Harnessing Data for Inclusive Ecology Education: Building Programs to Move the Discipline Toward Systemic Change

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Introduction

Over the years, universities and academic societies have developed intervention programs to counter the underrepresentation of students from communities historically and presently marginalized in science (Estrada et al., 2016, Callahan et al. 2017, Ahern-Dodson et al. 2020). Despite these efforts, the exclusion of marginalized communities, including Black, Indigenous, and People of Color (BIPOC), remains all too common in science, technology, engineering, and math (STEM) disciplines (National Science Foundation 2019, Miriti 2020, Segarra et al. 2020, Tseng et al. 2020). Indeed, the emergence of grassroots movements and social media campaigns, such as Black Birders Week, #ShutDownSTEM, #ShutDownAcademia, and #BlackInTheIvory, has underscored how much work remains to be done before academia is truly inclusive (Baldwin et al. 2020, Crane and Liverpool 2020, Thompson 2020). During the 2020 Ecological Society of America (ESA) Annual Meeting symposium on “Harnessing Data for Inclusive Ecology Education
Meeting Reviews

using Learning Analytics, Resource Access, Psychosocial Metrics and Collective Impact,” presenters
described a number of educational programs, paying particular attention to how data from these programs
can support educators in increasing inclusion in undergraduate ecology education.

This meeting review has two goals. First, speakers and organizers summarize key takeaways about
inclusion in undergraduate education from the programs they presented. Second, inspired by comments
and questions raised during the live Q&A held on 6 August 2020, the authors propose a set of guiding
questions for helping individuals identify ways they can work to increase diversity, equity, inclusion,
and social justice (DEIJ) in classrooms, research labs, and ecology, more broadly.

Summary of Presentations: Integrating Inclusion into Educational Programs

Learning from classroom data: Critical frameworks for advancing equity, inclusion, and social justice
in science education (Susan J. Cheng and Timothy A. McKay)

Data are powerful tools, necessary for helping educators assess the impacts of their courses and
programs. In this talk, presenters highlighted how considerations of inclusion cannot begin at the stage
of data interpretation or use when engaging with education data. Instead, questions of inclusion need to
be part of every stage of the data analytics process: design, collection, analysis, reporting, interpretation,
and use. This is because, as sociologist Eduardo Bonilla-Silva describes, “the problems we pose, the
theories we use, the methods we employ, and the analyses we perform are social products themselves
and to an extent reflect societal contradictions and power dynamics” (p. 13). How might educators
begin considering inclusion at each stage of the data analytics process? They can use frameworks from
critical theories (e.g., critical race theory, critical gender studies, decolonial studies, whiteness studies),
which provide guides for revealing power dynamics and their impacts. Without the kinds of insights
that critical frameworks provide, educators risk using data in ways that perpetuate and reify negative
stereotypes about, and deficit framings of, marginalized groups.

In drawing attention to power dynamics and the constructedness of social categories that data analytics
rely on (e.g., race), critical frameworks invite educators to check their assumptions and make them explicit (Zuberi and Bonilla-Silva 2008). As one practical first move in this direction, educators could
ask a series of critically informed “who, what, where, when, why, and how” questions. To illustrate what
this might look like, let’s consider an example. The Foundational Course Initiative (https://crlt.umich.
edu/fci), a program at the University of Michigan’s Center for Research on Learning and Teaching
(funded by the President’s Academic Excellence Fund), brings together instructional consultants and
course instructors to take an iterative, evidence-driven approach to increase equity, inclusion, and
student learning in introductory courses. This approach involves asking a series of critical questions
when collecting and engaging with student data, such as: Who do we recruit to participate in surveys or
focus groups? What do we identify as important learning outcomes—content knowledge exclusively,
or also attitudes such as confidence or sense of belonging? How are identity categories described? For
instance, is gender assumed to be binary or biological? Are broad race/ethnicity categories, such as
“Asian,” masking heterogenous experiences and identities (Teranishi et al. 2020)?

Questions like these can inform the data analytics work done within and across classrooms and
departments, and even across institutions. For example, the Sloan Equity and Inclusion in STEM
Introductory Courses (SEISMIC) project (https://www.seismicproject.org/), funded by the Alfred P. Sloan Foundation, is one inter-institutional collaboration integrating critical approaches into its research on equity and inclusion in STEM courses at public research universities. SEISMIC research projects about measurements, classroom experiments, and change implementation are considering new ways that data can be better used to equitably represent diverse student experiences. Furthermore, SEISMIC’s constructs group is interrogating how concepts such as “equity” and “inclusion” are constructed and used in science, and how critical approaches can be applied to create more nuanced and dynamic understandings of equity and inclusion work in STEM.

