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PERSPECTIVES AND NOTES

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Research–management partnerships: An opportunity to integrate genetics in conservation actions

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Abstract

Preserving genetic diversity is a central goal in conservation biology, but there is a mismatch between the availability of genetic data and its use in conservation policy. In this study, we surveyed conservation practitioners from academic and government institutions to identify barriers preventing the use of genetic data for conservation practice and policy. Our survey data indicates that the majority of respondents are interested in using genetic tools, and many have used them in the past. Most of these genetic studies were facilitated by partnerships with academic and private organizations, which was the preferred method for integrating genetic research in practice by managers. Although much progress has been made to incorporate genetic study in conservation practice, differences in research goals, the cost of analyses and lack of specialized personnel continue to be barriers to incorporating genetic study in evaluating management actions and informing legislation. We recommend increasing the number of collaborative partnerships between genetic researchers and conservation managers to support management strategies of wild populations.

KEYWORDS

conservation genetics, management, partnerships, research-implementation gap

1 | INTRODUCTION

Genetic diversity is one of three levels of diversity that the Convention on Biological Diversity has committed to safeguarding (Adams et al., 2004). This is because genetic diversity is essential to maintain adaptive capacity and avoid the deleterious effects of inbreeding, which is essential to ensure that species and populations can persist in environments subject to increasing anthropogenic stress (Carroll et al., 2015; Coleman, Weeks, &

Hoffmann, 2013; Hoffmann & Sgrò, 2011; Wernberg et al., 2018). As a result, the importance of integrating genetic and evolutionary concepts into conservation planning is becoming well recognized (Cook & Sgrò, 2018; Hoban et al., 2013; Taylor, Dussex, & Van Heezik, 2017), and studies in conservation science increasingly focus on understanding genetic diversity (Di Marco et al., 2017). However, despite this recognized importance, a growing body of literature suggests that conservation policy and management decisions are often made without considering genetic information (Cook & Sgrò, 2017; Magris, Treml, Pressey, & Weeks, 2016; Rose et al., 2018).

The disconnect between availability of genetic data and the application of this information in conservation policy is a globally recognized challenge (Frankel, 1974; Soulé & Mills, 1992). A quantitative meta-analysis across three continents demonstrated acknowledgment, but not uptake of genetic information in conservation and policy, and also highlighted the strong need to understand barriers to the use of genetic data in conservation practices (Cook & Sgrò, 2017). Similarly, in a review of more than 300 threatened species recovery plans, Pierson et al. (2016) show that while integration of qualitative genetic concepts into threatened and endangered species recovery plans was observed, quantitative data was rarely included, unless required by legislation (e.g., in the United States, Gibbs and Currie (2012)). Thus, identifying the factors that inhibit the flow of genetic and evolutionary information between researchers and conservation managers will be essential to developing robust conservation practices and policies (Nguyen, Young, & Cooke, 2017; Roux et al., 2019; Young et al., 2016).

Detailed analyses of the factors leading to underutilization of genetic information in conservation has been conducted in the United States (Haig et al., 2016), New Zealand (Taylor et al., 2017), and Australia (Cook & Sgrò, 2018). Studies found that incorporation of genetic data into conservation is hindered by a lack of understanding of genetic concepts, limited funding and availability of relevant expertise, and limited communication among scientists and practitioners (Cook & Sgrò, 2018; Taylor et al., 2017). Moreover, the measures of academic achievements (journal prestige, H score, etc.) drive funding and research interests toward fundamental science questions rather than those providing applied impact (species listing, data supporting policy). This impedes the generation of genetic data and analyses meaningful for conservation, as well as its communication to managers (Haig et al., 2016). These studies highlight the need for conservation managers and researchers to work on increased communication and developing shared conservation goals to facilitate the uptake of genetics concepts into conservation practice. Ensuring genetics are integrated into conservation and management strategies are vital in a future of increasing climate and anthropogenic stress (Coleman & Goold, 2019; Wood et al., 2019).

Here, we aim to inform this process by conducting a survey about the use of genetic assessments in conservation management. In contrast to previous studies, we specifically aimed this survey at conservation managers. We defined managers as people directly involved with the conservation of a species or area or in planning conservation strategies (such as species action plans), supervising species management or monitoring, as well as evaluating the outcome of such practices. Scientists without experience in on the ground conservation were not considered managers for this purpose. We asked respondents about their experiences using genetic assessment, and barriers they have encountered to incorporating genetic information into management plans. This survey was designed, implemented, and analyzed by members of the Society for Conservation Biology's (SCB) Conservation Genetics Working Group (CGWG) (see the Supporting Information for Materials and Methods). The majority of the 50 respondents was from either government or academic institutions, mostly from the United States and identified their job role as either biologists or natural resource managers (Figure 1).

