# Biodiversity is the solution

## National Forum on Biodiversity

Scientific Meeting
May 20th to 22nd 2024
University of Palermo

Finanziato dall'Unione europea
NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA

NATIONAL BIODIVERSITY FUTURE CENTER

Finanziato dall'Unione europea NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

NATIONAL BIODIVERSITY FUTURE CENTER

1st annual report of the National Biodiversity Future Centre

**Biodiversity is the solution**
National Forum on Biodiversity

Scientific Meeting
May 20th to 22nd 2024
University of Palermo

---

**CURATORS**

Massimo Labra, Gianluca Sara, Simonetta Fraschetti, Gian Marco Luna, Mariachiara Chiantore, Lorena Rebecchi, Francesco Frati, Carlo Calfapietra, Donatella Spano, Maria Chiara Pastore, Andrea Galimberti, Hellas Cena, Gloria Bertoli, Danilo Porro Isabella Saggio, Telmo Pievani, Giuseppe Gigli, Maria Carmela Basile, Alberto Di Minin, Luca De Biase e Riccardo Coratella

---

**AUTHORS**

Alessandro Chiarucci
Alessio Bonaldo
Andrea Filippetti
Andrea Galimberti
Andrea Tenucci
Antonio Carbone
Antonio Costantini
Carlo Calfapiertra
Carlo Rondinini
Chiara Montagnani;
Claudia Gorga
Donatella Spano
Elena Paoletti
Fabrizio Tuzi
Flavia Guzzo
Francesco Frati
Francesco Matteucci
Francesco Regoli
Gabriele Colombo
Gabriella Scipione
Giacomo Pigatto
Gianluca Sarà
Gian Marco Luna
Giulia Capotorti,
Giuseppe Brundu
Giuseppe Gigli
Gloria Bertoli
Hellas Cena
Isabella Saggio
Danilo Porro
Ilaria Bruni
Isabella Saggio
Jacopo Cricchio
Lino Cinquini
Lorena Rebecchi
Luca Bolognini
Luca De Biase
Luigi Fiorentino
Marco A. Bologna
Maria Carmela Basile
Maria Chiara Carrozza
Maria Chiara Pastore,
Mariachiara Chiantore
Massimo Labra
Michele Cesario
Michele Mauri
Paolo Biella
Rachele De Giuseppe
Riccardo Coratella
Roberto Giannantonio
Sandra Citterio
Sarah Rossi de Gasperis
Simone Mereu
Telmo Pievani
Simonetta Fraschetti
Werther Guidi Nissim

# Table of contents

# Preface

About a year and a half after its birth, the National Biodiversity Future Centre (NBFC) gathers the first results of an ongoing effort to generate knowledge and innovation in biodiversity by bringing together researchers belonging to different bodies, universities and companies. NBFC, according to its primary mission, acts as a scientific reference to support management and intervention bodies, business activities and citizens, in order to preserve, monitor, restore and enhance biodiversity.

In addition to having contributed to the training of a new class of researchers (around 600 PhD, post doctoral researchers and researchers), regardless of gender, and to involving in its activities almost 2000 co workers interested in this subject , the centre has also contributed to diffusing knowledge and awareness related to the in-depth analysis on themes concerning parks, marine reserves and cities throughout the Italian territory filling the well-known gap between Northern and Southern Italy.

This activity of scientific dissemination has been carried out thanks to the digitization of biodiversity starting from the heritage preserved in museums and collections all over the Italian territory. This is a highly symbolic activity allowing the historical knowledge of our country to be gathered and provided to researchers from all over the world so as to teach them how to prevent animal extinction, protect endemism and implement ecosystems and habitat.

In order to reach an ever increasing public, NBCF has equipped itself with a biodiversity Gateway, that is a physical and virtual place where products resulting from research and technological innovations, as new sensors, information and AI technology may become on one side tools at the service of the citizens to contribute to the preservation of biodiversity and, on the other side, business activities innovation basis to generate both economic and social value.

At present NBCF is progressively taking root at European and international level becoming an actual world reference. The centre, recognised by OCSE as strategic partner, contributes to the great European initiatives and is entering into agreements with countries all over the world, starting from the Mediterranean countries with which it shares strategies and projects aiming at mitigating the effects of climate change on nature.

Maria Chiara Carrozza
*Director of CNR*

# Introduction

It may seem a paradox, given that this is a strictly scientific subject, but it is precisely the law - or rather public law – to explain the importance that the notion of biodiversity will play on our institutional and production system in the coming years.

Short presentation of NBFC.

It is a consortium company mainly owned by public research organisations working as Hub of the National Biodiversity Centre funded under the National Recovery and Resilience Plan with 320 million euros. Due to reasons that I will explain later, the centrality that the protection of biodiversity could assume in the medium to long term suggests that NBCF might play a role and continue its action also after December 31st 2026 when PNRR (National recovery and resilience plan) expires.

Let's go back to the public law. On February 8th 2022 amendments to articles 9 and 41 of the Constitution were approved introducing environment, biodiversity and animal protection among the fundamental principles of the Constitutional Charter. For the first time, since 1948, the articles of the Constitution providing the so-called "Fundamental Principles" have been amended (articles 1 to 12).

The amendment of article 9 of the constitution places " the environment, biodiversity and ecosystems protection , also in the interest of the future generations" among the fundamental principles. It also provides that the State Law regulates ways and forms of animal protection.
The constitutional amendment also modifies the second paragraph of article 41. The amendment provides that private business is free and cannot be carried out as opposed to social utility or " jeopardizing health, environment, safety, freedom or human dignity", The article also provides that the law shall determine programmes and controls so that public and private activity can be directed towards "social and environmental goals".

Therefore article 9 of the Constitution not only protects the landscape but also the environment, the biodiversity and the ecosystems; on the other hand the private business cannot be carried out in conflict with health and environment. Consequently, if we wanted to apply the new principles to the construction of new works, for example, we could legitimately conclude that the assessment of the appropriateness (and legitimacy) of a new construction no longer depends solely on the need of protecting the landscape but also takes into consideration equally protected values such as environment, biodiversity and ecosystem. Accordingly an accurate balancing of interests is requested at administrative level – central or local – in order to assess, on a case by case basis, if the work to be realised brings

more benefit to environment, biodiversity and ecosystems in the interest of the future generations than the harm to the landscape.
A legal clarification should be made.

As explained by the Constitutional Court “protection of environment and of ecosystem” is not a hendiadys but rather two separate notions, where the first mainly relates to the human being habitat while the second relates to the conservation of nature as a value in itself (Judgment n. 12/2009) and hence a fortiori biodiversity gets an autonomous law assessment. According to Rio Convention definition of biological diversity, this is to be understood as the variability of all living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity as a concept “includes the variability among living organisms and between living organisms in the ecosystems” which is a different concept – though related – from the notions of “environment” and “ecosystems”.
Therefore, the synergistic protection of environment, ecosystems and biodiversity “also in the interest of the future generations” turns into a constitutional constraint leading to a sustainable development. It is to be highlighted the interweaving between the need of protection and the contemporary society’s equally pressing need to continue its economic development that – not to mention other needs – is indispensable to the creation of the revenue supporting the welfare state.

Now NBFC has the difficult mission of realising the PNRR project acting with foresight in a context of new constitutional laws. Protection of biodiversity and economic development are closely associated with the alliance between science, business and the production world, highlighting that without the economic development our southern cities, but not just them, would decay, failing to achieve the goal of maintaining and increasing the respect for the law. In this crucial connection there is a space that in the future could be taken by NBFC so that biodiversity protection may be successfully connected to the increase in prosperity. If environment protection were to be understood as a means of impoverishing the current lower and middle classes the concept of intergenerational solidarity – well expressed in paragraph three of article 9 – would be gone.

Final thoughts on the value of constitutional amendments.

Some, to belittle it, have dusted off the notion of programmatic constitutional law (which is not bounding or not even considered as a real rule of law) quickly dismissed by the Constitutional Court since its first decisions in the second half of the 1950’s.
Constitution is certainly a programme to the ordinary lawmaker since it is an axiological system but it is also a superordinate rule in comparison to regular rules of law and administrative provisions. Therefore those who think that biodiversity protection shall remain a wishful thinking will be disappointed. Protection will constitute a principle considered by the judge, in particular the administrative law judge, when verifying the activity carried out by the public administration in production. It can be assumed that the administrative law judge will operate in a more capillary and incisive way in comparison to the judicial review.

Companies have well understood that and in fact they are already showing interest in working with NBCF!

Luigi Fiorentino
*Presidente del National Biodiversity Future Centre*

# Opinion Statement

## Biodiversity is the solution

**Describe the Anthropocene as an environmental crisis is to ignore its most important message.
When people work together, supported by scientific and technological knowledge, they can influence politicians' decisions and change the world for the better.**

---

**WHY IS BIODIVERSITY THE SOLUTION?**

In the current status of climate change, habitat loss, local and global species extinction it is crucial to recognize the key role played by biodiversity in the functioning of the planet.
Biodiversity is essential to humanity and to the health of ecosystems which are the basis of the regeneration of environmental resources.

Among Mediterranean Countries Italy is one of the richest in biodiversity and endemic species. This is to be recognised and promoted.
For our Country protection and enhancement of biodiversity should be considered a priority with reference to both sustainable development and opportunities for young people.

Biodiversity is the solution because it guarantees:

1. **The functioning of ecosystems:**
Biodiversity guarantees ecosystems stability, resilience and functional relationships.

2. **Adaptation to climate change:**
Biodiversity mitigates the effects of the climate change reducing the impact of natural hazards such as floods, heat waves and landslide.

3. **Social and economical sustainability:**
Biodiversity is a support for justice and social equity. Furthermore it is the starting point for sustainable production processes, green jobs and many human primary activities such as fishing, farming and agricolture.

4. **Human well-being:**
Human health is closely connected to the biodiversity of the environment where people live; besides, biodiversity is the the starting point for the development of new pharmaceutical molecules, food supplements and food that can provide human health benefits.

5. **Safeguard of traditions and culture:**
Biodiversity in Italy is not only related to nature but is the very basis of our culture and our history determining the identity of our Country.

---

## WHY NATIONAL BIODIVERSITY FUTURE CENTRE IS NEEDED?

Despite the fact that over the last decades the national and international scientific community has been studying biodiversity also proposing effective solutions to preserve, restore, monitor and enhance it, a coordinating entity was missing able to gather and promote the research results on one hand, and on the other hand make accessible to public bodies knowledge and technologies allowing them to act on the territory. NBFC interpreted that need by creating a connection network hosting more than 2000 researchers coming from research institutes, universities and companies in order to carry on applied research and innovation related to Mediterranean biodiversity and create value for our country.

**Mission.** The term “Moonshot” taken from Apollo 11 mission that brought the man to the moon, symbolises technically complex audacious ventures aiming at reaching unattainable goals. As far as biodiversity is concerned, this concept translates into a mission which is crucial for the future of our planet. Biodiversity is the very basis of life on earth and today it is undergoing unprecedented pressures due to human activity. NBFC considers biodiversity care as a “Moonshot”, an ambitious goal requiring an action resulting from a coordinated decision made by scientists and social and business bodies.

01

# Italy, custodian of the Mediterranean biodiversity

## 1.1 Protecting future generations

**BIODIVERSITY FOR NEW GENERATIONS**

Past societies have distinguished themselves by their remarkable adaptability to the different environmental and climate conditions. Areas rich in water, with fertile soil, were the first to be inhabited, and there people developed farming and agricultural practices. Although the process of domestication, began 10,000 years ago, had impacted on biodiversity; both environment and ecosystems seemed to tolerate this process given its limited influence. The collapse started in the last century, in the Anthropocene Epoch, were the demographic growth associated with deep human-induced environmental and land changes, provoked serious effects on climate and biodiversity. It was not only a problem related to territorial expansion or to intensive agriculture but rather the consequence of a distorted view of nature seen as an element to be exploited in order to get an immediate revenue.

Anthropocene factors determining biodiversity loss and environmental erosion are rooted in models of production and consumption that evolved in a rather short period of time that resulted in the rapid growth of a species at the expense of others. Those models that do not consider the human being as a part of natural systems but rather outside them, did not lead to an equitable social well being generating instead profound inequalities between the countries and damaging seriously every ecosystem on the planet with a huge production of waste (originating the term Consumocene).

In order to reverse the trend, actions of conservation of nature had already been taken already in the last century leading, on 2024, to the protection of about 16% of the earth surface and 8.2% of marine areas. These values, although relevant, are considered and insufficient to guarantee future and present biodiversity resilience. According to Global Biodiversity Framework in order to favour the recovery of marine and terrestrial ecosystems it is necessary to protect at least 30% of the related areas. It is to be highlighted that biodiversity protection is not just a matter of numbers but also includes the quality of conservation strategies, the ecosystem dynamics and above all the balance between human being and nature.

The idea at the basis of National Biodiversity Future Center is that studying biodiversity not only has important implications in terms of land management and conservation but also in terms of construction of a new socio-cultural approach leading to a more resilient and sustainable future for all inhabitants of the planet. Protecting ecosystems is about ensuring that future generations may continue to enjoy the benefits of nature.

This concept is so important that is also mentioned in article 9 of our Constitution where the value of environmental, biodiversity and ecosystems protection in the interest of future generations is highlighted. Besides the moral obligation, there is the recognition of the heritage value and the implicit message that

our society should learn how to meet the present needs without jeopardizing the future generations' ability to meet their own needs by exploiting, better than we did, biodiversity.

È quindi necessario creare un nuovo rapporto tra l'uoTherefore it is necessary to create a new relationship between people and biodiversity. It is crucial to move from a dualistic vision in which there are "us" human being and "them" organisms composing biodiversity, to a model were we are a part of the natural systems. This means to leave Anthropocene, an epoch characterised by the conquer of some areas of the planet and by the adaptation to human needs, and enter Simbiocene (Albrecht, 2015). In this new epoch human being develop relationships of cooperation and mutual advantage (symbiosis) with other animal species and with the whole biosphere.

In order to lead this process of transformation, National Biodiversity Future Centre bases its research and innovation procedures on participatory models involving all people in the change according to **three main biodiversity perspectives**:

1. **Nature for nature** highlighting the importance of biodiversity conservation according to what it is and to what it offers in terms of evolution over time. This aspect emphasizes biodiversity changing nature in an environment that changes over time.

2. **Nature for Society** focusing on instrumental values and direct benefits that nature offers to people such as agricultural production, farming, provision of new medications and processes affecting environment and climate. This perspective is undoubtedly the one that most emphasize the dependence of our species on biodiversity.

3. **Nature as culture** enhancing biodiversity multidimensionality in human life considering scientific, artistic, cultural and religious aspects. This perspective leaves space for personal sensitivity emphasizing biodiversity as one of the more relevant elements to shape peoples' socio-cultural difference and their change over time.

In view of leaving to generations future resilient ecosystems, NBFC operates by developing scientific knowledge and technological innovation to conserve and restore biodiversity and by planning actions and efficient monitoring tools able to prevent erosion phenomena and promoting the culture of biodiversity.

# 1.2 Biodiversity in numbers

**PROTECTED AREAS**

**871** PROTECTED AREAS

**3 million** HECTARES OF PROTECTED LAND

**2.850.000** HECTARES OF PROTECTED SEA

**658 km** OF COAST

**24** NATIONAL PARKS

**16.000** HECTARES

**6%** OF THE NATIONAL AREA

ITALY IS ONE OF THE COUNTRIES WITH THE MOST PARKS IN EUROPE

**32** MARINE PROTECTED AREAS

**TERRESTRIAL ECOSYSTEMS**

(data taken from: IUCN 2023 Capotorti et al. 2023)

**85** TYPES OF TERRESTRIAL ECOSYSTEMS

**4** BROADLEAF EVERGREEN FORESTS

**30** DECIDUOUS BROADLEAF FORESTS

**10** CONIFEROUS FORESTS

**8** HERBACEOUS ECOSYSTEMS

**8** SHRUBLAND ECOSYSTEMS

**3** PSAMMOPHILUS ECOSYSTEMS

**4** ROCK AND GLACIER ECOSYSTEMS

**4** FRESHWATER HYGROPHILOUS ECOSYSTEMS

**3** COASTAL HALO-HYGROPHILOUS ECOSYSTEMS

**8** HYDROPHYTIC ECOSYSTEMS

**3** SALTWATER ECOSYSTEMS

**MARINE ECOSYSTEMS**

(Data taken from: Barcelona Convention (UNEP/MED, 2006)

**394** HABITAT IN THE DIFFERENT BAROMETRIC RANGES

**267** considered to be of high conservation value whose presence should be considered a priority in the maritime spatial planning and in new establishment of Marine Protected Areas.

(Montefalcone et al. 2021, Annex 1)

Classifying living organisms and analysing biodiversity of marine ecosystems is not so easy, The first obstacle to the creation of a proper inventory is the need of creating a standard classification system describing and mapping habitats. In the Mediterranean for over 100 years researchers have been trying to describe marine habits (mainly benthic) and the lack of a common terminology certainly does not help.

Recently a major effort was made related to Barcelona Convention (UNEP/MED, 2006) considering "habitat" as a main operating unit intended as a group or a set of bodies operating on a specific environmental area, distributed according to specific characteristics.

**ECOSYSTEMS AT RISK OF EROSION**

| STATUS OF THE NATION | NUMBER OF ECOSYSTEMS | PROTECTED $KM^2$ | PROTECTED $KM^2$ IN ITALY | PROTECTION COMPARED TO THE TOT. OF ECOSYSTEMS |
|---|---|---|---|---|
| CR | 7 | 957,3 | 0,3% | 0,7% |
| EN | 22 | 9146,8 | 3% | 7,1% |
| VU | 29 | 49260,4 | 16,3% | 38,5% |
| NT | 18 | 59512,6 | 19,7% | 46,5% |
| LC | 4 | 7395,1 | 2,4% | 5,8% |
| NE | 5 | 1808,07 | 0,6% | 1,4% |
| total | 85 | 128080,27 | 42,3% | 100% |
| **% at risk** | – | **46,30%** | **19,60%** | – |

CR(Critically Endangered); EN (Endangered); VU (Vulnerable); NT (Near Threatened); LC (Least Cocern); NE (Not Evaluated).

- 58 ecosystems at risk (7CR,22EN,29VU)
- 18 near threatened ecosystems (NT)
- 4 not at risk (LC)
- 5 not evaluated (NE)

The ecosystems at risk national surface (mostly vulnerable) is 19% corresponding to almost half of the whole surface covered by natural and semi-natural ecosystems (46,3%).