In important ways, ecologists are well positioned to more strongly integrate critical scholarship into their teaching and mentorship. After all, ecology is a field that brings together tools and theories from multiple fields to understand Earth’s biodiversity. Critical theories can help our field understand its own diversity issues and how to begin to intervene in them.

*Community-focused holistic undergraduate programs to retain students in STEM (Deborah E. Goldberg)*

Multiple factors influence student success in STEM, including academic and social integration, knowledge and skill development, support and motivation, and monitoring and advising (Stolle-McAllister et al. 2011). Nevertheless, interventions often focus on one of these factors in isolation from the others, with perhaps the most historically widespread approach focused on remedial programs to increase knowledge and skill development. However, this approach ignores the psychosocial aspects of academic and career success, and emphasizes student deficits rather than inadequacies of the education system. In this talk, we described two holistic programs that focus on all four factors.

One of the oldest and most successful of these holistic programs is the Meyerhoff Scholars Program. The Meyerhoff program was started in 1988 at the University of Maryland Baltimore County (UMBC) by Freeman Hrabowski, who is now the university’s president. To date, there are over 1,200 Meyerhoff graduates. Meyerhoff students are approximately five times more likely to enroll or graduate from a Ph.D. or M.D./Ph.D. program than students who were admitted but went elsewhere. The Meyerhoff program provides students with financial aid, a summer bridge program built around a family-like community, a programmatic focus on academic achievement and mutual responsibility, advising that supports discussion of non-academic challenges, study groups, and research experiences (Maton et al. 2012). Sense of belonging, shared identity, financial aid, and academic support have been identified as key mechanisms for the program’s success (Stolle-McAllister et al. 2011, Maton et al. 2012, Maton et al. 2016).

In 2008, the University of Michigan created the M-STEM Academies, modeled after Meyerhoff. M-STEM began in the College of Engineering and was expanded into biology and then to all of the natural sciences in the university’s liberal arts college as the M-Sci Academy. The M-Sci Academy has included 230 students to date, with demographics that are more diverse than the college’s overall population many more students are first-generation college students, from low-income families, and/or belong to underrepresented racial and ethnic groups. To test the impact of M-Sci participation on graduation and grade point average (GPA) in STEM, least absolute shrinkage and selection operator (LASSO) statistics and propensity score matching were used. Results indicated that M-Sci led to significantly higher retention of students in STEM, but no difference in STEM GPA between participants.
and matched non-participants. Student responses on surveys indicated an increase in sense of belonging, but no change in self-efficacy.

While M-Sci results in significant increases in retention, it has not been as dramatically successful as Meyerhoff. One reason could be the difference between resources provided by the two programs. Most notably, M-Sci has less scholarship money available for students, which means both less relief from financial stress and less incentive for students to participate in community norms and activities that are known to be effective, including adopting community-focused attitudes. A second set of potential explanations has to do with institutional context. Meyerhoff has been a major priority for the UMBC administrative leadership, ensuring strong and consistent support since its inception. UMBC is also a smaller institution, so that the Meyerhoff Scholars can have a bigger impact on the campus culture. In contrast, the University of Michigan is larger and more decentralized, such that multiple programs and offices focus on the goal of making STEM education more inclusive and equitable. Thus, support for any one program, especially one that cuts across different colleges, is weaker and less consistent, with a consequent smaller impact on the larger culture. Future research needs to focus on the role of institutional context on program assessment.

The role of psychosocial factors in broadening participation: Outcomes from the SEEDS program (Luanna B. Prevost)

The Strategies for Ecology Education, Diversity, and Sustainability (SEEDS; https://esa.org/seeds/) program is ESA’s flagship program for broadening participation in ecology by providing opportunities for undergraduate students to explore ecology through a range of activities. SEEDS was established in 1996 as a partnership between the United Negro College Fund, ESA, and the Institute of Ecosystem Studies, with funding from the Andrew Mellon foundation. This program was fully adopted into ESA as its flagship program in 2002 (Berkowitz et al. 2003). SEEDS was developed to diversify and improve representation of all racial and ethnic groups in the field of ecology (Berkowitz et al. 2003, Beck et al. 2014). Over the last 24 years, SEEDS alumni have gone into a variety of ecology-related careers (Mourad et al. 2018), and begun taking active leadership roles in ESA (Sealey et al. 2020).