2 | USE AND PERCEPTIONS OF GENETIC ASSESSMENTS

Our findings regarding the perceptions of, use of, and barriers to conducting genetic assessments reinforce and extend those of earlier surveys (Cook & Sgrò, 2018; Hoban et al., 2013; Taylor et al., 2017). Overall, respondents to our survey were positive about the use of genetics in conservation, and indicated genetic assessments had positive outcomes. Almost all respondents had considered using genetics for conservation management, and 80% had performed a genetic assessment in their managed area, either directly or through collaboration (Figure 1d), although a limitation to the survey could be that respondents may be biasedtoward individuals who were already more interested in using geneticdata to inform conservation. However, given the consistency of results, it appears that a positive perception of genetics for conservation management may not have a geographic bias, although applications and barriers may differ among countries and regions for reasons such as funding and legislation (e.g., Torres-Florez et al. (2018)).

We found that the perception of the utility of genetics in conservation was not a barrier to its integration in

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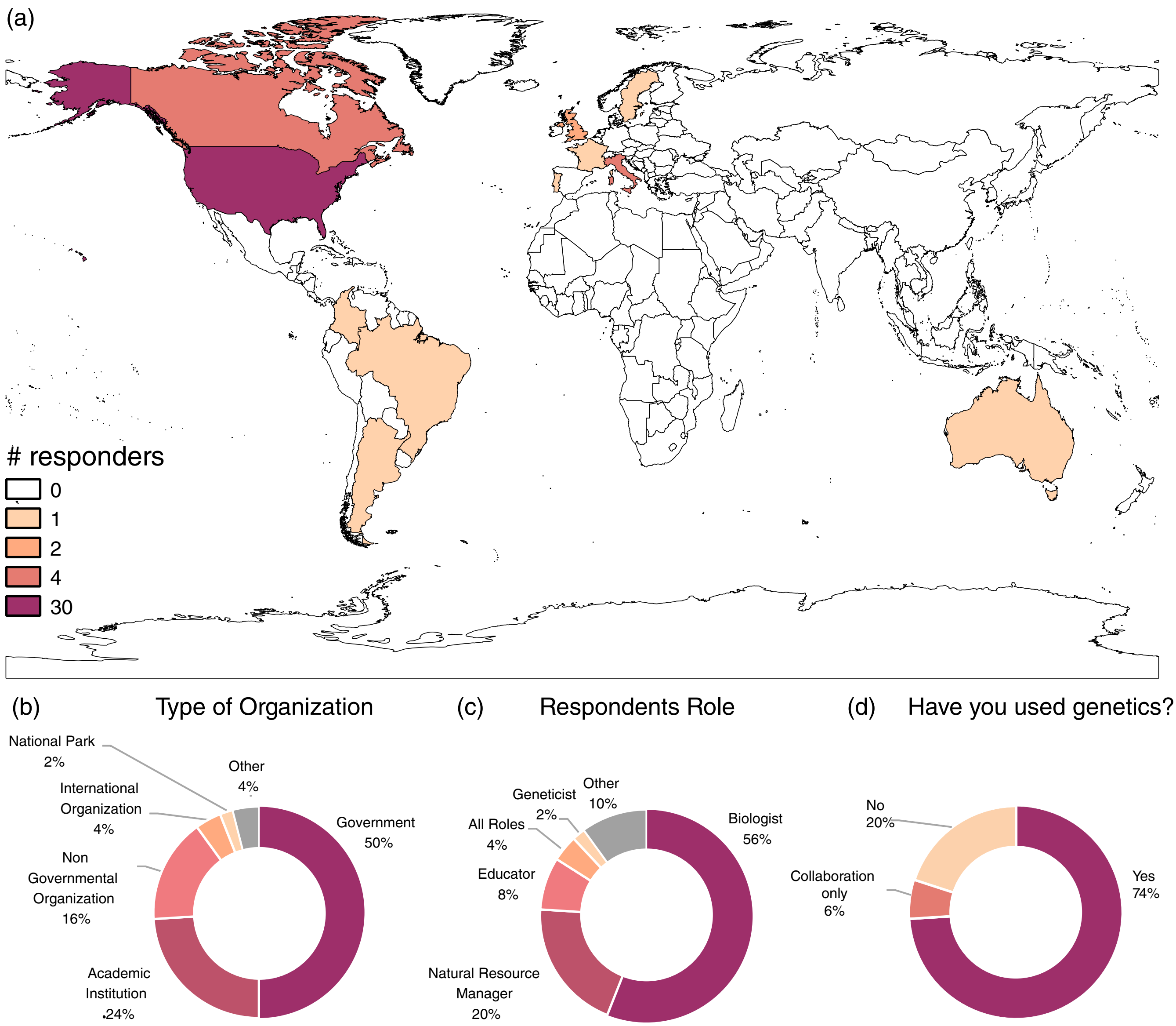

