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PERSPECTIVE

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The Coalition for Conservation Genetics: Working across organizations to build capacity and achieve change in policy and practice

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Abstract

The Coalition for Conservation Genetics (CCG) brings together four eminent organizations with the shared goal of improving the integration of genetic information into conservation policy and practice. We provide a historical context of conservation genetics as a field and reflect on current barriers to conserving genetic diversity, highlighting the need for collaboration across traditional divides, international partnerships, and coordinated advocacy. We then introduce the CCG and illustrate through examples how a coalition approach can leverage complementary expertise and improve the organizational impact at multiple levels. The CCG has proven particularly successful at implementing large synthesis-type projects, training early-career scientists, and advising policy makers. Achievements to date highlight the potential for the CCG to make effective contributions to practical conservation policy and management that no one "parent" organization could achieve on its own. Finally, we reflect on the lessons learned through forming the CCG, and our vision for the future.

KEYWORDS

capacity building, conservation genetics, genetic diversity, international policy, policy and practice, scientific networks

1 | INTRODUCTION

Tackling complex global problems requires a united front. The critical biodiversity challenges faced by the planet have motivated heightened collaboration among scientists, as indicated by increasingly collaborative paper authorship (Barlow et al., 2018), diverse collaboration across disciplines (Brondizio et al., 2016; Darwall et al., 2018), and improved collaboration across international and socioeconomic boundaries (Parreira et al., 2017). Biodiversity preservation intersects intimately with the socio-political frameworks that underlie the use of natural resources. Conservation action thus demands a broad and interdisciplinary outlook to incorporate the global diversity of ecosystems and human communities that depend on them. The environmental nongovernmental organization (ENGO) sector already utilizes such coordinated approaches, for example through the International Union for Conservation of Nature (IUCN) Conservation Planning Specialist Group or the Centre for Plant Conservation, which develops best practices around plant conservation, identifies and supports species "champions" (organizations focused on particular plants), and promotes collaboration and idea sharing. As conservation scientists, unless we take an integrated research and policy approach, fragmented research agendas are unlikely to make sufficient progress toward finding innovative solutions that have major impact (Brondizio et al., 2016).

The Coalition for Conservation Genetics (CCG) is designed to cross these boundaries and benefit conservation of genetic biodiversity by bringing together four field-leading organizations, each with their own historical perspectives, priorities, and modes of action, to address major challenges facing the incorporation of genetics in conservation practice (Figure 1). By connecting these stakeholder groups, the CCG provides lines of communication and focused efforts across operational, geographical, and disciplinary boundaries (including across ENGOs, government agencies, and institutions that engage the public). Doing so provides the opportunity to align, and thus amplify, key messaging, for example, on the importance of genetic diversity for species resilience. Furthermore, the members of these organizations operate in diverse parts of the world, with expertise on a range of taxonomic groups and ecosystems, bringing together diverse individual perspectives. Together, the CCG acts as a lens for capturing, aggregating, and focusing perspectives in new ways, generating new solutions to shared challenges, and thus could be a model for other conservation organizations on how to magnify impact. Here, we provide the historical context that serves as the foundation for the formation of the CCG, detail the

FIGURE 1 Overview of the four working groups currently represented by the Coalition for Conservation Genetics (CCG). The figure conveys the specific expertise of each group (i.e., research, interpretation, policy, and management) and demonstrates the overlap in the primary goals of each group

different perspectives each member group brings to the CCG, identify key issue areas and achievements to date, outline our vision for the role and future of the CCG, and then discuss some lessons learned for successful coalition formation.

2 | HISTORICAL PERSPECTIVE ON CONSERVATION GENETICS AND POLICY

Conservation genetics as a scientific discipline dates back to the 1970s (Figure 2). Australian geneticist Otto H. Frankel was among the first to warn of the dangers of losing genetic diversity (Frankel, 1970, 1974). However, policy developments also helped push scientists to focus on the role of genetics in population and species conservation. The United States Endangered Species Act (ESA) stipulated in 1973 that species have intrinsic value and should be conserved. In 1978, the ESA broadened the definition of species to include “any distinct population segment of any species of vertebrate fish or wildlife” (US Fish and Wildlife Service & National Marine Fisheries Service, 1996). Thus, identifying populations and population structure became important to implement the Act, and for such identification, the allozyme techniques that became available in the 1960s–1970s were invaluable (Lewontin & Hubby, 1966; Utter et al., 1972, 1973). From the start, empirical knowledge was translated into conservation management advice, and the critical need to monitor genetic diversity in conservation was identified (Ryman, 1981).

