Brussels, 17 May 2024

COST 034/24

DECISION

Subject: Memorandum of Understanding for the implementation of the COST Action “Genetic Nature Observation and Action” (GENOA) CA23121

The COST Member Countries will find attached the Memorandum of Understanding for the COST Action Genetic Nature Observation and Action approved by the Committee of Senior Officials through written procedure on 17 May 2024.

MEMORANDUM OF UNDERSTANDING

For the implementation of a COST Action designated as

COST Action CA23121
GENETIC NATURE OBSERVATION AND ACTION (GENOA)

The COST Members through the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action, referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any document amending or replacing them.

The main aim and objective of the Action is to implement genetic diversity indicators to broaden the uptake and use of genetic diversity for species assessments to protect biodiversity.
Global ecosystems face increasing pressures from climate change and anthropogenic activities.
Understanding and protecting genetic diversity is paramount to providing species with the ability to adapt to change. This will be achieved through the specific objectives detailed in the Technical Annex.

The present MoU enters into force on the date of the approval of the COST Action by the CSO.

OVERVIEW

Summary
Genetic diversity is fundamental for adaptation and essential to species survival, hence for nature's contributions to people. Furthermore, genetic knowledge supports the effective use of resources to ensure the holistic protection of biodiversity. While genetic diversity data and indicators are available, they are often not integrated into species management and monitoring schemes in Europe due to a lack of capacity. Furthermore, current national policies and practices have not yet 'adapted' to the new Global Biodiversity Framework. In order to better understand genetic diversity in species and their populations and actively use it to monitor and safeguard biodiversity, there is an urgent need to refine, assess, inform and facilitate the implementation of genetic diversity data and indicators across European countries. This implementation of genetic diversity data should be achieved by including practitioners, companies, policymakers and the wider public. The needs of all these stakeholders should be investigated and taken into account in order for collaborations to be inclusive and effective, as such, building knowledge, capacity and trust among partners. Hence, GENOA will co-create and improve the procedures, methods and data on genetic diversity (indicators) and co-develop tailored dissemination packages to reach out to and exchange with targeted stakeholders to enable a better understanding of genetic diversity information. In addition, the monitoring, reporting and application of genetic data will improve, which will contribute to the conservation of biodiversity at all levels.

Areas of Expertise Relevant for the Action	Keywords
● Biological sciences: Conservation biology, ecology, genetics ● Biological sciences: Population biology, population dynamics, population genetics, plant-animal interactions ● Biological sciences: Biodiversity, comparative biology ● Biological sciences: Environmental and marine biology	● Genetic Diversity ● Biodiversity Monitoring ● Ecosystem Resilience ● Capacity Building ● Co-creation

Specific Objectives
To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination
● Evaluate the correlation and complementarity among various approaches to genetic diversity and genetic indicator monitoring to improve their integration - approaches which differ in scale, technological and capacity needs.
● Collaboratively assess how genetic and genomic data in focal species can inform management to support associated biodiversity and healthy ecosystems/ecosystem function.
● Use coordinated efforts to improve and facilitate the adoption of methods, Standard Operating Procedures (SOPs), and approaches for fast and easy calculation, use and reporting of the genetic diversity indicators.
● Determine, through a co-creation process and engagement, the extent to which diverse stakeholder groups (conservation practitioners, policymakers and indigenous people and local communities (IPLCs)) as well as the wider public understand genetic diversity concepts and identify potential barriers for their uptake.
● Systematically identify and coordinate multidisciplinary avenues by which genetic diversity indicators and other metrics can be integrated into national, regional, and international policy (e.g., input to stakeholders at

national and EU scale).

Capacity Building

● Provide knowledge exchange and capacity building efforts for supporting genetic diversity assessments for conservation problems using genetic and genomic technologies (e.g., not indicators) tailored to various stakeholders needs.

● Provide knowledge share - including the necessary advice, support, and collaboration among countries - to successfully deploy genetic diversity indicators nationally, transboundary and for, EU, and international reporting.

● Provide innovative opportunities for knowledge sharing to raise awareness about the value and importance of genetic diversity in key stakeholder groups (policymakers/governmental bodies at different levels, conservation practitioners, small and medium enterprises (SMEs) and the public, including IPLCs).

● Foster regional genetic knowledge hubs/networks that will persist beyond this Action and serve as stakeholder platforms for transnational mutual experience exchange, including by promoting active participation of ITCs.

● Develop a well-rounded, transdisciplinary future scientific workforce that is trained in both policy and science, and able to communicate effectively with diverse stakeholder groups.

TECHNICAL ANNEX

1. S&T EXCELLENCE

1.1. SOUNDNESS OF THE CHALLENGE

1.1.1. DESCRIPTION OF THE STATE OF THE ART

The United Nations Convention on Biological Diversity (CBD) defines three pillars of biodiversity: genes, species, and ecosystems. **Genes are the foundation of all biological variation**, allowing species to adapt to changing environments. Species survival and ecosystem resilience depend on genetic diversity, which is especially important under a changing climate. Genetic diversity is the DNA variation among individuals *within populations* and *among populations* (intraspecific diversity), which adapts to local environmental conditions. The urgency of conserving genetic diversity has become evident as major studies have documented the scale of **genetic diversity loss** in species ranging from 6% to 30% (Exposito-Alonso et al., 2022; Leigh et al., 2019). Hoban et al. (2021) projected that future losses would exceed 50% of genetic diversity if no action is taken, while Frankham (2022) stated that associated impacts on fitness would make many species and populations unviable, thus accelerating extinctions. The Planetary Boundaries framework and the analyses of crop wild relatives also point out that losses of genetic diversity have reached unprecedented levels (Richardson et al., 2023; Tobón-Niedfeldt et al., 2022).

Genetic diversity is rarely integrated into national, regional, and international biodiversity monitoring programmes (Hoban et al., 2021; Pearman et al., 2023), despite its clear contribution to ecosystem services (Des Roches et al., 2021). For example, within the EU, the Habitats Directive hardly considers genetic information for the evaluation of the conservation status, despite its importance for species survival (Habitats Directive Art 17, n.d.). Additionally, genetic monitoring (repeated analysis of the genetic data for populations over multiple time points) is rarely used in Europe to evaluate the status of species and populations (Hvilsom et al., 2022; Pearman et al., 2023). Furthermore, regions in Europe which harbour the most significant amount of adaptive potential (especially southern Europe and the Balkans) are currently receiving the least amount of genetic diversity monitoring (Pearman et al., 2023). This poses a serious problem as the current biodiversity and climate crises imperil genetic diversity and its loss will have cascading impacts on ecosystem services, human health, wellbeing, security, and economic stability (Des Roches et al., 2021; Díaz et al., 2020; FAO, 2010; The Sustainable Finance Platform, 2020).

In spite of being neglected in national/regional policies and action plans, **genetic diversity knowledge has great potential** to guide effective biodiversity conservation and restoration action, informing on connectivity among areas (e.g. protected areas), local adaptation of populations to their environment, forensics and parentage (e.g. identifying wolf-dog hybrids), historic or baseline conditions for restoration, including seed sourcing for translocations/reintroductions, and management of captive populations (Heuertz et al., 2023). While there is a European network of Genetic Conservation Units for trees, there is no mechanism to use this model for a wide range of taxa as the basis of Other Effective area-based Conservation Measures (OECM; Minter et al., 2021). Genetic knowledge supports effective use of resources to ensure holistic protection of biodiversity in line with the proposed European Nature Restoration law and global efforts to protect 30% of nature by 2030.

DNA-based genetic monitoring has become more accessible in the last decade due to decreasing sequencing costs, availability of data for many species, capacity building efforts across Europe and investments from EU, national, and private initiatives (e.g., ERGA, BIOSCAN). The surge in genomics data is matched by advancements in European and global **data infrastructures and databases**, such as ENA, Knowledge Centre for Biodiversity, ELIXIR, and DiSSCO, which are helping to improve the management, analysis, sharing, and interconnectivity of diverse data sources in Europe and beyond, including significant natural history and biobank **collections** housed in European museums, herbaria, botanic gardens, zoos, and culture collections. Such collections can even be used to study temporal changes in genetic diversity and represent invaluable resources setting baselines for genetic diversity monitoring (Jensen et al., 2022). Further, there is a range of proxies that can be used without recourse to genetic techniques (Hoban et al., 2023; O'Brien et al., 2022).

