



Figure 2: Causal Knowledge Discovery for Sustainable Ecosystems. **Top left)** The Irish Ground Fish Survey (IE-IGFS, Orange) and the Spanish Survey on the Porcupine Bank (SP-PORC, Blue) were part of the 2018 International Bottom Trawl Survey, coordinated by the International Council for the Exploration of the Sea [7]. Ireland and Spain use different Gears: The GOV gear has a larger vertical opening (Ireland, 3-4 m) respect to the Baka used on the Porcupine Bank (Spain, 2-3 m). This makes catchability different for fish species, such as Megrin (*Lepidorhombus whiffiagonis*, **Center left**) and Haddock (*Melanogrammus aeglefinus*, **Center right**), in which both countries have very different commercial interests. Haddock is a species of the cod family, highly prized in northern Europe, while Megrin is a species of flatfish, consumed largely in Spain and France. Spain catches Megrin better than Haddock and viceversa for Ireland. This generates a strong bias in the distribution maps (compare Megrin vs. Haddock map, Center) with potential implications for biodiversity management and sustainability in natural ecosystems. **Right** Causal knowledge discovery graph representing the 2-countries, 2-species and 2 gears for the example above. The whole data set for 2018 contains 11 countries, 461 fish species (approx. 200k individuals sampled), and 5 gears. Each country, species and gear is composed by many nodes: For example country contains fishery, environmental agency, stakeholders, etc. Species contains size-classes, habitat preference, species interactions, etc. Red and blue links mean competition and cooperation links connecting each pair of nodes.

nects knowledge discovery to biology-inspired federated networks to study the properties of cooperative forecasting and strong inference in the face of global sustainability and biodiversity challenges (Figure 2 and Tables 3.1.a-c).

1.3 Interdisciplinarity and non-incrementality of the research proposed

To succeed with ROBHOOT, it is essential to build an interdisciplinary team that includes scientists from different disciplines, including evolutionary biology, ecology, computational neuroscience, computer science, data science, complex systems and experts in biodiversity sampling methods and the infrastructure related to international protocols for sampling the Seas. Data knowledge discovery gained by analysis and modelling of the computation discovery capabilities of evolutionary-inspired semantic algorithms by the evolutionary biology, computer science and complex system members of this consortium (EBD-CSIC, IFISC-CSIC, SDSC) can be transferred to the causal domain addressed by the other part of the consortium with expertise in evolutionary biology, data science and causal inference