When assessing the impact of education programs like SEEDS, it is important to identify what mechanisms may be contributing to observed outcomes. Education scholarship has demonstrated that psychosocial drivers play a role in the retention and persistence of BIPOC in STEM (Estrada 2014, Maton et al. 2016). To examine how SEEDS activities influence students’ psychosocial experiences, we measured changes in students’ ecological self-efficacy, sense of belonging and community, and identity as an ecologist and scientist. Self-efficacy describes one’s confidence in one’s ability to perform a given task (Bandura 1986). Sense of belonging and sense of identity describe one’s perception of cohesion with a larger group and affiliation with other members of that group (Hurtado and Carter 1997, Estrada 2014).

With funding from the National Science Foundation (NSF), we surveyed students before and after they participated in three types of SEEDS activities: ESA Annual Meetings (50 students), field trips to biological stations (20 students), and leadership meetings focused on the connections between ecology and society (20 students). The survey included quantitative Likert-type survey items adapted from previous surveys (Hurtado and Carter 1997, Baldwin et al. 1999) and open-ended questions that were analyzed for emergent themes. Responses showed that all three activities contributed to an increase in
ecology self-efficacy and sense of community/belonging. Attending field trips and annual meetings increased students’ sense of identity as a scientist and their understanding of ecology. Particularly salient to a sense of belonging were interactions that students had with ecologists, which made them feel part of a supportive and inclusive ecology community, especially when meeting with scientists with shared identities. Another theme that arose from student responses was that discussions with scientists who shed light on their struggles with science made ecology seem more accessible.

The mixed-methods approach used to examine the SEEDS program suggests that these different opportunities may complement each other in helping students persist in, and pursue, ecological careers. Participating in research and attending presentations can build confidence in ecology skills. A mentoring community that is diverse in composition (e.g., professionals and near-peers) and reflects, at least in part, the identity of the student, can help build a sense of community and science identity. The question remains as to when these experiences have the most impact on psychosocial factors and if participating in more than one activity provides reinforcement. Similar to many ecological studies, longitudinal and long-term data will help expand our understanding of how changes in our environment can build a more diverse community.

Using collective impact to increase minority participation to reshape the workforce (George Middendorf)

It is difficult for any single program to provide students with all the resources they might need or benefit from as they move through college and on to their first early career experiences. In recognition of this challenge, the EcologyPlus collective (https://ecologyplus.esa.org/) was formed to increase BIPOC awareness of, and access to, ecology-related career opportunities across sectors and professions. Currently, EcologyPlus consists of 17 partners (individuals and organizations), including regional universities, non-profit organizations, scientific societies, and local/federal agencies in the Washington DC-Maryland region.

To organize efforts across a large number of partners, EcologyPlus uses the collective impact approach (Mourad and Middendorf 2020), a form of cross-sector collaboration of otherwise disparate and unconnected efforts brought together to address complex social and environmental challenges (Kania and Kramer 2013). Work organized around collective impact is structured around five elements: (1) a common agenda, (2) shared measurements and a strategic learning process, (3) reinforcement of high leverage activities, (4) inclusive community engagement, and (5) a social innovation movement facilitated by active leadership. For EcologyPlus, the collective focuses on long-term mentoring, connecting students with professionals and programs, and providing guidance for a variety of environmental career pathways. Between 2018 and 2019, EcologyPlus has provided resources to a pilot cohort of 16 undergraduates, three graduate students, and three early career scientists/professionals with support from NSF. These resources include skills workshops, networking/seminar events, monthly mentor meetings, a remote research experience, and a career fair organized by EcologyPlus partner representatives.

Assessment data involving the pilot cohort indicate that EcologyPlus is having positive impacts on participants (undergraduate students, graduate students, and early career professionals), mentors, and partner representatives. For participants, awareness and use of peer networks increased from 55% to 94%. More participants reported that their perception of their identity as a scientist was consistent with their cultural background, an increase from 25% to 44%. In addition, there was a substantial increase, from 32%
to 88%, in the number of participants who understood what career information sources and opportunities were available. Nearly all participants (94%) felt that an ecological/environmental career was realistic. Mentors reported success in sharing relatable career experiences with their mentees and in helping them set professional goals. Data also pointed to an area needing improvement. Participants expressed an interest in receiving additional guidance during the mentorship component of their EcologyPlus experience.