Mainstreaming genetic diversity monitoring comes with **new challenges and risks**. Novel genomic and bioinformatic tools are even more complex to grasp for non-specialists than standard population genetic analyses, potentially producing a new **capacity gap**. The first approach to regional

monitoring of genetic diversity in wild species was reported for Scotland (Hollingsworth et al., 2020) and pilot programs to make genetic monitoring a routine in classical species assessments have only just started up in some countries (e.g., Sweden, Switzerland, and Brazil), and will need guidance and support (O'Brien et al., 2022). Although the application of DNA-based methodologies to monitor populations has increased over the last decade in Europe, it is usually used only to identify individuals, e.g., to estimate population sizes and assess population densities (Bischof et al., 2020). Despite genetic data's increased availability and applicability for driving activities in conservation and sustainable use of natural resources, **data generation and analysis remain expensive and limited to relatively few species** (e.g., species of economic/conservation interest, interest of local/regional management).

The CBD Kunming-Montreal Global Biodiversity Framework (KMGBF), adopted in 2022, explicitly highlights the importance of genetic diversity for wild species in Goal A and Target 4. Due to the synergic action of many international networks, including EU-based efforts, Parties to the CBD adopted a headline indicator (A.4 KMGBF Monitoring Framework) related explicitly to assessing genetic diversity (CBD, 2022; Hoban et al., 2023). This is of the utmost importance as all Signatories of the CBD are **now obligated to measure and report on spatial and temporal changes in genetic diversity**. Specifically, A.4 uses the effective population size (Ne) to measure genetic health of separate populations within species. Functional ecosystems depend on their constituent species' genetic health, associations, and interactions (Blanchet et al., 2023; Raffard et al., 2019). Therefore, proxy-based, or DNA-based indicators and approaches must be connected directly to species management to inform which actions are most appropriate to support and conserve species within **functional ecosystems**.

Genetic diversity indicators are a crucial advance in assessing the genetic health of a population because they can also be estimated through proxies (e.g., census population size) **using non-DNA-based data that are easier to obtain**. Specifically, available information on demography and geography of species' ranges can be collected from diverse sources to calculate genetic diversity indicators. They can leverage existing management plans, maps, local knowledge, citizen science, **making genetic diversity monitoring more accessible to all** (Hoban et al., 2021; Stillman et al., 2023). The Ad Hoc Technical Expert Group (AHTEG) on indicators for the KMGBF, COOP4CBD, the Biodiversity Indicators Partnership, and the Coalition for Conservation Genetics, among others, is working to develop guidelines for operationalising the genetic diversity indicators, including A.4. The strategies for indicators implementation **require massive efforts to provide networking, capacity building, case studies, and infrastructure, which does not currently exist but is needed**. Effective monitoring and reporting on genetic diversity to allow for meaningful global aggregation and factual insight into trends in species' genetic status will depend on the capacity of each Party to collect, mobilise, and assess data for national and regional populations of species.

1.1.2. DESCRIPTION OF THE CHALLENGE (MAIN AIM)

In GENOA (Genetic Nature Observation and Action), we focus on a **broad uptake and use of genetic diversity for species assessments, and the scientific knowledge underpinning it, to protect biodiversity specifically through the implementation of genetic diversity indicators**. As global ecosystems face increasing pressures from climate change, habitat degradation, and anthropogenic activities, the need to understand and protect genetic diversity is paramount to provide the necessary foundation for populations of species to adapt. The specific challenges (CHs) involved in the implementation of genetic diversity indicators are:

CH1: Understanding the **policy** landscape and providing direct support and capacity to nations and other stakeholders in **reporting** on the status and trends of genetic diversity and supporting the development of future policies protecting genetic diversity. The connections between conservation geneticists and policy must be improved and follow a co-creation process to facilitate uptake of genetic diversity in nation level reporting to Convention on Biological Diversity, EU obligations and future policies. This will be tackled in Working group 1: Informing and supporting emerging and future policy.

CH2: Standardisation and systematic collection (and data storage) of the population demographic and geographic non-DNA **proxy data**, and **DNA data** when available, underlying the calculation of genetic diversity indicators and making the **analysis** of these data fast, reliable, and easy for all the relevant institutions required to report on genetic diversity changes (e.g., countries, regional/sub-regional institutions, botanic gardens, seed banks, zoos and aquaria). The collection of genetic indicator data must be quickly scaled up to thousands of species across dozens and eventually all countries in the world, which will require networking, improved guidance, and data infrastructure. There is an immediate demand for standardised and harmonised procedures, analytic tools, and guidance for genetic diversity monitoring to meet Europe's conservation policy requirements. This will be tackled in Working group 2: Applying cutting edge science and best practices to achieve successful implementation of genetic diversity indicators.

CH3: Improving the uptake of genetic diversity knowledge and especially genetic diversity indicators in the **management** plans of species, in situ and ex situ, and of biodiversity-rich areas. Indicators must be connected directly to the management of species, including use of indicators to inform which species need conservation action and which (cross-border) management actions are most appropriate. In addition, decoding the link between genetic diversity at the level of species' populations with the genetic diversity and functioning of associated species, will advance the **genes to ecosystem framework**. This will be tackled in Working group 3: Improve the conservation management of species and ecosystems using genetic diversity knowledge.

CH4: Engaging actively with stakeholders to gain a better understanding of the barriers to communication around genetic diversity threats, and improvement of communication modes to increase the **public awareness** about the pivotal role of genetic diversity. We must make the key issues in genetic diversity more understandable to non-scientists and make policy and communication outputs more accessible to all, including the engagement of youth and other communities. In doing so, it is crucial to take into consideration the diversity of local communities across Europe. Further, at present, collaboration among policymakers, conservation practitioners and researchers (across disciplines) are limited. This will be tackled in Working group 4: Use multidisciplinary approaches to bridge the communication divide and increase the public awareness about the relevance of genetic diversity.

CH5: Integration, **communication** and **collaboration** between the conservation genetics community and other parts of the **biodiversity monitoring community** such as EuropaBON, Biodiversa+, IPBES, EEA and others. The conservation genetics community must integrate into mainstream conservation biodiversity networks, and be more welcoming and inclusive, also internally. This will be tackled in (Net)Working group 5: Multifaceted networking in the biodiversity monitoring community and beyond.

1.2. PROGRESS BEYOND THE STATE OF THE ART

1.2.1. APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE OF THE ART

The challenge of integrating and effectively using genetic diversity concepts and their related indicators in conservation and management actions aiming to halt and reverse biodiversity loss will be approached by establishing a pan-European network. This network will encompass academic experts from the social and natural sciences, conservation practitioners and policymakers. It will also foster an inclusive culture and knowledge exchange, where transparency and open communication are vital, and where relevant stakeholders will be involved from the beginning in a co-creation process to reach the objectives of the Action. The partners in this network will collaborate while considering each other's specific needs. Through pan-European networking and collaboration, our community seeks to solve identified scientific and socio-economic challenges (CHs) through the following actions (CHAs):

CHA1.1: Assist in implementation procedures for using the adopted headline indicator A.4 to monitor and report on genetic diversity, considering national and regional differences. This will support procedures to record additional complementary genetic diversity indicators without DNA data, e.g. the CBD complementary indicator "populations maintained", and, with DNA data, e.g. genetic diversity scorecard (O'Brien et al., 2022) and genetic essential biodiversity variables (EBVs, (Hoban et al., 2022)) compiled by EuropaBON.

CHA1.2: Co-create with relevant stakeholder processes for the collection and analysis of data relevant to genetic indicators, while simultaneously being tailored to their needs and scientifically evaluated from social as well as natural science perspectives for efficiency and learning, ensuring continuous feedback and improvement.

CHA2.1: Foster integration and facilitate future joint efforts in testing suggested approaches and help further develop best practices for assessing (calculating indicator values) and standardised reporting on genetic diversity indicators, and supporting genetic diversity conservation, on a pan-European scale.

CHA2.2: Provide examples of approaches for genetic indicator calculation tailor to the data available in different countries highlighting shifting ways to reach the common goal of integrating genetic diversity in reporting and biodiversity conservation.

CHA3.1: Investigate the understanding of genetic diversity among conservation practitioners and policymakers and examine the implementation processes, including merits and shortcomings. This will interactively build capacity on genetic diversity knowledge and integration into conservation practice and policy.

CHA3.2: Address lessons-learned to engage with practitioners from the beginning and identify their needs to improve strategies for effective monitoring of genetic indicators.

CHA3.3: Design and implement indicator-informed genetic conservation actions.

CHA4.1: Integrate methodologies, epistemological frameworks, and perspectives from social and natural sciences. Achieve a more holistic view of the complexities associated with localised relevance and effective collaborations.