Italy's ecosystems map


A1- Residential areas with a continuous fabric, industrial, commercial and infrastructure areas, mining areas, building sites, dumpsites and artificial ground
A2 - Residential areas with discontinuous and sparse fabric
A3 - Urban green areas
B1 - Arable land
B2 - Rice paddies
B3 - Vineyards
B4 - Orchards and minor fruits
B5 - Olive groves
B6 - Arboriculture
B7 - Stable grassland (permanent forage)
B8 - Mixed agricultural areas
B9 - Areas predominantly occupied by agricultural crops with important natural areas
B10 - Agroforestry areas
C1 - Forest ecosystems with Quercus ilex subsp. ilex of Insubria
C2 - Quercus ilex subsp. ilex forest ecosystems of the Po Valley
C3 - Forest ecosystems, peninsular, with Quercus ilex subsp. ilex and/or Q. suber (and Q. callíprinos in Salento)
C4 - Forest ecosystems with Quercus ilex subsp. ilex and Q. suber on the larger islands
C5 - Alpine and pre-alpine forest ecosystems with Quercus petraea subsp. petraea and/or Q. robur subsp. robur
C6 - Alpine, pre-alpine and Karst forest ecosystems with Quercus pubescens subsp. pubescens, Q. cerris and/or Ostrya carpinifolia
C7a - Forest ecosystems of the Po Valley, lowlands, with Quercus robur subsp. robur
C7b - Forest ecosystems of the Po Valley, hilly, with Quercus petraea subsp. petraea e/o Q. pubescens subsp.pubescens
C8 - Apennine and sub-Apennine forest ecosystems with Quercus petraea and/or Q. cerris
C9 - Apennine and sub-Apennine forest ecosystems dominated by Quercus pubescens subsp. pubescens and/or Ostrya carpinifolia
C10 - Mesophilous peninsular forest ecosystems with Quercus cerris
C11 - Peninsular, thermophilous forest ecosystems, with Quercus cerris and/or Q. frainetto
C12 - Peninsular, thermophilous, forest ecosystems with Quercus virgiliana
C13 - Forest ecosystems of south-eastern thermophilic oak forests with Quercus virgiliana, Q. trojana subsp. trojana, Q. ithaburensis subsp. macrolepis or Q. frainetto
C14 - Peninsular, meso-hygrophilous forest ecosystems with Quercus robur
C15 - Forest ecosystems of the larger islands with deciduous oaks (Quercus virgiliana, Q. congesta, Q. ichnusae, Q. cerris)
C16 - Alpine, pre-alpine and Karst forest ecosystems, dominated by Ostrya carpinifolia, Fraxinus excelsior subsp. excelsior and/or Carpinus betulus
C17 - Forest ecosystems of the Po Valley with Carpinus betulus, Fraxinus excelsior subsp. excelsior and other mesophyll broadleaf trees
C18 - Peninsular forest ecosystems (locally in the larger islands), from lowland to submontane, with Ostrya carpinifolia, Fraxinus ornus subsp. ornus, Carpinus betulus, C. orientalis subsp. orientalis, Ulmus minor subsp. minor
C19 - Alpine and pre-alpine forest ecosystems with Castanea sativa
C20 - Forest ecosystems of the Po Valley with Castanea sativa
C21 - Forest ecosystems of the Peninsular, hilly and sub-mountainous regions, with Castanea sativa
C22 - Forest ecosystems with Castanea sativa, hilly and mountainous, of the larger islands
C23 - Alpine and pre-alpine forest ecosystems with Fagus sylvatica subsp. sylvatica, with Picea abies, Abies alba, Sorbus aucuparia
C24 - Apennine and sub-Apennine forest ecosystems with Fagus sylvatica subsp. sylvatica, with Abies alba, Taxus baccata, Ilex aquifolium, Acer cappadocicum subsp. lobelii
C25 - Forest ecosystems of southern Italy with Fagus sylvatica subsp. sylvatica, with Abies alba, Acer psudoplatanus, Ilex aquifolium, Quercus congesta, Q. dalechampii and Q. petraea subsp. austrothyrrenica
C26 - Riparian, alpine and pre-alpine forest and shrub ecosystems with Salix alba, S. eleagnos, S. myrsinifolia, S. daphnoides, Populus alba, Myricaria germanica, Alnus incana, Fraxinus excelsior subsp. excelsior
C27 - Riparian forest and shrub ecosystems of the Po Valley with Salix alba, Populus alba, P. nigra subsp. nigra , Alnus glutinosa, Viburnum opulus
C28 - Riparian forest and shrub ecosystems, peninsular, with Salix alba, S. purpurea subsp. purpurea, S. brutia, Populus alba, P. nigra subsp. nigra, Alnus glutinosa, Fraxinus angustifolia subsp. oxycarpa, Hypericum hircinum subsp. Majus
C29 - Riparian forest and shrub ecosystems, of the Major Islands, with Salix alba, S. gussonei, S. arrigonii, S. atrocinerea subsp. atrocinerea, Populus alba, Fraxinus angustifolia subsp. oxycarpa, Nerium oleander subsp. oleander, Tamarix sp. pl., Vine
C30 - Forest ecosystems, alpine and pre-alpine, with allochthonous broadleaf trees (Robinia pseudoacacia, Acer negundo, Quercus rubra, Populus ×canadensis, Amorpha fruticosa)
C31 - Forest ecosystems of the Po Valley with allochthonous broadleaf trees (Robinia pseudoacacia, Amorpha fruticosa, Prunus serotina)
C32 - Forest ecosystems, peninsular, with allochthonous broadleaf trees (Robinia pseudoacacia, Ailanthus altissima, Eucalyptus sp. pl.).
C33 - Forest ecosystems of the major islands with allochthonous broadleaf trees (Robinia pseudoacacia, Eucalyptus sp. pl.)
C34 - Forest ecosystems of the north-Adriatic coasts with Pinus pinaster subsp. pinaster and/or P. pinea
C35 - Forest ecosystems, coastal and hilly, peninsular (locally in Insubria), with Pinus pinaster subsp. pinaster, P. pinea and/or P. halepensis
C36 - Forest ecosystems with Pinus pinaster subsp. pinaster, P. pinea and/or P. halepensis on the Major Islands
C37 - Forest ecosystems of the Alps, Pre-Alps and Karst with Pinus sylvestris and/or P. nigra subsp. nigra
C38 - Forest ecosystems of the Po Valley with Pinus sylvestris and/or P. nigra subsp. nigra
C39 - Peninsular and Sicilian forest ecosystems, mountainous, with P. nigra subsp. nigra, P. heldreichii subsp. leucodermis and/or P. nigra subsp. laricio
C40 - Alpine and pre-alpine forest ecosystems with Picea abies and/or Abies alba
C41 - Apennine forest ecosystems with Picea abies and/or Abies alba
C42 - Pre-Alpine and Alpine forest ecosystems with Pinus cembra and/or Larix decidua
C43 - Forest ecosystems with allochthonous conifers (Pinus strobus, Pseudotsuga menziesii, Cedrus sp. pl., Cupressus sp. pl.)
D1 - Herbaceous ecosystems, mountainous and high-mountainous, of the Alps, with Carex myosuroides, C. curvula, C. firma, Festuca violacea subsp. violacea, Sesleriella sphaerocephala
D2 - Herbaceous, mountainous and hilly ecosystems of the Alps, with Trisetaria flavescens, Brachypodium pinnatum, Lolium perenne
D3 - Herbaceous, low-lying and foothill ecosystems of the Alps and lowlands of the Po Valley, with Arrhenatherum elatius, Alopecurus pratensis subsp. pratensis, Sanguisorba officinalis, Chrysopogon gryllus
D4 - Apennine, mountain and high mountain herbaceous ecosystems with Sesleria juncifolia subsp. juncifolia, S. nitida subsp. nitida, Festuca violacea subsp. italica, Nardus stricta, Carex kitaibeliana
D4 - Apennine herbaceous ecosystems, mountainous and high mountainous, with Sesleria juncifolia subsp. juncifolia, S. nitida subsp. nitida, Festuca violacea subsp. italica, Nardus stricta, Carex kitaibeliana
D5 - Herbaceous, peninsular, mountain and hillside ecosystems with Brachypodium genuense, B. rupestre, Bromopsis erecta subsp. erecta and Cynosurus cristatus, with local occurrences of Dasypyrum villosum and Trifolium sp. pl.
D6 - Herbaceous, low hill and foothill ecosystems of the central-northern Apennines, with Dasypyrum villosum, Avena sp. pl., Trifolium sp.pl., Dactylis glomerata
D7 - Herbaceous, montane, southern Apennine and insular ecosystems, with Stipa sp. pl., Festuca morisiana subsp. morisiana, Armeria sardoa
E1 - Shrub ecosystems, mountainous and high mountainous, of the Alps, with Pinus mugo, Rhododendron sp. pl., Vaccinium sp.pl.
E2 - Shrub ecosystems, mountainous and hilly, in the Alps and Karst, with Alnus alnobetula, Salix sp. pl., Berberis vulgaris, Erica carnea subsp. carnea, Juniperus communis
E3 - Shrubby, hilly ecosystems of the Alps and lowlands of the Po Valley, with Calluna vulgaris, Genista cinerea, Cytisus scoparius subsp. scoparius
E4 - Shrubby, mountainous, Apennine ecosystems, with Juniperus communis subsp. alpina, Pinus mugo subsp. mugo, Vaccinium myrtillus, Oreoherzogia fallax
E5 - Shrub, mountainous ecosystems of southern Italy and the larger islands, with Juniperus hemisphaerica, Astragalus sp. pl., Berberis aetnensis, Genista sp. pl.
E6 - Shrub ecosystems, hilly and lowland peninsular (locally in Insubria), with Spartium junceum, Rosa sp. pl., Crataegus monogyna, Juniperus oxycedrus, Prunus spinosa subsp. spinosa, Rubus ulmifolius, Cytisus scoparius subsp. scoparius, C. vill.
E7 - Shrub ecosystems with evergreen, peninsular species in Phillyrea latifolia, Arbutus unedo, Erica arborea, Pistacia lentiscus, Myrtus communis, Rosa semperviren
E8 - Shrub ecosystems with evergreen, island species Olea europaea var. sylvestris, Ceratonia siliqua, Pistacia lentiscus, Myrtus communis, Euphorbia dendroides
F1 - Chasmophytic (Asplenium petrarchae subsp. petrarchae, Bituminaria morisiana, Dianthus rupicola, D. sardicola, Centaurea gr. ucriae, Brassica sp. pl., Polypodium cambricum) and glareicolous inland and coastal ecosystems of the Major Islands
F2 - Peninsular psammophilous ecosystems with Cakile maritima subsp. maritima, Sporobolus virginicus, Elymus farctus, Achillea maritima subsp. maritima, Silene canescens, Calamagrostis arenaria subsp. arundinacea, Crucianella maritima
F3 - Psammophilous ecosystems of the larger islands with Cakile maritima subsp. maritima, Armeria pungens, Silene succulenta subsp. corsica, Elymus farctus, Calamagrostis arenaria subsp. arundinacea, Daucus rouyi, Ephedra fragilis, Seseli tortuosum subsp. marit
F4 - Alpine chasmophytic (Potentilla nitida, Campanula sp. pl., Androsace vandellii, Primula hirsuta, Saxifraga bryoides, S. cotyledon) and glareicolous (Noccaea rotundifolia, Androsace alpina, Artemisia genipi, Trisetaria distichophylla ) ecosystems
F5 - Apennine and peninsular coastal Casmo-Comophytic ecosystems (Potentilla apennina, Primula apennina, Saxifraga callosa subsp. callosa, Campanula fragilis, Dianthus rupicola subsp. rupiccola, Antirrhinum siculum, Lomelosia crenata, Centa
F6 - Ecosystems of the inland and coastal reliefs of the larger islands, chasmophytic (Asplenium petrarchae subsp. petrarchae, Bituminaria morisiana, Dianthus rupicola, D. sardous, Centaurea gr. ucriae, Brassica sp. pl., Polypodium cambricum) and glareicolous
F7 - Glaciers and perennial snows
G1 - Hygrophilous, riparian (locally glareicolous) and moorland, dulcicolous, alpine ecosystems with Calamagrostis pseudophragmites, Phragmites australis, Caltha palustris, Carex rostrata, C. diandra, Chamaenerion fleischeri, Petasites paradoxus
G2 - Hygrophilous riparian, dulcicolous ecosystems of the Po Valley with Phragmites australis, Typha sp. pl., Arundo donax, Carex riparia, Agrostis stolonifera, Polygonum sp. pl., Cladium mariscus, Scrophularia canina, Chamaenerion dodonaei
G3 - Hygrophilous riparian, dulcicolous, peninsular ecosystems with Phragmites australis, Typha sp. pl., Arundo donax, Carex riparia, C. acuta, Agrostis stolonifera, Ranunculus flammula, Scirpoides holoschoenus, Paspalum sp. pl., Scrophularia canina, Helichrysu
G4 - Hygrophilous riparian, dulcicolous ecosystems of the larger islands with Phragmites australis, Typha sp. pl., Arundo micrantha, Carex panormitana, C. microcarpa, Agrostis stolonifera, Helichrysum italicum subsp. tyrrhenicum, Santolina insularis, Paspalum va
G5 - Coastal, north Adriatic, aloigrophilous ecosystems with Salicornia veneta, Sporobolus maritimus, Salicornia fruticosa, Salicornia perennis, Limonium narbonense, Juncus maritimus, Spirobassia hirsuta
G6 - Coastal, peninsular, alo-hygrophilous ecosystems with Salicornia perennans subsp. perennans, Salicornia fruticosa, Halimione portulacoides, Arthrocaulon macrostachyum, Limonium narbonense, Juncus acutus subsp. acutus, Carex extensa, Puccinellia festucifo
G7 - Halo-hygrophilous, coastal ecosystems of the larger islands, with Salicornia procumbens subsp. procumbens, S. perennans subsp. perennans, Salicornia perennis, Halopeplis amplexicaulis, Arthrocaulon meridionale, Halocnemum cruciatum, Limonium narbonense, L. v
G8 - Hydrophytic, dulcicolous, lentic, alpine ecosystems with Chara sp. pl., Nitella sp. pl., Lemna sp. pl., Myriophyllum alterniflorum, Potamogeton alpinus, Stuckenia filiformis, Isoëtes echinospora, Sparganium angustifolium, Littorella uniflora, Ranunculus
G9 - Hydrophytic, dulcicolous, lentic ecosystems of the Po Valley, with Chara sp. pl., Lemna sp. pl., Salvinia natans, Potamogeton acutifolius, P. perfoliatus, Nymphoides peltata, Trapa natans, Hottonia palustris, Ranunculus circinatus, Utricularia austra
G10 - Hydrophytic, dulcic, lentic, peninsular ecosystems with Chara sp. pl., Nitella hyalina, Lemna sp. pl., Ceratophyllum demersum, Hydrocharis morsus-ranae, Potamogeton lucens, P. schweinfurthii, P. trichoides, Ranunculus baudotii, Najas minor
G11 - Hydrophytic, dulcicolous, lentic ecosystems of the larger islands with Chara sp. pl., Lemna sp. pl., Ceratophyllum demersum, C. submersum subsp. submersum, Potamogeton natans, P. schweinfurthii, P. pusillus, P. coloratus, Myriophyllum alterniflorum
G12 - Hydrophytic, dulcicolous, lotic and spring ecosystems, alpine, with Ranunculus trichophyllus, R. penicillatus, Cardamine amara, Epilobium alsinifolium, Carex frigida, Saxifraga aizoides, Stellaria alsine
G13 - Hydrophytic, dulcicolous, lotic and spring ecosystems of the Po Valley, with Ranunculus trichophyllus, Isoëtes malinverniana, Callitriche sp. pl., Hippuris vulgaris
G14 - Hydrophytic, dulcicolous, loticolous, peninsular ecosystems with Ranunculus trichophyllus, Helosciadium nodiflorum subsp. nodiflorum, H. inundatum, Glyceria fluitans, Baldellia ranunculoides, Nasturtium officinale
G15 - Hydrophytic, dulcicolous, loticolous ecosystems of the larger islands with Ranunculus penicillatus, R. baudotii, Myriophyllum alterniflorum, Potamogeton nodosus, P. crispus, Isoëtes tiguliana, Zannichellia obtusifolia
G16 - Coastal, north Adriatic, brackish ecosystems with Cymodocea nodosa, Zostera marina, Ruppia maritima, Zannichellia pedunculata, Chaetomorpha linum
G17 - Saline, coastal, peninsular ecosystems with Cymodocea nodosa, Zostera marina, Nanozostera noltei, Ruppia maritima, R. spiralis, Stuckenia pectinata, Zannichellia palustris, Ulva lactuca
G18 - Coastal, brackish ecosystems of the larger islands with Cymodocea nodosa, Nanozostera noltei, Ruppia spiralis, Zannichellia obtusifolia, Althenia filiformis subsp. Filiformis

As far as see is concerned, it is well known that Europe's largest part of habitat threatened by degradation is in Mediterranean Sea (32%).

| RED LIST CATEGORY | EU28 | EU28+ |
|---|---|---|
| CR | 0 | 0 |
| EN | 5 | 4 |
| VU | 10 | 10 |
| NT | 5 | 3 |
| LC | 4 | 2 |
| DD | 23 | 28 |
| total | 47 | 47 |

CR (Critically Endangered - threatened with extinction); EN (Endangered-threatened); VU (Vulnerable); NT (Near threatened); LC (least concern - not threatened) DD (Data Deficient)

**Ecosystems Risk Factors:**

Risk factors threatening the largest number of terrestrial ecosystems belonging to the different ecoregions are:

- The geographical distribution narrowing (in all ecoregions, slightly less marked in Alpine and Appennine provinces)
- Intensive agriculture (mainly in Padan Basin, Tyrrhenian and Adriatic ecoregional provinces)
- Biological invasions (above all in Padanian Basin and Tyrrhenian ecoregional provinces)
- Land consumption, resulting in artificialization phenomena also inside ecosystems (Tyrrhenian, Padan Basin and Alpine ecoregional provinces)
- Forest fires (mainly in Tyrrhenian ecoregional province)

---

**PLANT BIODIVERSITY IN ITALY**

**DATA ON ITALIAN FLORA** (data taken from Galasso et al. A second update to the checklist of the vascular flora alien to Italy. Plant Biosystems)

**8241** NATIVE PLANT SPECIES AND SUBSPECIES

**23** LYCOPHYTES

**108** FERNS

**8080** ANGIOSPERMAE

**30** GYMNOSPERMS

**20%** of the Italian Flora: exclusive endemic species (1702 taxa)

**VEGETATION** (from: Blasi C. editor. 2010. La vegetazione d'Italia con carta delle serie di vegetazione in scala 1: 500000. Rome, Italy: Palombi Editori)

**279** TYPES OF NATURAL VEGETATION

**225** FOREST STRUCTURED

**45** SHRUBBY AND HERBACEOUS alpine and oro mediterranean altitude

**4** SHORES AND COASTAL DUNES

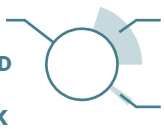
**5** AQUATIC ENVIRONMENT

With respect to this potential diversity, the plant communities listed for Italy (systematic units which also include the replacement stages of mature vegetation) refer to 395 alliances arranged within 175 orders and 75 classes.

With reference to the Habitats Directive 92/43/EEC, the Italian Manual for the Interpretation of Habitats also recognises for the national territory the presence of 132 habitats among the 233 listed at EU level. (http://vnr.unipg.it/habitat/index.jsp).

## SPECIES AT RISK

**2500** TAXA EVALUATED FOR THEIR EXTINCTION RISK



**24%** THREATENED WITH EXTINCTION

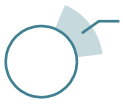
**54** EXTINCT UNITS

**1702** ENDEMIC ITALIAN SPECIES

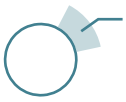
**20%** THREATENED WITH EXTINCTION

2500 taxa of Italian flora (chosen between endemic species, international-level protected species and interesting from a protection point of view because belonging to particularly threatened environments such as coastal and humid) have been assessed threatened with extinction by the Italian Society of Botany (SBI) researchers.

Of the 2500 taxa as many as 500 native plants (24% of the assessed taxa) ere threatened with extinction and 54 unit are already extinct.
Considering only the Italian endemic species (1702) about 300 taxa (almost 20% of the Italian endemic flora) are close to the threshold of extinction.



**16.6%** of the assessed taxa (404 taxa) show deficient data therefore it's not possible to establish how close they are to extinction.

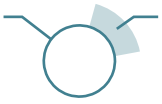


**14%** of endemism (247) show deficient data therefore it is not possible to establish how close they are to extinction.

(data taken from: Orsenigo, S., et al. "Red Listing plants under full national responsibility: extinction risks and threats in the vascular flora endemic to Italy. Biological Conservation 224: 213-222." (2018); Orsenigo, Simone, et al. "Red list of threatened vascular plants in Italy." Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology 155.2 (2021): 310-335)

## PLANTS – EXOTIC SPECIES

**10023** TOTAL PLANTS IN ITALY



**1782** EXOTIC SPECIES

**2** TAXA LYCOPHYTES

**13** FERNS AND RELATED

**1730** ANGIOSPERMS

**37** GYMNOSPERMS

**899** ALIEN SPECIES IN ITALY

**649** NATURALISED

**250** INVASIVE

**796** TAXA CASUAL ALIENS

## FAUNAL BIODIVERSITY IN ITALY

Based on the 1995 Checklist drafted by the Scientific Committee for the Fauna of Italy with the Ministry for Environment, the fauna of our country was composed of 55,608 Metazoa species of which 97.8% were invertebrates (46,000 arthropod species of which almost 37,000 insects), and 1,814 Protozoa.

In a 2007 update, the species surveyed were 56,897 (+ 2000 protozoa) and the new Checklist being drawn up this year ranges from 61.000 to 63.000 species of Metazoa.

**61.000** ANIMAL SPECIES IN ITALY

**38.500** INSECTS

A 2024 update estimates an animal diversity of about 61.000 species. As far as insects are concerned the presence of about 38.500 species is hypothesized. The huge diversity of Italian fauna is due to Tertiary and Pleistocene geological history, environmental mosaicism and the presence of ancient islands.

### ENDANGERED SPECIES: ANIMALS

**20%** of species and subspecies of terrestrial and freshwater fauna are **ENDEMIC** or **SUB ENDEMIC**

**31%**
OF AMPHIBIANS ARE ENDEMIC

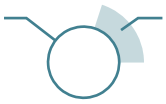
**18,3%**
OF FRESHWATER BONY FISHES ARE ENDEMIC

20% of the total of terrestrial and freshwater fauna species and subspecies are endemics or sub endemics. Very high percentages of endemism occur obviously among insects, but also among vertebrates: amphibians are 31% endemic and freshwater bony fish 18.3%. Even some species of small mammals are exclusive to Italy.

### DATA ON "FLAGSHIP" SPECIES

**552** species of birds flagged in Italy

**280**
NESTING



**26%**
IN THREAT CATEGORIES OF IUCN RED LIST

**17 SPECIES OF AMPHIBIAN**
IN THREAT CATEGORIES OF IUCN RED LIST

**19 SPECIES OF REPTILES**
IN THREAT CATEGORIES OF IUCN RED LIST

**126**
MAMMALS

**59**
OF EU INTEREST

Among vertebrates, birds have at least 552 species reported in Italy of which 280 are breeding and the others as migratory, wintering or erratic. At least 26% of the breeding species in Italy fall into a category of threat on the Italian IUCN Red List.

In the herpetofauna, 17 species of amphibians and 19 species of reptiles fall into Italian IUCN Red List threat categories. Among the 126 mammals, 59 are of EU interest.

### THE ECOREGIONAL DIVERSITY

Both the climatic heterogeneity and the high degree of articulation of the lithomorphological features are mainly due to the orographic complexity of the Italian territory, which is characterised by two major mountain chains, the Alps and the Apennines, extensive hilly and plateau areas, by the wide Po alluvial plain, widespread and heterogeneous river valleys, large and small islands and a natural coastline of approximately 7,500 km, in addition to the latitudinal extension.
One of the elements that contributes to the high environmental heterogeneity is undoubtedly the climate variability. Although completely surrounded by the Mediterranean sea, Italy has a relatively mild Mediterranean climate which is mainly concentrated along the Tyrrhenian coast, and Calabria, Sicily, Sardinia and Salento coast.
About 50% of the national territory has temperate climate conditions and about 25% sub-Mediterranean climate conditions. To this remarkable heterogeneity and articulation of the physical characteristics of the environment it is to be added a complex palaeogeographical and paleoclimatic history that determined the current presence of a very rich flora and fauna of great biogeographical value, combined with an equally articulated vegetation and ecosystem structure further diversified by human activities.