Partners viewed the diversity goals, mentorship focus, inclusion of recent graduates, and partner diversity as program strengths. They found the program to be a valuable resource and benefitted from the expansion of their professional networks, but also found it challenging to find time to participate. Further, partner representatives agreed that recognition of their participation by their organization would help address some of the challenges they encounter during the collaboration. These areas of strengths and improvements as well as the evolution of principles used in, and building off of, collective impact (DuBow et al. 2018, Ennis and Tofa 2020) will be considered as EcologyPlus continues designing and providing opportunities to foster the inclusion of students from BIPOC communities in a range of ecology-related careers.

Guiding Questions for Building a More Inclusive Ecology Discipline

This symposium presented a few ways that educators might catalyze change in undergraduate ecology through structured programs in classrooms, universities, academic societies, and regional and national networks. Although these programs were implemented at different scales, two common themes emerged. First, student experiences should be at the center of how we design, assess, and improve upon existing programs. This is particularly important to remember as educators and program leaders shift student experiences from in-person settings to online platforms in response to the COVID-19 pandemic. Second, to reach the goal of inclusion, educators and program leaders need to consider and value the affective and psychosocial aspects of the student experience (see Duffy et al. 2019).

Making these intervention programs successful and building a more inclusive and equitable ecology community requires that all ecologists participate in this kind of work, including through our everyday practices as teachers, research mentors, and leaders in our departments and institutions. To provide a starting blueprint for how each of us can identify productive ways to intervene in our local contexts, we present three guiding questions.

1. “How can I create inclusive and equitable experiences for students in my classroom?” We encourage instructors to reflect on where in their classrooms they can intervene to build inclusive experiences for students from marginalized communities. Group work in classes, for example, is one place where students may find themselves uncertain about whether they can share all aspects of their identity (Cooper and Brownell 2016). Students may also experience microaggressions from other students or instructors (Harrison and Tanner 2018), which can contribute to lowering sense of belonging, self-efficacy, and science identity (Johnson-Ahorlu 2012, Dortch and Patel 2017). Instructors can build a more inclusive classroom by providing structures that prepare students to respectfully and collaboratively interact with peers with different (in)visible identities. Course curriculum is another place in the classroom where students could feel excluded. Past research has shown that student perceptions of who a scientist is can change when they engage with
curricula showcasing a diversity of scientists (Schinske et al. 2016). In addition, instructors can promote inclusivity in the classroom by framing and describing identity categories (e.g., gender, race, and disability) in ways that avoid stigmatizing terminology and stereotypes (Hales 2020).

2. **“How can I build a research laboratory that is inclusive and equitable?”** Whether we intend for it to be or not, the research lab ends up being one place where students learn which aspects of DEIJ are valued or dismissed by the ecology community. Research mentors have the opportunity to create a lab space where students don’t feel like parts of their identity need to be separated from their role as a scientist or mentee (see Byars-Winston et al. (2020)). The lab is also a place where ecologists can affirm the importance of DEIJ issues, such as by modeling how to productively have discussions about racism, amplify the work of BIPOC scientists, and examine how lab practices can be more equitable (Chaudhary and Berhe 2020).

3. **“How can I help turn effective intervention programs into durable structures in ecology?”** A constant challenge that pilot programs face is uncertainty regarding their lifespan. Often, funding for DEIJ initiatives is temporary, lasting only a few years and requiring continual efforts to fundraise (Rincon and George-Jackson 2016). In some cases, it can be harder to obtain funding to continue an existing program than it is to start a new one. Institutional commitment is needed to turn effective programs into permanent fixtures of higher education and ecology. Ecologists can help support these efforts by advocating for programs that are important components of the undergraduate education experience at their own institutions, or they can join cross-sector alliances that highlight the importance of this kind of work to partners and funders.