CHA4.2: Explore innovative transdisciplinary methodologies that engage practitioners such as government, land managers, conservation agencies and members of civil society (youth group activities, knowledge institutions (universities, land management training institutes, schools), visitors of nature reserves, museums, botanical gardens and zoos), including citizen scientists (volunteers, hobbyists, amateurs, naturalists, ambassadors for genetic indicators, hunters, fisherman, foresters, wildlife observers, landowners and artists).

CHA5.1: Advance interdisciplinary communication and research, enabling the integration of the conservation genetics community into mainstream conservation biodiversity networks.

CHA5.2: Promote interdisciplinary collaborations among researchers from various disciplines and stay attuned to emerging trends and challenges in biodiversity conservation.

1.2.2. OBJECTIVES

1.2.2.1. Research Coordination Objectives

Following the challenges, the Action's objectives are structured into two primary categories: Research Coordination Objectives (RCOs) and Capacity-Building Objectives (CBOs). RCOs focus on assessing, integrating, and promoting the understanding of genetic diversity metrics, aiming to enhance their applicability in diverse contexts. Meanwhile, CBOs emphasise knowledge exchange, capacity enhancement, and the development of a holistic, transdisciplinary scientific workforce attuned to both policy and science (**Figure 1**).

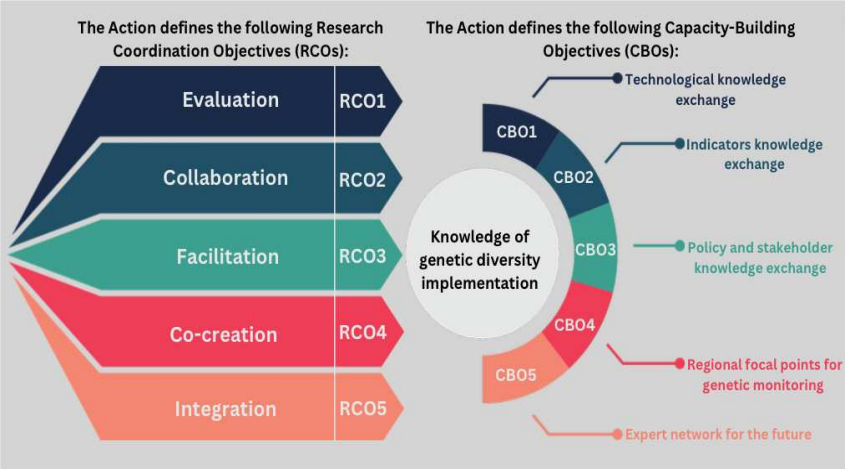


Figure 1. The Research Coordination Objectives (RCO) and Capacity-Building Objectives (CBO) to improve the needed knowledge of genetic diversity implementation (see also 1.2.1.1 and 1.2.1.2.).

The Action defines the following Research Coordination Objectives (RCOs):

RCO1. Evaluate the correlation and complementarity among various approaches to genetic diversity and genetic indicator monitoring to improve their integration - approaches which differ in scale, technological and capacity needs.

RCO2. Collaboratively assess how genetic and genomic data in focal species can inform management to support associated biodiversity and healthy ecosystems/ecosystem function.

RCO3. Use coordinated efforts to improve and facilitate the adoption of methods, Standard Operating Procedures (SOPs), and approaches for fast and easy calculation, use and reporting of the genetic diversity indicators.

RCO4. Determine, through a co-creation process and engagement, the extent to which diverse stakeholder groups (conservation practitioners, policymakers and indigenous people and local communities (IPLCs)) as well as the wider public understand genetic diversity concepts and identify potential barriers for their uptake.

RCO5. Systematically identify and coordinate multidisciplinary avenues by which genetic diversity indicators and other metrics can be integrated into national, regional, and international policy (e.g., input to stakeholders at national and EU scale).

1.2.2.2. Capacity-building Objectives

The Action defines the following Capacity-Building Objectives (CBOs):

CBO1. Provide knowledge exchange and capacity building efforts for supporting genetic diversity assessments for conservation problems using genetic and genomic technologies (e.g., not indicators) tailored to various stakeholders needs.

CBO2. Provide knowledge share - including the necessary advice, support, and collaboration among countries - to successfully deploy genetic diversity indicators nationally, transboundary and for, EU, and international reporting.

CBO3. Provide innovative opportunities for knowledge sharing to raise awareness about the value and importance of genetic diversity in key stakeholder groups (policymakers/governmental bodies at different levels, conservation practitioners, small and medium enterprises (SMEs) and the public, including IPLCs).

CBO4. Foster regional genetic knowledge hubs/networks that will persist beyond this Action and serve as stakeholder platforms for transnational mutual experience exchange, including by promoting active participation of ITCs.

CBO5. Develop a well-rounded, transdisciplinary future scientific workforce, a workforce that is trained in both policy and science, and able to communicate effectively with diverse stakeholder groups. Increasing capacity in all activities will be ensured by, e.g., forming a Young Professionals Group that involves and integrates Young Researchers and Innovators, under-represented genders, and countries/regions with less capacity.

2. NETWORKING EXCELLENCE

2.1. ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

2.1.1. ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

GENOA aims to have a twofold added value:

i. In a scientific and technical perspective: leveraging on previous efforts, GENOA is expected to offer, on the one hand, an up-to-date synopsis of the most relevant scientific advances in the field of conservation genetics and, on the other hand, to tackle for the first time how these advances are perceived by many different stakeholders, from practitioners to policymakers and local communities. This aspect is of crucial relevance to overall increased awareness on the centrality of safeguarding and considering the primary layer of biodiversity, genetic diversity. GENOA is therefore adding the specific dimension of intra-population genetic diversity and inter-population genetic differentiation to existing EU science-oriented initiatives and agencies such as Biodiversa +, Europa BON, Horizon Europe Cluster 6, the Global Knowledge Biodiversity Centre, the European Environmental Agency, the recently constituted European Reference Genome Atlas (ERGA).

ii. In the science-policy interface: it is only very recently (December 2022) that genetic diversity has been adequately recognised as a central asset in biodiversity conservation: the Kunming-Montreal Global Biodiversity Framework of the Convention on Biological Diversity has laid the vision for the 2050 which finally has the safeguard of genetic diversity among one of the four major Goals. The EU has played a pivotal role in achieving this historical result. Nonetheless, this newly inserted dimension must be better explained and accompanied by guidance tools on how to measure the genetic indicators. This is indeed where GENOA is poised to have an added value making it possible to co-create an effective knowledge exchange between scientists and practitioners to make the implementation phase of the KMGBF feasible by 2026. By then all the signatories' countries must produce the first reports on genetic indicators. This holds, of course, for all the European countries and GENOA is meant to offer support in this direction. Moreover, this support can be, moreover, of immediate help for many existing EU policies such as the European Biodiversity Strategy for 2030, the Habitats Directive, Natura 2000 network. Further, mainstreaming the basic concepts of genetic diversity and how to measure genetic diversity change is of value for several European institutions and efforts aiming at preserving, in-situ and ex-situ, biodiversity like the European Association of Zoos and Aquaria, EUROPARC Federation (the network of European natural parks), the European Forest Institute and several NGOs working on a continental scale (e.g., WWF, BirdLife International, IUCN).

GENOA has the potential to address the most relevant conservation issues at continental and global scales by implementing genetic diversity-based monitoring solutions that support actions to ensure resilient ecosystems, sustainable resource use, and the preservation of biodiversity for future generations. GENOA offers added value by promoting an interdisciplinary approach, integrating perspectives from various scientific and disciplinary fields, including biology, ecology, evolution, social science, and science communication. This approach will underpin existing decision-making processes

and effectively integrate genetic diversity indicators, leading to more comprehensive, successful, and informed conservation actions.

2.2. ADDED VALUE OF NETWORKING IN IMPACT

2.2.1. SECURING THE CRITICAL MASS, EXPERTISE AND GEOGRAPHICAL BALANCE WITHIN THE COST MEMBERS AND BEYOND

GENOA recognizes the importance of securing a critical mass of expertise and a broad geographical representation to achieve its ambitious goals. The project will actively engage a diverse network of stakeholders and European Research Infrastructures, universities, research institutes, zoos, museums, and botanic gardens. Simultaneously, we will collaborate with a wide range of professionals and authorities, such as social scientists, technology developers, local to international authorities, and EU-body environmental coordinators (e.g., EEA, EUFORGEN). By fostering collaboration among such a broad community of experts interacting through a pan-European network (comprising around 40 COST countries), the development and sharing of innovative techniques for genetic diversity conservation will be significantly facilitated. Moreover, empowering and retaining young researchers will increase the efficiency, effectiveness, and impact beyond GENOA implementation.