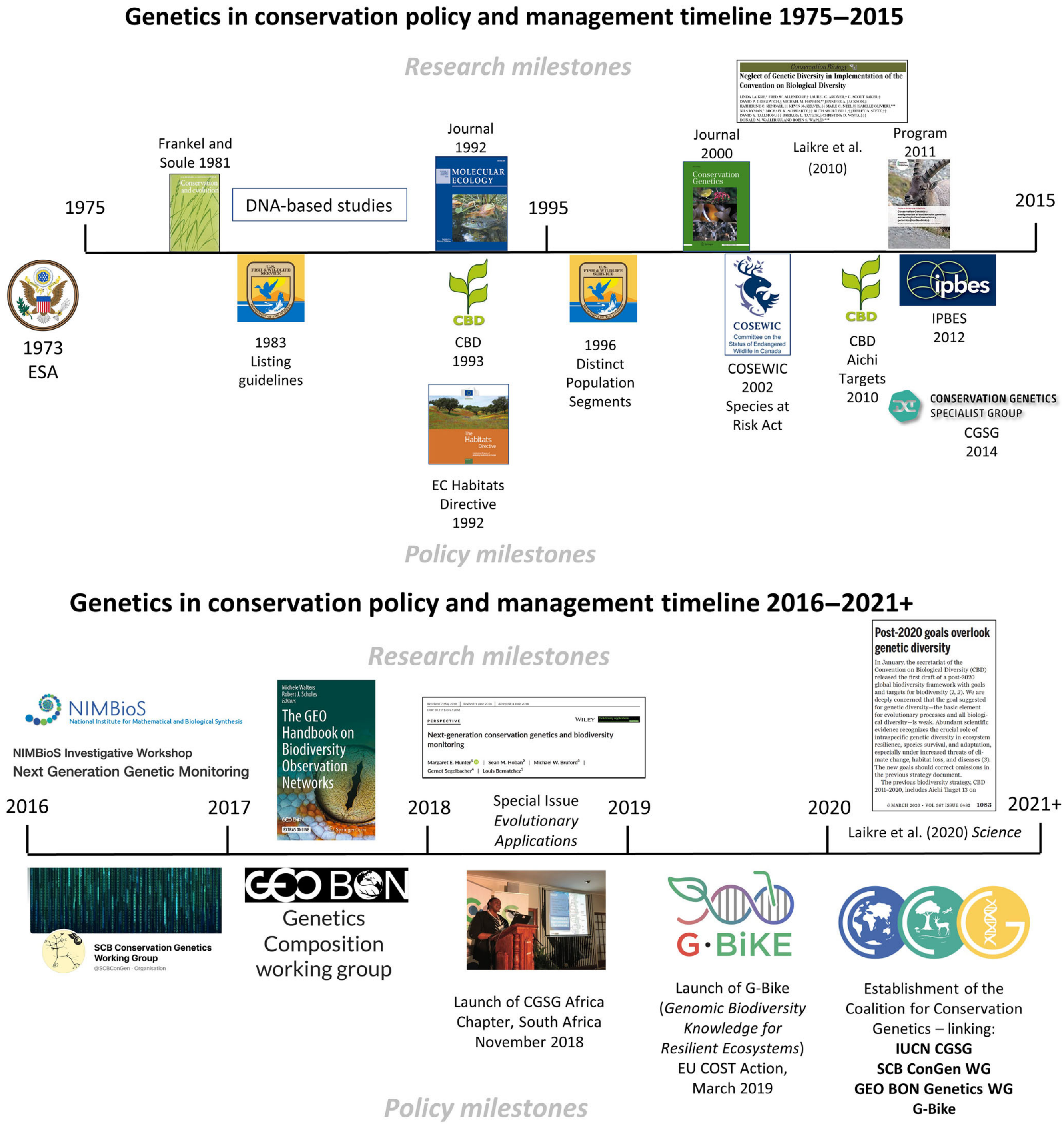

FIGURE 2 Development of the field of conservation genetics in research and policy

In the United States, federal law in 1976 (The National Forest Management Act, NFMA) required managers to "maintain viable populations" of species. The NFMA wording motivated scientists, led by Michael Soulé and Otto Frankel, to explore the "minimum viable population" concept from several perspectives, including population genetic and evolutionary principles. This work became a central pillar in conservation biology research (Frankel & Soulé, 1981; Soulé & Wilcox, 1980). Guiding principles on the population sizes needed to maintain genetic viability were presented in these first conservation biology textbooks (e.g., the effective 50/500 population size [N_e] rule; Franklin, 1980). The scientific journal *Conservation Biology* was first published in 1985 and the conservation genetics principles were an important cornerstone (Ehrenfeld, 1995).

Allozyme electrophoresis was complemented in the 1980s with techniques that enabled the study of mitochondrial (Avise, 1994; Gyllensten et al., 1985) and nuclear

(Ellegren et al. 1993; Jeffreys et al. 1985a, b) DNA variability, as well as polymerase chain reaction (PCR) technology to amplify DNA, and associated marker types such as randomly amplified polymorphic DNA (RAPDs) and microsatellites (Avise, 1994; Bruford & Wayne, 1993). These developments greatly expanded the reach of empirical conservation genetics for management, and led to the inception of scientific journals such as *Molecular Ecology* (1992). The journals *Conservation Genetics*, initiated in 2000, and *Evolutionary Applications*, founded in 2008, further strengthened the important role of genetics in conservation.