Ecoregions of Italy:

← Divisions and Provinces
↓ Sections and sub sections

(Images taken from the Report on the state of Natural Capital in Italy, 2017)

| 1 Temperate Division |
|---|
| 1A Alpine Province |
| 1A1 Western Alps Section |
| 1A1a Alpi Marittime Subsection |
| 1A1b Northwestern Alps Subsection |
| 1A2 Central and Eastern Alps Section |
| 1A2a Pre-Alps Subsection |
| 1A2b Dolomiti and Carnia Subsection |
| 1A2c Northeastern Alps Subsection |
| 1B Po Plain Province |
| 1B1 Po Plain Section |
| 1B1a Lagoon Subsection |
| 1B1b Central Plain Subsection |
| 1B1c Western Po Basin Subsection |
| 1C Apennine Province |
| 1C1Northern and Northwestern Apennine Section |
| 1C1a Toscana and Emilia-Romagna Apennine Subsection |
| 1C1b Tuscan Basin Subsection |
| 1C2 Central Apennine Section |
| 1C2a Umbria and Marche Apennine Subsection |
| 1C2b Lazio and Abruzzo Apennine Subsection |
| 1C2c Marche and Abruzzo Sub-Apennine Subsection |
| 1C3 Southern Apennine Section |
| 1C3a Campania Apennine Subsection |
| 1C3b Lucania Apennine Subsection |
| 1D Italian part of the Illyrian Province |

| 2 Mediterranean Division |
|---|
| 2A Italian part of Ligurian-Provencal Province |
| 2B Tyrrhenian Province |
| 2B1 Northern and Central Tyrrhenian Section |
| 2B1a Eastern Liguria Subsection |
| 2B1b Maremma Subsection |
| 2B1c Roman Area Subsection |
| 2B1d Southern Lazio Subsection |
| 2B2 Southern Tyrrhenian Section |
| 2B2a Western Campania Subsection |
| 2B2b Cilento Subsection |
| 2B2c Calabria Subsection |
| 2B3 Sicilia Section |
| 2B3a Iblei Subsection |
| 2B3b Sicilia Mountains Subsection |
| 2B3c Central Sicilia Subsection |
| 2B3d Western Sicilia Subsection |
| 2B4 Sardegna Section |
| 2B4a Southwestern Sardegna Subsection |
| 2B4b Northwestern Sardegna Subsection |
| 2B4c Southeastern Sardegna Subsection |
| 2B4d Northeastern Sardegna Subsection |
| 2C Adriatic Province |
| 2C1 Central Adriatic Section |
| 2C1a Marche and Abruzzo Coastal Subsection |
| 2C2 Southern Adriatic Section |
| 2C2a Gargano Subsection |
| 2C2b Murge and Salento Subsection |

This extraordinary complexity has been synthesized thanks to the division of the national territory into ecoregions hierarchically organized into 2 Divisions, 5 main Provinces and 2 trans-national province parts, 12 Sections and 33 Sub sections (Blasi et al., 2018).
This territorial ecological subdivision has been adopted as official statistics starting from 2020 (ISTAT: https://www.istat.it/it/archivio/224780), and is useful to interpret the species and ecosystems richness and also represents a valuable reference to assess the current status of EUAP and Natura 2000 protected areas and to direct the future efforts of both proactive and reactive protection. (Capotorti et al., 2012)

**Biodiversity is the solution because Italy has great responsibility towards the other countries of the European Union and towards the Mediterranean countries.**

**Italy is the country with the greatest abundance of species, of habitats and with the highest rate of endemic species.**

**Well over 50% of the plant species and 30% of the animal species coming under EU conservation Interest are Italian endemic species, i.e. live only within our boundaries.**

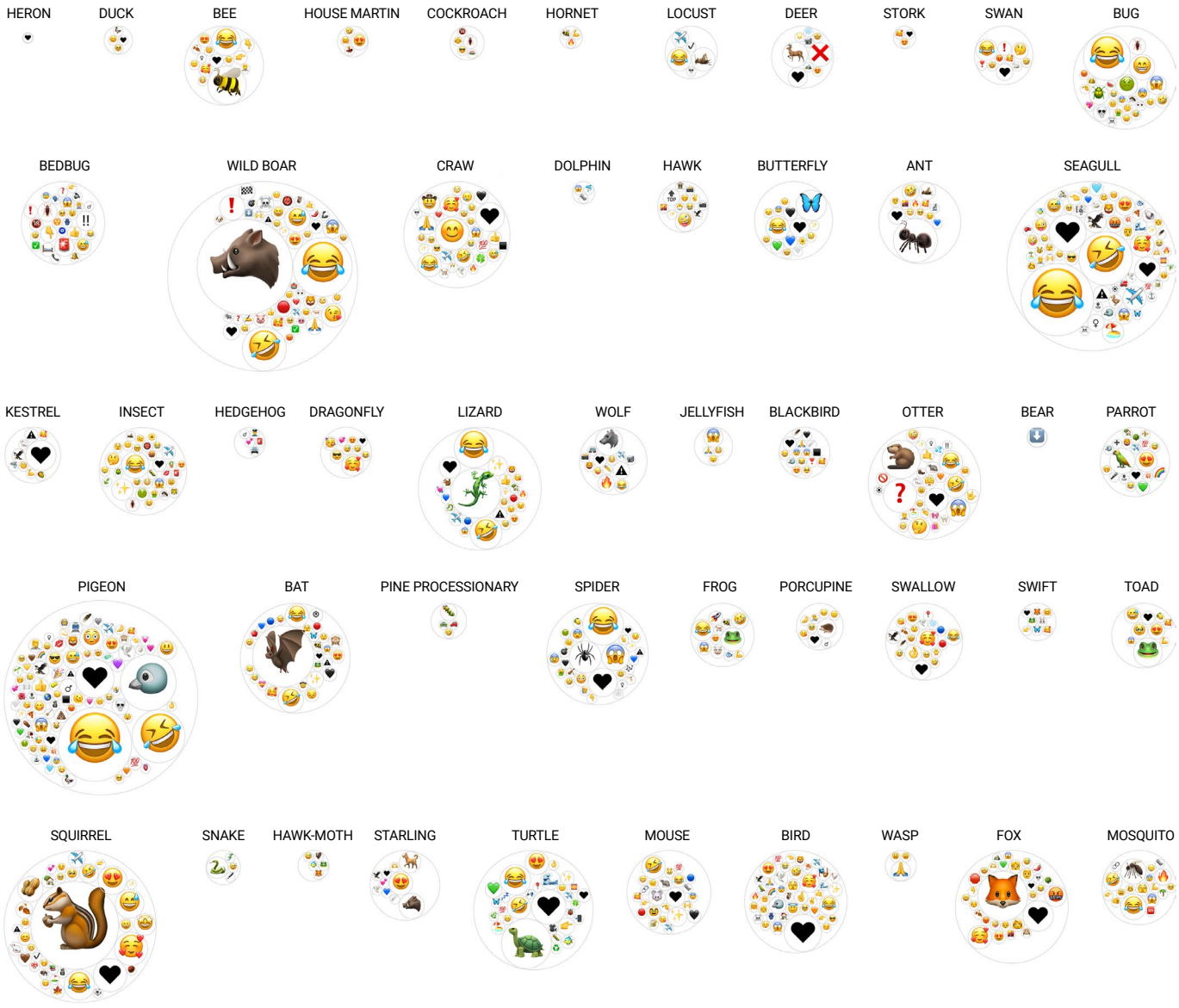
## 1.3 The perception of biodiversity

There is a broad social consensus on the importance of conserving and restoring biodiversity, but often in common perception this objective remains rather abstract. The initiatives implemented by administrations at various levels and on different scales such as the establishment of new parks and protected areas, the creation of shared gardens, reforestation projects and de-asphalting of roads are more tangible than propaganda actions and often generate conflicts between the different actors, starting with the inhabitants of the area who may perceive such initiatives as an imposition. NBFC has always operated according to participatory models where all interested people participate in research actions aimed at improving nature. The crucial point however, is knowledge.
What do the 'non-experts' think about biodiversity?
The National Biodiversity Future Centre has set up online forums, blogs and social media. In these forums, different actors present their arguments and express their positions through pictures, memes, videos, hashtags and comments. Therefore these spaces are crucial for capturing the multiplicity of actors, voices and perspectives connected to the theme of biodiversity and its perception. NBFC has developed innovative digital methods for collecting and analysing the opinions of different user groups on different biodiversity-related topics with the aim of generating a digital observatory capable of collecting suggestions, opinions and proposals. The observatory aims to be a point of contact between Conservation, Enhancement and Restoration of Biodiversity activities implemented by NBFC and by the civil society.
The first action of this observatory was to assess whether citizens really know about biodiversity and thus whether they are ready to bring it back into their daily lives.

A first study carried out by NBFC concerned the perception of the population related to urban animals. We started with videos obtained from TikTok concerning

more than 30 animal species and we generated a "bestiary" focusing on how they are represented on the platform. The analysis results in a map of the "taxonomic bias" showing which animal are most popular and which are less popular. Pigeon, wild boar, seagull and squirrel are the most mentioned animals in the Italian urban environment, while smaller animals such as bees and butterflies rarely appear in users' videos; exceptions to this are the bug and the mosquito that are more mentioned but most often negatively. The interesting aspect is the association between animals and some descriptions, words that users use to talk about them. For example, some animals such as wild boar and spiders are often associated with the adjective "dangerous" while animals such as squirrels and otters are associated with positive adjectives (nice and good). The first element that emerges is that users, for example, do not distinguish between local and alien species; an example is the red and grey squirrel. The emotional aspect is also interesting: there animals that arouse feelings of wonder and amazement like the heron, the stork, the butterfly and the parrot (the latter is alien) and animals arising negative feelings of disgust and annoyance like spiders, bugs, mosquitos, and other insects that are essential for ecosystems functional biodiversity.

What emerges from this short experiment is that there is a need for a widespread knowledge about biodiversity, education about nature and its protection both in order to make protection activities operational and for the citizens to become a strategic support element to countering erosion threats and loss of species.




Emoji most commonly associated with the different urban animals on TikTok Italy

(Michele Mauri, Gabriele Colombo, Alessandra Facchin)

# 1.4 Biodiversity: from knowledge to culture

NBFC strategy plan to implement the knowledge of biodiversity and to generate culture is composed of **4 ACTIONS**:

---

**1. LET'S TRAIN OUR YOUNG PEOPLE**

1 The 1st National Doctoral programme on biodiversity has been established. Born in 2023, it is already attended by 35 active students. Almost 200 PhD students should be added, coming from other universities, who reached the Centre to attend biodiversity-related training and research courses.

2 We are going to train a new generation of Biodiversity Experts. That is experts on living organisms and their classification.
These professional figures will be the basis of green jobs, therefore NBFC offers a wide choice of courses combining base scientific and taxonomic knowledge with innovative tools such as AI, bioinformatics and genomics that they can enhance.
This action includes masters of biodiversity, teachers and people interested in specific groups of organism who will generously transmit their knowledge to the future generations.

---

**2. LET'S CREATE TOOLS FOR CITIZENS**

1 Tools. NBFC has developed simple species identification tools, dedicated portals with updated surveys and scientific and educational publications that can be used by the citizens in order to prevent the entry of alien species and protect endemic organisms.

2 Participatory planning. NBFC has developed participatory planning methods where the citizen is actively involved in planning, realising and managing areas rich in biodiversity.

**3. LET'S SUPPORT INSTITUTIONS**

1 NBFC aims at being the scientific reference of the Ministry of Research for biodiversity conservation and management and consequently provides public bodies and institutions with scientific guidelines related to biodiversity conservation, monitoring and restoration.

2 Direct relationship with public authorities. NBFC carried out coordination actions with local authorities in order to support biodiversity protection and territorial redevelopment providing actions ranging from scientific support to urban forestation.

**4. LET'S EXPLAIN BIODIVERSITY**

In a country where humanistic culture has always overcome scientific and naturalistic culture, in order to make citizens understand the importance of biodiversity it is crucial to talk about theoretical and practical aspects of research and innovation referred to biodiversity. This is why an action on territory is needed with events and exhibitions bringing science closer to citizens also enhancing its cultural meaning. In this regard NBFC has planned and will organise a great national exhibition in one of the points of reference of art exhibit in the Capital: Palazzo delle Esposizioni.

The exhibition purpose is bringing together art and science, the naturalist and the innovator through both an imagination mood and real case study. The exhibition will include events and training path concerning not only biodiversity but also the "One health" subject connecting planet and human health according to the new EU policies and more. Information on One health will be also integrated by publishing products such as books, podcasts and webpages.

# 1.5 Services provided by biodiversity

Biodiversity is not just a list of species living in certain environments but is also the set of interactions that they develop among themselves and with the environment: this set constitutes the true value of biodiversity. Interactions among species are fundamental because they underlie all ecosystems and generate value: from maintaining ecosystems stability, to energy production to the recirculation and regeneration of environmental resources.
Understanding how much and how these interactions act on biodiversity well-being, ecosystem stability, and the quality of life and well-being of humans is a priority aspect for a sustainable development and is the cornerstone of NBFC activities.

In particular, NBFC research activities led to an approach based on the functioning of systems bringing gradual benefits. These systems rely on a strengthening of the relationship between organisms and environment and on biodiversity maintenance and consequently they are more sustainable and long-lasting. This new vision is born from the knowledge of ecosystems and from the awareness of direct and indirect benefits that they can produce for humans and environment.

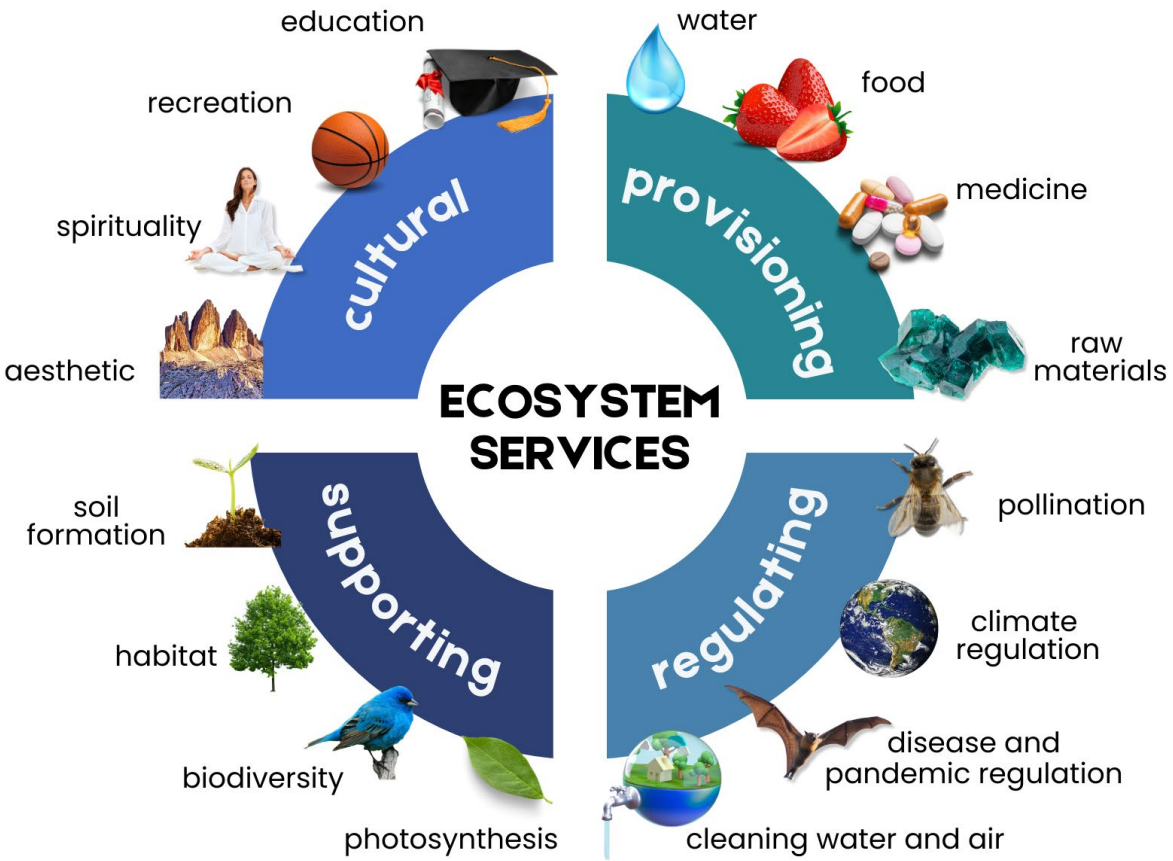
Ecosystem Services makes the mentioned "human benefits" measurable according to four main categories: supply, regulation, support, culture.

**SUPPLY**
Is referred to the direct value that ecosystems provide to society such as food, raw materials, medicines and bioactive compounds. In this regard NBCF focused on enhancing this type of services, for example in fisheries sector as well as in that of forests, by setting scientific data based rules, in order not to endanger fish stocks in our seas, forests, or create negative relationships between agriculture, farming and biodiversity. Also new species are being studied, including alien and invasive species, which could provide important resources for industry (e.g. food), human well-being and environmental redevelopment.

**SUPPORT**
The most basic ecosystem services contributing for example to soil formation, to photosynthesis, and to the cycle of nutrients that are essential for the generation of minerals such as nitrogen, phosphorus and potassium which are key elements for organisms growth and development . NBFC is developing strategies to maximise photosynthesis also supporting forestation and green areas diffusion projects, and actions aiming at supporting reproduction, nutrition and sheltering for every living organism in the different Mediterranean environments.

**REGULATION**
Biodiversity contributes to water and air circulation directly affecting climate and mitigating the extreme events. In this regard, in addition to identifying appropriate strategies to fight climate change and reduce pollution, NBFC implements strategies to promote the most complex ecosystem regulation services such as pollination, seed dispersal, balance between prey and predators, and between parasites and parasitoids that are crucial to prevent pandemic events.

**CULTURE**
Is referred to non material benefits provided to humans by ecosystems and their inhabitants trough spiritual enrichment, cognitive development, thinking and landscape aesthetic, artistic and scientific suggestions.
In this regard NBFC acts by involving people in the processes of knowledge and enhancement of biodiversity, in actions of conservation of land and animal species and stimulating participation in natural ecosystems planning and management.



NBFC, taking into account the mentioned categories, analysed the status of the different Ecosystem Services in order to guide scientifically the actions of restoration of altered ecosystems, support planning environmental redevelopment projects also considering consequences on the socio-economic and cultural context.
In addition to feeding the NBFC data platforms, information gathered by the Centre researchers will make it possible to perform predictive analysis generating early monitoring systems aimed at preventing erosions both of biodiversity and of ecosystem functions.

In the end, NBFC is going to study the supply of future values that could emerge from ecosystems contributing to the generation of new more sustainable processes and products. That can be realised by studying biodiversity previously considered “unexplored” because it was located in hard to reach areas or because too “difficult” to find or to identify. Thanks to the use of new technologies like biorobotics, AI and biotechnologies, NBFC is training a new generation of scientists able to consider biodiversity according to new models that are a little less anthropocentric and a little more sustainable.

02

# Let’s reach the goal

## 2.1 Path towards constitution

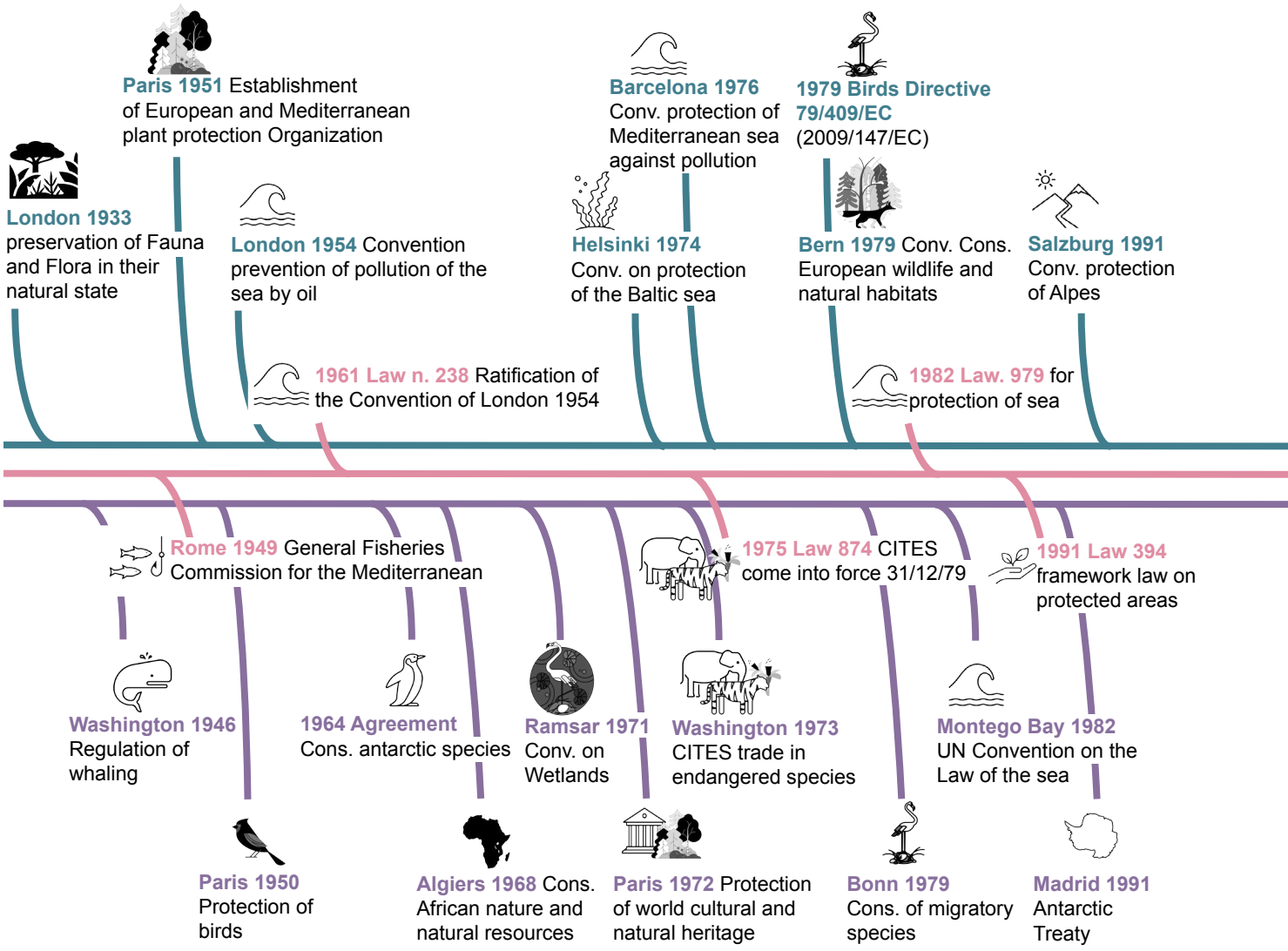
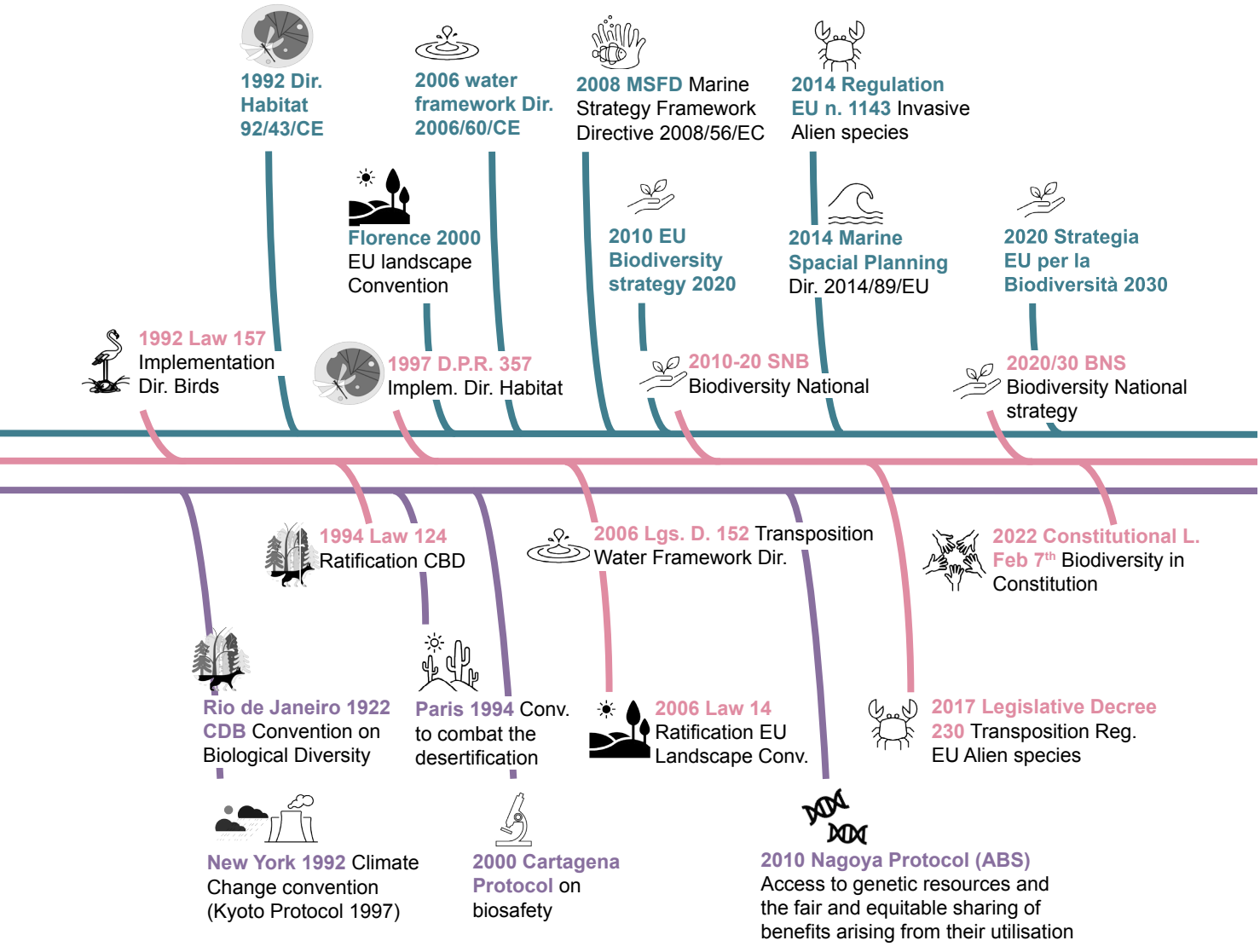


Figure shows the timeline representing the most important stages concerning environment law at international and European level leading to the current national laws.