A functional society relies on the uptake and use of relevant knowledge. GENOA aims to close the gap between the theory and application of genetic diversity indicators by developing practical, accessible, and co-produced tools. This will enable efficient implementation of existing global and EU biodiversity policy for the crucial genetic level of biodiversity. Efficient safeguarding of genetic diversity through monitoring activities will aid in reaching global sustainability goals such as the UN Sustainable Development Goals.

2.2.2. INVOLVEMENT OF STAKEHOLDERS

The early identification and involvement of stakeholders are crucial for GENOA to succeed, as they maximise support, input, and dissemination of the action's outputs and enhance its impact on society (**Figure 2**). GENOA considers numerous stakeholders involved in European and national policy agencies strategically reaching out to additional stakeholders through WG2 and WG5 and considering a detailed dissemination plan tailored to target a range of relevant parties (see also 3.2.2). The Executive Dissemination Committee (EDC) will also play a pivotal role by issuing customised communication and activities targeting key stakeholders.

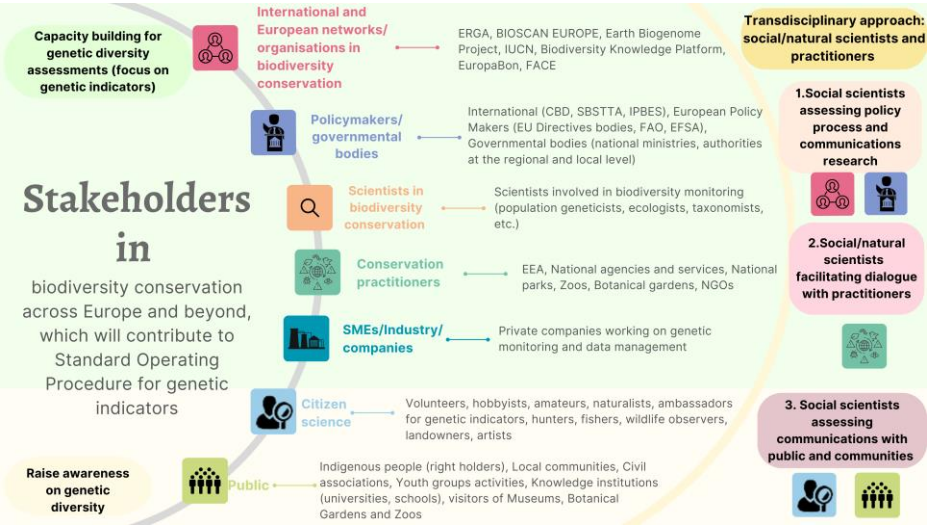


Figure 2. Stakeholder diversity and their involvement in GENOA for capacity building on standardised genetic diversity assessments and action.

By enhancing communication among stakeholders, the action will serve as a multidisciplinary forum, fostering collaboration among academia, research institutes, international biodiversity networks, public groups, SMEs, environmental managers, and policymakers as follows:

Scientific Researchers: Scientific researchers from the natural and social sciences form an integral component of the intricate matrix of stakeholders. Natural scientists (geneticists, biologists, and ecologists) will provide essential insights into the importance of monitoring genetic diversity indicators to understand their ecological implications. Their expertise and knowledge will contribute to determining the genetic diversity indicators, analysing data, and interpreting results. Social scientists will be pivotal

in bridging the communication gap between key actors/stakeholders and geneticists. Both natural and social scientists will be essential in evaluating the co-creation process and workshops, applying quantitative and qualitative research methods. This collaborative effort ensures that the application of genetic indicators aligns with the dynamic interplay in different governance levels. As part of the transdisciplinary research team, researchers will ensure the outcome's rigour and scientific validity.

Young Researchers and Innovators (YRI) and Trainees: YRIs and trainees, particularly PhD students, will have a significant role in the project. As part of the broader stakeholder groups, they are anticipated to bring fresh perspectives and enthusiasm to the co-creation process. They actively participate in data collection, analysis, and fieldwork, contributing to the development and implementation of the genetic diversity indicators. As part of the critical mass of expertise, they benefit from capacity-building initiatives and training programs, fostering the next generation of experts.

Small and Medium Enterprises (SMEs): SMEs, particularly those vested in biodiversity conservation and the sustainable use of genetic resources, will be active contributors. Their interests align with the larger goal of preserving and understanding genetic diversity, often because it is part of their business models or corporate social responsibility strategies. These companies can provide financial backing to research initiatives, aiding in developing case studies that illuminate the real-world implications of genetic indicators. Their involvement can also extend beyond funding. With their infrastructure, they can actively participate in the actual implementation of genetic diversity indicators, especially in regions or contexts relevant to their business operations, improving their environmental performance and contributing to a better nature for all. Furthermore, companies specialised in technology and data management offer a unique value to process, analyse and prepare user-friendly access to vast amounts of data while respecting the rights of data owners. These companies can assist in creating sophisticated yet practical tools for genetic diversity monitoring and management.

NGOs: Non-Governmental Organisations (NGOs) will be important stakeholders, particularly as part of the citizen stakeholder group. They bring valuable perspectives and engagement through media outreach, citizen science projects, and advocacy efforts. Their involvement in the co-creation process ensures that community-based conservation perspectives are considered. NGOs play a role in bridging the gap between scientific research and on-the-ground conservation actions.

Policymakers: Policymakers (specifically, focal points to the CBD, national and EU legislators, heads of federal agencies, etc.) are key actors in implementing the indicators to monitor genetic diversity. They will be part of the policymakers/governmental bodies stakeholder group, actively involved in conservation and restoration policy and decision-making processes. Policymakers will offer their insights and input during the co-creation workshops, specifically addressing the implementation of genetic diversity indicators. Their endorsement and backing are crucial in streamlining the integration of these indicators into national policies and guidelines, ensuring coordination with conservation managers at subordinate governance levels and collaboration with the public and stakeholder groups. The regional/sub-regional bodies are key actors (including environmental managers) and building a network of hubs to respond to adaptive needs is a priority, bridging the gaps to implement active conservation strategies and strengthening the government's capacity from a bottom-up perspective.

Indigenous people and local communities (IPLCs): We would also seek to involve local communities as they hold deep-rooted knowledge, traditions, and connections to the land and its resources. Prioritising engagement of local communities will allow us to tap into their reservoir of traditional knowledge and long-standing experience with their environment. To the extent possible, we will try to incorporate the wisdom of indigenous people, recognised as right holders, by acknowledging them regarding genetic diversity conservation emphasising their intrinsic rights to their ancestral territories, allowing them to benefit from the advantages that safeguarding genetic diversity brings.

International networks that focus on biodiversity observations (EuropaBon, ERGA): These networks offer robust frameworks and refined methodologies with overarching global biodiversity objectives. Their contributions will also enable a holistic overview of European biodiversity monitoring endeavours. Furthermore, the databases they generate facilitate the systematic organisation of biodiversity data, which is sourced from diverse monitoring schemes within Europe and broader.

Public groups: This group includes civil associations, youth group activities, educational institutions (universities, schools), visitors to nature reserves, museums, botanical gardens, and zoos. Local Community members are the heart of any region, possessing unique insights and values rooted in their lived experiences connected with nature and biodiversity. Civil Associations amplify diverse community voices, ensuring a wider representation in decision-making. Youth Groups offer fresh, forward-thinking perspectives, representing the aspirations of the next generation. Knowledge Institutions such as universities and schools, serve as hubs of research, education, and innovation, bridging the gap between theoretical knowledge and practical applications. Meanwhile, Visitors to Museums, Botanical Gardens, and Zoos bring a passion for learning and appreciation for biodiversity, influencing public perception and awareness about conservation matters.

3. IMPACT

3.1. IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAKTHROUGHS

3.1.1. SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

Scientific impact: (A) Short-term impacts within Action: (1) Develop conceptual and terminological unification of genetic diversity indicators achieved through understanding of different perceptions, views, and opinions in natural and social science. **(2)** Create strategic enhancement of research skills for young researchers through comprehensive Training Schools (TS), workshops, short-term scientific missions (STSMs), virtual mobility grants (VMGs), and collaborative online training resources/materials (SOPs). **(B) Long-term impacts beyond Action: (1)** Enhance methodological progress through augmented access to research resources in genetic diversity by incorporating databases, standards, and guidelines. **(2)** Design new tools for assessing genetic diversity indicators and enhancing communication shared with the research community across Europe and beyond.