In the international policy arena, the United Nations (UN) Convention on Biological Diversity (CBD; www.cbd.int) entered into force in 1993. The CBD was negotiated in parallel with the UN Climate Change Convention (UNFCCC; unfccc.int), highlighting the strong connection between climate change and biodiversity. The CBD recognizes that biodiversity of genes, species, and ecosystems should be identified, conserved, monitored, and sustainably used. The CBD is the most important biodiversity conservation policy globally, with 196 signatory parties. It influences practical conservation measures and regional and national policy all over the world. For instance, the European Union (EU) Habitats Directive (and other environment Directives) links strongly with the CBD. Every participating country must produce National Biodiversity Strategy and Action Plans, National Targets, and must regularly submit National Reports on biodiversity conservation progress to the CBD. Nonetheless, although CBD is influential, nations have previously failed to meet their biodiversity targets (Hoban et al., 2021b).

Despite the strong historical connection between conservation genetics research and policy, incorporation of guidelines for conserving genetic diversity into international policy is conspicuously lacking (Laikre et al., 2010). For example, the CBD conservation target for genetic diversity 2010–2020 Aichi Target 13 (www.cbd.int/sp) focused predominantly on domesticated species and thus was regarded as fundamentally inadequate (Hoban et al., 2020; Laikre et al., 2020). The lag in the application of existing genetic knowledge in management and policy has been called the "conservation genetics gap" (Taylor et al., 2017), and many reasons for its existence have been discussed (Cook & Sgrò, 2017, 2019; Sandström et al., 2019). Unfortunately, the technical complexity of the recent genomics and bioinformatics revolution in empirical conservation genomics appears to have contributed toward widening the gap even further, despite early hope that affordable genomic data would act as a bridge (Allendorf et al., 2010; Shafer et al., 2015). Conservation genetics researchers are increasingly acting to highlight this gap and develop strategies to fill it (Hoban et al., 2020, 2021a; Kershaw et al., 2021; Laikre et al., 2020).

3 | OVERVIEW OF CONSERVATION GENETICS WORKING GROUPS

Several conservation genetics working groups were established in response to accelerating availability of genetic tools and scientific research efforts, combined with increasing calls from conservation practitioners for accessible tools and guidance. The Conservation Genetic Resources for Effective Species Survival EU Framework VII project (ConGRESS; Hoban et al., 2013) emerged as one of the first groups to bring together many researchers to develop policy and management guidance, training materials, and capacity building efforts. ConGRESS presaged other entities in exploring similar efforts during the last decade. In 2020, four of the conservation genetics groups agreed to link together and form the CCG to increase the global reach of the conservation genetics community in the policy arena and to maximize inclusivity: the IUCN Conservation Genetics Specialist Group (CGSG) established in 2014, the Society of Conservation Biology (SCB) Conservation Genetics Working Group (CGWG) created in 2016, the Group on Earth Observations Biodiversity Observation Network (GEO BON) Genetic Composition Working Group (GCWG) founded in 2018, and the European Genomic Biodiversity Knowledge for Resilient Ecosystems (G-BiKE) Cooperation in Science and Technology (COST) Action project, which started in 2019 specifically aimed at European practitioners and policy professionals. Below, we provide a brief overview of the background, scope, and broad objectives of the four working groups. While each group undertakes complementary work to advance consistent goals, each also has a specific focus of expertise, which we broadly categorize here as research (GEO BON GCWG), interpretation (of scientific data for policy and management purposes) (G-BiKE), policy (IUCN CGSG), and management (SCB CGWG), to reflect the pathway from science to decision-making (Figure 1).

3.1 | Research: GEO BON Genetic Composition Working Group

The GEO BON GCWG (https://geobon.org/ebvs/working-groups/genetic-composition/) focuses on providing the tools and information necessary for improving and operationalizing genetic monitoring. This group is aligned with the mission of GEO BON to acquire, coordinate, and deliver biodiversity observations to the scientific community and decision makers. The GCWG is one of six working groups in GEO BON focusing on various levels of biodiversity (species, traits, community composition, ecosystem function and services). The GCWG is working to support, aggregate, and leverage genetic biodiversity monitoring data, and develop standards, metadata definitions, and open data platforms. GCWG has proposed essential biodiversity variables (EBVs, Pereira et al., 2013, *GEO BON Handbook* https://link.springer.com/book/10.1007/978-3-319-27288-7), proxies, and indicators for genetic diversity monitoring at regional, national, and global scales. Its focus also includes the investigation of genetic diversity in relation to other levels of biodiversity (species, traits, and ecosystems) and documenting change over time. Work was initiated in 2012, but the group coalesced in 2018 at the GEO BON All Hands meeting in Beijing. The GCWG currently has 195 members from 49 countries. A first major effort included commenting on the role of genetic diversity in the CBD and recommending three appropriate genetic indicators for the CBD post-2020 global biodiversity framework (Hoban et al., 2020, 2021a; Laikre et al., 2020). The second major effort was to develop four EBVs which will allow for standardized assessment of genetic data (Hoban et al., 2021a). Additionally, a review of CBD National Reports for inclusion of genetic diversity identified a global focus on cultivated versus noncultivated species and limited reporting of genetic indicators (Hoban et al., 2021b). The review recommends increased awareness and standardized reporting requirements on genetic diversity and improved genetic diversity targets and indicators (Hoban et al., 2021b).

