or to some index calculated for a specific area within a location. So, "**number of species, indices, area, location**" entities have to be added (Fig. 2).

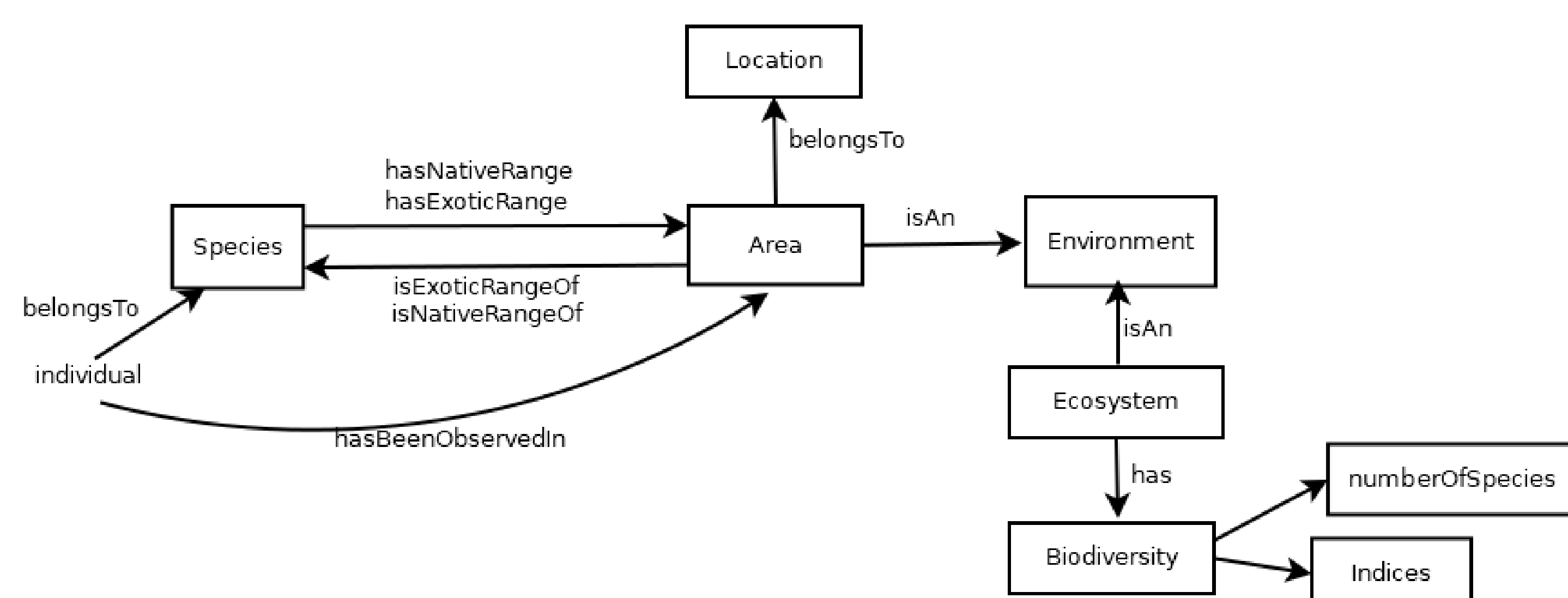
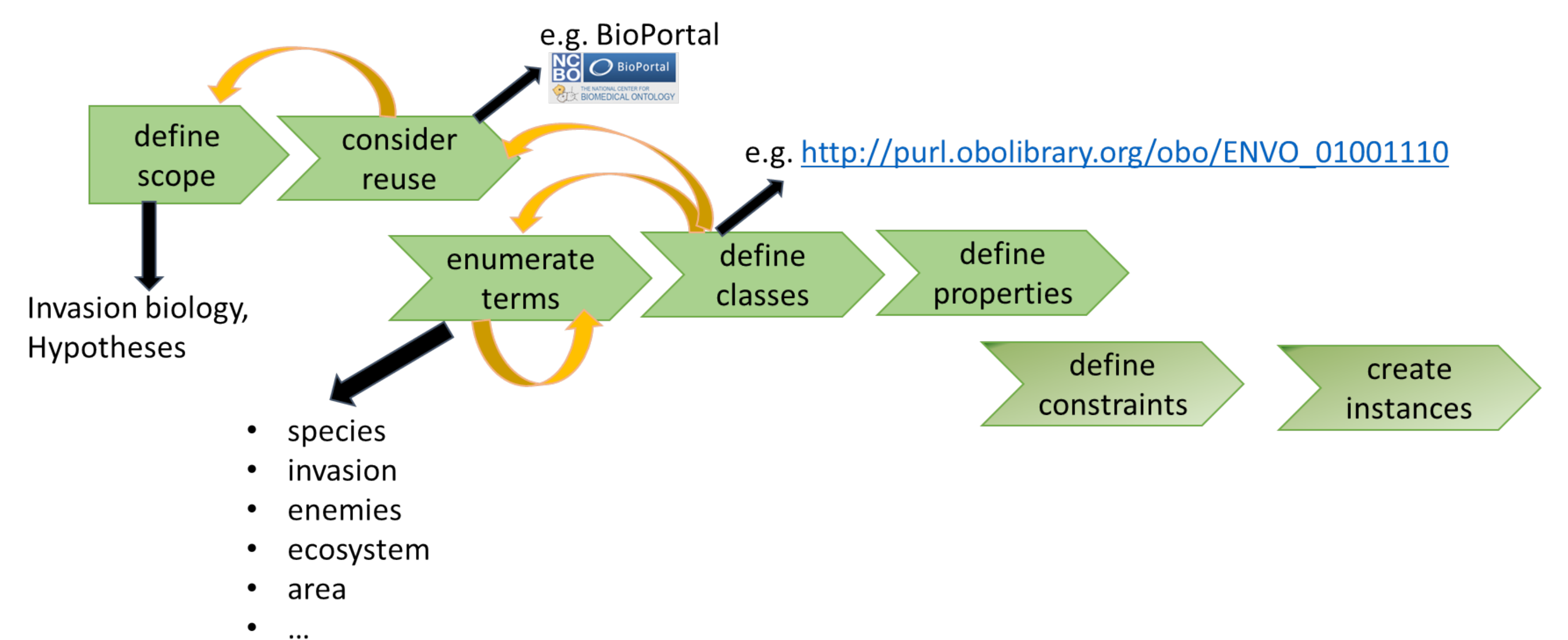


