**spoke 3 : TERRESTRIAL AND FRESHWATER BIODIVERSITY**

**(from taxonomy to genetic diversity)**

| **Vision** |
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With Italy representing one the global hotspot of biodiversity, terrestrial and freshwater organisms are crucial in a variety of ecosystems, as well as in economically-relevant environments

| **Mission**  |
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The mission of Spoke 3 is:

- Contributing to enriching and compiling a taxonomic list of terrestrial and freshwater animals, plants and microorganisms

- Monitor endangered species and highlight the drivers of their erosion, in order to define methods to arrest it.

- Identify invasive alien species, define methods for early warning, measure their impact on autochthonous species and develop protocols to control or eradicate them

- Describe ecological networks in agricultural soils and freshwater environments, in order to preserve them in contexts in which they represent economically valuable habitats.

- Getting the citizens involved in research activities with the goal of producing more data and enhancing public awareness.

| **Strategic Objectives** |
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With the overarching goal of collecting more data on terrestrial and freshwater biodiversity, the researchers affiliated to Spoke 3 aim at studying Italian biodiversity in different contexts, exposed to various abiotic factors (temperature, altitude, humidity, etc): from alpine habitats to coastal dunes; from forests to prairies; from lakes and inland waters to rivers.

Research approaches range from classical taxonomy to genetic and genomic studies, and include classical ecological surveys. Citizen science projects are implemented to extend monitoring.

Researchers of Spoke 3 also contribute significantly to support educational programs aiming at creating a new generation of biodiversity experts, equipped with the widest scientific toolkit.

| **State-of-art analysis** |
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**General**

Given its longitudinal and altitudinal extension, as well as its position stretched into the Mediterranean Sea, Italy exhibits a huge variety of habitats which in turn explain its number of different terrestrial and freshwater species. This wealth of biodiversity needs to be widely studied in order to achieve the most updated compilation of Italian terrestrial and freshwater biodiversity.

At the same time, the Italian scientific community has lost hundreds of taxonomists, whose wealth of expertise is at risk of extinction, just like many native taxa.

Modern biodiversity studies cannot leave aside interspecific and genetic diversity, seen as an important component of true biodiversity in an evolutionary framework.

In addition, the assessment of biodiversity of many economically-relevant ecosystems and habitats (such as the overall quality of soils and water bodies) plays a crucial role in supporting economic activities, including agriculture and aquaculture.

**Mapping gaps and opportunities**

Within the strategic goals of Spoke 3, the main gaps present may be considered the following:

* any gap in the taxonomic and distributional data on terrestrial and freshwater species;
* gaps in taxonomic expertise, intended as the availability of scientists who are expert for specific taxa;
* gaps in the knowledge of the ecological relationships in fauna and flora of agricultural soils and their relationships with soil productivity;
* a nation-wide inventory of museum-stored samples;
* gaps in the public awareness of the importance of biodiversity

At the same time, the NBFC offers the extraordinary opportunity to fill those gaps - at least partially - by providing financial and human resources specifically dedicated to this goal. We also have the opportunity of training taxonomic experts, in both traditional and integrated taxonomy, thereby including the use of genetic data. Another opportunity is represented by the possibility of cataloguing the available taxonomic knowledge using digital platforms, including digitalized museum specimens and genetic/genomic data.

| **Research & Innovation priorities** |
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**Activity 1** - **Improve basic knowledge of terrestrial and freshwater biodiversity complementing traditional and modern approaches**. A database of Italian biodiversity will be compiled, creating new biobanks, implementing museum collections, and interconnecting the available knowledge with the newly acquired metadata. The database will be freely accessible and linked with similar international initiatives. The training of a new generation of taxonomic naturalists, equipped with a complete toolkit of morphological, genetic and digital methods of data collection and analysis will be supported.