3.2 | Interpretation: European Genomic Biodiversity Knowledge For Resilient Ecosystems

The overall goal of G-BiKE COST Action (2019–2023; https://g-bikegenetics.eu) is to help establish the use of genomic data as a standard tool for monitoring and managing wild and ex-situ populations of plants and animals in COST Action countries. G-BiKE's ultimate aim is to definitively integrate measuring and monitoring of genetic diversity of all kinds of species in EU policy related to biodiversity such as the EU Biodiversity Strategy for 2030, the EU Green Deal, the Natura 2000 sites framework, and the Habitats Directive. G-BiKE's working groups focus on: (1) mobilizing the policy community in Europe to improve uptake of genomic approaches; (2) genomic monitoring, including development of EU-relevant targets and indicators for genomic diversity; (3) the use of genomics as a tool to assess the status and resilience of ecosystem services; and (4) understanding and forecasting the application of new biotechnological approaches in conservation. G-BiKE is a "COST Action"—a specific networking project financed by the EU under the H2020 Framework—funded from March 2019 to 2023, and builds on the previously EU-funded project ConGRESS. G-BiKE has a clear European dimension with 39 COST-associated countries involved (including Turkey and Israel) plus four so-called Near Neighboring Countries (Tunisia, Algeria, Jordan, and Armenia). More than 100 practitioners and scientists are officially registered as members. The networking activity is based on thematic workshops, "Training Schools," and "Short Term Scientific Missions (STSMs)" that are short-term (from 5 to 90 days) visiting researcher positions. STSMs are usually granted to young investigators and practitioners. Other working groups could take up this interpreting role in the future.

3.3 | Policy: IUCN Conservation Genetics Specialist Group

Formed in 2014, the CGSG (https://www.cgsg.uni-freiburg.de/) is a Specialist Group of the Species Survival Commission (SSC) of the IUCN (a global organization of 18,000 experts that provides guidance on safeguarding the planet). CGSG was founded to promote the use of genetics in conservation management and decision making to assist the SSC (https://www.iucn.org/commissions/species-survival-commission/) in applying genetics to threatened species, and to lead the development and analysis of genetic data in conservation. CGSG works on policy development and assists other Specialist Groups within the SSC to carry out necessary research for their missions, including the application of molecular tools and the interpretation of results (e.g., for identifying conservation units or the taxonomic status of species, understanding population genetic diversity, and improving in-situ and ex-situ genetic management). In addition, CGSG focuses on raising public awareness of the importance of genetic diversity. CGSG comprises over 115 scientists and practitioners organized in regional chapters across the world. CGSG is developing IUCN guidance documents and statements (e.g., on monitoring genetic diversity and biobanking) and is actively creating a network among SSC Specialist Groups. CGSG put forward a resolution to the World Conservation Congress highlighting the importance of genetic diversity in the coming decade (Resolution 93; https://www.iucncongress2020.org/motion/109) and has actively engaged in a revised wording for post-2020 CBD genetic targets (especially Target 4 on species and Target 13 on genetic diversity, see Hoban et al., 2020; Laikre et al., 2021) as well as including genetic diversity in the Key Biodiversity Area standards (KBA Standards and Appeals Committee, 2020). CGSG has also organized a number of conservation genetics meetings at international conferences as well as producing and contributing to scientific literature relevant for decision making (Laikre et al., 2020; Russo et al., 2019).

3.4 | Management: SCB Conservation Genetics Working Group

The CGWG (https://conbio.org/groups/working-groups/conservation-genetics-working-group/) was created within the SCB with the purpose of promoting the use of genetic data to address real world problems in conservation studies and management decisions. Conservation manager and academic researcher partnerships are critical to the conservation of biological diversity, and this group was established as a forum to foster these relationships through bi-directional communication and education. A key charge of the group is to understand the challenges in creating manager-academic partnerships, and to facilitate communication through online forums (the SCB website, email list, and social media pages), and in-person interdisciplinary conference sessions and workshops. To accomplish this, CGWG surveyed managers about their use of genetic information and found that the majority of conservation managers are eager to incorporate genetic data into their management plans, but often lack the funding and personnel to do so (Taft et al., 2020). Thus, CGWG aims to facilitate mutually beneficial partnerships between managers and academic researchers. CGWG's membership consists primarily of North American and European managers and scientists but includes members from around the world.