Fig. 2: Entities and relations extracted from H2

## Core Ontology for HoH

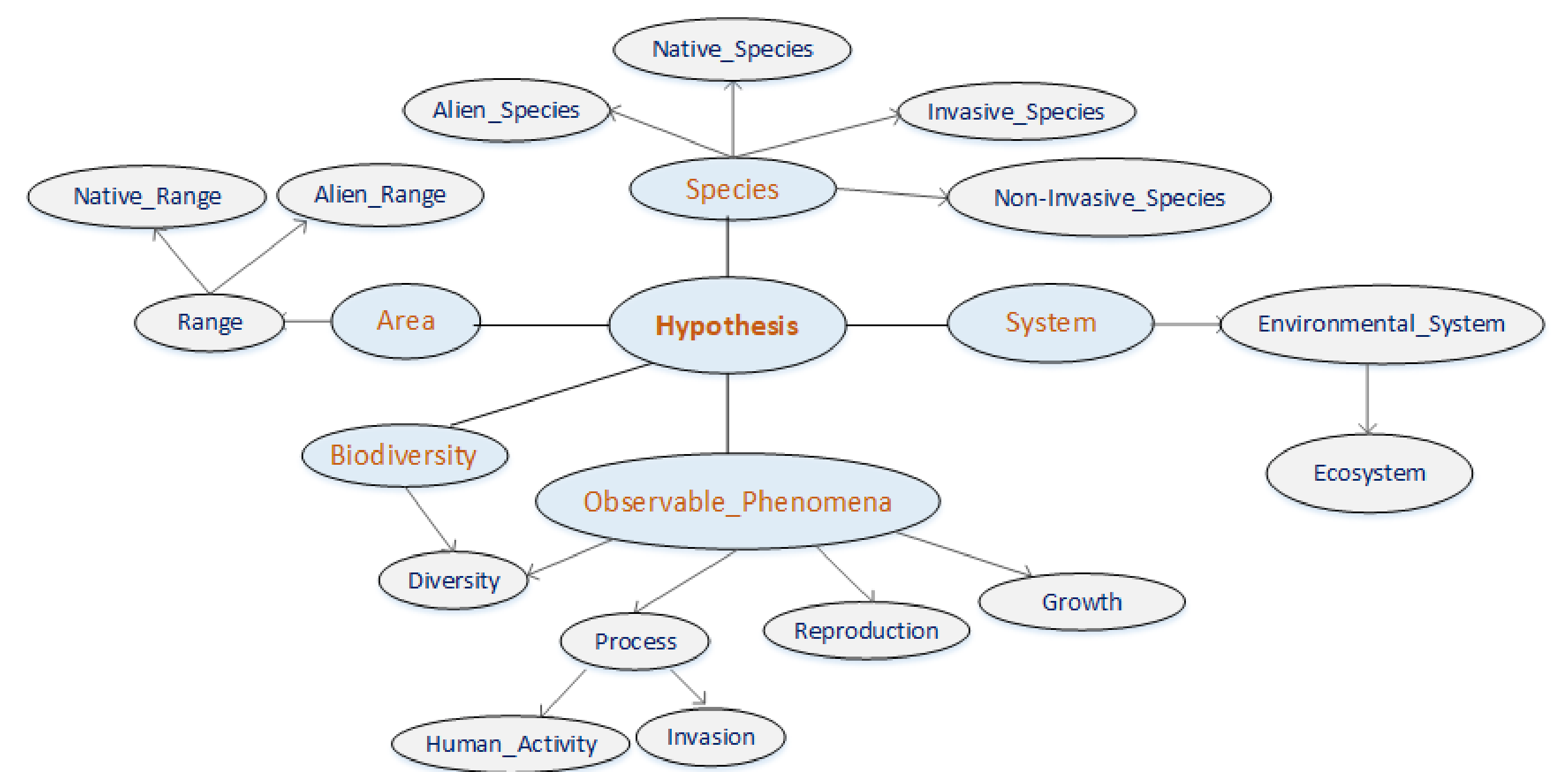
**Process:** Applying an iterative process



### Strategy:

- ▶ Adopting a fusion/merge strategy [2], where the new ontology is developed by assembling and reusing one or more ontologies
- ▶ Processing the description of each hypothesis extracting relevant terms (with the help of domain experts)
  - simple and compound terms, e.g. "invasion" and "invasion success" are considered
- ▶ Making use of the BioPortal API<sup>a</sup> to look for relevant ontologies that cover the set of extracted terms
- ▶ Coping with several challenges, such as
  - same term can be differently represented in several ontologies
  - e.g., term "**ecosystem**" has been found in 21 ontologies representing different pieces of the domain

### Outcome:



<sup>a</sup><http://bioportal.bioontology.org/>

## References

- [1] T. Heger, A. T. Pahl, Z. Botta-Dukát, F. Gherardi, C. Hoppe, I. Hoste, K. Jax, L. Lindström, P. Boets, S. Haider, et al. Conceptual frameworks and methods for advancing invasion ecology. *Ambio*, 42(5):527–540, 2013.
- [2] H. S. Pinto and J. P. Martins. Ontologies: How can they be built? *Knowledge and Information Systems*, 6(4):441–464, 2004.

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