Report from the Office of Polar Programs Subcommittee on

Diversity, Equity, and Inclusion

Submitted to the OPP Advisory Committee,
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Preface

This report is presented by the Subcommittee for Diversity, Equity, and Inclusion to the Advisory Committee of the National Science Foundation's Office of Polar Programs (OPP). The subcommittee was commissioned in September 2020 by then OPP Director Kelly Falkner with a charter to 1) characterize the current state of diversity of the NSF-sponsored polar research community; 2) examine existing efforts by NSF and others to enhance diversity, equity, and inclusion (DEI); and 3) identify and recommend the most promising strategies for OPP to significantly enhance DEI in the polar sciences. The report presents our recommendations along with findings from research on DEI programs at NSF and other agencies.

Working through the pandemic, and facing many challenges as individuals, the subcommittee committed energy and time to frequent meetings, learning activities, and focused writing sessions. As Co-Chairs, we are very grateful for the subcommittee members' engagement during trying times for everyone. We are indebted to support from Ms. Beverly Walker whose knowledge of the workings of the Foundation and OPP, and her constant support of the group, allowed us to complete the work. We also thank all the OPP program officers who took time to share insights and data with us.

Further, given the importance of increasing diversity in polar research, this subcommittee looks forward to OPP's successful efforts to implement these recommendations. We also hope this report can serve as a learning resource for the broader polar science community. As Co-Chairs, we look forward to continued dialogue on this important effort as we work together to broaden participation in the polar sciences.

Linda Bailey Hayden, Co-Chair
Gretchen E. Hofmann, Co-Chair
OPP Subcommittee on Diversity, Equity, and Inclusion

Upper panel: Dr. Jerome Mitchell (ECSU), Antarctica; Lower panel, L to R: Je'aime Powell (ECSU), Greenland; Maya Smith (WSSU) and Ya'Shonti Bridgers (ECSU), Juneau Icefield Research Program (JIRP); Dr. Matt Calhoon, University of Alaska Anchorage, College of Engineering. Dr. Calhoun is the only Alaska Native in the world with a PhD in civil engineering. He was a student in the Universities Alaska Native Science and Engineering Program (ANSEP) as an undergraduate and earned his PhD through ANSEP's "Grow Our Own" component.

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Summary

Broadening participation in science, technology, engineering and math (STEM) has been a core goal for the National Science Foundation (NSF), with diversity and inclusion appearing prominently as one of the 10 Big Ideas in 2016–2017 in the form of NSF INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) (National Science Foundation 2021). Diversity reports and data analyses (e.g., National Center for Science and Engineering Statistics 2021*)* have highlighted areas of progress as well as continued challenges, such as that the share of undergraduate students who were Hispanic or Latino increased from 2016 to 2018 but the share of Blacks or African Americans declined during that time. The most recent NSF Strategic Plan for 2022-2026 identified diversity and inclusion as a major driver in innovation and discovery (National Science Foundation 2022).

In the NSF Strategic Plan released March 28, 2022, diversity and inclusion are identified as NSF core values. A report from the National Science Board, *Vision 2030*, underscored several critical goals for inclusion at the national level, noting that the U.S. faces a significant "talent gap" (National Science Board 2022). The report described the shortfall in training diverse scientists as the "missing millions" (see Fig. 2 in this report) and also set forth goals for the future, noting "...the number of women must nearly double (by 2030), Black or African Americans must more than double, and Hispanic or Latinos must triple the number that are in the 2020 U.S. S&E workforce." This is a significant challenge that must be met at every step of the science education and training continuum. This report from the Office of Polar Program's Subcommittee on Diversity, Equity, and Inclusion is focused on making recommendations that will enable OPP to contribute to the vision and roadmap set for 2030 and beyond.

In preparing this report, the OPP Advisory Subcommittee (SC) on Diversity, Equity, and Inclusion (DEI) was tasked with 1) characterizing the current state of diversity of the NSF-sponsored polar research community; 2) examining efforts by NSF and others to enhance DEI in scientific disciplines; and 3) identifying and recommending the most promising strategies for OPP to significantly enhance DEI in the polar sciences. This report makes recommendations that would advance OPP's DEI efforts and highlights important ongoing DEI activities at OPP and NSF that should be supported and continued.