FIGURE 1 Metadata from the 50 respondents to the survey. (a) World map with countries color coded by number of respondents. (b) Respondent's organization type. (c) Respondent's role in their respective organizations. (d) Respondents answer to the question of whether they have used genetics in their managed areas

conservation (Figure2). Many respondents who had previously conducted a genetic analysis considered genetic data to be highly useful for establishing baseline information and informing management decisions, as well as analyses which inform understanding of the population under their management (e.g., size, structure, and delineation) (Figure 2a and 2b). Overall, when comparing respondents from nonacademic institutions to those from academic institutions, the latter more strongly agreed that genetics is useful for establishing baseline information, informing management and legislation, and for assessing management actions (Figure2c). Nonacademic respondents that had performed a genetic assessment considered genetics to be more useful at informing management than assessing the effectiveness of management actions (Figure 2b and 2c). This result may represent a need for baseline and repeated genetic studies to assess effectiveness of management actions, and highlights the difficulty in overcoming the barriers to performing genetic analyses (discussed below). Although responses varied, there was also an overall trend toward a perception of genetics being useful for informing legislation, although less so by nonacademics (Figure 2d). We believe as barriers to obtaining genetic data decrease, genetic information will become more common and can more frequently inform legislation.

Similarly to previous studies, respondents identified access to funds, and relevant expertise as key barriers