Socio Economic impact: (A) Short-term impacts within Action: (1) Work closely with practitioners, policymakers and IPLCs on ways to improve conservation of genetic diversity at EU, national and sub-national levels. **(2)** Work in cooperation with policymakers/governmental bodies to identify the solutions and opportunities for genetic indicators implementation. Such roadmaps including both policy and management will offer opportunities for a worldwide application of genetic diversity monitoring and reporting. **(3)** Develop a framework to better understand and address the barriers to effective science communication especially around the communication of genetic concepts and threats. This will delve into the underlying reasons why researchers face challenges in effectively communicating with stakeholders. **(4)** Launch initiatives to directly involve local communities, ensuring that their on-ground experiences, socio-economic conditions, and cultural values are integral to the conservation efforts by ensuring sustainable and socially equitable outputs. Additionally, we will make efforts to reach out to local communities and indigenous peoples within European territories to ensure they are informed about and acknowledged in project activities related to genetic diversity conservation. **(5)** Initiate and foster collaboration in developing the best practices for CBD genetic indicators reporting and monitoring. Using controlled vocabularies and test cases coupled with identifying and bridging policy gaps around protecting, managing, and conserving genetic diversity through workshops, reports, and scientific publications will be impactful. **(6)** Work closely with SMEs to develop case studies demonstrating the real-world implications of genetic indicators, to allow for the actual implementation in regions or contexts relevant to their business operations. Their infrastructure can actively participate in implementing genetic diversity indicators in regions or contexts relevant to their business operations, improving their environmental performance and contributing to a better nature for all. **(B) Long-term impacts beyond Action: (1)** Build a strong foundation for reporting genetic diversity status and trends at the European and global policy level, specifically for targets set for 2030, in collaboration with EEA and the CBD Secretariat, with contributions from relevant policy bodies. **(2)** Use documentation and understanding of barriers to build better communication modes and processes between research and practice. **(3)** Use the newly created connections between policy and science to have policy-informed science and science-informed policy. **(4)** Contribute to the economic benefits of biodiversity, from both the anthropocentric view (i.e., as Natures Contributions to People) and the value of biodiversity at the ecosystem level; vital ecosystem services depend upon the conservation of genetic diversity.

Technological impacts: (A) Short-term impacts within Action: Use a standardised inventory that enables collecting and archiving genetic diversity data and info across Europe over space and time. Given the rapid environmental changes we observe, such an archive will allow coming generations to evaluate future biodiversity conservation and management challenges timelier and more informedly than possible today. **(B) Long-term impacts beyond Action:** Develop sophisticated data management systems for integrating diverse data that can inform genetic diversity indicators.

GENOA will also have a positive long-term impact, in line with ***Sustainable Development Goals 14 (Life below water) and 15 (Life on land)***, to help reduce the current escalation of species extinction that has adverse effects on sustaining ecosystem services and nature's contributions to people.

3.2. MEASURES TO MAXIMISE IMPACT

3.2.1. KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

Knowledge creation: GENOA will contribute to knowledge creation through the assessment of genetic diversity. Genetic diversity assessment data have been collected in a pilot study from nine countries, including some European countries (Hoban et al., 2023), and a genetic diversity scorecard has been published in Scotland (Hollingsworth et al., 2020). Leveraging staff exchanges and workshops will extend the current knowledge by including species assessments from other European countries. In addition, genetic/genomic metrics will be compared to genetic indicators as proxies. New knowledge will become available regarding the use of genetic indicators and improving methodologies for calculating indicators. By involving social scientists in workshops with citizen scientists and the local community, we will try to evaluate potential barriers in implementing genetic diversity indicators. We will follow the ten Principles of Citizen Science Engagement (Hecker et al., 2018). Online resources will support activities to ensure accessible information flows and feedback.

Knowledge transfer: To maximise the uptake of knowledge by different target groups, various knowledge transfer tools will be used, such as Workshops, Training Schools, Seminar series, and Conference participation. Events bespoke in participation format (in person, online, hybrid) and target group will ensure inclusive attendance, topic-oriented learning and broadening of audience beyond Europe. Virtual (by VMGs) and in-person mentoring (by STSMs) will target PhD students, early-career (e.g., ECI) and mid-career professionals. Additional outreach tools such as policy briefs, guidance documents, video recordings and an interactive website will be used for broader knowledge transfer. Website content, such as databases and case studies, will be openly accessible to practitioners and policymakers to aid in interpreting data, decision making and incorporating indicators in future reporting activities. Knowledge will also be shared with the public by using a variety of platforms such as citizen science programs, science fairs and educational material for schools, including comics. Trained early-career researchers will participate in outreach activities. Social media feeds will provide regular information about all outreach products of the Action.

Career development: The contribution of GENOA to the development of careers will be two-fold. One aspect focuses on endorsing the advancement of early career researchers at PhD and postdoctoral levels through training schools, STSMs and workshops covering various aspects of conservation genetics and biology and social science. They will also be encouraged to take on leadership roles (e.g., participation in the Young Professionals Group, co-leading working groups, etc.) to develop or strengthen soft skills. Secondly, mid-career researchers will also advance by capitalising on various learning tools (STSMs, VMGs, workshops) and co-authoring publications, particularly those from ITCs. In addition, this project will include professionals with academic and practical backgrounds, so targeted training workshops will be offered to stakeholders for career development. Adequately considering the gender dimension and the need to target ITC countries will guide our career development plan.

3.2.2. PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

To bolster the network of diverse stakeholders across Europe, we intend to harness the latent knowledge about genetic diversity inherent within citizen science platforms and natural history society networks (e.g., zoos). By actively involving a spectrum of groups, including hunters, fishermen, foresters we aim to bridge the gap between scientific research and public understanding. This synergy with citizen science will be further enhanced through an array of initiatives, such as workshops, public events, or even hands-on sampling collection exercises. Members of the public can also contribute to the collection of proxy data (e.g., species distribution through observations) and even the analysis of the data (those with statistical experience/education) and the development of popular papers, comics, and other visual materials. The interpretation of results will be enriched by integrating traditional/local knowledge ensuring a bidirectional, holistic, and inclusive approach to biodiversity assessment.

GENOA will implement a dedicated dissemination and exploitation strategy through internal and external activities. These activities will be coordinated through an Executive Dissemination Committee (EDC). The EDC (experts from all WGs, YPGs, and local communicators who will help in breaking language barriers in the hubs), with input from the broader scientific community, will be responsible for the development of the relevant dissemination material, the organisation of the outreach activities and the delivery of all activities with a clear mandate to ensure: i) effective and sustainable dissemination, through actively engaging stakeholders in e.g. events; ii) exploitation of the Action's results, through stakeholder relevant/specific dissemination materials; iii) propositions of policies, directly through Policy Briefs and webinars/workshops and indirectly through external networks e.g. IPBES.

To actively disseminate and engage the GENOA target group in achieving the outcomes, different activities will be carried out as follows: (1) *Advertising the Action*: creation, maintenance and update of the Action website and social media channels (Facebook, X [former Twitter] and YouTube). They will include the latest development and information on the topic, links to webinars, conferences, media

coverage, educational clips, public online databases. (2) *Disseminating the Action:* publishing and dissemination of bi-annual newsletter which will be sent to the network and the interested public (upon website registration), press releases, news, short videos to raise general awareness about genetic diversity, development of popular papers/comics/cartoons (e.g., arts students). (3) *Reaching stakeholders via tailored policy briefs and webinars*: policy focused webinars and policy briefs recorded and distributed and translated into numerous languages. (4) *Organization of Workshops, Seminars, Webinars, Training Schools, Kick-off and final meeting, and Hands-on sampling collection exercises* to promote knowledge transfer and mutual collaboration to engage with our stakeholder group. During these, new materials will be presented, tailoring the message to different target groups, and successful case studies will be analysed. Feedback from target groups will be collected using popular approaches such as science cafes, online breakfast clubs and science fairs. GENOA will actively participate in, e.g., European researchers' night together with other organisations, seeking to organise events simultaneously in some partner countries. Participants will be asked to engage actively by collecting each other's signatures in different colours, representing genetic diversity, on the event's tote bag. At the end of the event, these are used as a variable to 'monitor' the genetic diversity in the 'population' of participants and 'report' it (number of coloured bags = Ne, compared to the census size = number of participants). (5) *Exploitation of the Action's results*, through scientific publications in relevant international journals; stakeholder relevant/specific dissemination materials, propositions of policies, directly through Policy Briefs and webinars/workshops and indirectly through external networks e.g., IPBES; participation in international conferences and policy-making forums and dissemination via hubs and Young Professional Group (YPG). (6) *STSMs and VMGs* will be implemented to enhance the Action partner's coaction, sharing, and brainstorming. (7) *Extended Networking:* the networks will seek new partners and contributors, from policy, local communities and YPG.