The SC recommendations for long-term change include a concerted effort to amplify Indigenous priorities and perspectives throughout the Office of Polar Programs and NSF. The inclusion of Indigenous knowledge is one of the most important DEI challenges that OPP faces. In 2021, the NSF issued a Dear Colleague Letter (NSF 21-077) "Update on NSF's Efforts to Improve the Inclusion of Local and Indigenous Voices in Arctic Research," in response to formal and informal feedback from Indigenous communities and Arctic researchers regarding barriers that prevent meaningful engagement with Indigenous communities and the co-production of Indigenous knowledge. While existing NSF and OPP efforts are commendable, there remains a gap with respect to integrating Native Peoples and broader research activity in the Arctic.

These recommendations are meant to guide OPP in its deliberations, and to support creative and intentional actions by OPP, with many of these practices and strategies requiring long-term sustained activity. The SC realizes that new budgetary commitments may be necessary

but has not attempted to weigh the relative costs and benefits of the various recommendations. Here, we list five major categories of recommendations with greater detail following in the sections below.

Principal Recommendations:

- ❖ Amplify Indigenous priorities and perspectives throughout OPP's programs and activities.
- ❖ Employ the Collective Impact (CI) model as a means to set the DEI agenda in OPP and to sustain it over time.
- ❖ Recruit and hire a new Program Officer responsible for DEI leadership in OPP.
- ❖ Enhance engagement with Minority Serving Institutions (MSIs), faculty, and graduate students to cultivate diverse participation and contributions to polar research.
- ❖ Engage and work with other NSF programs to remove structural barriers in postdoctoral and graduate fellowship programs, and consider increased investment in both.

1.0 CURRENT STATE OF DIVERSITY IN THE POLAR RESEARCH COMMUNITY

The Office of Polar Programs (OPP) is part of the Geosciences (GEO) directorate at the National Science Foundation. OPP's scope is uniquely defined by geography rather than discipline. OPP awards grants to researchers in a wide range of scientific fields for studies in the Arctic and Antarctic regions (OPP 2019). OPP includes the Arctic Sciences (ARCS) division comprised of Arctic Social Sciences, Arctic Observing Networks, Arctic Natural Sciences, and Arctic System Science; and Antarctic Sciences (ANT), comprised of Astrophysics and Geospace Sciences, Ocean and Atmospheric Sciences, Earth Sciences, Glaciology, Organisms and Ecosystems, and Integrated System Science.

OPP staff and advisors coordinate closely with other NSF directorates, and the SC adopted this integrative approach, looking across NSF and to other federal agencies for examples of DEI success and best practices.

1.1 A National Challenge

Diversity, equity, and inclusion are deficient in virtually all scientific and technical disciplines in the United States, with disparities evident in secondary and university education, postgraduate training, and professional careers.

NSF's Committee on Equal Opportunities in Science and Engineering (CEOSE) compared representation by gender, race, and ethnicity in science and engineering careers to representation in the overall U.S. population, finding that Black women and men, Hispanic women and men, and White women are included in these fields at only one third to one half of parity (CEOSE 2021). CEOSE concluded that "although gains have been made by most demographic groups in most science and engineering disciplines, overall participation of women, underrepresented racial/ethnic groups and persons with disabilities within STEM fields is still disproportionately low" (CEOSE 2021:15) (Fig. 1).

The National Academies of Sciences, Engineering, and Medicine and the Pew Research Center have confirmed this national assessment, in addition noting gender and racial disparities in STEM salaries (Fry et al. 2021; NASM 2020). Geosciences in particular have been characterized as "the least diverse discipline within STEM" in which there has been "no progress on diversity in 40 years" (Bernard and Cooperdock 2018; National Science Foundation 2017).

Inequities in STEM arise from deep-seated and pervasive social attitudes, and are manifested through discrimination, harassment, explicit and implicit biases, differential access, and historical and systemic racism that can deter aspiring scientists at every stage of their education and careers (CEOSE 2017; NASM 2019, 2020).