Biodiversity protection is a global issue. The first forms of protection took place at international level and concerned specific species and habitats, but moving forward to the present days there has been a shift to a more global approach aiming at protecting biodiversity as a whole.

Conventions, Directives and EU strategies
Italian laws- implementation of European or international conventions and direc
International conventions

(Figure by Sarah Rossi de Gasperis and Claudia Gorga)



International agreements are a common and shared basis for ecosystem, species and genetic biodiversity protection. They arise from international meetings, thanks to agreements between different countries often under organisations like UNEP, UNESCO, IUCN, UNCED. The actual turning point was the United Nations Conference held in Rio de Janeiro on 1992 with the Convention on Biological Diversity (CBD) where the countries committed themselves to general biodiversity protection. COP (Conference of the Parties) composed of all signatory countries – was given the task of assessing progresses in the implementation of the Convention and defining plans and courses of action. COP meetings on biodiversity are held periodically every two years and to date (may 2024) the sixteen meeting is going to be held, in Cali, Colombia, from October 21st to November 1st 2024.

International treaties are a very powerful tool but they also have weak points: participation is on voluntary basis, therefore some countries can follow the guidelines and pursue their own interests; in addition to that resources are missing to check the strategies implementation in the different countries and to estimate their effectiveness. Public opinion pressure plays a significant role in the implementation of treaties.

The implementation boundaries allowing an appropriate management of natural resources often do not coincide with political boundaries. The importance of dialogue between countries to conserve nature and biodiversity has also long been recognised at European level.
The most powerful legislative instruments in this regard are the Birds Directive and the Habitats Directive, which gave rise to Natura 2000 Network, the European network of Special Areas of Conservation (SAC) and Special Protection Areas (SPAs) that were supposed to ensure the achievement of the objectives set out in the 1992 Convention on Biological Diversity. A Network that the EU Biodiversity Strategy for 2030, 'Bringing nature back into our lives', approved by the European Parliament on 9 June 2021, intends to strengthen and expand. In this document it is stipulated that by 2030 the protected areas European network shall cover 30% of the marine and terrestrial surface.

In the document, however, it is clearly highlighted how the seriousness of the situation requires the pursuit not only of the historical conservation goals but also of actions of nature restoration beyond protected areas in order to recover both natural and seminatural ecosystems by 2030.

In line with this decision, on June 22nd 2022, the European Commission submitted to the European Parliament the Nature Restoration Law which was definitively approved on February 24th 2024. The goal of the member states is to restore at least 20% of terrestrial and marine areas by 2030 and to recover all degraded ecosystems by 2050.

The protection of territory and biodiversity in Italy is articulated on several levels and is subject to different national and regional laws. The first law enacted in Italy relate to the ratification and enforcement of international conventions up to the framework law on protected areas that is an important step in our legislation since it "sets the basic principles for the establishment and management of protected natural areas".

A second fundamental step has been recently taken, on February 2022, when the legislative chamber definitively approved the law amending article 9 and article 41 of the Constitution; by this article, environment, biodiversity and ecosystems protection become a law enshrined in the Italian Constitution. Article 41, moreover, specifies that health and environment should be protected by economy, at the same level as security, freedom and human dignity; institutions must now guide public and private economic initiatives towards not only social but also environmental targets.

It is important to highlight that NBFC based on the message of the Constitution, has set a research and innovation programme placing one health at the centre of a strategic vision aimed at guiding sustainable development over the logic of conflicting interests. Enhancing biodiversity means both giving direct value to biological resources and encouraging economic activities that do not impact negatively on nature.

# 2.2 Protecting Biodiversity as interlinked to human health

NBFC considers biodiversity conservation as one of the greatest challenges for both our country and the Mediterranean countries and highlighted a series of threats including alteration, degradation and habitats fragmentation, the overexploitation of natural resources and the diffusion of invasive species even in protected areas. Data are alarming: 68% of Italian ecosystems are not in a good environmental status and the process of land consumption has reached the speed of 2,4 square meters per second.

**ENVIRONMENT AND BIODIVERSITY IN ITALY**

(taken from WWF 2023 report with integration)

**96%** increase of ALIEN INVASIVE SPECIES in Italy over the last 30 years

**89%** of EU habitats are not in a very good state of preservation

**68%** THREATENED ECOSYSTEMS

**30%** SPECIES THREATENED WITH EXTINCTION

**21.500 km²** BUILD-UP LAND

**1.150 km²** CONSUMED LAND IN 15 YEARS

In order to stop these trends, NBFC has committed itself to reinforce the protected areas nets through an analysis of the protection state by entering in the system historical information, collecting systematically new data and interaction with institutions and public bodies operating in dozens of protected areas including areas that are the symbol of our country such as Gran Paradiso National Park, Stelvio, Casentinesi Forests National Park, Lazio, Abruzzo and Molise National Park, and several protected marine areas as for example: Torre Guaceto, Ustica, Porto Cesareo, Miramare, Portofino, Tavolara and Porto Conte.

**Currently, the protected Italian areas, along with Natura 2000 Network (source MiTE 2021) cover an area of almost 10.500.000 hectares, that is 17% of the national terrestrial surface and 17% of marine surface.**

The campaigns carried out by NBFC confirm that in many areas there is a greater species diversity, greater biomass and also a diversity of habitats in comparison to non protected environments. It also emerge that in these areas there are thriving economies based on sustainable activities and shaped on the territory needs such as artisanal fisheries and the collection of essences. In Italy there are many successful examples in marine and terrestrial protected areas.

## EXAMPLES OF SUCCESS

**PORTOFINO MARINE PROTECTED AREA (AMP)** was established on 1998 and is the only one, in the Mediterranean sea showing a marked improvement of the red coral population status. AMP has become an important site for the monitoring of major events: in Portofino have been reported the first benthic organisms die-off, above all gorgonia, connected to global warming and here the effects of small-scale fisheries and underwater activities on benthic population have been recognised.

Portofino marine protected area →
(photograph by Federico Betti, Universiity of Genoa)

**TORRE GUACETO MARINE PROTECTED AREA**, in its over thirty years of existence, represents another extraordinary example of Mediterranean conservation and sustainable management. Strict protection and conservation measures and the close cooperation between the management authority and local entities, fishermen, non-governmental organisations, research institutes, are a part of a governance that allowed local population to benefit from biodiversity recovery. In particular, small-scale fishermen have been involved since the beginning in the setting up of rules leading to a sustainable use of fishery resources. This experience led to the request, by the fishermen themselves, also outside the protected marine area, of expanding the reserve boundaries, and the NFBC researchers are caefully considering the proposal.

↑ Aerial view of AMP of Torre Guarceto, Salento
(credits: Consorzio di Gestione di Torre Guaceto)

Terrestrial ecosystems show many successful examples related to conservation among which mention should be made of the first integral reserve in the history of the country and the protection by **LAZIO, ABRUZZO AND MOLISE NATIONAL PARK** of seriously threatened large vertebrates.

The **RESERVE SASSO FRATINO** is the first established integral natural reserve (recognised officially on 1971) with an area of 764 hectares. It is characterized by a non restored well preserved forest ecosystem including mature ancient woodlands, where the natural vitality is returning to dominate the ecosystem, according to the nature rhythms, and where it is possible to find all Appennine beech-forest fauna species with the only significant absence of the bear. On 1985 the reserve of Sasso Fratino was awarded the European Diploma for Protected Areas, that has been renewed also on 2019, and on 2017 the ancient beech-forest of Sasso Fratino are recognized by UNESCO as a World Heritage Site and placed on the serial site: "Ancient Carpathians and European beech-forests"

↑ Reserve of Sasso Fratino
(credits: Gianluca Piovesan, University of Tuscia)

**EXAMPLES OF SUCCESS**

**ABRUZZO, LAZIO AND MOLISE NATIONAL PARK (PNALM)** was established more than 100 years ago by King Decree on January 11th 1923, with the purpose of protecting great mammals iconic species like the Marsican Bear and Abruzzo Chamois. At the beginning it covered an 18.000 hectares area that, on 2011 became the National Park of Abruzzo, Lazio and Molise that included more than 20 municipalities for an area of 50.000 hectares. The population of Abruzzo Chamois which in the 80's numbered approximately 400, now hovers at around 2.500 individuals. The bears population is probably stable numbering about 50 individuals that now are also moving to neighbouring areas (Majella Park, Natural Reserve of Monte Gizio and other neighbouring protected areas). The wolves population, thanks above all to the reduction of the anthropic pressure, expanded throughout the whole peninsula numbering up to 3.300 individuals according to a recent survey made by Istituto Superiore per la Ricerca Ambientale. The National Park of Abruzzo and Molise therefore has been a reservoir of biodiversity that proved to be fundamental for the still ongoing re-naturalisation of Appenines.

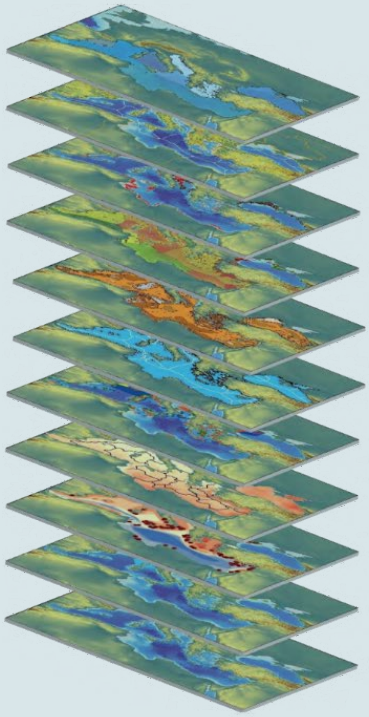
These are clear positive examples showing how land conservation , if managed effectively, can result in very good outcomes. However, in other cases, territory management and protection are inadequate or even just "theoretical". The reasons are multiple. Protected areas are often established without the necessary basic scientific knowledge and systematic conservation planning providing clearly stated criteria (i.e. connection, representation and effectiveness) with the consequence that their establishment is not clearly connected to protection needs. The reasons do not only relate to design. The poor control of the territory and the absence of coordinated and monitoring carefully structured activities certainly play an important role in limiting the socio-ecological effects of protection. In this regard NBFC has the task of providing scientific and technological support to public administrations and public bodies so that these areas really become protected areas with a full recovery of biodiversity.

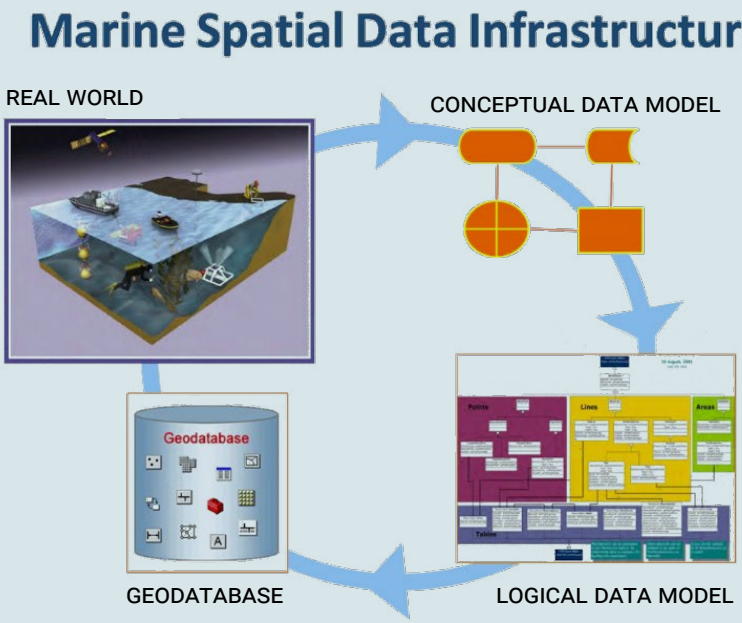
One of NBFC goals is to actively participate in the process leading to expand protected areas in hot spot areas including subjects currently excluded from protection and territorial management policies on the basis of new scientific data and cross-disciplinary skills. In Italy, land protection is connected not only to Protected Areas and Natura 2000 sites, but also to other entities managing marine and terrestrial territory, born from the enforcement of national, international and European Directives. For example: at sea, 30% of the territory to be placed under a protection regime could be achieved through the official declaration to CBD of Other Effective Conservation Measures (OECM) already existing in the Italian seas, and the recognition, also partial, of the Fishery Restricted areas (FRA) already declared by GFCM-FAO. The creation of a new network of N2k sites beyond 12 nautical miles, specifically dedicated to the rigorous protection of seamounts, the creation of new MPAs in which there are large restricted areas the re-zoning of the already established AMP areas to increase the exclusion zones, the revision of the rules of artisanal fishing permitted in the already established AMP B zones, so that these latter can be recognized as strictly protected, will be the instruments leading to the full protection of 10% of the territory. Naturally, these steps require basic knowledge on the distribution of biodiversity where NFBC can make a significant contribution.

The role of NBFCs is also related to the generation of knowledge and to the systematization of information. Data on biodiversity, in Italy, have been collected since the 18th century. However while knowledge on terrestrial and river fauna is quite advanced, the knowledge about sea distribution and status of biodiversity is still limited and needs to be expanded and updated. The analysis carried out by NBFC show how only 12% of the Italian coasts have been mapped from a geomorphological point of view and only 2.5% from the point of view of species and associated habitats. These are laughable percentages considering that we have high resolution data from the entire surface of the moon, Mars and Venus. In this respect NFBC geoportal was designed to become an important data management tool, a reference model for the whole country.

**NBFC GEOPORTAL**

Architecture and implementation of the geoportal have been designed to collect, make homogeneous, integrate, share and access data on biodiversity in an interoperable way (historical and current data, data from experimental studies and monitoring-related, concerning single populations/species/habitats/ecosystems), environmental variables and anthropic pressures. The geoportal allows researchers to capitalize on this information to achieve biodiversity goals and to implement the spatial planning in Italy. The architecture is designed to meet all standards and best practices for data collection, integration, availability and shareability, according to FAIR (findable, accessible, interoperable, reusable) principles. All of this information can more easily be shared in order to more solidly represent Italian and Mediterranean biodiversity in an EU context.






Graphic representation of the NFBC geoportal
(modified for NFBC by Boero et al. 2016 – i22394303v6Spl)

## 2.3 European biodiversity strategies for 2030

The European Strategy for the Protection of Biodiversity 2030 is based on the principle of the ecosystem approach (https://www.cbd.int/ecosystem), not providing the protection of individual species and that of certain environments, but recognizing the value of all living organisms and their networks of interactions in order to promote the stability of ecosystems and to generate the ecological functions necessary to improve the quality of the environment. This is a guarantee for human well-being and to guarantee human well-being. In this vision, humans are considered an integral component of ecosystems

The first goal of the EU Biodiversity Strategy for 2030 is to counteract the decline of biodiversity and protect the diversity of ecosystems, habitats and species. The strategy aims to restore at least 30% of terrestrial and marine areas, through protection measures and through ecosystem renewal initiatives that consolidate existing protected areas introducing new ones.

The EU Biodiversity 2030 challenge also includes actions to mitigate the causes of biodiversity degradation such as reducing the use of pesticides (to be reduced by 50%) and activities aimed at supporting fundamental ecosystem services such as pollination.

In strategic actions, Europe focuses on the importance of the redevelopment of areas particularly subject to erosion such as wetlands and river areas but also on the transformation of human practices, starting from the development of more sustainable agricultural practices and targeted forestation actions in marginal areas such as the urban context.

The EU 2030 strategies for biodiversity are synergistic with other major European initiatives such as the Green Deal which includes a package of strategic initiatives aimed at promoting the green transition and achieving climate neutrality by 2050.

Another plan in line with EU Biodiversity 2030 is the Zero Pollution initiative which provides for actions aimed at drastically reducing air, water and soil pollution also for the well-being of humans and other living organisms.

NBFCs supports the achievement of EU Biodiversity 2030 goals through research and innovation actions aiming to:

1. Protect species at risk of extinction and prevent the spread of invasive weed species that alter functional relationships in ecosystems.
2. Define adequate strategies for the conservation, monitoring and restoration of biodiversity also aimed at mitigating climate change.
3. Reduce soil consumption and the alteration of land and marine areas, including by establishing actions to improve agriculture, fisheries, aquaculture and food security.

Within the NBFC, research activities have been identified aimed at supporting specific actions of the EU Biodiversity 2030 plan.

As far as marine ecosystems are concerned, NBFC involves over 2000 researchers in order o develop knowledge and strategies aiming to the:

1. **Extension of Marine Protected Areas**: expansion of marine protected areas to cover at least 30% of territorial waters, with a rigorous management of the areas of greatest biodiversity.
2. **Regeneration of fish stocks**: implementation of sustainable fishing practices based on the ecosystem approach to ensure that fish stocks and their habitats are maintained or restored to levels that do not compromise their ability to recover.
3. **Reduction of marine pollution**: Drastic limitation of marine pollution, especially from plastics and chemical contaminants, to preserve the health of marine ecosystems.
4. **Promotion of the blue bioeconomy**: development of a sustainable blue economy, focused on the responsible use of marine resources for food, energy and materials

The main actions identified for **URBAN ECOSYSTEMS** are:

1. **Forest protection and restoration**: Protection of all primary and ancient forests and promotion of large-scale forest restoration to increase resilience and CO2 storage capacity.
2. **Restoration of agricultural and rural land**: identification of more sustainable agricultural practices, starting from the species adopted up to agronomic practices, in order to develop a more functional relationship between agro biodiversity and biodiversity even in periurban and marginal areas.
3. **Sustainable management of wild flora and fauna**: implementation of biodiversity management plans balancing conservation needs with those of local communities and of the tourism industry.

The main actions identified for **TERRESTRIAL ECOSYSTEMS** are:

1. **Development of green infrastructures**: increase in urban green spaces through new planting actions and promotion of Nature Based Solutions, i.e. solutions inspired by nature to bring biodiversity back to cities, such as urban wetlands, green rows, flowerbeds and green spaces connecting large urban parks.
2. **Promotion of sustainable mobility**: reduction of cities congestion and pollution by identifying circular production systems and defining guidelines for the well-being of both man and biodiversity.

The EU 2030 strategies represent a member countries joint commitment to protect biodiversity through the implementation of current laws, the development of new policies and the strengthening of existing policies
Protecting biodiversity is seen not only as a moral and environmental duty, but also as an essential requirement for the economy and social and cultural evolution.

With regard to the EU community NBFC stands as a scientific knowledge reference for

- Supporting local authorities in actions aimed at restoring biodiversity and redeveloping altered ecosystems and degraded areas.
- Providing guidelines for implementing EU laws on nature restoration by identifying solutions for different habitats and species, developing measurement systems and procedures to guarantee efficiency and sustainability of the implemented actions.
- Identifying sustainable processes and products to move from linear industrial systems to circular models capable of transforming waste biomass into high added value products.

The EU Biodiversity Strategy for 2030 is vital to ensuring a sustainable future for Europe, turning the ecological crisis into an opportunity to integrate biodiversity protection into all branches of the economy and promoting sustainable management of natural living resources. This approach will not only raise the quality of life of European citizens, but also ensures that Europe continues to be a world leader in environmental management and biodiversity conservation.

But if human beings have a central and integrated role in ecosystems, then it is necessary to involve communities in their management. In fact, among the most salient aspects of the 2030 Biodiversity Strategy, considered of fundamental importance in NBFCs, is the awareness that the involvement of local, coastal, agricultural and urban communities is an essential measure to increase the sensitivity of all citizens and taker on the importance of biodiversity and to promote their active participation in local conservation projects. The involvement of actors from all sectors and all strata of society is based on the idea that local communities living in the area are bearers of crucial interests and that their rights and interests must be recognized. In consideration of the fact that cultural and social as well as biological diversity are considered central components of the ecosystem approach, that as mentioned is a cornerstone in the 2030 Biodiversity Strategy, the management of ecosystems must take this into account. And from this it follows that ecosystems must be managed, in a fair way, due to their intrinsic values and for the tangible or intangible benefits they provide to human beings. In carrying out scientific research in all these areas, NBFC researchers are animated by the courage and openness making them to deal with different and innovative ideas and approaches with a dialectic that is always open to the renewal of contents and their communication.

**EUROPE'S PATH TO BIODIVERSITY**

| | |
|---|---|
| **SEPTEMBER 18, 2020** | The European Economic and Social Committee defines the central elements on biodiversity and adopts an opinion on the Strategy. |
| **OCTOBER 23, 2020** | The Council adopts the Conclusions on the Strategy |
| **JANUARY - APRIL 2021** | Public consultation on nature restoration objectives |
| **JUNE 9, 2021** | European Parliament Resolution on the Strategy |
| **JUNE 22, 2022** | The Commission adopts the proposal for a Nature Restoration Law. |
| **MARCH 2023** | The Commission publishes guidelines on forests. |
| **JULY 5, 2023** | Commission adopts proposal for a Soil Health Law. |
| **AUGUST 31, 2023** | The Italian National Center for Future Biodiversity (NBFC) begins with the largest investment in biodiversity in the world. |
| **NOVEMBER 21, 2023** | The Commission adopts the proposal for a Regulation establishing a monitoring framework on EU forests. |

# 2.4 Steps to achieve the goals

NBFC aims to identify effective strategies to improve the conservation and restoration of biodiversity in Italy by following the targets defined on a European and international scale.
By 2030, important results are expected to be achieved for the benefit of people, planet, climate and e-economy, complying with the 2030 Agenda for sustainable Development and with the goals of the Paris Agreement on climate change.
In addition to addressing the five main causes of biodiversity loss, the centre aims at filling knowledge and technology gaps to ensure EU legislation and shared objectives full implementation.

**THE MAIN CAUSES OF THE DECLINE IN BIODIVERSITY**

LAND USE CHANGES
(deforestation, monocultures, intensive urbanisation)

DIRECT EXPLOITATION: HUNTING AND FISHING

CLIMATE CHANGE


POLLUTION

INVASIVE ALIEN SPECIES

The national centre started from the National Biodiversity Strategy 2030 (SNB-2030) of the Ministry of the Environment and Energy Security which are inspired by the community Agenda 2030, to implement knowledge and support actions dedicated to each activity.