**Activity 2 - Assess and monitor endangered species/communities, as a consequence of climate change and anthropogenic perturbations.** We will identify native species at risk of extinction and hot-spots of biodiversity, suggesting and planning protection and conservation interventions through multilevel data-driven modelling approach to predict and simulate biodiversity dynamics from environmental parameters. By in vivo and in vitro studies using field analyses and multi-omic data, we will be able to disentangle those processes that occur spontaneously as part of the natural evolution of species and ecological communities from processes accelerated by external disturbances, such as the anthropogenic impact and the consequences of environmental changes to estimate evolvability and the potential for adaptation of Mediterranean organisms, to implement predictive models of biodiversity resilience, and guide conservation plans of endangered species.

**Activity 3 - Identify invasive alien species and evaluate their impact on autochthonous species.** Given their impact on native biota, we will evaluate the impact of invasive alien species for the protection of natural ecosystems of crucial value for human activities such as forests, agricultural soils and the agrifood sector. We will build a knowledge and monitoring network capable of prevention, early detection and rapid response to the entry of alien species to carry out timely protection and sustainable eradication interventions.

**Activity 4 - Focus on the knowledge of soil and freshwater biodiversity in order to maximize their ecological function.** We will deepen the study of two environments of crucial importance for ecosystem services: soil and inland waters. For soil biodiversity, important in agricultural and forestry sectors, using target species of microbes and micro-arthropods, we will evaluate ecological relationships using consolidated indexes for assessing the quality of ecosystems; for biodiversity of inland waters, due to its importance as an indicator of water quality, model species particularly sensitive to environmental pollution and other disturbances will be considered.

**Activity 5 - Implement citizen science projects to get citizens and local communities involved.** We will involve citizens, associations and local communities in data acquisition and monitoring projects through the citizen science tools. This will allow us to make everyone understand the symbolic and practical value of biodiversity, making its knowledge and its conservation a commitment of all citizens. Spoke 3 will also contribute to the educational activities of the Center, thereby pursuing SDG-4 (Quality Education) of the Agenda 2030.

| **Expected Impacts** |
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**Scientific impact.** The research of spoke 3 will have an impact in improving the knowledge of Italian biodiversity, filling species lists (including distributional data), identifying internal hotspots of biodiversity, improving the knowledge on the biodiversity of endangered habitats, evaluating the impact of invasive alien species for the protection of natural ecosystems of crucial value for human activities, building a digitalized database of Italian biodiversity, developing new teaching programs and approaches aimed at educating a new generation of biodiversity experts.

**Economic Impact**. While the research activities of Spoke 3 are purely scientific, indirect economic impacts may be identified in the following areas:

* **Agricultural production.** Assessing the distribution and abundance of soil fauna, flora and microorganisms will provide valuable comparable data for evaluating the effects of biological *vs.* traditional cultivation.
* **Water quality.** Biological indexes will be implemented to assess water quality in economically-relevant water bodies.
* **Green Jobs.** The training of researchers will generate knowledge and high-profile skills which can be functional to cover positions in the ‘green jobs’ realm such as Protected Areas, National and Regional Parks, Local Surveillance Authorities.
* **Pharmaceutics, Nutraceutics, Cosmetics.** Taxonomic knowledge and species abundance and distribution represent the basis for exploiting molecules with useful properties in the mentioned fields (see Spoke 6).

**Social Impacts.** Citizen will benefit from the contact with the researchers and the outcome of the NBFC (eg.: Biodiversity Science Gateway).

* **Public awareness.** Citizen engagement will raise public awareness on the importance of monitoring, preserving and restoring biodiversity.
* **Citizen Science**. Citizen Science projects will stimulate social cooperation and cohesion in local communities.

**Political impact.** A better informed population is more capable of exerting a positive pressure on governments, by requesting specific actions dedicated to the preservation and restoring of biodiversity. In addition, a new classes of biodiversity experts, along with the presence of a National Center on Italian Biodiversity, will be able to provide, upon request, informed documents guiding political decisions, for the benefit of the citizens.

| **Collaborations and Stakeholders** |
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Spoke 3 has activated the following collaborations:

* Collaboration with the Command for Forestry, Environmental, and Agri-food Units (CUFAA);
* Collaboration with sequencing facilities and genomics projects (e.g.: ERGA)
* Collaboration with National reserves (e.g.: Stelvio National Park, Parco Nazionale Dolomiti Bellunesi)