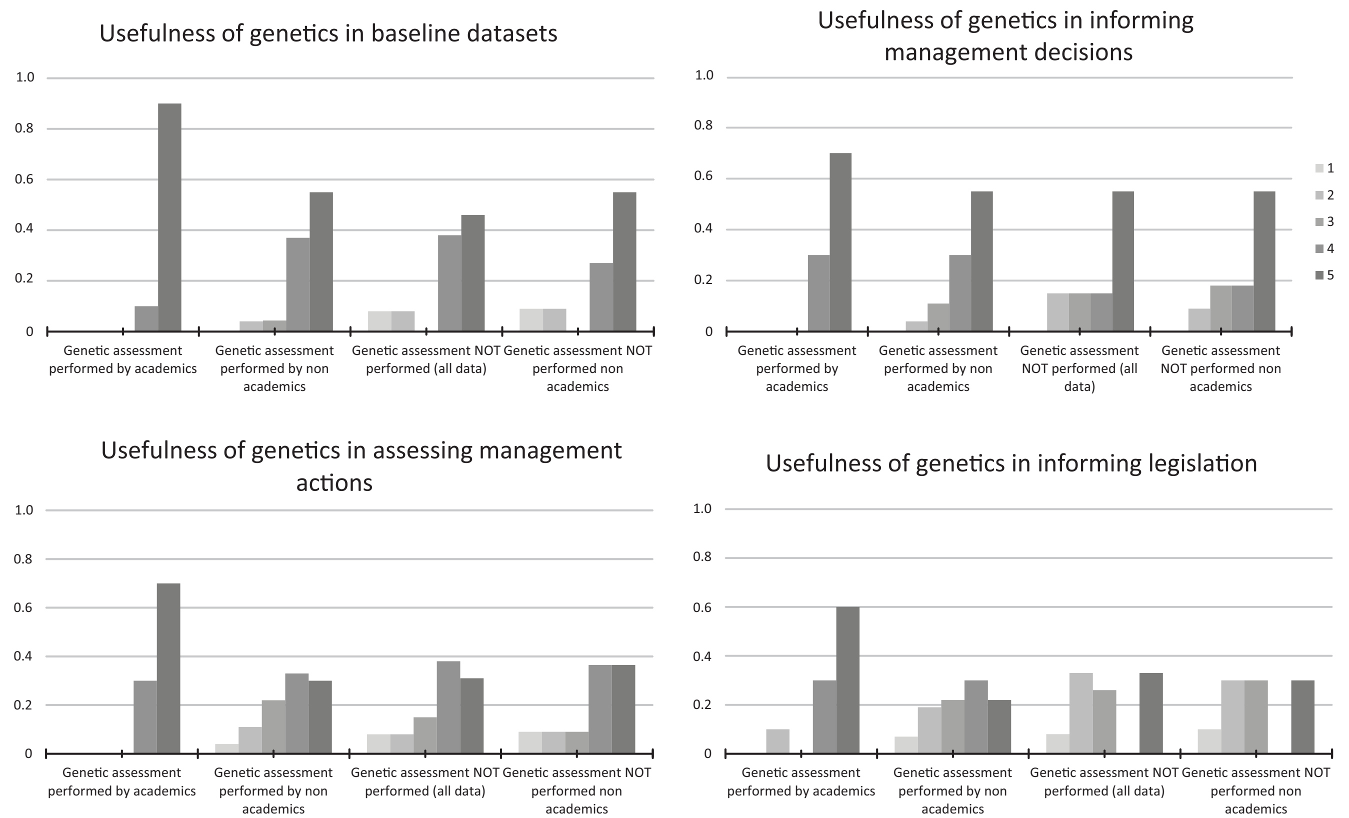

FIGURE 2 Percentage of academic and nonacademic respondents' ratings for usefulness of genetic assessments to (a) generate baseline information for the managed area; (b) informing management decisions; (c) assessing the success of management actions; and (d) informing legislative actions. These results reflect answers both from those that have and have not ("NOT") conducted a genetic assessment themselves (categories listed in the *x*-axis). Numbers in the legend range from 1 (not useful) to 5 (extremely useful). Detailed results can be found in Table S4, Supporting information)

influencing the application of genetics to conservation management (Table S1, Supporting Information). We also identified a high frequency of partnerships for conducting genetic assessments: 78% of respondents have partnered/contracted with someone to conduct a genetic assessment, and there was a preference for partnering with academic rather than nonacademic collaborators (Table S2, Supporting Information).

We examined if the effectiveness of communication between managers and those performing the genetic studies on managed populations was a barrier. Out of 36 respondents who answered this question, 94% received the results of the genetic studies on their managed populations (Table S3, Supporting Information). A majority of respondents (88%) stated the results applied to their management goals, and 83% stated the genetic assessments helped inform management decisions (Table S3, Supporting Information). The same number of respondents (83%) reported the experience led to continued collaboration or investigation, and this is also reflected in the large proportion of respondents (70%) who stated their assessment is ongoing (Table S3, Supporting Information). Further, the experience inspired new projects for 69% of respondents (Table S3, Supporting Information). Where genetic assessments were complete at the time of the survey, respondents indicated positive outcomes from results obtained from partnerships with academic research institutions, and the results were not "too technical" (91%). Thus effective communication between those performing the genetic studies and those receiving the results does not seem to be a barrier for integrating genetics in conservation management (Table S3, Supporting Information). These results appear to differ from previous studies where one of the main limitations identified was a lack of knowledge on how to interpret evolutionary based scientific recommendations (Cook & Sgrò, 2018).

3 | PRACTICAL APPLICATIONS, CHALLENGES, AND OPPORTUNITIES

Genetics was recently identified as the most frequent topic in 4,471 conservation planning articles published between 2000 and 2016 (Mair et al., 2018), indicating that the use of genetic data has a firm place in contemporary conservation management among academics and nonacademics (Cook & Sgrò, 2018; Garner et al., 2016; Haig et al., 2016; Pérez-Espona & ConGRESS-Consortium, 2017; Rodríguez-Clark et al., 2015). For those respondents who did not perform genetic assessments, the main barrier was lack of personnel to conduct the laboratory work, which is also associated with lack of funding (Table S6, Supporting Information). We also found concordance in what types of genetic questions respondents would like to have answers for, with the highest interest (>80%) in assessing population size and assessing population structure (Figure 3). These highest-ranking management concerns are similar to those identified in previous surveys and published papers (Cook & Sgrò, 2018; Garner et al., 2016; Haig et al., 2016; Pérez-Espona & ConGRESS-Consortium, 2017; Rodríguez-Clark et al., 2015). Detecting hybridization was the topic with the lowest interest, with <55% respondents who had not conducted a genetic assessment expressing interest compared to ~46% of those who had conducted an assessment (Figure 3), possibly because hybridization is not a concern in the majority of current management situations, but may become more important into the future. For those respondents who did not perform genetic assessments, the main barrier was lack of personnel to conduct the laboratory work, which is also associated with lack of funding (Table S1, Supporting Information). These trends support the idea that managers see value in the information genetic tools can provide and the practicality of using genetic information to support decision making, especially if they show clear applicability to their management goals, but highlights how defining the questions must be a collaborative process between researchers and managers (Holderegger et al., 2019). More information from managers who do not use genetic data would be helpful to understand if barriers to use extend beyond funding to include a lack of perceived usefulness of genetic analyses.