SNB 2030 has **2 MAIN GOALS**:

1. Building a coherent network of terrestrial and marine protected areas, promoting effective management tools and specific measures for the different areas in order to reach the overall target of 30%, i.e. at least 13% more land and 19 % more sea compared to the current state. The Strategy also intends to strengthen governance and management tools to make the network of protected areas truly effective.

2. Restoring terrestrial and marine ecosystems with 7 areas of intervention: Species, Habitats and Ecosystems, Food and Agricultural Systems, Livestock, Forests, Urban Green Space, Internal Waters, Sea and Soil.

The transversal aim is to ensure that at least 30% of the species and habitats protected by Directives 2009/147/EEC "Birds" and 92/43/EEC "Habitats" reach a satisfactory conservation status by 2030 reducing at the same time pressure on habitats by promoting the restoration of large degraded areas.
In this ambitious plan, ISPRA - Higher Institute for Environmental Protection and Research has a task of very significant intervention consisting in identifying new areas to protect, extending and connecting those already subject to protection and carrying out the monitoring and reporting on the activities. NBFC proposes itself as an ally to provide scientific, research and innovation contents so that the set objectives can be jointly achieved and sustainability guaranteed over time.

In particular, in order to achieve the first objective more focused on conservation, **5 PRIORITY ACTIONS** were defined in the SNB-2030 document.
For each of these NBFCs has identified strategic support activities:

**PRIORITY ACTIONS AND STRATEGIC SUPPORT ACTIVITIES**

| 2030 SNB ACTION | NBFC ACTIVITIES |
|---|---|
| Legally protect at least 30% of the earth's surface and 30% of the sea surface through an integrated system of protected areas, Natura 2000 network and other legally protected areas. | • Scientific reports on marine and terrestrial areas with high biodiversity and connectivity<br>• Species and ecosystems analysis of the conservation status |
| Ensure that at least one third of legally protected land and marine areas, including all primary and ancient forests, are rigorously protected. | Provide adequate scientific information to support conservation with particular reference to endemic, vulnerable species and widely eroded ecosystems. |
| Guarantee the ecological-functional connection of protected areas on a local, national and supranational scale. | • Assess ecological connectivity at the genetic level<br>• Propose strategies to promote the connectivity of protected and/or high biodiversity areas |
| Effectively manage all protected areas by defining clear objectives and conservation measures, monitoring them appropriately. | Provide scientific and innovation support to parks and marine areas through co-financed projects (20,000 euros already committed) |
| Ensure the necessary financing of protected areas and biodiversity conservation. | Promote partnerships with protected areas to carry out applied research, communication and dissemination projects |

## 2.5 Parks do not necessarily include all types of biodiversity

Parks, marine areas and reserves are certainly considered places of biodiversity protection but, as we have seen, they are not sufficient to stop the loss of species. To this it must be added that there are several species that adapt to different environments, including anthropised ones and others that live in very peculiar contexts such as deep seabeds and mountain peaks. Furthermore, numerous species have distribution areas that go beyond the dimensions of the protected area while others still live in confined areas (many endemic) which often are not included in protected areas. Therefore taking into consideration only protected areas we risk to underestimate the species richness of our country losing a large portion of biodiversity. For this reason, NBFC has undertaken a biodiversity mapping action in different areas of the country composed of areas with different degrees of protection combined with unprotected areas which, although containing a high biodiversity, due various reasons have not been included among the protected areas.

At the same time, NBFC has developed innovative approaches to restore biodiversity in different environmental contexts which also contribute to the projects of the Ministry of the Environment referred to PNRR. In particular, NBFC is active on the following projects:

1

Scientific support and technological innovation for the remediation of contaminated areas and of the so-called "orphan sites". Italy is characterized by areas showing different degrees of environmental erosion and biodiversity; they range from particularly polluting or otherwise compromised post-industrial sites, from the point of view of biodiversity, to abandoned agricultural areas and marginal territories next to roads and motorways. Many of these environments are defined as "orphan sites" as the person responsible for the contamination cannot be identified.

The Ministry of the Environment has identified as many as 260 "orphan sites" on the national territory on which remediation or restoration actions are being activated. NBFC has developed prototypes based on innovative phytotechnologies aimed at the extraction of contaminants, their stabilization and in some cases also biodegradation. It also analysed the legal and administrative aspects in order to implement bioremediation processes as an alternative to the much more expensive and impactful classic remediation procedures.

2

A second strategic action of the ministerial plan concerns the digitalisation of national parks and marine protected areas and the monitoring of habitats. This action will allow the implementation of knowledge and above all the management of information for both the monitoring and the conservation of biodiversity.
In this regard, NBFC activities have made it possible to:

- create digital databases on the distribution of different species with different degrees of detail and information.
  These products will be an important starting point for parks and reserves.
- map the habitats and define their state of conservation and alteration. NBFC reports and scientific publications allow to obtain a more up-to-date picture of knowledge related to the state of habitats and above all innovative monitoring tools.
- define the tools to assess ecosystem services and analyse functional biodiversity that is the trophic relationships between the different components of the ecosystem.

3 The latest project of national importance, promoted by the Ministry of the Environment, concerns the monitoring of pollinators especially in protected areas. Currently, this monitoring has been entrusted to National Parks but it is necessary to exploit effective tools to evaluate both the health status of insects and their foraging and pollination efficiency. NBFC has developed innovative technologies and operational guidelines, which have been tested in the field and analysed from a technical-scientific point of view, to counteract the decline of pollinators and to strengthen their presence.

**ECOLOGICAL TRANSITION MINISTRY AND ISPRA PLAN TO ACHIEVE THE FOLLOWING GOALS:**

REALISATION OF OBSERVATION SYSTEMS OF MARINE AND MARINE-COASTAL ECOSYSTEMS

MAPPING OF SEAGRASS MEADOWS AND HABITATS OF EU INTEREST

SEABED AND MARINE HABITATS ECOLOGICAL RESTORATION ACTIVITIES

IMPLEMENTATION OF PROTECTIVE MEASURES

## 2.6 Cities will become greener

Forests are one of the fundamental elements for improving, increasing and protecting biodiversity. Urban forestation, defined by Konijnendijk in 2004 as "*the art, science and technology of managing trees and forest resources in and around community ecosystems for psychological, sociological, aesthetic, economic and environmental benefits that trees provide to society*", has become one of the priority policies of cities around the world to combat climate change, improve the quality of the urban environment and is a fundamental part of strategies to increase natural capital.

Italy, that on 2018 hosted in Mantua the first world forum of urban forests, by the 2019 Law Decree (Climate Decree)issued the first national call for urban reforestation in the 14 Metropolitan Cities, making available 30 million Euros for tree replanting, forestry, and creation of urban and peri-urban forests in metropolitan cities and from 2022 (under the PNRR call Mission 2 Component 4 Investment 3.1 "Protection and enhancement of urban and extra-urban greenery ") has committed itself to creating urban, peri-urban and extra-urban forests, with the planting of 6,6 million trees (that is 6,600 hectares of urban forests) in the same cities.

The investment earmarked for metropolitan cities exposed to air pollution, to the impact of climate change, to the loss of biodiversity, and for their 1,268 municipalities where more than 21 million people live in a territory that occupies an area of 4,663 million hectares, equal to 15.47% of the national territory and which includes, in addition to urban ecosystems, natural ecosystems and agroecosystems, also includes the containment of infringement procedures connected to failure to comply with the limits established by Directive 2008/50/ EC related to air quality.

If the increase of urban areas natural capital is essential to improve, increase and protect biodiversity, there are on the other hand some critical nodal aspects allowing or preventing the implementation of this important objective.

The first element concerns the necessary relationship between territorial governance plans and greenery plans in order to structurally constitute the integration between the existing urban dimension, its strategic transformation and the inclusion of strategies related to the increase of natural capital (Green Plans). In this regard, NBFC is conducting studies on the state of the

art on greenery plans in Italy (18 greenery plans and strategies approved in provincial capital cities, three developing plans, out of 109 capital municipalities), on nature-based solutions (NbS) in the Mediterranean area, to formulate guidelines supporting public administrations in equipping themselves with suitable tools that operationally lead to improving, increasing and protecting biodiversity .

The second element concerns the general lack of knowledge on the effects of plantations in urban areas, especially regarding the interactions between species and the stresses to which the plant component is exposed, in particular with respect to climate change. In this regard, NBFC research is identifying which plant species are best able to withstand water stress while innovative plans for monitoring planting interventions have been promoted, also based on remote sensing and biomolecular technologies.

The third element concerns the growing need to work with citizens to co-plan and increase knowledge related to biodiversity spaces.
With reference to this , NBFC has carried out experimental plants in Milan, Florence, Rome and Campobasso, a living lab has been opened for the co-design of biodiversity spaces and many dissemination activities are underway.
The final purpose is to evaluate which are the most appropriate intervention strategies to restore biodiversity as a whole in the redeveloped areas and guarantee its persistence and succession over time.


**Greening plans (12)**
SO Greening Plan of Sondrio (2007)
BZ Greening Plan of Bolzano (2022)
VI Urban greening plan of Vicenza (2018)
PD Municipal urban greening plan of Padova(2022)
PR Greening plan of Parma (2022)
RE Greening Plan of Reggio Emilia (2021)
FO Greening plan of Forlì (2021)
LI Urban greening plan of Livorno (2023)
PI Greening plan of Pisa (2000)
AV Municipal greening plan of Avellino (2022)
CA Greening plan of Cagliari (1996-2006)
MT Greenng plan management and maintenance of Matera(2021)

**+ Green infrastructure strategies (4)**
TO Green infrastructure plan of Torino(2021)
GE Genova green strategy (2022) + preliminary study for a greening plan design (2008)
BO Greening strategy for the urban climate of Bologna (2022)
TR Local strategy for the urban green of Terni (2018)

**X Other green planning instruments (3)**
FE Action plan on green infrastructures of Ferrara (2019)
PO Action plan on urban forestation of Prato (2019)
LU Masterplan of the urban green of Lucca (2020)

**Greening plans under elaboration(4)**
TN Greening plan of Trento
MN Greening plan of Mantova
FI Greening plan of Firenze
RN Greening plan of Rimini

03

# NBFC: The biodiversity centre that makes the difference

## 3.1 Researchers, Businesses and citizens united for biodiversity

The NBFC's action is structured around **5 OBJECTIVES** that are the result of intensive analysis and critical evaluation work of national and Mediterranean biodiversity and the needs in terms of conservation, monitoring and restoration of biodiversity. These objectives are the focus of the alliance between researchers, innovators and citizens and their achievement is fundamental to support the institutions intervening in nature conservation.

1 **Educating a new generation of scientists**
We have operate o create a fertile ground for innovative minds, training scientists who, in addition to possessing solid theoretical knowledge, have the technological tools to face the challenges of the future. This translates into encouraging multidisciplinary approaches, experiential learning and international collaborations, so as to respond to the reorganization of work and governance systems.
Nowadays, researchers and technicians must be flexible and open in their relationships with different stakeholders, permeable to the impact of the international context, as well as capable of adopting new technologies such as Artificial Intelligence and Bioinformatics. Furthermore, there is a need to emphasize the importance of biodiversity in the academic curriculum to ensure that new generations are aware of its implications on various fields of science and society.

2 **Promote the development of large databases**
The second objective aims to generate and make scientific knowledge on Italian and Mediterranean biodiversity freely accessible. The fragmentation of information in the various research centres, museums

and institutions weakens both the capacity for analysis and action to protect biodiversity, as well as international relations and projects aimed at protecting nature. NBFC intends to aggregate the different resources, fill the gaps but above all generate differential access interfaces for the different users. Open data is essential to building a more inclusive and collaborative scientific community, where researchers, conservationists and citizen scients can share discoveries and use the existing data to intervene on biodiversity. Open Data accessibility is also fundamental to stimulate innovation and collaboration with companies that will be able to obtain process and product innovations from biodiversity and improve production systems in a sustainable way

3 **Deployment of Key Enabling Technologies (KETs)**
This objective focuses on the use of advanced technologies to improve biodiversity research. KETs (Key Enabling technologies) include biotechnology, electronics and microelectronics, information and communication technologies, robotics, advanced materials and advanced manufacturing technologies. The adoption and implementation of these technologies is revolutionizing scientific research and knowledge of biodiversity. In this respect NBFC is working to bring these technologies within the centre's projects, creating prototypes, implementing software and collaborating with bodies and companies specialized in the sector.

4 **Bringing research discoveries to market**
With the objective of "Go to Market", we intend to facilitate the path that brings scientific discoveries from the laboratory to the market. This involves supporting the development of startups and companies that are based on innovative research in the field of biodiversity, as well as encouraging investments in the sector and creating policies that favour the commercialization of sustainable technologies. the NBFC has dedicated an entire area of the centre (spoke 8) to this objective and has identified measures dedicated to supporting innovation and technological transfer. The ultimate goal is the economic valorization of biodiversity, demonstrating that this sector can be one of the main drivers of growth in our country and employment for young people.

5 **Biodiversity Gateway for collective engagement**
The ultimate objective is to create a "Biodiversity Gateway", a gateway between research and society where the products of research and innovation will become value for citizens, innovators and institutions. The idea is to clearly show the tangible and intangible benefits of biodiversity, for example through disseminating success stories, engaging in citizen science and offering educational resources. This can help raise public awareness and promote collective action towards environmental sustainability and biodiversity conservation.

> It cannot be ignored that the evolution of forms of public-private partnership, the emergence of "bottom-up" decision-making models, the spread of public debate as part of decision-making processes (and even as a preparatory moment to the production of legislation), are nothing else than the manifestation of a need for active participation which necessarily passes through moments of discussion, cross-examination and sharing of information.

## 3.2 Preserving biodiversity

The National Biodiversity Future Center has identified a recipe made up of **4 INGREDIENTS** to protect the biodiversity of our country and more generally of the Mediterranean.

OBSERVE AND MEASURE — PRESERVE AND PROTECT — REPAIR AND MAINTAIN → **VALUE AND BUILD THE FUTURE**

**OBSERVE AND MEASURE**

No one can think of conserving biodiversity without knowing it. There are various tools to identify an organism but certainly the most immediate is to observe it and analyse its appearance. In most cases these are morphological analyses, but over the years new approaches have been developed, for example based on DNA analysis, on the presence of certain chemical compounds, up to more complex studies on behaviour and reproduction. Artificial intelligence applied to image recognition has then made it possible to increase the number of characters that can be evaluated, of information to be connected to them analysing them quickly and effectively. Based on these considerations, the NBFC has undertaken the path of *integrative taxonomy* which combines traditional morpho-functional knowledge on living organisms with other sources of information in order to correctly classify organisms.

The second fundamental tool is that of measurement and is the basis of biodiversity monitoring strategies. Once the species has been recognised, it is essential to understand its distribution, its variability and its response to the environment. The elements allowing the evaluation of the state of health of a species are also useful for measuring the effects of the environment on biodiversity.

The significant actions implemented by NBFC to support the observation and measurements of biodiversity in this first phase are:

- Training of *biodiversity experts*. Investing in young people to train modern taxonomists, biodiversity experts who, using innovative technologies, learn to recognize and classify species. In NBFC training activities, we specific knowledge on the various groups are learned (*how to recognize the species of an ecosystem*) along with the more technical and specialized ones, linked to morphological, chemical, molecular and ecological peculiarities. An essential ingredient of the training actions are the enabling technologies specifically adapted to observation and monitoring activities: drones, camera traps, sensors and satellites, coupled with artificial intelligence technologies.
  These technologies provide crucial tools both for the collection, cataloguing and use of the information acquired and for the census of species and the monitoring of ecosystems and entire regions.

Finally there are the technologies for the recovery and the integration of historical data and information that come both from NBFC data platforms and from the use of big data and AI systems aimed at completing knowledge.

- Creation of a permanent network of sites of Area Vasta (Broad Area Sites – BAS), including approximately 17% of the Italian territory, characterized in terms of biodiversity and conservation risks allowing to prevent future erosion scenarios.

- Collection of faunal and floristic data related to rare, endemic species of conservation interest distributed throughout Italy in order to update the checklists and to know the response to disturbing factors. For each species, data are collected on distribution, richness and response to human-induced environmental changes.

- Collection of genetic/genomic data related to endemic species and/or particularly relevant for conservation purposes. This action, in addition to supporting ex-situ conservation strategies, allows to identify suitable genetic strengthening actions and monitor their effectiveness over time.

- Integrated monitoring campaigns of exotic flora and fauna species spread in terrestrial and marine environments with the aim of identifying access routes, diffusion strategies and the impact on local biodiversity. The final objective is the development of translocation/eradication actions and the definition of guidelines for monitoring and management.

- Vegetation analyses in urban areas aimed at estimating biodiversity in anthropized contexts deepening knowledge on plant successional dynamics also to monitor the effectiveness of forestation and urban greening events. Critical analysis of successful and problematic cases of urban forestry and development of technologies based on remote sensing to estimate functional parameters of urban forests. The final objective is to maximize the success of the interventions and stimulate the productivity of the plants.

- Assessment of the biodiversity of soil ecosystems (flora, fauna, microbiota) aimed at understanding the effects of area management practices and providing management guidelines to preserve the current biological richness.

- Assessment of the effects of global climate change on biodiversity, with particular attention to the reproductive dynamics and to the response to stress of species of conservation interest. The target is to identify rapid response monitoring systems to prevent the loss of these species.

- Development and validation of new monitoring tools: sensors, drones, robots for remote and automated data collection, hyperspectral data to estimate biological diversity also at a physiological and functional level. These technologies are validated in an operational environment.

- Development of artificial intelligence (AI) systems for biodiversity monitoring by exploiting already available databases and new resources produced by NBFCs.

- Development of molecular technologies to monitor changes in biodiversity. Protocols based on environmental DNA, automatic samplers, and omics approaches have already been developed both as monitoring systems and as traceability approaches for contaminating species.

- Analysis of the effects of pollutants (including emerging ones) on living organisms. Identification of stressors on in vivo models. Identification of stress markers to carry out large-scale monitoring. The in-depth study of the biological effects of the various pollutants will make it possible to define a list of priorities and risks based on their presence and danger.

Through these actions, NBFC has a wide range of technologies to observe and measure biodiversity even in real time (*early warning*) and this is crucial to prevent the erosion of the most vulnerable ecosystems

An aspect that NBFC pays particular attention to is the study and functional characterization of "hidden" biodiversity. It is about all those organisms that are invisible to the human eye either because they are too small (< 1 mm) and/or because they are present in environments inaccessible to humans such as the soil or the sea depths. The degree of biodiversity of these organisms, which include bacteria, algae, fungi and micrometazoans, enormously surpasses that of the animals and plants visible to humans which are mistakenly associated with greater environmental value. These small organisms play fundamental functional roles in ecosystems (providing important ecosystem services), such as decomposition of organic matter, mutualistic symbiosis, and control of pathogenic species. The study of these organisms involves the use and development of cutting-edge technologies and methods (e.g. eDNA, spectroscopic and genomic analyses) that NBFC has promoted both among its researchers and during training activities.

**CONSERVE AND PROTECT**

Conserving biodiversity means taking care of it and this is not achieved only by relegating nature to protected areas or dedicated parks but it is essential to understand the needs of the different species and ecosystems and ensure that these are taken into consideration.

Thanks to scientific research we know that there are species that are more resistant to stress factors such as pollution and urbanization (synanthropic), but there are also highly sensitive species that do not tolerate high stress factors.

The latter are particularly sensitive to disturbing factors such as climate changes, the presence of alien species and high-impact anthropic activities. Particular care must be dedicated to rare species, i.e. those found only in one or a few very limited areas, and to endemic species found only in our country, sometimes in very localized areas of this country.

Finally, conservation and protection does not exclusively address a specific species but also refers to entire habitats that are particularly altered and/or sensitive to stressful factors. In this sense, the European Community, through various directives, has identified valuable habitats and species to be safeguarded and protected and the member states have implemented intervention policies for their effective conservation

NBFC role in conservation is particularly important considering that there are now almost 2000 researchers working in the centre, and many of them know in depth the state of conservation of our country.

This set of knowledge and technologies has been used to develop the following strategic actions:

- Mapping of marine/terrestrial biodiversity at habitat level. Analysis on over 100 sites. Collection of information relating to biodiversity, environmental and socio-economic data.

- Analysis of the conservation of original habitats and of vulnerable habitats. Analysis of priority habitats and groups of organism living in different environmental contexts also in response to changing environmental conditions and management strategies.

- Urban biodiversity mapping and conservation Typing of the biodiversity of Functional Urban Areas (FUA) and of cities with more than 50,000 inhabitants, with the delimitation of urban ecosystems and the definition of urban/rural area thresholds in terms of richness and composition of biodiversity. Mapping specific interactions in urban areas such as pollinator plant, prey-predator interactions and responses to environmental stress in order to refine conservation.

- Innovative tools for conservation. Species molecular characterization using a DNA barcoding approach and genomic analyses of conservation interest taxa. The goal is to understand past and present population trends and predict how well key species will cope with habitat in a changing environment.

- Assessment of the state of conservation and protection of emblematic species/populations and of conservation interest. We are considering several terrestrial and marine species for which only fragmentary information is available, not sufficient to design effective protection strategies.

- Land conservation planning. This action is of great support for protected areas as it allows the identification of actions based on solid scientific knowledge to protect species and habitats, analyse the dynamics of biodiversity over time and propose dedicated governance strategies. This activity exploits the large collection of data and information promoted by the network of NBFC researchers combined with biodiversity informatics approaches.

- Definition of protection scenarios. This action is carried out thanks to the analysis of the conservation status of the various species in the registered areas and aims to define both prioritization tools and protection practices. One of the objectives of NFBC is to expand the conservation of biodiversity starting from the strengthening of Protected Areas up to the identification and protection of territories of great conservation value that are currently unprotected.

- Mapping of ecosystem services and development of dedicated tools. Development of technologies aimed at quantifying and mapping ecosystem services and identifying measurable indicators. Definition of guidelines to support ecosystem services also in relation to the socio-economic activities of different areas such as fishing, tourism and other anthropic activities typical of natural terrestrial and urban areas.

- Biodiversity-oriented maritime spatial planning. Creation of a web portal to map, organize and archive data of interest for marine protected areas (i.e.environmental data, maritime activities, socioeconomic conditions, planning and governance).

- In order to achieve the goal of protection of biodiversity, however, it is essential that these actions and technologies are amplified with the support of citizens and all interested stakeholders and that the approaches developed become efficient tools for local authorities, protected areas and local intervention agencies. In this sense NBFC is working to create a strong national network including all interested institutions.