Ecology as a discipline shares responsibility for having built and maintained barriers of exclusion (Anker 2009, Tilley 2011). This means that ecologists also share the responsibility for breaking down these barriers and building new structures in their place to promote inclusion and social justice. We hope the lessons and guiding questions presented here provide you with a beginning blueprint for meeting the charge shared by Hurtado (2007): “It is time to renew the promise of American higher education in advancing social progress, end America’s discomfort with race and social difference, and deal directly with many of the issues of inequality present in everyday life” (p. 186). Over a decade later, the need to renew this promise remains; it is our hope that as a community, we can take the actions needed to turn this promise into reality.

**Literature Cited**

Ahern-Dodson, J., C. R. Clark, T. Mourad, and J. A. Reynolds. 2020. Beyond the numbers understanding how a diversity mentoring program welcomes students into a scientific community. Ecosphere 11:e03025.

Anker, P. 2009. Imperial ecology: environmental order in the British Empire, 1895–1945. Harvard University Press, Cambridge, Massachusetts, USA.

Baldwin, A. N., N. A. Brantuo, and J. P. Pichardo. 2020. Black Feminisms and Pedagogical Space-Making. Pages 1–24 in C. A. Mullen, editor. Handbook of social justice interventions in education. Springer International Publishing, Cham, Switzerland.

Baldwin, J. A., D. Ebert-May, and D. J. Burns. 1999. The development of a college biology self-efficacy instrument for nonmajors. Science Education 83:397–408.

Bandura, A. 1986. The explanatory and predictive scope of self-efficacy theory. Journal of Social and Clinical Psychology 4:359–373.
Beck, C., K. Boersma, C. S. Tysor, and G. Middendorf. 2014. Diversity at 100: women and underrepresented minorities in the ESA. Frontiers in Ecology and the Environment 12:434–436. 
Berkowitz, A. R., E. Gur-Edeman, J. Taylor, and M. Jurgensen-Armstrong. 2003. SEEDS Strategies for Ecology Education, Development and Sustainability: The first six years. Ecological Society of America, Washington, DC, USA. https://www.esa.org/seeds/pdf/SEEDSreport.pdf 
Bonilla-Silva, E. 2017. Racism without racists: Color-blind racism and the persistence of racial inequality in the United States. Fifth edition. Rowman & Littlefield Publishers, Lanham, Maryland, USA. 
Byars-Winston, A., P. Leverett, R. J. Benbow, C. Pfund, N. Thayer-Hart, and J. Branchaw. 2020. Race and ethnicity in biology research mentoring relationships. Journal of Diversity in Higher Education 13:240–253. 
Callahan, C. N., N. D. LaDue, L. D. Baber, J. Sexton, K. J. van der Hoeven Kraft, and E. M. Zamani-Gallaher. 2017. Theoretical perspectives on increasing recruitment and retention of underrepresented students in the geosciences. Journal of Geoscience Education 65:563–576. 
Chaudhary, V. B., and A. A. Berhe. 2020. Ten simple rules for building an antiracist lab. PLOS Computational Biology 16:e1008210. 
Cooper, K. M., and S. E. Brownell. 2016. Coming out in class: challenges and benefits of active learning in a biology classroom for LGBTQIA students. CBE—Life Sciences Education 15:ar37. 
Crane, L., and L. Liverpool. 2020. Researchers on strike. New Scientist 246:14–15. 
Dortch, D., and C. Patel. 2017. Black Undergraduate women and their sense of belonging in STEM at predominantly white institutions. NASPA Journal About Women in Higher Education 10:202–215. 
DuBow, W., S. Hug, B. Serafini, and E. Litzler. 2018. Expanding our understanding of backbone organizations in collective impact initiatives. Community Development 49:256–273. 
Duffy, M. A., J. W. Hammond, and S. J. Cheng. 2019. Preaching to the choir or composing new verses? Toward a writerly climate literacy in introductory undergraduate biology. Ecology and Evolution 9:12360–12373. 
Ennis, G., and M. Tofa. 2020. Collective impact: a review of the peer-reviewed research. Australian Social Work 73:32–47. 
Estrada, M. 2014. Ingredients for improving the culture of STEM degree attainment with cocurricular supports for underrepresented minority students. National Academies of Sciences White Paper. 
Estrada, M., et al. 2016. Improving underrepresented minority student persistence in STEM. CBE—Life Sciences Education 15:es5. 
Hales, K. G. 2020. Signaling inclusivity in undergraduate biology courses through deliberate framing of genetics topics relevant to gender identity, disability, and race. CBE—Life Sciences Education 19:es2. 
Harrison, C., and K. D. Tanner. 2018. Language matters: considering microaggressions in science. CBE—Life Sciences Education 17:fe4. 
Hurtado, S. 2007. Linking diversity with the educational and civic missions of higher education. Review of Higher Education 30:185–196. 
Hurtado, S., and D. F. Carter. 1997. Effects of college transition and perceptions of the campus racial climate on Latino college students’ sense of belonging. Sociology of Education 70:324–345. 
Johnson-Ahorlu, R. N. 2012. The academic opportunity gap: how racism and stereotypes disrupt the education of African American undergraduates. Race Ethnicity and Education 15:633–652. 
Kania, J., and M. Kramer. 2013. Embracing emergence: How collective impact addresses complexity. Stanford Social Innovation Review. https://ssir.org/articles/entry/collective_impact 
Maton K. I., Beason T. S., Godsay S., Sto Domingo M. R., Bailey T. C., Sun S., and Hrabowski F. A. 2016. Outcomes and processes in the meyerhoff scholars program: STEM PhD completion, sense
of community, perceived program benefit, science identity, and research self-efficacy. CBE—Life Sciences Education 15:ar48.