4. IMPLEMENTATION

4.1. COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

4.1.1. DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

The scientific work will be carried out in five Working Groups (WGs), each adhering to specific Research Coordination or/and Capacity Building Objectives. The Action strives to follow the JEDI (Justice Equity Diversity Inclusion) principles and to increase the inclusiveness and diversity of the team, promoting gender, age, and geographical balance amongst WGs, EDC, Core Group and Management Committee. GENOA strongly focuses on fostering interdisciplinarity, empowering young researchers and continuing collaborations by targeting inter-sectorial public-private and international mobility, contributing to dual-career opportunities with stakeholder groups. GENOA covers multiple professional stages and levels of expertise and members can join more than one WG based on their interests. Scientific tasks and objectives of WGs will be tightly integrated through sharing scientific data, researchers through STSMs, ideas and approaches through participation in meetings and workshops and creating new knowledge via training schools will enhance transversal working. The interplay of the working groups, tasks, and activities to foster genetic diversity knowledge is visualised in **Figure 3.** The main role of a foresail is to stabilise and increase performance and illustrate how improved genetic diversity knowledge will significantly increase efficiency of biodiversity conservation by using the outcomes of the five working groups and activities as well as in close interplay and tuning with policy and stakeholders.

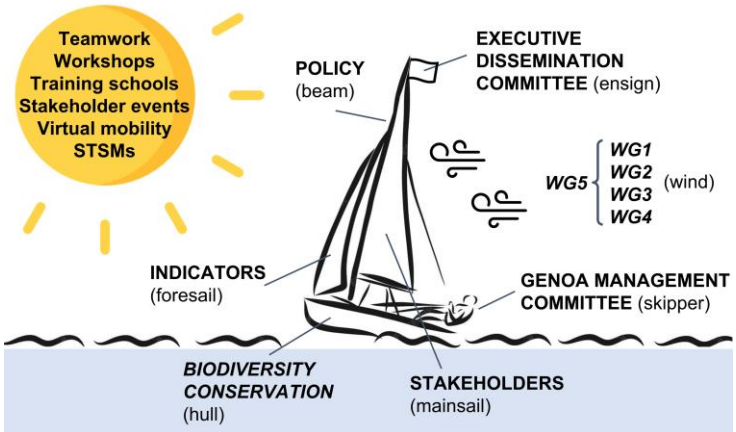


Figure 3. GENOA work plan can be depicted by a sailboat.

Working group 1 "Policy": Informing and supporting emerging and future policy (links to RCO5 and CBO2,4). The WG will focus on better integrating the protection, management, and conservation of genetic diversity in *EU, national and subnational policies,* working in cooperation with policymakers in Europe. This will build on recent efforts that brought science to global policy commitments (Carroll et al., 2023). The success of this WG will be measured by the number of countries assisted in drafting CBD National Reports and the number of research-policy-practice hubs on genetic diversity at the national, regional, and pan-European levels.

Objectives	**O1.1** Conduct a comprehensive evaluation and benchmarking exercise of how genetic diversity is included in national and in EU biodiversity policies similar to Hoban et al., 2021 and Laikre (2010), including existing, imminent and in draft legislation, such as the EU Nature Restoration Law. **O1.2** Evaluate, for at least 10 countries, the incorporation of genetic diversity conservation (including with indicators) within National Biodiversity Strategy and Action Plans (NBSAPs, submitted to CBD) and aim to understand national and regional challenges and opportunities towards genetic conservation. **O1.3** Assist national governments in the drafting of at least 10 new country level CBD National Reports addressing genetic diversity and including genetic diversity indicators. **O1.4** Facilitate development of research-policy-practice hubs on genetic diversity at the national, regional, and pan-European levels, to foster comprehension and regular communication among stakeholders across Europe.
Tasks	**T1.1** Series of workshops to learn about and evaluate EU and national policies for genetic diversity (O1.1, O1.2). **T1.2** Virtual workshops or STSMs for providing advice and guidance on CBD reports (O1.3). **T1.3** Regional workshops, held in the local language, to provide networking and drafting of coordination mechanisms for regional hubs (O1.4). **T1.4** Training School where scientists, conservation practitioners and other relevant stakeholders (e.g., IPLCs representatives, NGOs) can learn about relevant policies aiming at addressing genetic diversity loss and policy relevance at a regional and sub-regional level (O1.4).
Milestones	**M1.1** Produce a document with the results of how genetic diversity is included in legislation (Month 18).

Working group 2 "Indicators": Use the scientific team to build capacity needed for successful implementation of genetic diversity indicators (links to RCO1,3,4 and CBO2). This WG will create simple but effective support tools and build the capacity to implement genetic diversity indicators that do not need DNA data. The success of this WG will be measured by the number of tools and video-recorded guidance produced and used at the national, regional, and pan-European levels.

Objectives	**O2.1** Improve existing and emerging tools to facilitate genetic diversity indicator implementation for non-experts, including secure and easy-to-use data collection tools, data storage, and modular computer code that is easy to 'mix and match' for calculating indicators. **O2.2** Contribute to computational/ GIS tools to leverage citizen science databases such as iNaturalist and eBird to calculate the Populations Maintained indicator, by defining population boundaries and documenting loss of populations, based on scientifically tested rules (Hoban et al., 2023). **O2.3** Co-create written and video-recorded guidance for applying genetic diversity indicators, including clear, standardised terminology as well as detailed and regionally relevant (e.g., tailored to different regions of Europe) test cases for easy understanding, all translated into local languages. **O2.4** Elucidate the relationships between genetic diversity indicator values, inherent genetic diversity, national and global Red List and Habitats Directive threat status of species (and other, e.g., CITES, climate change vulnerability, EDGE), to clarify the distinct role of each approach.
Tasks	**T2.1** STMs and a workshop or hackathon (rapid computer coding sessions in a collaborative environment) (O2.1, O2.2). **T2.2** Three workshops, which include stakeholders/ "users" e.g., National Focal Points and Red List personnel: to co-create written (guidelines, SOPs, PowerPoints) and recorded (videos) guidance for genetic diversity indicators (O2.3). **T2.3** Workshop on review of knowledge about effective population size relating to the indicators (O2.4). **T2.4** STSMs to perform simulations of the genetic diversity indicators and assess correlations to e.g., genetic diversity statistics, EBVs, Red List status (O2.4). **T2.5** Training Schools that will follow a co-creation process with stakeholders, nationally, regionally and at the European level,

	where stakeholder relevant needs will be identified; the school will cover SOPs for how to measure genetic diversity and the genetic indicators (O2.3).
Milestones	**M2.1** Produce a document describing the empirical utility of genetic indicators in biodiversity conservation (Month 36).

Working group 3 "Genes to ecosystem": Improve conservation management of species and ecosystems using genetic diversity knowledge (links to RCO1,2 and CBO1). This WG will complement Working Group 1 on policy by engaging with different species and habitat management stakeholders. The WG will assess the degree to which species (e.g., IUCN threatened species) and habitat management plans and actions have or have not incorporated genetic diversity concepts (e.g., population genetic structure, effective population sizes, hybrids, genetic connectivity, etc.) and co-construct strategies for integrating genetic diversity information for improved management. This will enhance case-anchored practitioners and community engagement (through links with Ecosystem Services). The success of this WG will be measured by the number of reports and publications resulting from STSMs and workshops and the number of species and area assessments, conservation and restoration plans supplemented with genetic diversity knowledge.