---

#### REPAIR AND MAINTAIN

Although our country is rich in terms of biodiversity, there are numerous altered and degraded areas where individual species are highly at risk of extinction and ecosystems are impoverished and eroded. In these areas, it is a priority to restore biodiversity with effective actions. Repairing nature is not simple as it is not enough to plant a tree or a coral to redevelop the habitat and ensure that all components of the ecosystem return to how they were before. It is necessary to carry out specific interventions, analysing the area, eliminating stress factors and selecting the most suitable species and the most effective redevelopment strategies. NBFC's biggest investment was to learn from nature and choose the path of NbS or nature-based solutions to redevelop degraded areas.

#### WHAT A NBS IS

On 2022, the UN defined NbS as “actions to protect, conserve, restore, sustainably use and manage natural resources, natural or degraded terrestrial, freshwater, coastal and marine ecosystems that address social, economic challenges and environmental services in an effective and adaptive way, while providing human well-being, ecosystem services, resilience and biodiversity benefits”.
(UNEA, 2022)

At the European level, the expansion from an urban to a global perspective has shifted the focus beyond mitigation and adaptation to climate change as NbS are relevant in terms of providing decent work, thus including the concepts of inclusion -sivity, social and fair income, job security and social protection for families.
(ILO, 2022)

Furthermore, the crucial role that can be played by NbS in restoring biodiversity and conserving degraded and restored ecosystems clearly emerges, as also stated in the agenda of the recent EU funding partnership on biodiversity

NBFC is at the forefront in European NbS thanks to dedicated actions covering:

- Support for the establishment of the NbS Italy Hub, which has the role of bringing together all national public and private institutions active in the field of NbS, to improve the inclusion of NbS in national and local policies and financing programmes.

- Mediterranean NbS catalogue. Creation of an IT tool that allows the operator to select the area of interest (city or rural area), the main targets to be reached and which will be able to provide the best NbS as output also in terms of virtuous case study from which to draw inspiration, and to the calculation of the ecosystem services produced in case of implementation. The database that has been created is a great result for our country and will be at the service of various stakeholders such as administrations, planning and researchers to redevelop target areas. Furthermore, a mapping of potential application areas of NbS is being carried out based on three main environmental challenges such as climate adaptation/mitigation, air quality and water cycle.

In synergy with NbS strategies, there are specific actions that NBFC is implementing to strengthen and restore biodiversity. Among these the following are included:

- Mapping of the suitability of sites for carrying out restoration interventions. This action involves the analysis of different environments and the definition of parameters and guidelines to select the most suitable areas in which to carry out habitat restoration actions also considering the probability of success. The approach also makes it possible to identify priority "climate refuge" areas and sites that can be used both as donor sites and as repopulation areas.

- Definition of measurement and monitoring tools for recovery actions. The activity is aimed at evaluating the effectiveness of restoration ecology actions with specific attention to both the well-being of the introduced organisms (survival, growth) and the ecosystem as a whole. The action concerns both terrestrial and marine environments.

- Marine habitat restoration strategies. The activity is focused on the restoration of priority habitats: to date, restoration activities are underway concerning 7 different habitats (macroalgal forests, vermetid reefs, seagrass meadows, barren ground, oyster reefs, coral reefs and deep sea ), in 16 study areas along the Italian Peninsula. At the moment, 18 species are being restored, in some cases with a multi-species approach.

- Evaluation of the effects of different management regimes in degraded forest ecosystems. The study concerned several national sites undergoing strengthening to evaluate the resilience levels of the area and define the most suitable strategies for the ecological restoration of forest ecosystems.

- Development of sustainable urban forestry models. This action involved the mapping of national project policies and the definition of critical and value points to develop more effective models. Planning, monitoring and governance strategies were also identified

- Support for biodiversity supply chains. This action is dedicated to supporting the production of biodiversity such as the seed supply chain of tree species. NBFC worked on the selection of species and cultivars more performing trees and suitable for various afforestation interventions and plant traceability in order to guarantee the origin and support the public and private horticultural sector.

- Selection of herbaceous plants for urban and rural areas with different levels of anthropogenic disturbance. This action involved the identification of herbaceous species suitable for urban and peri-urban greening actions in rural environments. Genetic and epigenetic adaptation investigations were carried out and mixes of seeds suitable for different environments were produced (urban areas, agricultural contexts, post fire, wind storm, coastal, floods, chemical contamination, intensive agriculture, production of renewable energy).

- Technologies to support the growth and combat the fall of trees. This action has allowed the development of innovative technologies to analyse the health status of roots in different environments including urban soils and the response to different biotic and abiotic components. Using innovative digital twin tools, it is possible to carry out impact forecasts and support forestation interventions.

- Phytotechnologies for contaminated soils and fine dust abatement. The action is aimed at the development of phytostabilisation, phytoremediation and photodegradation approaches of environmental contaminants in contaminated sites. The activity involved the selection of germoplasm suitable for degraded and contaminated soils; the analysis of the phytoextraction and metabolisation capabilities of contaminants and the feasibility study of a phytoremediation project.

There is also a project under study concerning resilience strategies and maintenance of interventions. In this respect, in addition to evaluating ecological and biological aspects, NBFC is evaluating different management methods also capable of involving citizens as custodians of the territory.

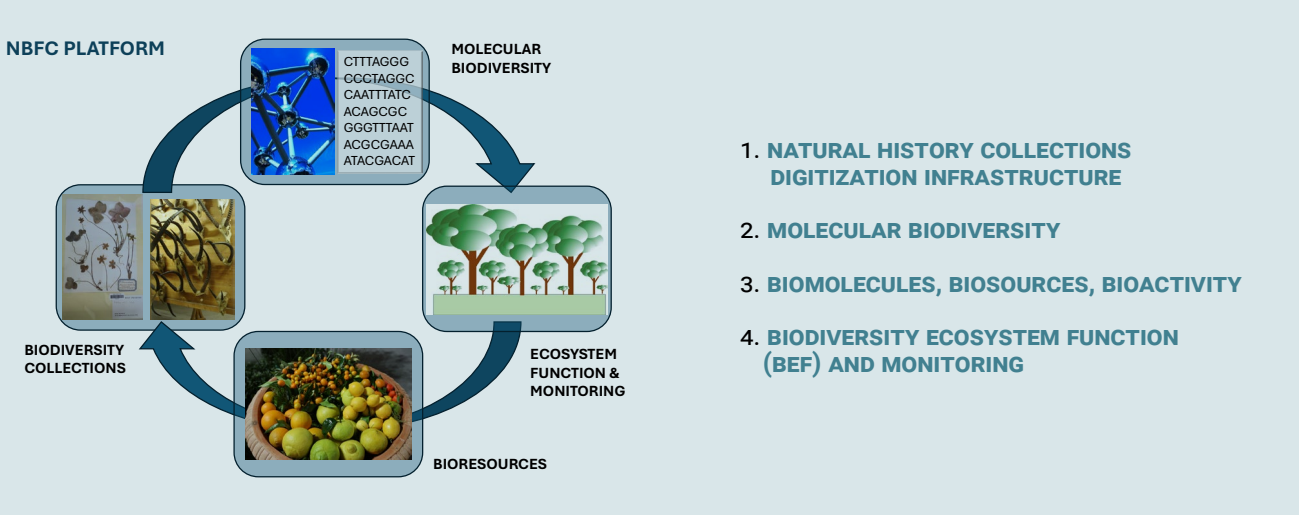
# 3.3 Biodiversity platforms

Of the eight million living species on Earth, one million are at risk of extinction. More than 80% of habitats in Europe are in a poor state of conservation with consequences also on ecosystem services and functions, such as carbon absorption capacity or resistance to climatic and anthropogenic disturbances. Only through the improvement of the process of collection, analysis, standardization and conservation of data on biodiversity and continuous and long-term monitoring will it be possible to make significant progress in the protection of ecosystems and threatened species. This requires a technological investment as well as a commitment to cataloguing and analysing. During NBFC planning it was highlighted that data on the biodiversity of our country include millions or even millions of billions of individual records of species, habitats, ecosystem functions and many other related information, whose archiving and management requires both adequate information tools and the training of a new generation of data analysts and e-biodiversity experts. It is also necessary to have adequate monitoring networks and advanced hardware-software systems in order to guarantee accessibility and sharing of information and the possibility of relating it to other direct or indirect environmental information, such as the European system Copernicus satellite images, biodiversity distribution of risk or threat factors, biodiversity activities related to conservation, restoration and enhancement. Finally, it is essential to promote data sharing between different institutions, bodies and countries in order to foster international collaboration and cooperation in biodiversity protection.

NBFC wanted to invest in each of these elements to create a national platform for collecting information on biodiversity acting as a digital twin - for monitoring and conservation purposes, to connect biodiversity to ecosystem functions and services. This multilevel platform is a fundamental tool for the national and international scientific community, for political decision makers and for intervening bodies who are called to protect biological diversity in different environmental contexts

The success of the creation of NBFC biodiversity platform lies in a highly qualified and multidisciplinary approach involving experts both in the field of computer science and computational sciences and of biodiversity (zoologists, ecologists, botanists, etc.). A second ingredient has been the access to very powerful HPC and Cloud resources such as those offered by the “Galileo 100” cluster[1] and ADA Cloud[2].
NBFC platform is based on four pillars respectively dedicated to the digitization and mobilization of information on biodiversity held in national museum collections (with an initial critical mass of at least 5 million specimens), to genetic biodiversity (with thousands of samples to generate data at three levels of complexity, ecosystem community diversity, species genomes and intraspecific genomic diversity), molecular biodiversity (through the analysis of data sets relating to bioresources, biomolecules and bioactivities), the relationship between biodiversity and ecosystem services (with integrated models of ecohydrology, community distribution and carbon cycle with the ability to update in near real time).

[1] https://www.hpc.cineca.it/systems/hardware/galileo100/
[2] https://www.hpc.cineca.it/systems/hardware/ada-cloud/



NBFC platform provides the scientific community with adequate model-making, calculation and analysis resources also based on Artificial Intelligence for predictions on the future of biodiversity, services to public administrations, for an adequate analysis of existing information, including new data that can be collected on a national scale by "citizen science" activities.
.

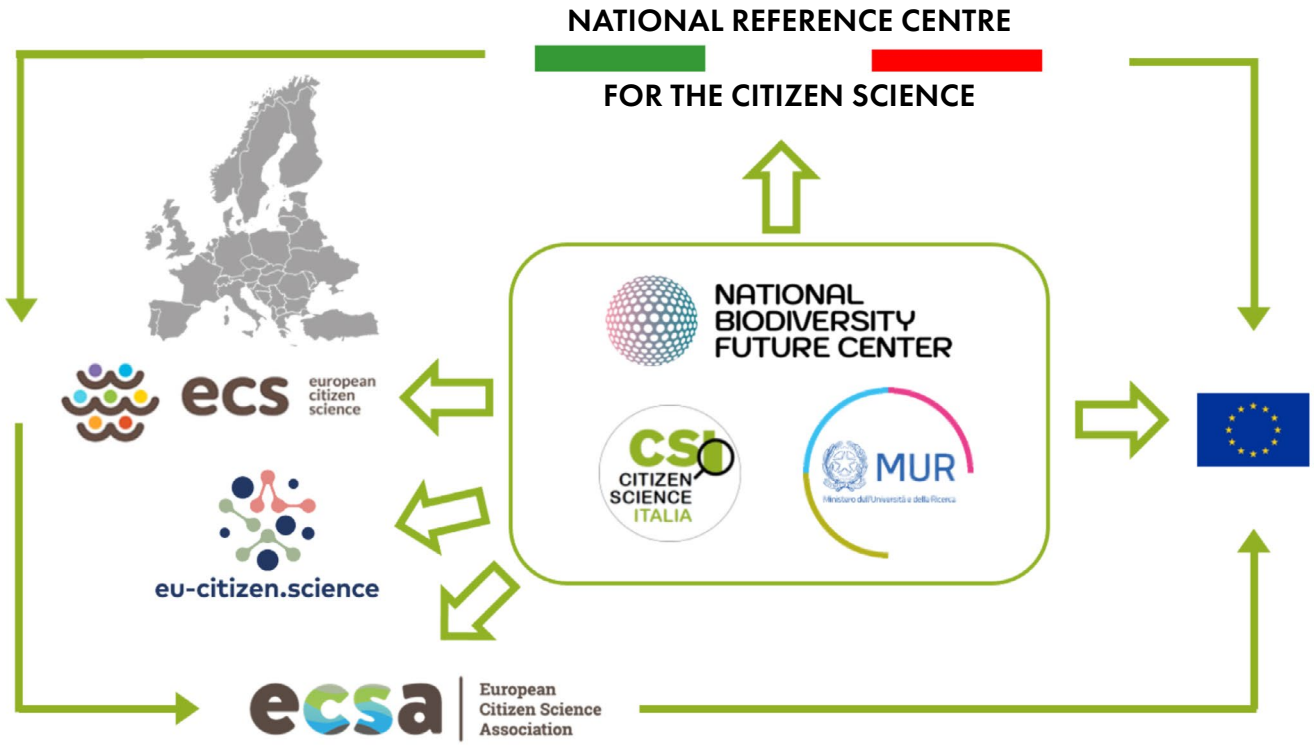
## 3.4 Citizens for biodiversity

NBFC's goals in the monitoring, conservation, restoration and enhancement of biodiversity will be achieved all the more successfully the more we are able to involve citizens; thus making it not an action imposed from above and the prerogative of the specialized academic community, but rather a shared and universal enterprise, since the resulting benefit is universal.
Therefore *Citizen Science* (*CS*), an activity that is now taking on connotations of a real professional discipline, allows us to involve citizens in a widespread and transversal way, starting from schools and individual territorial communities.
If it is true that *Citizen Science* is not just the observation of biodiversity, it is also true that most *CS* initiatives concern the observation and monitoring of ecosystems, the identification of species, their abundance and their cataloguing *Citizen Science* initiatives therefore contribute to the pursuit of NBFC objectives in at least two ways. On the one hand, they increase public awareness of the need to know, monitor, conserve and restore biodiversity. In essence, the awareness of biodiversity intrinsic (intangible) and extrinsic (with tangible economic and health impact) value. Added to this there is a real work of scientific education.

On the other hand, they provide potentially useful data to amplify the work of professionals on monitoring and conservation. To do this, however, there is a need for professionals who organize and guide, on the basis of scientifically sound principles, citizen observation campaigns and monitor their scientific correctness.

For this reason, the *Citizen Science* Italia Association has been recently established with the purpose to aggregate Citizen Science initiatives and experiences of a national (for example the City Nature Challenge) or local (such as the increasingly frequent Bioblitz) scope. NBFC promotes *Citizen Science* with concrete actions of technical, scientific and structural support. The research actions developed by the different groups follow collaborative models and include different stakeholders, facilitating knowledge exchanges and co-creation of strategies for nature conservation. In practice, NBFC has set up a working group made up of researchers, technicians, associations and citizens to identify a specific plan aimed at supporting the different macro-actions related to its project. Furthermore, work is underway to create an institutional agreement between the *Citizen Science* Association, NBFC and public bodies aimed at guaranteeing the continuity of the carried out activities with the creation of a coordination structure gathering the initiatives promoted by the various associations involved in *CS*. There is the then an interest to generate relationships and agreements with similar associations on an international scale, for example through the connection with the *European Citizen Science Association*.
At the same time, funds are allocated to support *Citizen Science* initiatives taking place in the country. Prominent among the various examples are those that address scientifically relevant topics from different disciplinary perspectives, such as the C4rivers project, with the involvement of communities and local administrations where zoological and botanical, but also chemical and even social data are collected (measuring of stakeholder involvement).

The recent amendment to article 9 of the Italian Constitution, which now includes the preservation of biodiversity "*also in the interest of future generations*" (where "also" identifies a double form of responsibility, both intergenerational and intragenerational), provides a legal and moral basis for this alliance and for the action of the NBFC. This constitutional commitment strengthens NBFC mission to work towards a future in which biodiversity is fully preserved and valued and ensuring our country a leadership role in global nature conservation strategies.




## 3.5 How do we make sure that all this will last over time?

Returning to the beginning of our discussion, we resume the subject of the “biodiversity moonshot”. The PNRR challenge has resulted in the most ambitious program ever attempted by the Italian state to support research and innovation in the field of biodiversity. This is not a trivial challenge. Paraphrasing the person who first launched the real moonshot in 1962: we are not monitoring, preserving, restoring and enhancing biodiversity because it is easy, we do it because it is difficult.

From this work on research and innovation in the field of biodiversity, important impacts are released on the territory, on the people who participate in these activities, and on society in general. How can we ensure that all this will last over time? Or rather, is there within the logic of the PNRR the ambition to go beyond the deadlines for reporting the expenses of the allocated budget? Non-trivial question, given that the European credit opening towards Italy through the Recovery and Resilience Plan has a specific deadline and that the resources must be spent and accounted for over the course of a handful of months. *Rebus sic stantibus* it would seem that the ultimate objective of the National Centres’ action is to reach the end of the spending period, complying with the rules and dealing with current spending within the expected times and ways. Moreover, this credit opening is part of an intervention framework of the EU Commission called "Next Generation". Furthermore, NBFC represents a concrete action to apply the new constitutional provisions of Article 9 which explicitly talks about the protection of biodiversity in the interest of future generations. We are therefore convinced that it is essential to focus not only on the correctness of spending activities but also on the quality of the spending itself in the interest of future generations, well beyond the time horizon given for the conclusion of the PNRR. This unique and interdisciplinary scientific community, which has come together for the first time to take up the challenge of this moonshot, must lay the foundations for a prosperous future.

In concrete terms, in order to promote a long-term result, while scientists and researchers are at work developing their research and innovation plans, the task of NBFC is first and foremost to **monitor and protect**. NBFC is committed to supervising and safeguarding research activities by establishing strong guidelines for the management of intellectual property, hence, not only protecting innovations but ensuring that they contribute positively to biodiversity, while respecting the integrity and value of scientific discoveries.

Furthermore, it is essential to **enable innovative practices**: the Centre, through its lines of intervention, promotes new practices in the field of monitoring, conservation, restoration and valorisation. This includes the identification of international best practices to be introduced also in Italy (since innovation is often adaptation), and the support to innovators who develop sustainable and environmentally friendly solutions, integrating cutting-edge technologies and methodologies.

The **international dimension of industrial policies** should also be monitored. Through its collaboration with international organizations such as OECD, JRC (Joint Research Centre), European Commission, United Nations and other international partners, NBFC influences industrial policies, integrating biodiversity into global business practices and promoting sustainable standards at international level. The first important result in this area was the work with the OECD which led to the inclusion of *biodiversity loss* among the investment priorities in research and innovation declared on April 24th by the Ministries of the OECD countries[1]. This is only a starting point, but an important one because it is essential to give autonomous dignity to this objective, distinguishing *green transition* from protection of biodiversity. It will be fundamental to continue on this path by intertwining collaborations with other international partners starting from the European Union and COP16.

It is essential to combine research support with an effective **deployment of innovation tools**. NBFC is putting resources into the hands of partner companies, small and medium-sized enterprises benefiting from the cascade tenders, parks and protected areas, to improve their ability to impact biodiversity. It will be necessary to actively monitor and support these projects, so that they actually can achieve the generative innovation objectives they set.

Furthermore, in the interest of the scientific and industrial community, **training and skills development** activities are crucial: NBFC considers education as a fundamental pillar, and to this end it promotes doctoral programmes, master's degrees and *one health and citizen science* training initiatives to prepare new generations to interact with and for biodiversity. "*People, people, people*" means that NBFC intervention tools should above of all educate a new generation of scientists, professionals, innovators and operators in the field of biodiversity. The task of the NBFC leadership is to monitor the impact of its various tools on this important objective, in order to ensure that tomorrow the country has the skills and the professionalism that are necessary to govern the system of research and intervention on biodiversity.

In conclusion, NBFC approach must be aimed at achieving **dual sustainability**: economy and biodiversity. Investments in the biodiversity sector, under PNRR, aim to generate a tangible return, both in terms of biodiversity (*Return on Biodiversity*) andin economic terms (*Return on Investment*). This translates into lasting benefits for both the environment and the society, creating a development model that enhances biodiversity as a driver of sustainable growth. Added to this is that the pursuit of double sustainability becomes a regenerative innovation: in this dimension, the principle of sustainability meets "*the mandatory duties of political, economic and social solidarity*" (art. 2 of the Constitution). Investing in biodiversity must generate wealth across the board and in every economic sector impacting conditions of environmental/energy poverty. Here is a summary of how to ensure that all is set out in these pages lasts over time. NBFC consensus and credibility are created by generating work and knowledge, promoting inclusion and sustainable development also for parts of societies and in territorial areas that are more vulnerable from a socio-economic point of view.

[1] OECD/LEGAL/0501: https://legalinstruments.oecd.org/en/instruments

04

# Biodiversity that generates value

## 4.1. Biodiversity and better quality of life

Biodiversity represents the beating heart of life on Earth, an indispensable element for human health and well-being. This complex web of life, which includes the variety of all biological forms, is essential for maintaining the balance of the ecosystems on which we depend for food, water, clean air and the natural resources necessary for our survival. Ecosystems are characterized by an intrinsic network of relationships between different organisms, adapted to the context in which they develop, offering indispensable resources such as food, water and bioactive molecules making the basis of medicines and that are essential for our sustainable future and health.

However, the devastating impact of anthropogenic activities has accelerated the loss of biodiversity to alarming levels, putting not only species and ecosystems but humanity itself at risk. Habitat destruction, pollution, climate change, and unsustainable use of resources are eroding the foundations of our health, food security, and quality of life. It is clear, therefore, that the protection of biodiversity is not a luxury but an urgent necessity to guarantee a sustainable future.

Our health and well-being are intrinsically linked to the health of the ecosystems from which we draw not only the air we breathe and the water we drink but also the foods that form the basis of our nutrition. A rich and varied diet, fundamental for human health, depends directly on biodiversity: from the variety of plant and animal species we consume, to the genetic diversity of the microorganisms that populate our digestive system. The protection of biodiversity, therefore, is an essential step not only to preserve the environment but also to ensure optimal nutrition and support to healthy lifestyles

The NBFC vision highlights how a conscious and sustainable management of natural resources, together with the promotion of agricultural practices that respect the variety of species, can positively influence our diet, enriching it with essential nutrients, reducing the risks of diseases related to nutrition and improving the quality of life. NBFC in order to deal with the loss of global biodiversity caused by a model of devastating anthropic development, as its primary objective, aims at restoring terrestrial and marine ecosystems by involving citizens in concrete actions on the territory and sharing the vision that protecting biodiversity means safeguarding our health and that of the planet, guaranteeing that way a sustainable future for generations to come.