4 | THE "COALITION FOR CONSERVATION GENETICS"

4.1 | Why a coalition?

Despite the significant work undertaken by individual working groups, it became apparent that these efforts were not having the desired impact on the policy landscape (Laikre et al., 2020). Surveys of managers continued to highlight the same barriers to including genetic data in their work as in previous surveys over the past decade (Cook & Sgrò, 2019; Sandström et al., 2019). The inclusion of genetic diversity in the implementation of the CBD has improved since the zero draft of the proposed post-2020 global biodiversity framework (Laikre et al., 2020), with some inclusion in targets, goals and indicators. As of late 2021, the inclusion of genetic diversity in the first draft of the post-2020 global biodiversity framework continues to improve, but remains unlikely to result in meaningful conservation measures. The CCG currently recommend that maintenance of genetic diversity among populations should reflect no further loss of genetically distinct populations, and that maintenance within populations should relate to the guidance on retention of 95% of heterozygosity over 100 years (Allendorf & Ryman, 2002, Diaz et al., 2020), via appropriate effective sizes and connectivity. Meanwhile a 2030 Milestone should specify that sufficient genetic adaptive capacity must be maintained, managed, and monitored for a higher number of populations. More specific aims could help to further conservation measures, such as by increasing the proportion of populations large enough to maintain adaptive capacity (effective population size > 500), maintenance of all genetically distinct populations, management and monitoring of genetically depleted populations, and restoration of conditions promoting evolutionary adaptation (Hoban et al., 2021b). In light of the barriers to the uptake of conservation genetics, the four individual working groups were incentivized to come together in early 2020 and discuss how best to coordinate their work to synergize their efforts. The groups decided to formalize the network as the CCG. As members in the CCG, the individual working groups maintain their own identities, memberships, and activities, but leaders of the groups meet frequently (i.e., monthly) to provide updates on work areas, share lessons learned, identify common challenges and potential solutions, collaborate directly on policy recommendations, develop common messaging and a funding strategy, and generate shared communication materials (e.g., a landing page, blog, and mailing list).

There are several benefits of a coalition approach: First, the skills and expertise of each group can be collectively capitalized upon. A coalition approach improves communication by speaking as a single voice to give common messaging and common terminology. By coordinating efforts across groups, the four focal areas (implementation, management, research, and policy) can be leveraged simultaneously, leading to more impactful combined science, recommendations, and education strategy (Figure 3), including translation to numerous languages and distribution of outputs (https://g-bikegenetics.eu). Increased coordination also avoids duplication of efforts, such as outreach surveys to the scientific and management communities, reducing the fatigue communities may face when asked to respond to multiple similar initiatives. Cooperative grant seeking can be undertaken, resulting in stronger funding proposals that bring together the contributions of each individual group (e.g., communications, capacity building, and research). In turn, funders receive a greater return on their investment, knowing that the project reflects the harmonized goal of multiple groups and will thus achieve greater impact. The CCG is also an important avenue for knowledge transfer, through the mentoring of Early Career Researchers. By drawing on the collective knowledge of its members, CCG can guide new generations of conservation geneticists by providing opportunities to interface with policy (national and global), gain experience in the way in which different working groups

Coalition for Conservation Genetics

Combining efforts as a coalition: translation and outreach

	Government		NGO		Manager		Public
	Politicians and officials	Statutory nature conservation bodies, agencies	Global	Local	In situ (land/wildlife, marine protected areas, fisheries)	Ex situ (seed/bio banks, zoos/aquaria)	
Blogs, social media	✓	✓	✓	✓	✓	✓	✓
Conferences		✓	✓	✓	✓	✓	
In-person briefings	✓	✓	✓	✓	✓	✓	
In-person events (e.g. science cafes, interdisciplinary policy groups)		✓					✓
In-region workshops				✓	✓		
Media outreach (press releases, building relationships with reporters)	✓		✓				✓
Meetings with professional associations					✓	✓	
Peer-to-peer networking	✓	✓	✓	✓	✓	✓	
Policy briefs	✓		✓				
Popular science magazines, digests		✓					✓
Protocols, technical guidance		✓	✓	✓	✓	✓	
Technology sharing, training				✓	✓	✓	
Trade publications, websites					✓		
Webinars	✓	✓	✓	✓	✓	✓	✓

FIGURE 3 Each working group carries out a variety of translation and outreach activities (listed on the left), targeted at different organizations or participants (green ticks). The benefits of a coalition approach include aligning messaging, drawing on varied and diverse expertise (across countries and cultural backgrounds), and assessing gaps or duplicated effort in outreach activities across groups

operate, and learn how to network to capitalize on collaborative funding opportunities. Finally, as in some other fields within conservation biology (Smith et al., 2017), the diversity, equity, and inclusiveness of the field of conservation genetics need systemic and rapid improvement. By working together, CCG can leverage its different roles (outreach, education, and funding) and presence in different geographic regions to offer opportunities and support for currently underrepresented groups. For example, CCG is seeking to host visiting scholars and to partner with in-country scientists to test and validate indicators of genetic diversity, and intentionally engage with groups in underrepresented geographic regions.