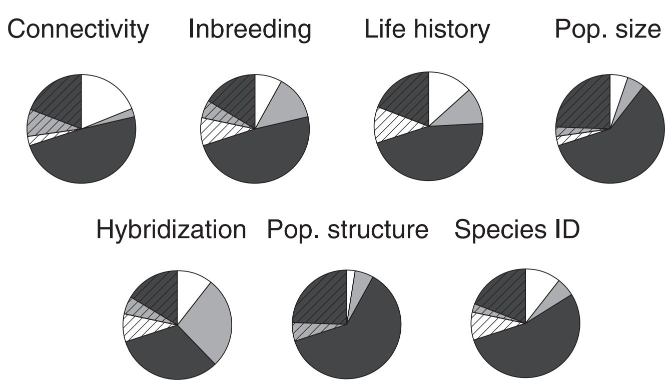

FIGURE 3 Summary of respondents from nonacademic institutions ratings of the likelihood of performing the above mentioned assessments in their managed areas if the absence of restrictions. Plain and striped pies represent those who have and those who have not performed a genetic assessment, respectively. White, light gray and dark gray background represent whether respondents "would not perform," had a "neutral" perspective, or "would perform" a particular assessment, respectively. Details of these results can be found in Table S4, Supporting information

4 | PARTNERSHIPS

We found partnerships in genetic studies were common in both private and academic research: the majority (78%) of respondents to our survey had partnered or contracted with someone to conduct a genetic assessment. Importantly, in most cases, the genetic assessment led to continued collaborations or investigations and development of new projects, indicating a benefit not recognized in earlier surveys. Almost two thirds of respondents had considered partnering to conduct a genetic assessment (Table S2, Supporting Information). Most of the partnerships originated from academic research groups (30%) or outside governmental agencies (27%), however, respondents were most comfortable working with academic geneticists for lab work (Table S2, Supporting Information). Of those who worked with academic geneticists, respondents commented on their own lack of genetic expertise, which led them to seek collaboration. Another limitation to performing a genetic assessment presented by managers was access to labs and access to funds, and a lack of access to personnel to perform the assessments (lab work, field work, and project design). Here partnerships with academics can also be mutually beneficial, by providing resources for student research. This could overcome the limitations of jurisdictions with poor genetics knowledge and/or lack expertise in genetic analyses, as well as limited financial resources. In these cases, by providing the necessary samples, international research institutes and academics can provide the remaining expertise and financial resources to complete conservation studies in these areas (Anthony et al., 2012). Those that were hesitant to work with academic geneticists commented on lack of understanding of conservation policy and management by academics, as well as a focus on academic questions that would not address their management needs. Those that would accept help from nonacademic geneticists highlighted benefits such as the valuable expertise provided by nonacademic geneticists; more management relevant studies, with the perception that nonacademics will not be biased by the need for publication; and the use of staff rather than students to perform work. Those hesitant to work with nonacademic geneticists highlighted drawbacks such as high costs, the work not resulting in published literature, low reputation of consultants, lack of knowledge or experience with nonacademic consultants, intellectual property agreement issues, and the limited availability of services. These new insights into preferences provide a foundation for identifying new partners and strengthening existing partnerships to facilitate the use of genetics for conservation and resource management.

5 | RECOMMENDATIONS

With the molecular tools available today, there are a greater number of conservation oriented questions that can be addressed, but there is also potential for a widening gap between research and application (Allendorf, 2017; Ouborg, Pertoldi, Loeschcke, Bijlsma, & Hedrick, 2010; Shaffer et al., 2015). We found a number of areas where genetic methods are already being applied to answer management questions. There were, however, a few avenues for improvement to increase the integration of genetic methods in conservation. Despite most respondents being from North America, we believe our results reflect a common issue in conservation everywhere.

It is important to consider the academic research questions vs. management needs prior to developing a project plan. This will enable researchers and managers to identify the scope of the project, clearly state assumptions and limitations of the chosen approach, and ensure that genetic research can be integrated in management practices. Ideally, this process should be collaborative from early on in the project design phase (Flanagan, Forester, Latch, Aitken, & Hoban, 2017; Merkle et al., 2019). Identifying the needs and goals of managers and the roles and responsibilities of each party at the beginning of the effort will facilitate successful collaborations. Managers have specific tasks and often baseline questions to be addressed, thus, when projects are developed solely by academics, genetic assessments may require too much time or might not be designed to address their specific questions (Merkle et al., 2019). Where data is shared, expectations regarding data usage (for those who want to publish) need to be clearly established. This is often done formally through legal research collaboration agreements between parties to ensure appropriate use of intellectual property, authorship, and data dissemination. It is critical that any partnership develops ground rules for collaboration to ensure each party ends up with the data they need for their research or management needs.