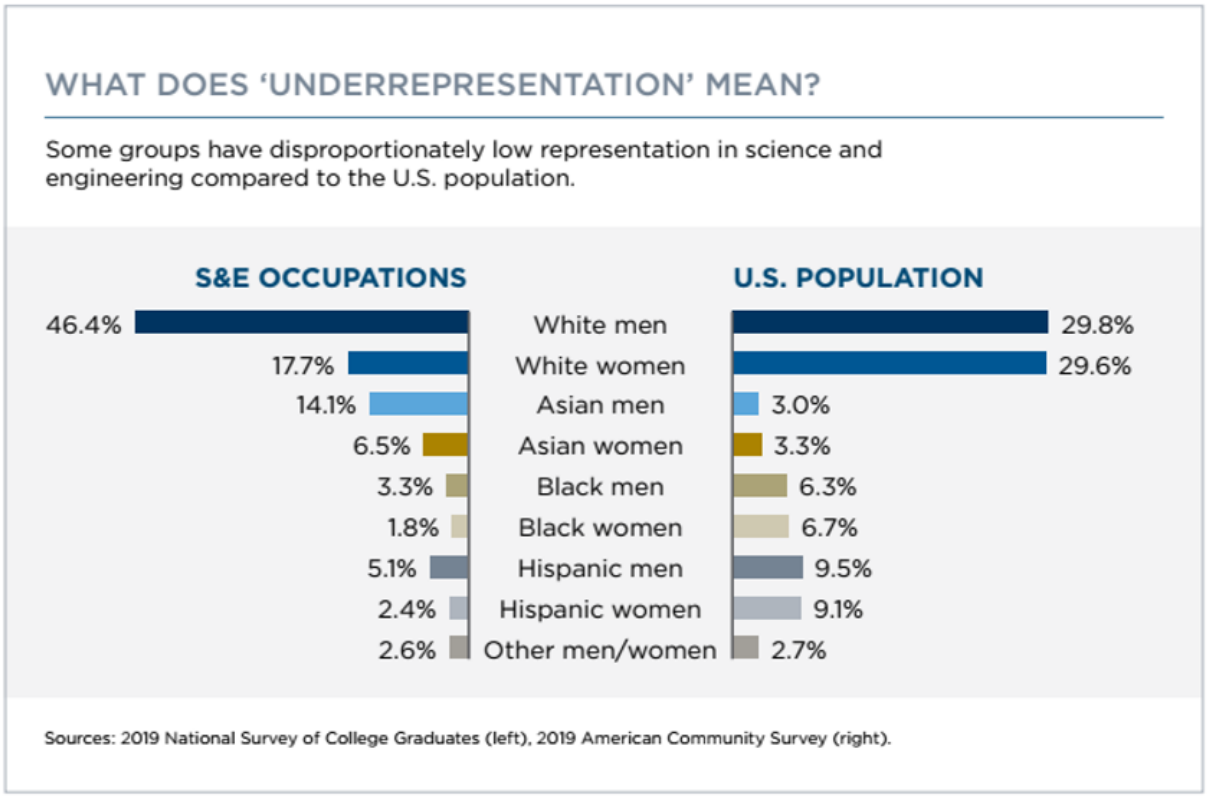

Figure 1. Demographic groups and their representation in U.S. science and engineering (CEOSE 2021).

1.2 Diversity and Equity in OPP Proposals and Awards

An analysis conducted for the SC (Scot Arnold, NSF OPP Senior Advisor, pers. comm. 2021) compared earned doctorates in representative polar STEM fields to national demographic data on gender, race, and ethnicity. While women make up 51% of the U.S. population, in 2019 they earned 66% of U.S. PhDs in anthropology; 52% of PhDs in biological and biomedical science; 46% of PhDs in geological, atmospheric, and ocean science; and 21% of PhDs in physics and astronomy. Although the representation of women is strong in several areas, the number of OPP proposals submitted by female Principal Investigators (PIs) in all fields

combined is only about half of what would be expected from their national rates of doctoral attainment. By the same statistical measure African American, Asian American, and Hispanic PIs of all genders are also significantly underrepresented as OPP proposers.

A 2020 Committee of Visitors (COV) considered other indications of disparity in OPP grant applications and awards. The committee examined 171 OPP proposals received in 2016–2019, which resulted in 64 awards and 105 declinations. The proposals were in Arctic Natural Sciences, Arctic Observing Network, Arctic Research Support and Logistics, Arctic System Sciences, Arctic Research and Policy Support, Arctic Social Sciences, and Polar Cyberinfrastructure. The COV reported that "in terms of gender, the ASSP [social sciences] program had the highest proportion of submissions from women, as well as awards granted compared to the other programs. Overall, a minority of awards went to female PIs and awards to underrepresented ethnic and racial minorities were even more limited."

The COV recommended that OPP increase the participation of minorities and women, particularly early career scientists, in the merit review process to reduce the potential for bias. The COV suggested that "reaching out to small and medium-size institutions, where there are a larger proportion of minorities, can help close the gap. This suggestion can be particularly effective at increasing the representation of Indigenous researchers that might remain foreign to the proposal reviewing process." The SC supports this recommendation from the 2020 COV.