4.2 | Benefits for research, interpretation, policy, and management

The CCG has identified five main categories of issues to address to provide benefits for research, interpretation, policy, and management (Table 1):

(1) *Developing guidelines and tools to help non-geneticists use genetic data, or to leverage nongenetic data to address genetic issues*. Creation of a coordinated list of best practices for genetic data can benefit managers, who are often faced with several competing scientific recommendations and need to decide how to prioritize actions to protect genetic diversity with other conservation needs (e.g., preventing habitat loss, policing poaching). Guidance on when genetics should be prioritized for conservation action, protocols to collect samples for genetic analysis, which species to select for monitoring genetic diversity, and identifying common metadata standards, for example, can make genetic data more usable by managers and increase the usefulness and value of collected data. Development of usable tools such as genetic indicators to support managers in protecting and monitoring genetic diversity via non-genetic proxies, and are designed to address pertinent real-world conservation challenges, can also make protecting genetic diversity more accessible and in some cases enable managers to achieve multiple conservation goals (Hoban et al., 2021a). A priority for the CCG is to

TABLE 1 List and publication status of collaborative outputs by the CCG

				Issues addressed[a]				
Action	**Status**	**Group(s)**	**Citation**	**1**	**2**	**3**	**4**	**5**
Peer-reviewed letter: Post-2020 goals overlook genetic diversity	Published	CGSG, G-BiKE, GCWG	Laikre et al. (2020)		✓		✓	
Peer-reviewed perspective: Genetic diversity targets and indicators in the CBD post-2020 Global Biodiversity Framework must be improved	Published	CGSG, GCWG	Hoban et al. (2020)	✓	✓		✓	
Policy brief: Genetic diversity target and indicators proposed for the CBD post-2020 Global Biodiversity Framework	Published	GCWG, G-BiKE CCG	https://g-bikegenetics.eu/en/pubs-policy-briefs/policy-briefs	✓	✓			
Peer-reviewed Perspective: Research-Management partnerships: An opportunity to integrate genetics in conservation actions	Published	CGWG	Taft et al. (2020)	✓				✓
Peer-reviewed perspective: Global commitments to conserving and monitoring genetic diversity are now necessary and feasible	Published	CCG	Hoban et al. (2021a)		✓		✓	
Peer-reviewed research article: Genetic diversity is considered important but interpreted narrowly in country reports to the Convention on Biological Diversity: Current actions and indicators are insufficient	Published	GCWG, G-BiKE	Hoban et al. (2021b)	✓	✓			
Policy brief: How do Parties report to the Convention on Biological Diversity on genetic diversity and how can reporting and monitoring be improved?	Published	GCWG, G-BiKE CCG	https://g-bikegenetics.eu/en/pubs-policy-briefs/policy-briefs	✓	✓			
Policy brief: Genetic variation—Key to adapting to environmental change	Published	G-BiKE CCG	https://g-bikegenetics.eu/en/pubs-policy-briefs/policy-briefs		✓			
Statement on genetic diversity to CBD parties	Published	CCG	https://www.cbd.int/conferences/post2020/submissions-zero-draft	✓	✓			
Peer-reviewed perspective: Global genetic diversity status and trends: Towards a suite of Essential Biodiversity Variables (EBVs) for genetic composition	In progress	GCWG	Hoban et al. (2022)		✓		✓	
"Conservation Genetics Network" database of researchers and practitioners	In progress	SCB, CCG				✓		
Recommendations for harmonizing genetic data and metadata standards	Planned	CCG		✓			✓	

(Continues)

TABLE 1 (Continued)

Action	Status	Group(s)	Citation	Issues addressed[a]				
				1	2	3	4	5
Summary of best practices for collection of conservation genetic samples and data	Planned	CCG		✓			✓	
Case studies to demonstrate application of proposed genetic diversity Indicators and EBVs	Planned	CCG		✓				✓

Note: How each output corresponds to the five priority areas of the CCG is indicated. Due to the recent formation of the CCG, some published works represent collaborations between member groups of the CCG that now have been integrated into the CCG's workplan.

Abbreviations: CCG, Coalition for Conservation Genetics; CGSG, Conservation Genetics Specialist Group; COST, Cooperation in Science and Technology; EBVs, essential biodiversity variables; G-BiKE, Genomic Biodiversity Knowledge for Resilient Ecosystems; GCWG, Genetic Composition Working Group; SCB, Society of Conservation Biology.