The high frequency of partnerships identified in this work may reflect a means by which conservation managers can overcome some of the barriers to conducting genetic assessments. Partnerships are beneficial for increasing conservation managers' ability to obtain genetic data. In turn, academics will benefit by gaining access to resources that could be used for their research and by working on projects that have conservation implications (Britt, Haworth, Johnson, Martchenko, & Shafer,2018; Hogg, Taylor, & Fox,2018). As such, there are many opportunities for building relationships and partnerships. We recommend an increased focus on partnerships to help close the research-implementation gap. Previous suggestions for closing this gap include adding managers as coauthors to resulting publications (Britt et al.,2018; but see Hogg et al.,2018), integrating researchers in conservation agencies (Roux et al.,2019), developing online resources connecting researchers and managers (Hoban, Arntzen, et al.,2013), publishing abstracts in local languages (Holderegger et al.,2019; Rodríguez-Clarket al.,2015), and adopting inclusive adaptive management approaches that serve the goals of all parties involved (Hogg et al.,2017). Respondents here highlighted the need for targeted networking events and symposia, incorporating genetics in multidisciplinary and more applied analyses (e.g., landscape genetics), and in the case of international collaborations, the need to often analyze samples *in situ* to avoid proprietary trust issues (Appendix II, Supporting Information). We also suggest incentivizing the creation and maintenance of collaborations, for example incorporating partnerships/collaborations efforts in the process of tenure evaluation for academics, and encouraging governmental agencies to obtain input from outside scientists for management questions, who can provide recommendations based on the best available science. Additionally, it would be important to create networks and information sharing platforms to allow managers to find potential partners by having information about individuals performing genetic studies, and the type of questions, taxa and data generated. We believe that increased communication of the utility of genetics and information gained with genetic studies will increase its use in legislation and demonstrate its integral role to address policy goals. Finally, continued genetic monitoring to evaluate conservation actions may not be common due to the costs of genetic analyses, and other limitations discussed in this study. By increasing partnerships and the access to the expertise needed to perform genetic analyses, we may see increases in the use of genetics for evaluating management actions and informing legislation. We believe that lawmakers will more readily consider genetic results to inform legislation when institutions and regulations associated with conservation efforts, like the International Union for Conservation of Nature and the Convention for Biological Diversity, consistently incorporate genetic as an important parameter for assessment and thus highlight its importance and utility in key aspects of species conservation.

The development of increased communication will promote the creation of collaborative efforts between managers and academic researchers. Although our results indicate that generally academics communicate their results to their management partners well, the same was not observed for communication through the scientific literature. Even when available, literature was not always considered, possibly because it is still very jargon based, academically focused, or may not be accessible due to pay-walls. There should be a greater focus from the academic community to publish in more management based journals, and also in local languages, whenever relevant (Holderegger et al., 2019). There is also a real need for dedicated science communicators to help bridge the gap between academics and practitioners. To help develop a common language, we recommend including both academics and managers in planning, supporting an academic evaluation system that promotes publication in management journals, or possibly more effectively, creating specific jobs (science communicators) which focus on helping conservation managers obtain practical advice published in academic journals.

Integrating genetics into conservation practice is essential in a future of anthropogenic and climatic change. Anticipating and planning for such change in management strategies ("future-proofing") will require that genetics, particularly as it relates to adaptive capacity and vulnerability, is considered and incorporated into management. Academics and practitioners must work together to identify and protect genetic characteristics most likely to confer resilience and persistence under future climates. Academics can perform the needed work, interpret results, and obtain funding, and managers are best suited to identify the questions that will be most applicable to management.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

H. R. T. led the study and defined its focus; H. R. T., D. N. M., and J. M. designed and implemented the survey and analyzed the responses; S. K. P. led database development and communications regarding the dissemination of the survey, including in connecting with the Social Sciences Working Group; H. R. T., D. N. M., J. M., S. K. P., and M. A. C. analyzed the responses from the survey; N. K. F., C. S. M., M. H. M., and S. B. conceived the study idea and provided support for the survey through the Conservation Genetics Working Group; all authors were involved with writing and revising the manuscript.

DATA AVAILABILITY STATEMENT

Survey responses are confidential and thus not accessible. A summary of the data can be obtained from the corresponding author upon request.

ETHICS STATEMENT

Interviews were conducted under an exemption from the Colorado State University Global's Institutional Review Board, under Exempt Category 2 (protocol 2017–005).

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REFERENCES

Adams, W. M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., … Walther, B. A. (2004). Biodiversity conservation and the eradication of poverty. *Science (80–)*, *306*, 1146–1149.