# 4.2 Our health depends on biodiversity

The correlation between our health, the surrounding environment and biodiversity is highlighted by alarming data: according to the World Health Organization, approximately 24% of human diseases are attributable to environmental factors[1], with projections that climate change could be responsible for 14.5 million deaths by 2050. In this regard NBFC works to generate essential knowledge to address this challenge in two directions. The first aims at understanding the direct and indirect effects of ecosystem alterations on human health through multidisciplinary studies from which a key concept has emerged, namely that the combined and synergistic effect of multiple environmental and biological factors to which an individual is exposed over the course of its life, called exposome, underlines how the environment in which we live has a significant impact on our well-being.
The second, closely linked to nutrition and food, explores solutions inspired by nature to promote people's well-being and health.
Man has always exploited biodiversity for agriculture, breeding and the discovery of compounds for the treatment of diseases and the improvement of the diet.
This process, known as bio-prospecting, is adopted by NBFC to search for new beneficial compounds in the immense biodiversity of the Mediterranean, with a sustainable approach that avoids over-exploitation and biopiracy or the 'theft' of natural resources that often occurred in developing countries by industrialized ones. The search for new bioactive compounds, even from waste matrices, paves the way for the identification of innovative nutrients and the creation of functional foods that can improve health and prevent diseases. This effort aligns with the need to transition to more sustainable diets, which reduce environmental impact and enhance local biodiversity. By adopting agricultural practices that maintain and increase biodiversity, we can ensure that future generations have access to a variety of nutritious foods and resilient food systems. This approach not only protects ecosystems, but also promotes optimal nutrition, further highlighting how our health is inextricably linked to the health of the planet.

[1] https://www.who.int/health-topics/environmental-health#tab=tab_2

# 4.3 A therapy for the environment

The association between air pollution and human health problems, such as asthma and bronchitis, is well documented by bodies such as the US Environmental Protection Agency (EPA), underlining a direct correlation between environmental quality and human health . At the center of NBFC's research there is the exposure to environmental components, or exposome, with the aim of identifying concrete actions to improve the quality of the environment starting from the air of our cities up to the challenges posed by high temperatures.
The increase in temperature has been shown to negatively affect health[1], aggravating existing pathologies, especially in the most fragile subjects, such as the elderly. These negative effects are probably due to a greater level of inflammation and oxidative stress in subjects suffering from chronic degenerative diseases, including neurodegenerative ones, who are more affected by high temperatures. The increase in body temperature can also interfere with the correct folding of proteins, exacerbating the symptoms of neurodegeneration

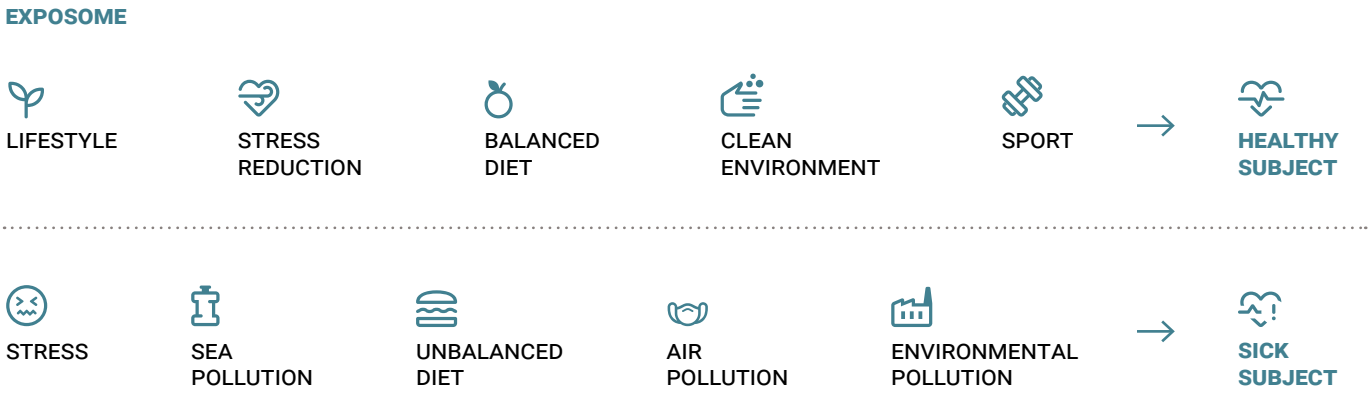
The NBFC research team has identified nature-based solutions to mitigate these impacts. An effective strategy is urban forestation and integrated spatial planning, which can significantly lower urban temperatures. The selection of trees suitable for the Mediterranean climate, capable of transpiring and reducing temperatures, is an example of how scientific research can be integrated with territorial action to create functional urban green areas.

Another area of success is the study of natural solutions (NbS) with a barrier effect against air pollution, capable of sequestering toxic compounds and

dangerous substances. There is also research aiming at identifying elements of the exposome that pose a threat to human health. For this reason, NBFC researchers are analysing the effects of the different components on cellular and human health effects, with the aim of deciphering the harmful mechanisms and developing markers for prevention.

The strategies adopted by the NBFC demonstrate that nature-based solutions (NbS) are fundamental to creating a future where the environment and human health can thrive together, highlighting the need for a holistic and integrated approach to research and to environmental planning.

[1] doi: 10.1038/s41467-023-44066-5




## 4.4 Biodiversity to clean the environment

It is now sadly known that a good part of the industrial activities that have contributed so much to the achievement of today's levels of lifestyle have also been a source of widespread pollution which still persists in many areas of the planet. In the NBFC redevelopment plans there is the definition of adequate strategies for remediation of areas contaminated by man in order to guarantee their safe use by users. Even if the case history of polluted soils is very wide, the majority of the contaminants fall into the two large categories of trace elements (i.e. metals and metalloids) and organic contaminants (aliphatic hydrocarbons, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phthalates, etc.). Although there are various technologies for reclaiming polluted soil, the most common are based on engineering approaches and are costly from an economic point of view, have an impact on the environment and generally their use is justified only if the remediation requires a very short time.
Fortunately, plants can represent an interesting tool for intervening on these areas through a particular reclamation technique called phytoremediation (known in English as phytoremediation). It uses certain types of plants, and often the microorganisms associated with them, to reduce the level of soil contamination by removing (phyto-extraction), degrading (phyto-degradation) or making soil pollutants less mobile (phyto-stabilisation). Although the technique requires on average longer remediation times than engineering approaches, it is much more advantageous from an economic point of view and is able to bring significant additional benefits by bringing biodiversity back to degraded areas and activating ecosystem services with great benefits for both environment and man.

Within the NBFC, research is being carried out aimed at the development of effective phytoremediation procedures through the definition of databases of specialized plants, which, associated with the microbial community, are capable of sequestering the different categories of pollutants. Microorganisms have an important role both to support the plant species used in phytoremediation and because, thanks to their metabolic diversity, they can also degrade emerging and structurally complex contaminants. The final objective is to provide local administrations with guidelines to improve the performance of the phytoremediation process, reducing the time required for remediation and improving the effectiveness of the system.
At the same time, NBFC intends to highlight and quantify the role of the phytoremediation as a system to activate and enhance the ecosystem services of

the various areas subject to interventions. The phytoremediation in contaminated abandoned areas, often devoid of vegetation, can in fact be conceived not only as a reclamation technique but as an opportunity to create a resilient ecosystem, capable of increasing biological diversity, regenerating environmental resources, supporting regulatory and supply services as well as cultural and aesthetic ones, transforming often forgotten areas into an element of value.

There is another important function performed by plants especially trees with their large foliage, which is to filter the air, cleaning it from gaseous and particulate pollutants. It is therefore another phytoremediation procedure that no longer addresses the soil but the air. Recently it has been understood that this phytoremediating capacity of the air differs from species to species. Starting from this knowledge, NBFC has developed the FlorTree model, whose database currently includes around 250 species suitable for the urban context and is continuously updated and is able to summarize the impact of individual woody species on air quality (trees and shrubs). The parameters that FlorTree uses include morphological characteristics (I.e. size of the crown at plant maturity, ratio between the mass and the area of individual leaves), phenological (length of the growing season) and physiological (capacity to absorb gas through stomata and emit volatile organic compounds) Each of us knows well that flowers and fruits smell but many do not know that this characteristic is due to the emission of volatile organic compounds (VOCs) which are in all respects hydrocarbons, similar to those emitted by anthropogenic activities but even more reactive in stimulating the formation of secondary pollutants (i.e. not emitted directly from sources).
Among the most important secondary pollutants we have aerosols and ozone, which are of great concern both for the levels they reach in European cities and for their toxic effects on human health and the state of ecosystems. Leaves can also emit VOCs, although this emission in most cases is below the odour threshold.

The Green Deal plans to plant an additional 3 billion trees by 2030 since they provide a multitude of benefits to citizens, including improved air quality. If the main objective of urban reforestation is to improve the air we breathe, it is useful to choose the species to plant among those that have the best impact on air pollution (i.e.Beeches, Maples, Ash trees) and avoid those that can even worsen air quality (i.e.oaks, poplars, willows, eucalyptus), especially in cities or areas that are subject to exceeding the thresholds of air pollution. FlorTree supports decision-makers in these choices, and will soon be available in a simplified and easily usable form (APP)

## 4.5 Biodiversity and business activities. Sustainable fishing and aquaculture

Scientific research conducted in NBFCs plays a fundamental role in counteracting the loss of biodiversity due to practices aimed at exploiting biological resources to meet human food needs, with particular attention to fish resources in order to guarantee a healthy and productive future for our oceans.
In this sense, the matters studied by NBFC researchers concern:

Understanding fish stock dynamics:
- Monitoring of fish populations to evaluate their health status, determining their size, structure, distribution and demographic trends. This data is crucial for assessing the pressure and define sustainable fishing quotas.
- Identification of species at risk through ecological and genetic studies allowing to identify the fish species most vulnerable to overfishing, pollution or other environmental stress factors.
- Understanding the biology of fish species, such as the reproductive cycle, nutrition, behaviour, population dynamics to predict the effects of different fishing practices.

Development of sustainable fishing practices:
- Development of selective fishing techniques, which capture only the target species, reducing the impact on unwanted fish species and accessory species.
- Minimization of waste, i.e. fish caught and then thrown back into the sea because it was not marketable. This includes developing ways to make best use of caught fish and promoting less waste fishing.

Science-based management:
- Policy recommendations: scientific data and analysis to support policies and regulations aimed at sustainable fisheries management and the marine ecosystems conservation.
- Monitoring the effectiveness of management measures by adapting and improving them over time.

Collaboration and awareness raising:
- Collaboration between scientists, fishermen and managers to develop shared solutions for sustainable fisheries management.
- Raising fishermen's awareness of the importance of adopting sustainable fishing practices and dissemination of good practices among coastal communities.
- Public education and awareness to promote conscious consumption of fish products.

Another production sector linked to marine biological resources is aquaculture. This production sector, which globally has surpassed fishing in terms of ability to provide proteins of marine origin is experiencing a moment of substantial stagnation in the EU.
The activities carried out in NBFC are aimed at giving new impetus to the sector, especially with a view to enhancing its ecological and economic sustainability.

The research is aimed at:
- Producing circular feed, with a view to valorising waste and with a low/no carbon footprint
- Eliminating antibiotics and drugs from feed, using bioactive molecules of natural origin that stimulate the well-being of the bred organisms, thus eliminating one of the major sources of impact on the environment by this product sector
- Studying the fish microbiome and the environment in which they live, to preserve their integrity and reduce the environmental impact of aquaculture practices
- Selecting more tolerant strains and genotypes, also in relation to climate changes
- Implementing aquaculture multitrophic integrated activities, i.e. co-breeding of extractive species (filter-feeding invertebrates and algae) which can substantially remove organic enrichment and fish release of nutrients (faeces and feed residues)

## 4.6 Biodiversity and pharmaceuticals

The study of Nature-Based Solutions for the environment, for the well-being of man and our society is one of NBFC research fields. The practice adopted by the NBFC to search for healing molecules in biodiversity is called bioprospecting.
Over the past year, almost 1000 species of plants, algae and marine organisms from the Mediterranean have been studied, whose natural molecules not only enrich our diet as new nutraceuticals or food additives, but also offer antioxidant and anti-inflammatory benefits, promising for clinical applications. Thanks to innovative technologies we can also exploit knowledge on biodiversity to research specific compounds and study the effect on humans.

NBFC started from the study of the Italian flora, in search of new and precious substances that can be used to prevent and treat widespread diseases, such as metabolic diseases, cancer and neuro-degenerative diseases. In this project, plants from the most diverse environments have been collected and studied but above all, thanks to new technologies, all the compounds present in these plants are being analysed with particular reference to secondary metabolites. These are mainly small molecules that very often interact with our cells producing various types of effects. Many drugs were born this way, studying living organisms and identifying molecules with various effects on humans.

In order to evaluate how these new molecules positively influence an individual's health, we must first have 'sensors' that tell us how the individual feels and how his or her state of health is.
These sensors are molecules present in our cells and are called biomarkers or indices of the individual's well-being; NBFCs researchers are trying, also with innovative methods based on artificial intelligence and bioinformatics, to identify these biomarkers.

Research will soon allow us to have a group of signals to monitor and also new molecules, such as small circulating RNAs, which can be analysed with a simple blood test or even with a harmless sample of saliva, which can predict how the subject and how a change in diet, exposure and behaviour affects his or her health. We are also aware that the state of well-being depends on multiple factors, from lifestyle, to diet, to stress, but also on factors linked to internal processes of the individual, such as his microbiota, i.e. the set of microorganisms that live in our intestines and other organs of our body. For this reason, NBFC also carries out complex research by enrolling groups of volunteers to investigate how certain eating behaviours, an active lifestyle and reduced exposure to stress can prevent multifactorial diseases.

## 4.7 Biodiversity and green industry

Too often man forgets that he is part of Nature, and not separate from it. Although the various industrial revolutions have allowed man to satisfy his many needs, it is precisely in Nature that it is possible to find an ally to accompany the primary needs of an ever increasing human community, managing to decouple the growth from the depletion of the planet's resources and the resulting negative environmental impacts.

Our primary supply chains, starting from that of food, are closely intertwined with the health of the soil, water, air, and deeply depend on a dynamic balance of biodiversity that maintains nutritional cycles (more precisely defined as biogeochemical cycles), the atmosphere as we know it, the possibility of producing organic carbon. However, our production processes, despite being based on admirable technological innovations, mostly continue to propose linear models, which can be simplified through the expression "Take, Make, Dispose". Furthermore, with minimal awareness of risks and consequences, we use the planet as a sink for our waste products, such as carbon dioxide and other greenhouse gases, plastics and other forms of waste, including pollution. From a systemic perspective therefore, the need for industrial processes based on a circular logic is accompanied by the study of how natural processes renew resources according to a scheme that can be simplified by the expression "from cradle to cradle".

In this scenario, the NBFC has activated research and innovation actions to seek innovative solutions in biodiversity. Considering that the greater biodiversity of the Planet lies in microorganisms and their enzymes, and that this potential is still largely unknown, it is possible to hypothesize that it is precisely in this unexplored biodiversity that the solutions for creating sustainable industrial processes can be found. In fact, microorganisms show an extraordinary effectiveness in transforming molecules and chemical elements through the biogeochemical cycles mentioned above, and they also have an extraordinary speed and flexibility in acquiring new skills precisely under the pressure of the conditions they are operating in. To cite some examples, the ability to fix carbon dioxide and carbon monoxide even in the absence of light, the ability to degrade some plastics, the ability to produce and secrete many bioactive molecules. This enormous potential can be exploited together with our ability for technological innovation to generate new production processes that reflect the principles of circularity set out above.
The tools that NBFC uses to develop the innovations necessary to change production processes are based on metabolic engineering, synthetic biology and process engineering. These methodologies make it possible to find microorganisms, in biodiversity, capable of regenerating resources in a biorefinery logic, making it possible to reconsider the end of life of products and goods. These processes aim to realize some of the key tasks of the United Nations 2030 Agenda in more than one of the 17 Sustainable Development Goals.

In particular, in the Italian territory it is possible to identify both particular ecological niches which include both urban hotspots and extreme environments, as well as centres of excellence that for decades have been dedicated to the valorisation of this biodiversity. Particular focuses of research are the development and technological transfer,the realisation of (bio) chemical platforms substituting or renewing those in use starting from waste biomasses; the production of new

fermented foods and drinks with selected nutritional characteristics; the characterisation and production of new bioactive molecules, including antibiotics; production of new polymers that are more easily biodegraded at the end of their life.
In NBFCs, biodiversity becomes the basis for new ones biotechnology that allows the generation of innovation and impact, in particular with processes aimed at i) minimizing waste and the environmental impacts of production processes, which can therefore bring the industry closer to a social context that creates economic and cultural wealth; ii) to promote new professions linked to the study, cataloguing and characterization of biodiversity, the management of bioprocesses and the study of the use of synthetic microbial communities.

## 4.8 Biodiversity and Environmental Intelligence

One of the areas of greatest innovation of NBFCs is Environmental Intelligence (EI). It is a discipline that integrates information from multiple sources making it possible to analyse and visualize ecosystem and environmental dynamics. It is important to underline that the ecosystem is a continuously evolving structure also due to global climate changes and that the description of the relationships between the different taxa requires the collection and processing of different data resources. For these reasons, NBFC has developed an EI approach that works at the interface between scientific, environmental and sustainability research, taking advantage of rapid advances in data acquisition using sensors, digital technologies, the Internet of Things (IoT) Artificial Intelligence algorithms in order to explore effective solutions for the conservation, monitoring and restoration of biodiversity.

It should also be noted that the management of different environments and ecosystems requires the involvement of multiple actors and through EI it is possible to identify and explore participatory decision-making processes in order to propose specific and personalized solutions for different matters.
*The environmental surveys carried out through EI can concern the collection of ex situ (i.e.satellite) or in situ (i.e. sensors in the soil) data on the presence of pollutants in the soil which, appropriately processed, can allow the identification of the strategy leading to the most effective remedial action.*
*Another example is represented by sensors that can detect the presence of pollutants in fresh, brackish or salt water which, as in the previous example, can then lead to implementation of actions to remove them.*
*Finally, the development of innovative sensors for the detection of air pollutants in both indoor and outdoor environments can help both the development of sanitization actions and any policies or rules preventing the same event from happening again.*

For a full affirmation of Environmental Intelligence, NBFC is facing multiple technological, economic and social challenges:

- Hardware Development: *devices, systems and infrastructures for the collection*, management and processing of data must generate the minimum possible environmental impact, in order not to transform a possible solution into a cause of damage to the environment;

- Software and Data Infrastructure Development: collection, classification, storage and processing of information will have to take place through broadband infrastructures in order to manage the large quantities of collected data. It will be crucial to respect cyber-security standards, making use of sub-systems for machine learning, deep learning and architectures suitable for highly parallel HPC (*high performing computing*) calculations (including the first quantum computing processing);

- Ecosystem Development: the multi-messenger approach should not be limited to the technological sphere, but extended to all levels. In particular, a broad relational network must be developed between people, institutions and stakeholders involved in the collection, processing and analysis of data, as well as between all the actors interested in the environmental problem who can participate in the evaluation of the proposed solutions and implement policies, regulations or investment programmes in the sector;

- Policy Setting: the activation of a political context available, on the one hand, to implement the change suggested by data, on the other hand to pursue this change using EI tools will be fundamental. At a European level, important steps in this direction have been made both in the H2020 Framework Program and in Horizon Europe, in particular through the European Innovation Council (EIC) funding of various projects aimed at stimulating the *development of products and the EI*.

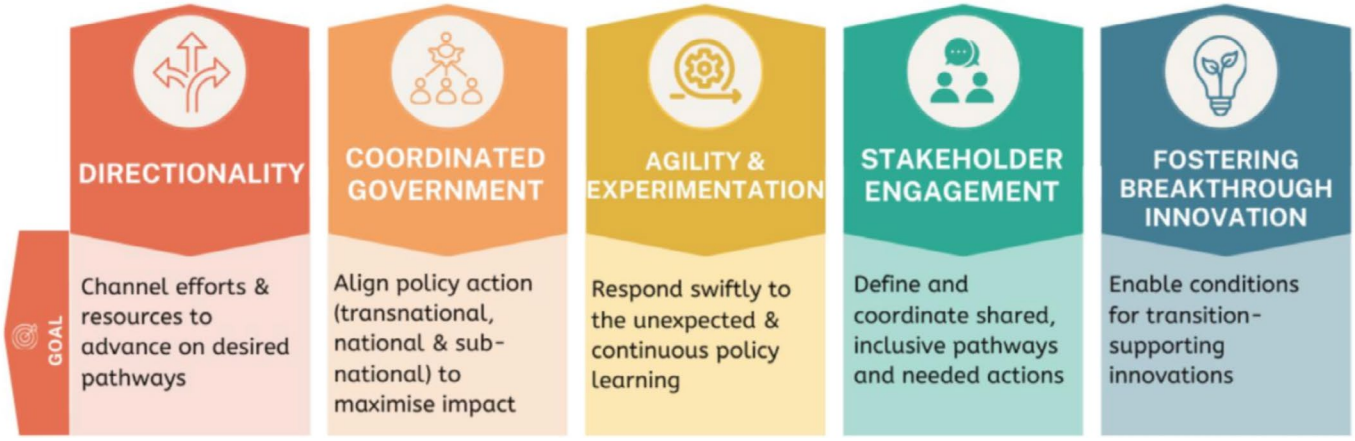
In conclusion, Environmental Intelligence presents itself as an emerging sector of the so-called «Environmental Deeptech Innovation", that is, that technological innovation aiming at preserving the environment through the continuous development and application of scientific knowledge. The multidisciplinarity and multimessenger character, based on the systematization and correlation of different technological approaches, makes this science a powerful tool for solving complex and dynamic problems such as those that will have to be faced in the future for the protection of biodiversity.

05

# Biodiversity: policies, economy and future

## 5.1 Policies for nature protection

Science, Technology and Innovation (STI) policies can play an important role in safeguarding biodiversity and fighting climate change. However, this requires a change of strategic vision. Conventional economic growth models that incorporate assumptions about the "correct" functioning of markets do not appear to be able to effectively address the risks associated with climate change and related environmental and ecological processes such as, for example, the loss of biodiversity.
According to the Organization for Economic Co-operation and Development (OECD), today we have entered a third generation of STI policies, where five new imperatives are needed to drive innovative development for the green transition: (i) **DIRECTIONALITY**, (ii) una **COORDINATED GOVERNANCE** between the different levels of government, (iii) **INVOLVEMENT OF THE MAIN STAKEHOLDERS** of the innovation system, (iv) **POLICIES AGILITY AND EXPERIMENTATION**, (v) **SUPPORT TO RADICAL INNOVATIONS**.
How is NBFC adopting these new approaches in the context of biodiversity protection?




The five key OECD approaches and tools for developing STI policies for the green transition

**DIRECTIONALITY**

To date, STI policies need to address major social and environmental challenges. NBFC has identified a package of public policies to mitigate market failures in the ecological transition: research and development directed towards green science constitute one of the pillars of the project. Left to the market alone, the direction of innovation and technological change would be socially suboptimal, with the risk of dedicating too few resources to research and innovation in the area of environmental sustainability.
In this respect, the framework is inspired by European mission-oriented policies as a coordinated package of policy and regulatory measures specifically designed to mobilize STIs to address well-defined objectives related to a social challenge, in a defined time frame. NBF's "Biodiversity Moonshot" aims exactly at this objective, that is, setting itself an ambitious and complex objective, that, for this very reason cannot be ignored.