Maton, K. I., S. A. Pollard, T. V. McDougall Weise, and F. A. Hrabowski. 2012. Meyerhoff Scholars Program: a strengths-based, institution-wide approach to increasing diversity in science, technology, engineering, and mathematics. Mount Sinai Journal of Medicine, New York 79:610–623.

Miriri, M. N. 2020. The elephant in the room: race and STEM diversity. BioScience 70:237242.

Mourad, T. M., A. F. McNulty, D. Liwosz, K. Tice, F. Abbott, G. C. Williams, and J. A. Reynolds. 2018. The role of a professional society in broadening participation in science: a national model for increasing persistence. BioScience 68:715–721.

Mourad, T., and G. Middendorf. 2020. Using collective impact to overcome systemic racism. Frontiers in Ecology and the Environment 18:368.

National Science Foundation. 2019. Women, minorities, and persons with disabilities in science and engineering: 2019. Special Report NSF 19-304. National Center for Science and Engineering Statistics, Alexandria, Virginia, USA.

Rincon, B. E., and C. E. George-Jackson. 2016. STEM intervention programs: funding practices and challenges. Studies in Higher Education 41:429–444.

Schinske, J. N., H. Perkins, A. Snyder, and M. Wyer. 2016. Scientist spotlight homework assignments shift students’ stereotypes of scientists and enhance science identity in a diverse introductory science class. CBE—Life Sciences Education 15:ar47.

Sealey, B. A., D. E. Beasley, S. J. Halsey, C. J. Schell, Z. H. Leggett, S. Yitbarek, and N. C. Harris. 2020. Human dimensions: raising black excellence by elevating black ecologists through collaboration, celebration, and promotion. Bulletin of the Ecological Society of America 101:e01765.

Segarra V. A., et al. 2020. Scientific societies fostering inclusive scientific environments through travel awards: current practices and recommendations. CBE—Life Sciences Education 19:es3.

Stolle-McAllister, K., M. R. S. Domingo, and A. Carrillo. 2011. The Meyerhoff way: how the Meyerhoff scholarship program helps Black students succeed in the sciences. Journal of Science Education and Technology 20:5–16.

Teranishi, R. T., B. M. D. Nguyen, C. M. Alcantar, and E. R. Curammeng. 2020. Measuring race: why disaggregating data matters for addressing educational inequality. Teachers College Press, New York, New York, USA.

Thompson, A. 2020. Black birders call out racism, say nature should be for everyone. Scientific American. https://www.scientificamerican.com/article/black-birders-call-out-racism-say-nature-should-be-for-everyone/

Tilley, H. 2011. Africa as a living laboratory: Empire, development, and the problem of scientific knowledge, 1870–1950. University of Chicago Press, Chicago, Illinois, USA.

Tseng, M., R. W. El-Sabaawi, M. B. Kantar, J. H. Pantel, D. S. Srivastava, and J. L. Ware. 2020. Strategies and support for Black, Indigenous, and people of colour in ecology and evolutionary biology. Nature Ecology & Evolution 4:1288–1290.

Zuberi, T., and E. Bonilla-Silva. 2008. White logic, white methods: Racism and methodology. Rowman & Littlefield Publishers, Lanham, Maryland, USA.