Objectives	**O3.1**. Assess national, regional, European Red Lists and conservation/restoration plans, including interconnections between in situ and ex-situ conservation plans, for key European species to determine the extent to which genetic diversity data, knowledge, approaches, and opportunities could be and are already integrated. Identify strategies to refine these assessments and species plans for improved genetic diversity conservation. **O3.2**. Assess the National reports on the EU habitats and bird directives, and Red List of Ecosystems (headline indicator A.1 of the KMGBF) assessments in Europe, to determine the extent to which genetic diversity data, knowledge, approaches, and opportunities could be and are already integrated. Identify strategies to refine these assessments and area management plans to incorporate genetic diversity with little or no additional cost. **O3.3.** Examine how genetic diversity in key European species is interconnected with genetic and functional diversity across species within ecosystems and where relevant, provide strategies to improve genetic diversity conservation across species. **O3.4**. Identify and examine strategies to improve the management of biological systems using genetic information when indicators are not applicable or difficult to apply, e.g., hybridization, clonality.
Tasks	**T3.1** Workshop to analyse Red List of species assessments and relevant species conservation and restoration plans (O3.1). **T3.2** Workshop to harvest and analyse reports on the EU habitats and bird directives and Red List of Ecosystems assessments (O3.2). **T3.3** STSMs and/or VMGs to digest and report on the extent genetic diversity is included (O3.1, O3.2, O3.3). **T3.4** Workshop together with key stakeholders, such as IUCN CPSG Europe, EEA, and IUCN European regional Office, based on STSM/VMG reports, to identify strategies for refining species and area conservation and restoration plans (O3.1, O3.2, O3.3). **T3.5** STSM or VMG to review information and suggest genetics-informed management action in systems (O3.4).
Milestones	**M3.1** Red Lists of species assessments and species management plans evaluated (Month 12). **M3.2** EU habitats and bird directives reports, and Red List of Ecosystems assessments evaluated (Month 24). **M3.3** Five species/area assessments, conservation or restoration plans supplemented with genetic diversity knowledge (Month 32)

Working group 4 "Engagement": Use of multidisciplinary approaches to bridge the communication divide and increase public awareness about the relevance of genetic diversity. (links to RCO4 and CBO3,5). By integrating social and behavioural sciences, we aim to identify and address challenges in communicating the relevance of genetic diversity by conservation managers, policymakers, and the public. The effectiveness of this WG's initiatives will be gauged by the extent to which these targeted audiences gain a clearer understanding of genetic diversity's importance. Key performance indicators will include increased participation in genetic conservation workshops, positive shifts in public awareness, and the implementation of informed policies by decision-makers. Feedback loops will be established, ensuring continuous improvement based on real-world results and stakeholder input. Ultimately, the success of WG4 lies in effectively bridging knowledge gaps, promoting the assessment of genetic indicators, and facilitating interdisciplinary collaborations. This will lead to a

heightened awareness and utilisation of genetic indicators in strategies aimed at conserving genetic diversity.

Objectives	**O4.1** Assess policymakers', conservation professionals' and other key actors' understanding and valuation of genetic diversity, to explore positions and reasons for obstacles. **O4.2** Collaborate with social scientists, communication specialists and design professionals to improve, refine and innovate dialogue strategies pertaining to genetic diversity conservation (e.g., a dedicated web-based, optimising existing policy briefs, region-specific examples for each country, and multilingual and visually engaging infographics, comics, cartoons, videos, and other media). **O4.3** Identify opportunities for engaging young people by establishing synergies with prominent youth movements around themes of climate change, conservation, and socio-environmental justice, including student/youth representatives in the leadership team. **O4.4** Develop accessible synopses of advancements in conservation genetics tailored for the public via dedicated blogs or video series on YouTube. **O4.5** Broadly advertise paradigmatic, engaging case studies in conservation genetics (e.g., Iberian lynx) by leveraging partnerships with conservation agencies, zoos, botanical gardens, and museums (and their organisations e.g., botanic garden and zoo associations) and other organisations that have broad reach to the public.
Tasks	**T4.1** Focus groups and active participation forums in different countries with conservation key actors (O4.1, O4.2). **T4.2** VMGs to develop, guide and launch interviews and questionnaires on knowledge, perceptions and practices concerning genetic diversity in different countries, in particular ITCs (O4.1, O4.2). **T4.3** Workshop for connecting with youth (O4.3). **T4.4** Establish a Young Professional Group for empowering and retaining young researchers (O4.3). **T4.5** Develop set of cartoons, comics, blogs, and videos via virtual mobility grants (O4.4). **T4.6** Two workshops with zoos, botanic gardens, museums, and other organisations to discuss and learn from case study examples (O4.5). **T4.7** Actively engage during events like the European researchers' night (see also 3.2.2) (O4.3). **T4.8** Utilise Scientific Cafe and Online Breakfast for increasing the level of collaboration between researchers, and the public; collaborate with existing citizen science projects (with the help of platforms like SciVil) (O4.2, O4.3). **T4.9** Training School to explain the most effective methods on how to gain insights about the general perception of genetic diversity concepts across different stakeholders (O4.2, O4.3).
Milestones	**M4.1** The establishment of the Young Professional Group (Month 21).

Working group 5 "Communication and collaboration": Multifaceted networking in the biodiversity monitoring community and beyond (links to CBO4,5). This WG will enable networking and coordination with other biodiversity and nature conservation organisations in the COST countries, including Biodiversa+, AHTEG, EuropaBON, IPBES (including ONet), Society for Conservation Biology, Coalition for Conservation Genetics, IUCN, and ERGA to promote collaboration across the biodiversity pillars (genes, species, ecosystems). Consequently, the Action stays current on scientific and applied developments and remains flexible to incorporate these into its activities. This WG will also ensure consistent, timely and clear communication among WGs and the Action management. To ensure an uninterrupted workflow, information delivery, and completion of tasks, an Executive Dissemination Committee (EDC), consisting of experts and YPGs from each WG, will be formed. EDC will also strive to include local communicators to help break hub language barriers by using some of the available online management tools to facilitate the internal work and allow continuous updates to the progress track. EDC will provide inputs for the Action's website, social channels, news editions, and reports. The news editions containing all relevant information about the Action's various activities will be sent biweekly to the action participants.

Objectives	**O5.1** Strengthen the involvement of conservation geneticists in broader biodiversity conservation initiatives by tracking and attending pertinent meetings/ conferences (e.g. EBR in March 2024: https://www.biodiversity.be/6008), calls for proposals, and coordination activities, and ensuring proactive representation (especially IPBES and EuropaBON). **O5.2** Enhance the involvement of non-geneticist conservation stakeholders and/or professionals in conservation genetics initiatives by strategically providing access and integration points to major conservation genetics conferences and related endeavours. **O5.3** Identify opportunities for disseminating lessons learned on biodiversity monitoring, encompassing both genetic and non-genetic methodologies, across partners and stakeholders. **O5.4** Communicate in a timely manner across the working groups to efficiently work together, allow all members to

	join initiatives, and ensure inclusivity and transparency by soliciting people with different backgrounds to offer different/missing perspectives on a given topic.
Tasks	**T5.1** Organise STSMs and VMGs for early career researchers to meet with cross-disciplinary researchers and support their attendance at conferences (O5.1, O5.2). **T5.2** Develop a help-line forum on the Action's website to allow for 'technical assistance' on any question about genetic diversity and divide this forum into indicators, policy, management, communication etc. (O5.3). **T5.3** Develop a flowchart of the Action's objectives, tasks, and deliverables and keep track of deadlines, using an online platform (O5.4). **T5.4** Ensure the updated information flow between different working groups, towards the chair and co-chair, and the whole community, through establishing an Executive Dissemination Committee and sending Biweekly News to inform participants on progress, actions, publications (O5.4).
Milestones	**M5.1** Executive dissemination committee established (Month 3). **M5.2** Help-line forum established (Month 6). **M5.3** STSMs, VMGs, and events participation completed (Months 12, 24, 36, 48). **M5.4** Biweekly News edition number 50 reached (Month 26).

4.1.2. DESCRIPTION OF DELIVERABLES AND TIMEFRAME

No	Deliverable	WG	Month
D1.1	Report on EU and national genetic biodiversity policy	1	16
D1.2	Scientific article on new evaluation of CBD National Reports	1	20
D1.3	Scientific report on outcomes of calculating genetic diversity indicators in 10 countries	1	36
D1.4	Completed network structure for regional hubs and plan for continuing beyond this grant	1	46
D1.5	Policy Briefs to summarise with simple wording the scenario of the national, regional and EU policies where genetic diversity needs to be better incorporated	1	36
D2.1	A set of computational tools and apps (data collection tools, and GIS applications) to support indicator deployment	2	24
D2.2	A written manual and video-taped guidance for indicator use, in numerous languages, contained in a single comprehensive guidance document on indicator utilisation, ensuring broad accessibility across diverse regions	2	18
D2.3	A comprehensive repository on genetic diversity indicators, containing curated scientific publications, background, and introduction videos, designed to introduce indicator utilisation to audiences with varying foundational knowledge, for both, novices, and experts	2	24
D2.4	Multiple scientific publications on the indicators, including on their correlation to genetic diversity data and threat status	2	24,45
D2.5	Policy Briefs in many languages aiming at summarising in non-technical wording the most relevant scientific outcomes	2	24,36
D3.1	Publication draft on genetic diversity in species management	3	24
D3.2	Publication draft on genetic diversity in area management	3	42
D3.3	Publication draft on genetic diversity management without typical genetic indicators	3	24,36
D4.1	Research publication assessing genetic understanding	4	18
D4.2	Research publication on assessing the state of knowledge before and after different types of intervention/ knowledge sharing	4	35
D4.3	Popular press/ report summary of the engagement via botanic gardens/ zoos, European researcher night, citizen, and youth engagement	4	24,36,48
D4.4	2 Scientific Cafe and Online Breakfast	4	39
D4.5	5 (stand-alone) cartoons and 1 comics series	4	6,9,21, 42,45
D5.1	Communication, dissemination, and networking strategy	5	5
D5.2	Website with the social feed	5	6
D5.3	Reports from the attended meetings/events/conferences of other conservation biology (monitoring) organisations, e.g., ECCB, SCB, IBA (Total: 10)	5	12,24,36, 48
D5.4	100 Biweekly News editions (M46).	5	46