Allendorf, F. W. (2017). Genetics and the conservation of natural populations: Allozymes to genomes. *Molecular Ecology*, *26*, 420–430.

Anthony, N. M., Mickala, P., Abernethy, K. A., Atteke, C., Bissiengou, P., Bruford, M. W., … Gonder, M. K. (2012). Biodiversity and conservation genetics research in Central Africa: new approaches and avenues for international collaboration. *Conservation Genetics Resources*, *4*, 523–525.

Britt, M., Haworth, S. E., Johnson, J. B., Martchenko, D., & Shafer, A. B. A. (2018). The importance of non-academic coauthors in bridging the conservation genetics gap. *Biological Conservation*, *218*, 118–123.

Carroll, C., Rohlf, D. J., Li, Y.-W., Hartl, B., Phillips, M. K., & Noss, R. F. (2015). Connectivity conservation and endangered species recovery: A study in the challenges of defining conservation-reliant species. *Conservation Letters*, *8*, 132–138.

Coleman, M. A., & Goold, H. D. (2019). Harnessing synthetic biology for kelp forest conservation. *Journal of Phycology*, *55*, 745–751.

Coleman, R. A., Weeks, A. R., & Hoffmann, A. A. (2013). Balancing genetic uniqueness and genetic variation in determining conservation and translocation strategies: A comprehensive case study of threatened dwarf galaxias, *Galaxiella pusilla* (Mack) (Pisces: Galaxiidae). *Molecular Ecology*, *22*, 1820–1835.

Cook, C. N., & Sgrò, C. M. (2017). Aligning science and policy to achieve evolutionarily enlightened conservation. *Conservation Biology*, *31*, 501–512.

Cook, C. N., & Sgrò, C. M. (2018). Understanding managers' and scientists' perspectives on opportunities to achieve more evolutionarily enlightened management in conservation. *Evolutionary Applications*, *11*, 1371–1388.

Di Marco, M., Chapman, S., Althor, G., Kearney, S., Besancon, C., Butt, N., … Watson, J. E. M. (2017). Changing trends and persisting biases in three decades of conservation science. *Global Ecology and Conservation*, *10*, 32–42.

Flanagan, S. P., Forester, B. R., Latch, E. K., Aitken, S. N., & Hoban, S. (2017). Guidelines for planning genomic assessment and monitoring of locally adaptive variation to inform species conservation. *Evolutionary Applications*, *11*, 1035–1052.

Frankel, O. H. (1974). Genetic conservation: Our evolutionary responsibility. *Genetics*, *78*, 53–65.

Garner, B. A., Hand, B. K., Amish, S. J., Bernatchez, L., Foster, J. T., Miller, K. M., … Luikart, G. (2016). Genomics in conservation: Case studies and bridging the gap between data and application. *Trends in Ecology & Evolution*, *31*, 81–82.

Gibbs, K. E., & Currie, D. J. (2012). Protecting endangered species: Do the main legislative tools work?*PLoS One*, *7*, e35730.

Haig, S. M., Miller, M. P., Bellinger, R., Draheim, H. M., Mercer, D. M., & Mullins, T. D. (2016). The conservation genetics juggling act: Integrating genetics and ecology, science and policy. *Evolutionary Applications*, *9*, 181–195.

Hoban, S., Arntzen, J. W., Bertorelle, G., Bryja, J., Fernandes, M., Frith, K., … Bruford, M. W. (2013). Conservation genetic resources for effective species survival (ConGRESS): Bridging the divide between conservation research and practice. *Journal for Nature Conservation*, *21*, 433–437.

Hoban, S. M., Hauffe, H. C., Pérez-Espona, S., Arntzen, J. W., Bertorelle, G., Bryja, J., … Bruford, M. W. (2013). Bringing genetic diversity to the forefront of conservation policy and management. *Conservation Genetics Resources*, *5*, 593–598.

Hoffmann, A. A., & Sgrò, C. M. (2011). Climate change and evolutionary adaptation. *Nature*, *470*, 479–485.

Hogg, C. J., Grueber, C. E., Pemberton, D., Fox, S., Lee, A. V., Ivy, J. A., & Belov, K. (2017). "Devil Tools & Tech": A synergy of conservation research and management practice. *Conservation Letters*, *10*, 133–138.

Hogg, C.J., Taylor, H.R., Fox, S. & Grueber, C.E. (2018). Response to Britt et al. 2018 "The importance of non-academic co-authors in bridging the conservation genetics gap" Biological Conservation 218, 118–123. *Biological Conservation*, *222*, 287–288.