[a]The CCG has identified five categories of issues to address: (1) Developing guidelines and tools to help non geneticists use genetic data, or to leverage non genetic data to address genetic issues. (2) Ensuring the integration of genetic issues and genetic conservation in global and local policy. (3) developing a well-trained and leadership-capable next generation of scientists who are diverse and globally representative. (4) better guidance for archiving genetic datasets, and developing tools and resources to make use of the wealth of genetic data in existence. (5) engaging case studies that can excite and inform managers and the public about genetic conservation.

bring land managers and ENGOs together with specialists to protect genetic diversity in-situ at local and national scales (Minter et al., 2021). Furthermore, the availability of personnel is often a roadblock in incorporating genetic data into management (Taft et al., 2020). The formation of the CCG can enable groups to work together to create resources for connecting managers without expertise in genetics with geneticists across a range of geographies and areas of expertise. This will be done by creating a central landing page online, where interested practitioners can centrally find relevant material, linked to existing workflows in some countries (Holderegger et al., 2020). Resource sharing is of particular relevance: the increasing use of genome-based approaches in conservation requires the analyses of huge amounts of data that can be effectively done only with adequate computational resources. An international network can better support these research efforts, providing substantial help to researchers from countries less equipped in this context.

(2) *Ensuring the integration of genetic issues and genetic conservation in global and local policy*. CCG directly connects technical experts with experts in policy implementation. Most of the current recommendations and guidelines on biodiversity are being established by large international bodies such as the CBD and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Most of CCG's activities have focused on the CBD post-2020 framework due to the timing of ongoing negotiations, although, in the future, CCG may shift to other international and national commitments and activities. For example, through the CBD process, a goal of CCG has been to improve the practical application of genetic diversity indicators, case studies, and cost estimates (Box 1; Table 1). The decision process, however, is country-based. This means, for example, that for a new resolution to be adopted, the majority of the Parties have to agree. Communication between various groups, including country delegates, requires substantial effort and, most importantly, understanding of their different cultural and political backgrounds. Working as a coalition enables the diversity of countries and cultures within each of the participating organizations to be drawn upon. CCG also combines efforts to horizon scan for future efforts, as activities and timelines are not always readily apparent and so the collaborative tracking of processes on a multi-year timeframe are required.

(3) *Developing a well-trained and leadership-capable next generation of scientists who are diverse and globally representative*. By combining its scientific expertise and experience in advising policy and coordinating efforts, the CCG provides a mechanism for researchers to have greater impact. Working together to identify study aims,

BOX 1 Benefits of a coalition approach in practice

Translating conservation genetic science into international policy: CCG has engaged with the CBD to provide help and assistance for developing science-based goals, action targets, and pragmatic indicators for genetic diversity. These collaborative efforts have been presented in several scientific publications (Hoban et al., 2020, 2021a, 2021b, 2022; Laikre et al., 2020, 2021), in policy briefs, information documents, as well as webinar series offered to all CBD national focal points as well as to other interested parties. Assistance has also been offered directly to the CBD Secretariat and comments on drafting documents from the CBD process have been commented on by collaborative efforts within CCG. The four working groups then pursued individual but coordinated actions to increase the uptake of this new scientific information into the CBD process. SCB composed and disseminated a policy statement, the IUCN CGSG and the IUCN Post 2020 Task Force provided comments directly to CBD, GEO BON GCWG composed an information document to SBSTTA (Subsidiary Body on Scientific, Technical and Technological Advice), and G-BIKE and GEO BON GCWG composed and disseminated a series of "Policy Briefs" that were translated into several languages (https://g-bikegenetics.eu/en/pubs-policy-briefs/policy-briefs).

Harmonizing data standards to enhance global scientific capacity. Four decades of genetic data collection, combined with increasing DNA collection from museums and ancient materials, provides an opportunity for monitoring genetic diversity change. Multiple data repositories and standards for documentation are emerging. However, genetic data are still often scattered, collected in divergent ways, and stored in different formats, limiting the FAIR (Findable, Accessible, Interoperable, and Reusable) capacity of the data. Members of CCG recently assessed the state of the art of genetic monitoring and identified several major areas where focus can be placed for the next steps to enable large scale, routine, standardized, and usable observations of scaled up genetic data (Hoban et al., 2022). Members also coordinated on publications writing, defining an emerging field known as macrogenetics, providing a critical perspective on the design, analysis and interpretation of such studies (Leigh et al., 2021; Paz-Vinas et al., 2021).

scope, and plans for data dissemination and potential actions leads to co-creation of research with managers and can more effectively and efficiently address the key knowledge gaps obstructing the integration of genetics research into international and national biodiversity conservation policy. Also, a top priority is to involve additional members and groups (e.g., national monitoring schemes, working groups within societies) with an increased representation of diverse stakeholders. These include other conservation genetics working groups including those with a regional focus. Member groups of the CCG are also seeking to host visiting scholars and train graduate and undergraduate students from underrepresented geographic regions.