Based on this profile of participation in the polar sciences and OPP grant solicitations, two types of intervention may improve DEI results. The first is outreach and support to women and minoritized communities to foster greater interest, entry, and success in STEM education and polar science careers. The second is removing barriers that may deter aspiring scientists and their institutions from submitting OPP proposals and being awarded grants, or which might adversely influence their chances of success.

1.3 OPP Awards to Minority Serving Institutions

An important DEI metric is the number of grants awarded to researchers at Minority Serving Institutions of higher learning (MSIs). As defined by the U.S. Department of Education MSIs include Asian American, Native American, and Pacific Islander Serving Institutions (**AANAPISI**); Alaska Native Serving Institutions (**ANSI**); Tribal Colleges and Universities (**TCU**); Hispanic Serving Institutions (**HSI)**; Alaska Native and Native Hawaiian Serving Institutions (**ANNH**); Native American Serving Non-Tribal Institutions (**NASNTI**); Historically Black Colleges and Universities (**HBCU**); and Predominantly Black Institutions (**PBI**) (Rutgers 2020). From 1987 to 2022 OPP made a total of 1,588 awards to MSIs, or 21% of all awards (Appendix A). OPP also made awards to non-profit Alaska Native organizations including the Barrow Arctic Science Consortium, Alaska Federation of Natives, Yukon River Inter-Tribal Watershed Council, Calista Elders Council, and others (**AKN**).

The distribution of OPP awards across the different types of MSIs is noticeably unequal (Table 1 and Fig. 2). HBCUs and PBIs are the most severely underrepresented; HSIs have relatively strong representation through grants to Arizona State University, University of Arizona, University of California (Santa Barbara and Santa Cruz) and other institutions in the

Southeast, Southwest, and California; and ANNH awards are also high, primarily because the University of Alaska Fairbanks is a strong contender for polar research grants and has many Alaska Native students. The AANAPISI category is highest of all due to the large number of awards made to the University of Washington in Seattle, which carries this designation.

Type	Total
AANAPISI	537
AANAPISI/HSI	122
AKN	71
ANNH	529
ANNH/NASNTI	1
HBCU	6
HSI	309
HSI/PBI	10
NASNTI	3
Total	1588

Table 1. Distribution of OPP awards to Minority Serving Institutions, 1987–2022.

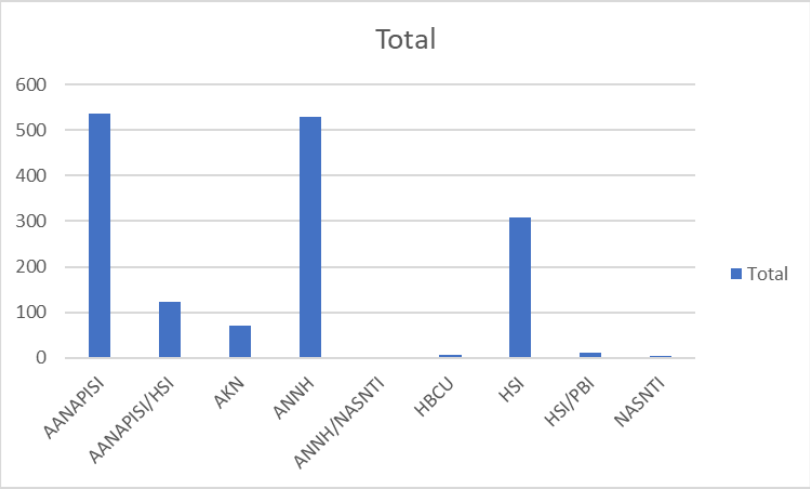

Figure 2. Distribution of OPP awards to Minority Serving Institutions, 1987–2022.

There are no strongly marked trends in the percentages of MSI awards through time, with the different categories rising and falling proportional to the total number of awards. Total awards and MSI awards peaked in 2007 during the International Polar Year and again in 2009

during the ARRA (American Rescue and Recovery Act) and have declined in recent years (Fig. 3).