Holderegger, R., Balkenhol, N., Bolliger, J., Engler, J. O., Gugerli, F., Hochkirch, A., … Zachos, F. E. (2019). Conservation genetics: Linking science with practice. *Molecular Ecology*, *28*, 3848–3856.

Magris, R. A., Treml, E. A., Pressey, R. L., & Weeks, R. (2016). Integrating multiple species connectivity and habitat quality into conservation planning for coral reefs. *Ecography (Cop.)*, *39*, 649–664.

Mair, L., Mill, A. C., Robertson, P. A., Rushton, S. P., Shirley, M. D., Rodriguez, J. P., & McGowan, P. J. (2018). The contribution of scientific research to conservation planning. *Biological Conservation*, *223*, 82–96.

Merkle, J. A., Anderson, N. J., Baxley, D. L., Chopp, M., Gigliotti, L. C., Gude, J. A., … VanBeek, K. R. (2019). A collaborative approach to bridging the gap between wildlife managers and researchers. *Journal of Wildlife Management*, *83*, 1644–1651.

Nguyen, V. M., Young, N., & Cooke, S. J. (2017). A roadmap for knowledge exchange and mobilization research in conservation and natural resource management. *Conservation Biology*, *31*, 789–798.

Ouborg, N. J., Pertoldi, C., Loeschcke, V., Bijlsma, R. K., & Hedrick, P. W. (2010). Conservation genetics in transition to conservation genomics. *Trends in Genetics*, *26*, 177–187.

Pérez-Espona, S., & ConGRESS-Consortium. (2017). Conservation genetics in the European Union—Biases, gaps and future directions. *Biological Conservation*, *209*, 130–136.

Pierson, J. C., Coates, D. J., Oostermeijer, J. G. B., Beissinger, S. R., Bragg, J. G., Sunnucks, P., … Young, A. G. (2016). Genetic factors in threatened species recovery plans on three continents. *Frontiers in Ecology and the Environment*, *14*, 433–440.

Rodríguez-Clark, K. M., Oliveira-Miranda, M. A., Aguilera Meneses, M., Martino, Á., Méndez, M. A., Miyaki, C., … Solé-Cava, A. (2015). Finding the "conservation" in conservation genetics—Progress in Latin America. *The Journal of Heredity*, *106*, 423–427.

Rose, D. C., Sutherland, W. J., Amano, T., González-Varo, J. P., Robertson, R. J., Simmons, B. I., … Mukherjee, N. (2018). The major barriers to evidence-informed conservation policy and possible solutions. *Conservation Letters*, *11*, e12564.

Roux, D. J., Kingsford, R. T., Cook, C. N., Carruthers, J., Dickson, K., & Hockings, M. (2019). The case for embedding researchers in conservation agencies. *Conservation Biology*, *33*, 1266–1274.

Shaffer, H. B., Gidiş, M., McCartney-Melstad, E., Neal, K. M., Oyamaguchi, H. M., Tellez, M., & Toffelmier, E. M. (2015). Conservation genetics and genomics of amphibians and reptiles. *Annual Review of Animal Biosciences*, *3*, 113–138.

Soulé, M. E., & Mills, L. S. (1992). Conservation genetics and conservation biology: A troubled marriage. In *Conservation of biodiversity for sustainable development* (pp. 55–69). Oslo, Finland: Scandinavian University Press.

Taylor, H. R., Dussex, N., & Van Heezik, Y. (2017). Bridging the conservation genetics gap by identifying barriers to implementation for conservation practitioners. *Global Ecology and Conservation*, *10*, 231–242.

Torres-Florez, J. P., Johnson, W. E., Nery, M. F., Eizirik, E., Oliveira-Miranda, M. A., & Galetti, P. M. (2018). The coming of age of conservation genetics in Latin America: What has been achieved and what needs to be done. *Conservation Genetics*, *19*, 1–15.

Wernberg, T., Coleman, M. A., Bennett, S., Thomsen, M. S., Tuya, F., & Kelaher, B. P. (2018). Genetic diversity and kelp forest vulnerability to climatic stress. *Scientific Reports*, *8*, 1851.

Wood, G., Marzinelli, E. M., Coleman, M. A., Campbell, A. H., Santini, N. S., Kajlich, L., … Vergés, A. (2019). Restoring subtidal marine macrophytes in the Anthropocene: Trajectories and future-proofing. *Marine and Freshwater Research*, *70*, 936–951.

Young, J. C., Searle, K., Butler, A., Simmons, P., Watt, A. D., & Jordan, A. (2016). The role of trust in the resolution of conservation conflicts. *Biological Conservation*, *195*, 196–202.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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