(4) *Better guidance for archiving genetic datasets, and developing tools and resources to make use of the wealth of genetic data in existence*. Members of CCG can leverage their broad networks to engage collaborators and colleagues developing genetic databases and metadata standards, to ensure they are interoperable and more accessible to genetic researchers and managers. The CCG plans to develop recommendations for harmonizing genomic data standards and mitigate gaps to improve broad community uptake of standard measures for evaluating conservation status (Box 1).

(5) *Engaging case studies that can excite and inform managers and the public about genetic conservation*. A coalition approach creates an opportunity for worldwide capacity building to improve the interpretation of genetic data for management and policy (e.g., what does a change in genetic diversity mean, when should results trigger actions). By leveraging combined resources and expertise in different modes of communication, the CCG can develop clearer, more harmonized messaging and communications materials to inform policy development and policy makers, NGOs, managers, and the public (Figure 3). A way to achieve this is through the development of compelling case studies to inform managers and the public about genetic conservation. The CCG has previously collaborated on several policy briefs and other materials that highlight easy to understand examples (e.g., how higher levels genetic diversity in pollinators and eelgrass improve ecosystem resilience to climate change, how genetic tools can aid forest managers decide which variants to plant under different climate scenarios) and have been translated into more than 30 languages

(https://g-bikegenetics.eu/en/pubs-policy-briefs). The CCG intends to expand the number of case studies and is developing new modes of communication (e.g., interactive maps, animations, and video) to engage new audiences .

4.3 | Lessons learned and recommendations

The process of establishing CCG has resulted in several "lessons learned" that may be useful for others interested in developing a similar framework for integrating groups to allow for the advancement of a field.

- *Consider strategic factors at the outset*. Developing standard operating procedures and lines of communication (including archiving communications) at the outset improves the efficacy by which groups can determine the scope and aims of a coalition, membership, and preferred modes of working and communication. Explicitly identifying the roles of each member group, including their expertise, available resources, funding sources, as well as their positions and policies, will ensure that efforts are not duplicative or hindered by misaligned goals.
- *Allocate adequate resources*: Leading impactful working groups requires more outreach time than participants might usually need to allocate. Working among various groups takes flexibility, rapid response capability, persistence, careful messaging, and non-scientific communication skills (e.g., visual artists). It is important to evaluate, and leverage, required resources.
- *Active, dedicated and inclusive leadership is a must*: Coalition leaders should plan to strategically manage time to allow for the regular engagement (e.g., monthly meetings) required to ensure projects continue to progress in a timely fashion. Numerous members should be engaged in the leadership processes to allow for many perspectives, and to provide coverage if leaders need to temporarily turn attention elsewhere. It is also critical to engage young and early career scientists to carry on the institutional knowledge. Smaller focused task groups can help share the workload.
- *Project and budget planning must be considered*: Each group participating in a coalition may have different time frames and funding from their respective "parent" organizations (e.g., IUCN has 4-year quadrennium periods, GEO BON rotates its Secretariat every 6 years, G-BIKE is based on grant funding with a fixed end in 2023). Each group also must follow the rules of its parent organization that may place boundaries on engagement, priorities, and structure (e.g., IUCN, SCB, GEO, etc.). These differences should be explicitly identified and incorporated into a coalition's long-term planning.
- *Harmonizing membership is necessary*: There may be differences in group membership, (e.g., open membership, invitation-only, etc.). It can be confusing and frustrating for members to switch between membership "cultures." At a minimum, it is important that a coalition clearly communicates the *modus operandi* of membership for each group.
- *Addressing geographic bias*: There is a clear geographic bias in all the groups comprising the CCG, which is dominated by Europe, Oceania, and North America, and is an emblematic problem facing the conservation field generally. Efforts can and should be made to facilitate greater participation from other continents, including via in-person and online events. Online events conducted in multiple languages are more accessible than in-person events and online CCG events have shown high levels of participation from underrepresented geographic regions due, at least in part, to the removal of barriers such as travel, funding, and language. However, there are very real challenges for scientists based in many parts of the world where infrastructure is underdeveloped and/or that are conflict zones, often areas with the greatest biodiversity. A coalition can combine efforts across groups to communicate with and include people in underrepresented regions more efficiently. A coalition can also draw on a wider network and greater resources for coordinating with, and supporting, regional scientists and conservation groups.

Scientists often struggle to have an impact on informing policy and link our results to actions relevant for managers. By combining different initiatives as a coalition, resources can be streamlined and coordinated, and calls to action and recommendations can be made with a single voice, leading to a more impactful effect on policy. The CCG could serve as a model for scientists and help other groups to work together toward common goals.

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CONFLICT OF INTEREST

The authors declare no conflict of interest

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