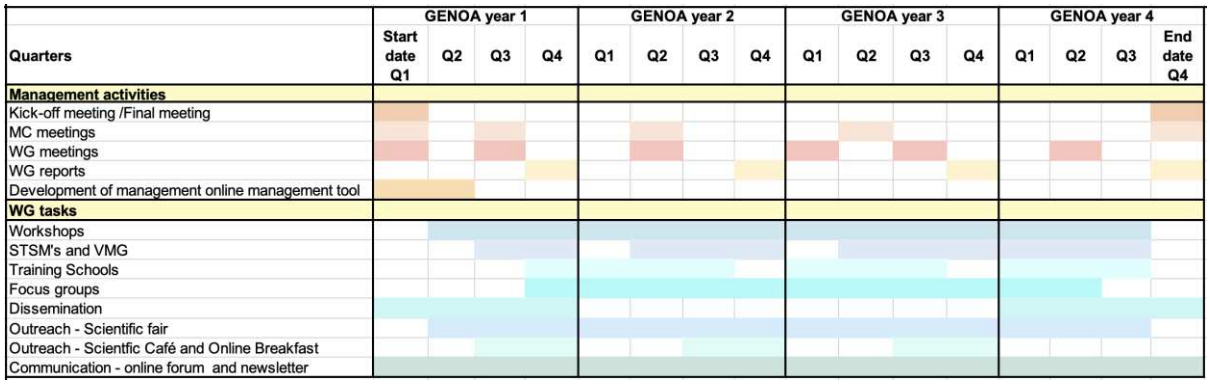
4.1.3. RISK ANALYSIS AND CONTINGENCY PLANS

The risk analysis and contingency plans included below represent the potential risks that may be present during GENOA implementation, along with the solutions proposed to achieve the objectives.

No	Description	Probability	Risk mitigation and contingency plan
1	Limited uptake of genetic indicators into management plans	Medium	Pushback regarding the inclusion of genetic indicators into the management plans by the stakeholders due to fear of capacity demands could be expected. Through co-creation, GENOA will engage stakeholders into designing time- and budget-effective approaches that will facilitate inclusion of genetic indicators in NBSAPs, leveraging the possibility of using non-DNA data to produce indicator values.
2	Low interest by the IPLCs	Medium	Outreach will be made through local IPLC associations and organisations. The MC and other participants from the IPLC countries will be involved in the communication process, also in native languages, to facilitate conversation. Social scientists will steer the process and will help better understand cultural specificities.
3	Low interest by public due to misconceptions about genetic diversity	Medium	GENOA will employ a clear, message-oriented, and continuous communication strategy to raise awareness about the basic concepts of genetics and genetic diversity among the public. Various communication tools and channels will be used to break common misconceptions about genetic diversity (e.g., genetic diversity assumes the genetic modification of organisms).
4	Delays in project implementation	Medium	The Core Group will follow the tasks, objectives, and timelines by using a project planner template integrated into the website. A regular reminder will be set out and interim checking will be conducted by the Core Group.
5	Limited involvement of stakeholders and conservation practitioners	Medium	Intervention by the MC and Core Group to increase participation. Each partner will have at least two stakeholder/practitioner organisations listed to ensure involvement/participation of at least one organisation. Action will also leverage on countries' obligations within the Global Biodiversity Framework to entice the involvement.
6	Discontinuity in knowledge transfer and information transfer	Medium	The Action foresees comprehensive communication instruments among the network members already implemented by the Action partners. Each WG will dedicate a person to ensure horizontal communication and the EDC will be in permanent contact with WG leaders and co-chair/deputy chairs, with the Core Group and the MC.

4.1.4. GANTT DIAGRAM

The following Gantt diagram details the planned yearly (Year 1-4) and quarterly (Q1-Q4) schedule for each of the Management Activities and WG tasks foreseen in **GENOA:**



REFERENCES

Bischof, R., Milleret, C., Dupont, P., et al. (2020). Proceedings of the National Academy of Sciences of the United States of America, 117(48), 30531–30538.

Blanchet, S., Fargeot, L., & Raffard, A. (2023). Molecular Ecology, 32(16), 4467–4481.

Carroll, C., Hoban, S., & Ray, J. C. (2023). Conservation Biology. https://doi.org/10.1111/cobi.14192

CBD. (2022). Kunming-Montreal Global Biodiversity Framework. https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf

Des Roches, S., Pendleton, L. H., Shapiro, B., & Palkovacs, E. P. (2021). Nature Ecology & Evolution, 5(5),574–582.

Díaz, S., Zafra-Calvo, N., Purvis, A., et al. (2020). Science, 370(6515), 411–413.

Exposito-Alonso, M., Booker, T. R., Czech, L., et al. (2022). Science, 377(6613), 1431–1435.

FAO. (2010). The second report on the state of the world's plant genetic resources. https://www.fao.org/agriculture/seed/sow2/en/

Frankham, R. (2022). Conservation Genetics, 23(5), 865–870.

Habitats directive art 17. (n.d.). Retrieved October 21, 2023, from https://cdr.eionet.europa.eu/help/habitats_art17

Hecker, S., Haklay, M. E., Bowser, A., et al. (2018). Citizen Science. 580.

Heuertz, M., Carvalho, S. B., Galindo, et al. (2023). Biological Conservation, 278(109883), 109883.

Hoban, S., Archer, F. I., Bertola, L. D., et al. (2022). Biological Reviews of the Cambridge Philosophical Society, 97(4), 1511–1538.

Hoban, S., Bruford, M. W., da Silva, J. M., et al. (2023). Conservation Genetics. https://doi.org/10.1007/s10592-022-01492-0

Hoban, S., Bruford, M. W., Funk, W. C., et al. (2021). Bioscience, 71(9), 964–976.

Hoban, S., Campbell, C. D., da Silva, J. M., et al. (2021). Biological Conservation, 261(109233), 109233.

Hoban, S., da Silva, J. M., Mastretta-Yanes, A., et al. (2023). Conservation Letters. https://doi.org/10.1111/conl.12953

Hollingsworth, P. M., O'Brien, D., Ennos, R. A., et al. (2020). Scottish Natural Heritage.

Hvilsom, C., Segelbacher, G., Ekblom, R., et al. (2022). IUCN, International Union for Conservation of Nature.

Jensen, E. L., Díez-Del-Molino, D., Gilbert, M. T. P., et al. (2022). Trends in Ecology & Evolution, 37(5), 420–429.

Laikre, L. (2010). Conservation Genetics, 11(2), 349–354.

Leigh, D. M., Hendry, A. P., Vázquez-Domínguez, E., & Friesen, V. L. (2019). Evolutionary Applications, 12(8), 1505–1512.

Minter, M., O'Brien, D., Cottrell, J., et al. (2021). Ecological Solutions and Evidence, 2(2). https://doi.org/10.1002/2688-8319.12061

O'Brien, D., Laikre, L., Hoban, S., et al. (2022). The Journal of Applied Ecology, 59(9), 2227–2233.

Pearman, P. B., Broennimann, O., Albayrak, T., et al. (2023). bioRxiv, https://doi.org/10.1101/2023.03.24.533448

Raffard, A., Santoul, F., Cucherousset, J., & Blanchet, S. (2019). Biological Reviews of the Cambridge Philosophical Society, 94(2), 648–661.

Richardson, K., Steffen, W., Lucht, W., et al. (2023). Science Advances, 9(37), eadh2458.

Stillman, A. N., Howell, P. E., Zimmerman, et al. (2023). The Journal of Applied Ecology. https://doi.org/10.1111/1365-2664.14512

The Sustainable Finance Platform. (2020). https://www.dnb.nl/media/cy2p51gx/biodiversity-opportunitiesrisks-for-the-financial-sector.pdf

Tobón-Niedfeldt, W., Mastretta-Yanes, A., Urquiza-Haas, T., et al. (2022). Nature Communications, 13(1), 6254.