**COORDINATED GOVERNANCE**

Governments and organizations must improve coordination to ensure success in digital and environmental transitions. This requires both horizontal coordination between different government sectors, such as science and technology, environment, labour, and fiscal and social policies, and vertical coordination between various levels of government. In this respect, NBFC is inspired by the objectives set by the Kunming-Montreal Global Biodiversity Framework (GBM) in 2022, which in fact call for strong international collaboration to achieve the new international targets by 2030. Among the objectives, the need to establish a technical-scientific collaboration mechanism through the institutionalization of a global coordination entity that includes a network of research centres and universities.
NBFC on this subject serves as a best practice. In fact, the hub and spoke model involves coordination developed by the central hub which sets the objectives developing at the same time a strong collaboration network with all the spokes. There are 8 spokes, the first 6 are thematic and pursue the objectives of knowledge and valorisation of biodiversity.
The other 2 spokes deal with communication and valorization of biodiversity in close collaboration with society and business. This vast national network which includes academic institutions, research centres, non-governmental organizations and other public and private actors is a winner as it makes it possible to aggregate skills, knowledge and develop valorisation activities quickly. The centre also acts as an interlocutor for the government and the various ministries involved in land and biodiversity protection programs and activities as well as in ecological and digital transition programs. NBFC has also developed a network of national and international relations (e.g. Joint Research Center-JRC, and OECD) to bring the solutions coming from research into the operational environment.

**PARTICIPATION AND INVOLVEMENT OF STAKEHOLDERS**

Stakeholder involvement refers to the inclusion, in policy making, of different actors in the STI ecosystem, including citizens, the industrial world and research institutes. This allows their perspectives, concerns and skills to be integrated into the process of developing innovation policies according to RRI (Responsible Research and Innovation) principles.

At an international level, NBFC has developed a network involving various strategic partners thanks to its collaboration with the OECD. Through some strategic projects such as "Harnessing Innovation for Biodiversity" and with the support of the OECD "Technology and Innovation Policy" (TIP) working group, an international network of experts has been established capable of sharing best practices in STI policies for biodiversity. Thanks to this work, biodiversity has been effectively integrated into innovation policy documents. This is fundamental to define the crucial role of the industry in this context.

**NBFC STEPS TOWARDS OECD**

**OCTOBER 5TH**
FIRST WEBINAR

**NOVEMBER 23RD**
SECOND WEBINAIR

**FEBRUARY 29TH — MARCH 1ST**
WORKSHOP AT VENICE

**MARCH 28TH**
THIRD WEBINAIR

Since its launch, the project has seen several activities: a first information workshop took place on October 5th 2023, followed by a second workshop on November 23rd 2023, both with a significant participation of international experts. During the 62nd TIP meeting and workshop, which took place in Paris from 5 to 7 December 2023, the evolution of the project was presented. A further workshop was organized in Venice from 29 February to 1 March. The results of the workshop summarized in a report are available here: https://issuu.com/oecd.publishing/docs/biodiversity_workshop_summary_march2024_for_public.

A third online workshop was held on March 28th , during which key messages were drafted to communicate to the ministers in view of the CSTP Ministerial meeting on 23-24 April in Paris. During the "multi-stakeholder dialogue" of the meeting, a table was dedicated to the protection and enhancement of biodiversity, moderated by the NBFC CIO Alberto Di Minin. Thanks to the management of the "multi-stakeholder dialogue" and the strong role of NBFC in the promotion of the project through the figures of Alberto Di Minin and Jacopo Cricchio, the importance of the protection and valorization of biodiversity to develop, with the words of the OECD, “Transformative Science, Technology and Innovation Policies for a Sustainable and Inclusive Future” was included in the final declaration of the Ministerial meeting , recognizing how the loss of biodiversity is one of the major risks to be faced to develop a better future and that innovation policies will necessarily have to take this into account.

The Ministries final statement will chart the OECD's path on STI issues for years to come and is available here: https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0501.

#### AGILITY AND EXPERIMENTATION OF POLICIES

Agility and experimentation in STI policy making leads to a flexible and adaptable approach aimed at achieving greater effectiveness. Agility involves the ability to respond quickly and effectively to changing circumstances and emerging challenges, focusing efforts where they are needed most. Experimentation involves systematically testing new ideas, policies or interventions to evaluate their potential impact and shape decision-making by leveraging evidence from experimentation.

In developing these processes, strong data monitoring and the development of digital technologies that are capable of collecting, sharing and analysing data that can be exploited for the implementation of agile and experimental policies are essential. In this respect NBFC propose the Biodiversity Gateway in order to systematize the generated knowledge and offer partners access to innovations, data resources and infrastructures and opening up to research aimed at achieving prototypes in an operational environment supporting production. In the gateway, companies and institutions will find the availability of researchers to face emerging challenges thanks to research and innovation processes, exploiting the principles of Open in Innovation and the development of public-private networks that is fundamental for generating value from biodiversity.

#### SUPPORT TO RADICAL INNOVATION

Public policies oriented towards the demand for new products and services capable of addressing environmentally related social challenges, based on the use of pre-commercial public procurement (PPC) and public procurement for innovation (PPI), seem to represent one of the most effective tools available to policy makers to promote and support the development of radical innovations

Over the last decade, the strategic use of public procurement has become a central theme of European innovation policy. In an economic phase characterized by the scarcity of available resources, the public demand for innovation seems to represent an effective means to improve the provision of public services by consuming fewer resources and facing complex social challenges by directing the process of technological change towards socially shared objectives.

NBFC intends to respond to public demand for innovation and provide the basis for "green public procurement". From an analysis carried out by NBFC spoke 8 (data extracted from UE Tender Elecronic Daily ) it emerges that our country shows a lower share of expenditure for the two components of procurement for innovation in the biodiversity sector, compared to to Northern European countries where these tools are used to a greater extent, especially for the acquisition of data (monitoring to overcome the knowledge gap) and for the development of models for data interpretation and risk management also through the request for development of specific artificial intelligence tools.

In this respect, NBFC has developed various actions to promote innovative practices in the field of biodiversity with particular reference to) the inclusion of Small and Medium Enterprises through the co-financing of strategic projects to accelerate the development of products, services and processes in the field of biodiversity (overall budget 20 million euros). 150 applications were received and are

being selected. ii) support to local authorities such as parks and marine protected areas. projects aimed at the conservation, monitoring and restoration of biodiversity in strategic areas of the country have been promoted and funded.

Through these initiatives aimed at external organizations, NBFC is committed to stimulating the co-creation of innovative business ideas and cultivating new professional talent.
Italy needs a coherent and long-term action plan precisely defining strategic objectives, tools and priorities. It is essential that innovative policies for the protection and enhancement of biodiversity become a central and regional administrations strategic goal. The National Strategy for Biodiversity to 2030 is certainly a good starting point. NBFC plays a crucial and strategic role for achieving the objectives set by the strategy consisting in acquiring knowledge on the territory and providing scientific, technological and innovation support to public and private bodies to conserve and restore biodiversity.

## 5.2 The economic value of biodiversity

Economic development is connected to biodiversity, as it is based on the consumption of natural resources. In recent decades there has been a deterioration of biodiversity and ecosystems at a global level and this phenomenon is extremely connected to anthropic activities of an economic and corporate nature, with consequent negative socio-economic repercussions. In fact, the World Economic Forum itself classifies the loss of biodiversity and the collapse of ecosystems as the third risk in terms of severity that companies and society in general will have to face in the coming years. Over half of the world's economic production depends on ecosystems and their services and some sectors such as forestry and agri-food heavily dependent on them.

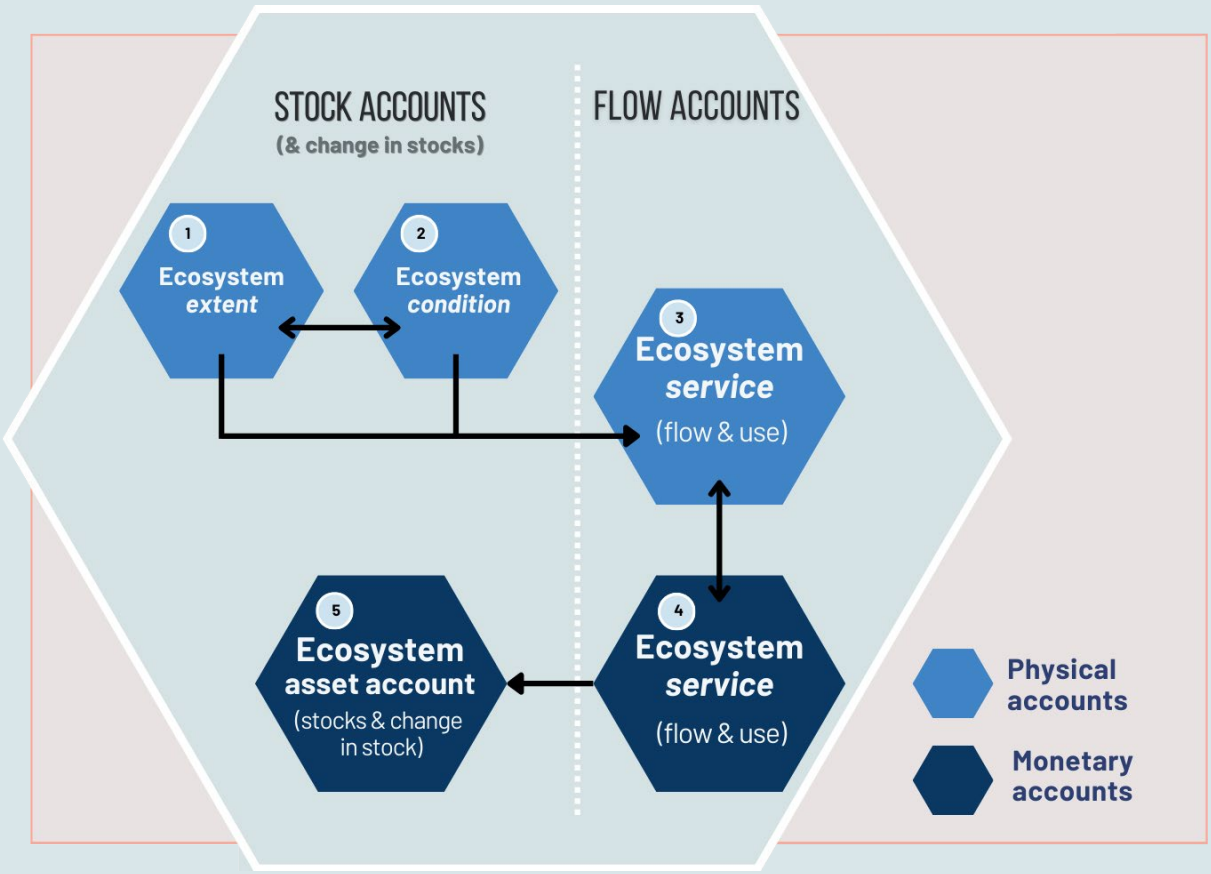
In this sense, the industrial and financial sectors must consider the loss of biodiversity as a cost and a potential risk due to the cessation or reduction of ecosystem services on which business bases its value creation processes. In fact, companies receive biodiversity and ecosystem "services", for example the supply of raw materials and fertile land, clean water and environmental resources and pleasant landscapes, creating real "addictions". The World Bank has estimated that the economic consequences of biodiversity loss are substantial and that the loss of ecosystem services could cost global GDP 2.7 trillion in 2030.

As a proof of this and in order to enhance the contribution of biodiversity to the global economy, the UN has developed System of Environmental-Economic Accounting - SEEA- that, after the introduction, in 1953, of the System of National Accounts (SNA) to standardize and coordinate the collection of economic statistics such as GDP, is perhaps one of the most important statistical reforms of the recent decades.

**SEEA**

In 2012, the SEEA was adopted by the United Nations General Assembly as the UN Statistical Standard that complements the SNA and provides a multipurpose conceptual framework for understanding relationships/interactions between economy and environment. The SEEA aims at integrating economic and environmental data to provide a more complete and multipurpose vision of the interrelationships between economy, environment, environmental goods stocks and changes in stocks due to them bringing benefits to humanity. It contains internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics and accounts. The SEEA framework follows an accounting structure similar to that of SNA and provides an interconnected system of physical and monetary accounts to appraise the value of ecosystems in a comprehensive and coherent way.

IL SEEA




Connections between physical and monetary accounts of ecosystems

(UN et al. (2021, p. 32)

The objective of SEEA monetary accounts is to determine the exchange value of ecosystems and their services, i.e. the sums of money payable to asset owners for the assets themselves or for the use of their services. Therefore, Ecosystem Accounts, building a bridge between natural science and political economy, aim to provide statistical information with the aim of:

- describing ecosystems according to an ecological perspective (typing of ecosystems and spatially explicit measurement of their extensions and conditions), that is relevant for the representation of economic aspects;
- describing what socioeconomic systems draw from ecosystems (ecosystem services) consistent, in the classification of beneficiaries, with the national accounting schemes;
- providing a basket of monetary values, measured within the national accounts, variously referable to ecosystem services.

Such values are often identified with the economic importance of ecosystems and their services
In March 2021, the first 7 chapters of the SEEA were granted "international statistical standard" status by the UN. These chapters define the physical aspects of ecosystem accounts, while the debate on measuring the related monetary values is still ongoing, with Italy actively involved in the discussions. The monetary part of the SEEA, in fact, was excluded from the standard as it is very complicated to define the multidimensional value of the environment in a way consistent with the basic assumptions and categories of national accounting.

Although currently largely unrealized, the environmental accounting agenda has the potential to promote a more pluralistic view of economic values and policy formulation. Visualizing monetary values variously 'connected' to ecosystem services can inspire greater consideration for ecosystems in the public Decision-making process: on the one hand,

decision-making processes can be conditioned by the monetary evaluations related to everything that is at stake when they affect ecosystem services, on the other hand, public decisions can transform the effective price systems, to make them converge towards configurations that are more favourable to the conservation of biodiversity and production, taking into account the different monetary values estimated for the productions and the produced assets depending on ecosystem services.

The European Commission is also promoting the integration of ecosystem accounts into the European Environmental Accounts Regulation and is working to bridge the methodological gap with other accounts. The economic evaluation of biodiversity and ecosystems in the corporate context is affected by the same philosophical and practical criticisms of valorisation according to the macroeconomic approach, in particular with regard to their accounting in monetary terms.

One way to understand the value of biodiversity for businesses and financial institutions is to think about dependencies in terms of risk. In fact, if the loss of biodiversity led to the collapse of ecosystems and, consequently, to their inability to provide services, this would have important repercussions on the companies depending on these services. Companies could therefore risk seeing their financial survival capacity compromised, with consequent inability to honour the financing and investments received. Therefore, through this risk transmission mechanism, financial institutions are also exposed to risks related to the loss of biodiversity and the collapse of ecosystems.

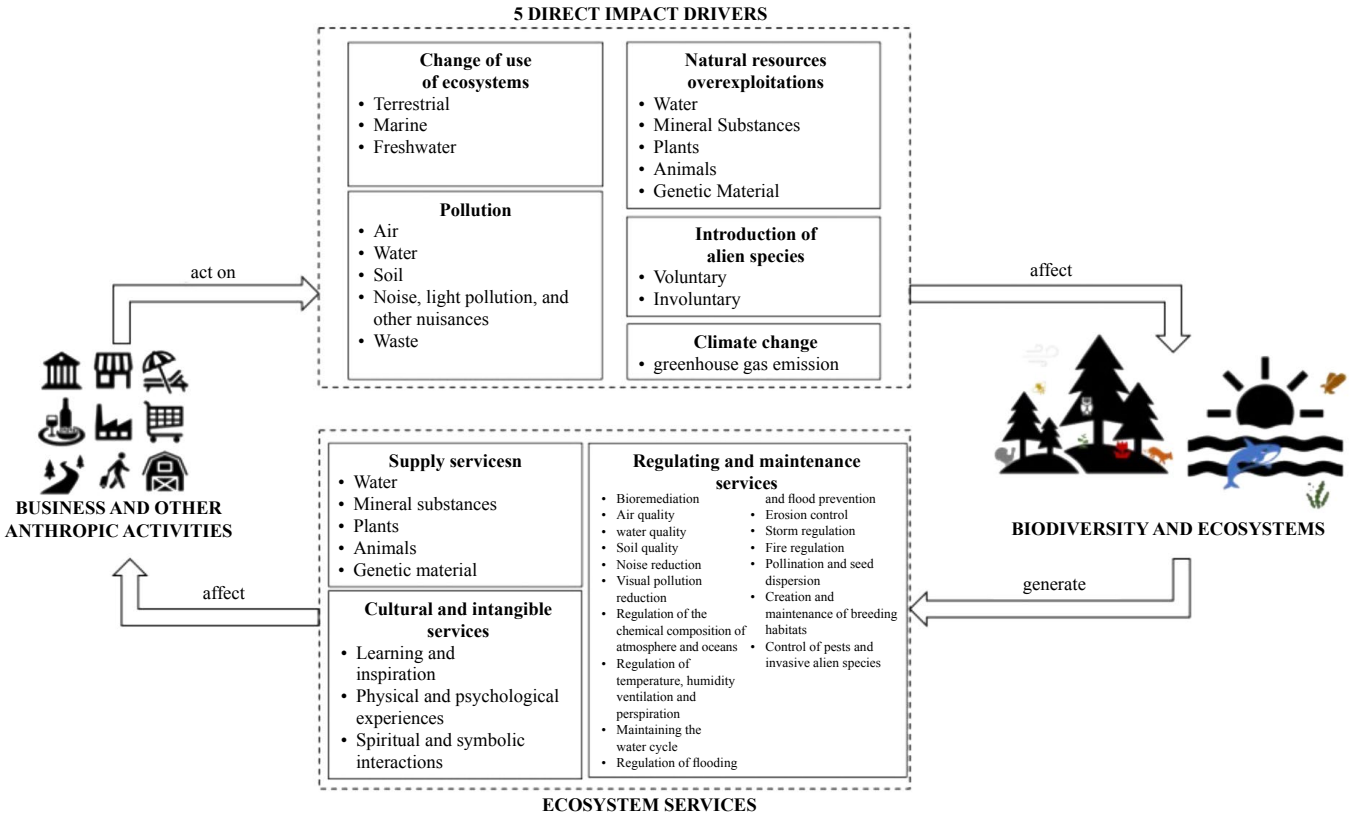
The main types of climate and biodiversity risks to which organizations are exposed are set out below:

- Risk arising from the loss of value of natural assets: this risk refers to the decrease in the economic value of natural assets, such as fisheries resources, forests, agricultural land and natural habitats, due to the loss of biodiversity.
- Risk from natural disasters: natural disasters, such as forest fires, floods or extreme climate events, can directly damage natural habitats and biodiversity, resulting in financial losses for companies that depend on these ecosystems.
- Regulatory risk: Increasingly stringent environmental regulations can pose financial risks to companies that fail to comply with biodiversity conservation laws. For example, the imposition of limits on the extraction of natural resources, the obligation to restore destroyed habitats or the introduction of taxes on emissions can negatively affect the profitability and competitiveness of non-compliant companies.
- Risk of commodity price volatility: Fluctuations in the prices of raw materials, such as wood, seafood or food, may be influenced by the availability and quality of natural ecosystems.

Following these considerations, NBFC researchers focused on analysing the impact and performance of economic activities on biodiversity, involving theoretical and practical aspects. Initially, we proceeded with the identification of models to evaluate the impact of company activities on biodiversity using parameters, good practices, international comparisons and appropriate tools.

In particular, a systemic model of impacts-dependencies has been developed which is useful at company level for the development of informed reasoning on the topic of biodiversity, its value and its measurement.

The second action, currently underway, concerns the implementation of tests of some models for identifying impacts and dependencies at company and supply chain level which can then be linked to appropriate indicators collected and systematized by various qualified international sources.




Systemic model of corporate impacts-dependencies

(our calculation based on SBTN (2020, 2023), Natural Capital Coalition (2016), IPBES (2019), Jaureguiberry et al. (2022), ENCORE (2024), UN (2021), Haines-Young e Potschin (2018))

# 5.3 Towards the biodiversity gateway

NBFC **8 CONCRETE STEPS** towards the next National Forum

1 | Make NBFC technical resources operational with particular reference to tools aimed at the conservation, monitoring and restoration of biodiversity;

2 | Connect research and territory starting from protected areas and parks distributed across the national territory, including those that were winners of the NBFC parks tender;

3 Validate the products and processes created in an operational environment and promote social and economic valorisation;

4 Strengthen connections with local authorities to scientifically support operational interventions;

5 Strengthen international connections in order to generate participatory and shared projects;

6 Stimulate entrepreneurship and collaboration between research and business;

7 Consolidate education and communication tools dedicated to biodiversity;

8 Generate the Biodiversity gateway.

The Biodiversity Gateway is the set of connecting functions between the centre's scientists, citizens, businesses, public administrations and biodiversity professionals. It is organized to facilitate interdisciplinary collaboration between researchers.
And it offers to stakeholders the knowledge developed by scientists, the services necessary to valorise it, and the media structures necessary to communicate it.

The Gateway is structured on the basis of a strong digital infrastructure and a set of physical presences. The digital infrastructure is composed of a portal for the use of information by the community and a platform for access to the data collected and recorded by researchers.
The main physical offices are located in Palermo and Venice, where the services necessary to design and support scientific and technological collaboration projects are respectively concentrated, especially in the Mediterranean, and the services to accelerate technological innovation and the launch of business-oriented initiatives to enhance the science of biodiversity. In other cities, the Gateway can rely on centres specialized in activities related to citizen science, BioUrban planning, and the production of innovative solutions for science communication. All the physical places in which the Gateway develops its functions are also venues for exhibitions and initiatives dedicated to citizens so that they can learn about and appreciate biodiversity in all its forms and meanings. Parks and museums that deal with biodiversity also contribute to this, as they can enhance their function by also becoming windows on the communication of the NBFC's research to citizens and demonstrators of good practices of public administrations.

The knowledge produced by the science of the NBFC is therefore organized so that it can change the trajectory of cultural development and the awareness of Italian society towards biodiversity. They are presented proactively, not waiting for stakeholders to become interested in biodiversity, but trying to gain their trust and attention with constant and widespread work of sharing knowledge with all citizens and proposing to the business system all opportunities offered by science and technology developed within university research.

This is a real need , because biodiversity must be perceived for its value. Ecosystem services are undervalued, but their importance is essential for the functioning of social and economic life. And after all, nature is an answer to some of the great challenges of the 21st century, starting with the climate emergency. But we need to know much more and much better about all this. The Gateway must serve its stakeholders, from scientists to citizens, from businesses to public administrations and professionals, so that awareness of the value of biodiversity makes a decisive leap in quality. The NBFC's two thousand scientists are a major cultural force, a community that knows and supports them has an unparalleled capacity for impact. The Gateway is at the service of a vision: the construction of common ground where people can find the energy and the motivation to make the choices necessary to transform a profound and problematic epochal transition into a huge improvement in the quality of life.