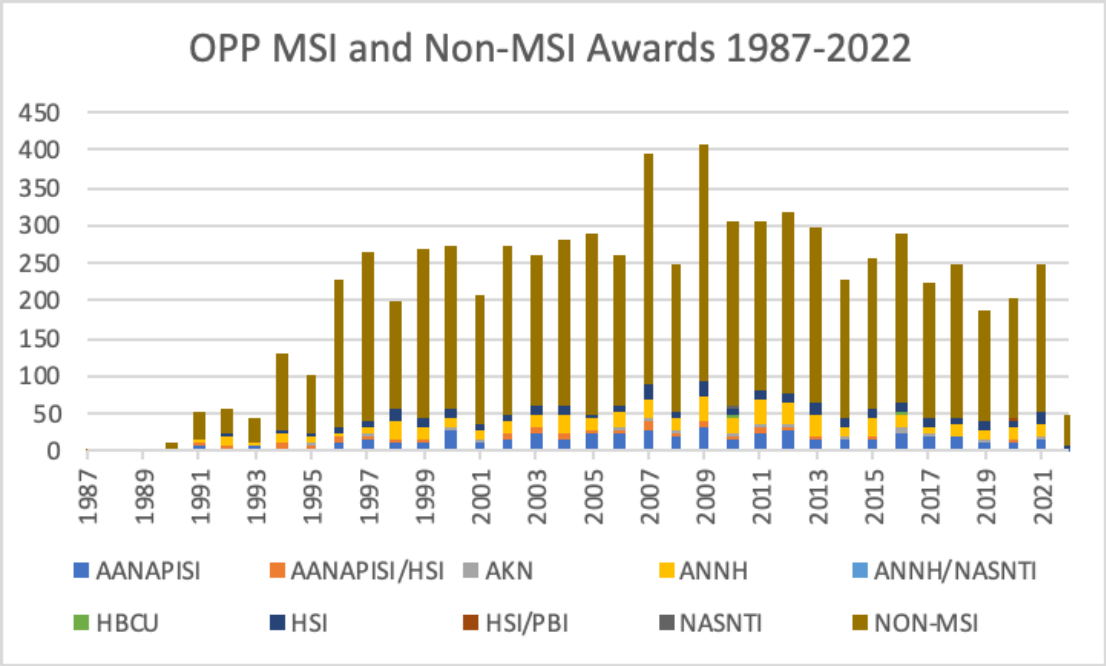

Figure 3. OPP awards to Minority Serving Institutions and non-MSIs, 1987–2022.

These data, derived from the NSF online awards database, indicate that awards to MSIs and Alaska Native organizations consistently make up about one fifth of total OPP awards; that a handful of major universities dominate the MSI space; that only about 50 of the more than 700 MSIs in the U.S. have ever received an OPP award; and that there has been a particularly low rate of submissions and awards to HBCUs and PBIs. This situation calls for focused exploration of how OPP collaboration with MSIs might be broadened and increased, creating opportunities to bring new talent and perspectives into the polar sciences.

2.0 EFFORTS BY NSF AND OTHERS TO ENHANCE DIVERSITY, EQUITY, AND INCLUSION

2.1 NSF DEI Efforts

The National Science Foundation accepted the challenge of increasing diversity four decades ago when it established CEOSE in 1980 to encourage the "full participation of women, minorities, and persons with disabilities in scientific, engineering, and professional fields." NSF's Broadening Participation (BP) initiative focuses on these goals and has been funded at over $1B annually for the last five years. Examples of current BP programs are NSF INCLUDES, the Louis Stokes Alliances for Minority Participation, INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education), GOLD (Geoscience Opportunities for Leadership in Diversity), GOLDEN (Geoscience Opportunities for Leadership in Diversity – Expanding the Network), and cross-directorate support to HSIs, HBCUs, and tribal colleges. The majority, including STEM education, fellowships, and Research Experiences for Undergraduates

(REUs) are administered through Education and Human Resources (EHR). In addition, Cultural Transformation in the Geoscience Community (CTGC) is focused on community-based research, participatory research, and place-based research, which often involves diverse communities (Harris et al. 2021). James and Singer (2016) categorized NSF programs as having either a BP focus, with 100% of the budget dedicated to BP objectives; a BP emphasis with 50% or more dedicated budget; or BP potential, addressing BP to some degree but with minor funding.

2.2 Broadening Participation at OPP

Based on analysis of the NSF online awards database, OPP has made 7,419 grant awards of all types since 1987. Of these, 1,421 (19%) included "broadening participation" in the title or abstract, indicating researchers' intentions to support DEI goals in their work, even if only as a secondary objective (Appendix B). The number of OPP awards with these keywords increased until 2009–2010 then declined, even more than noted earlier decrease for total and MSI awards (Fig. 4).

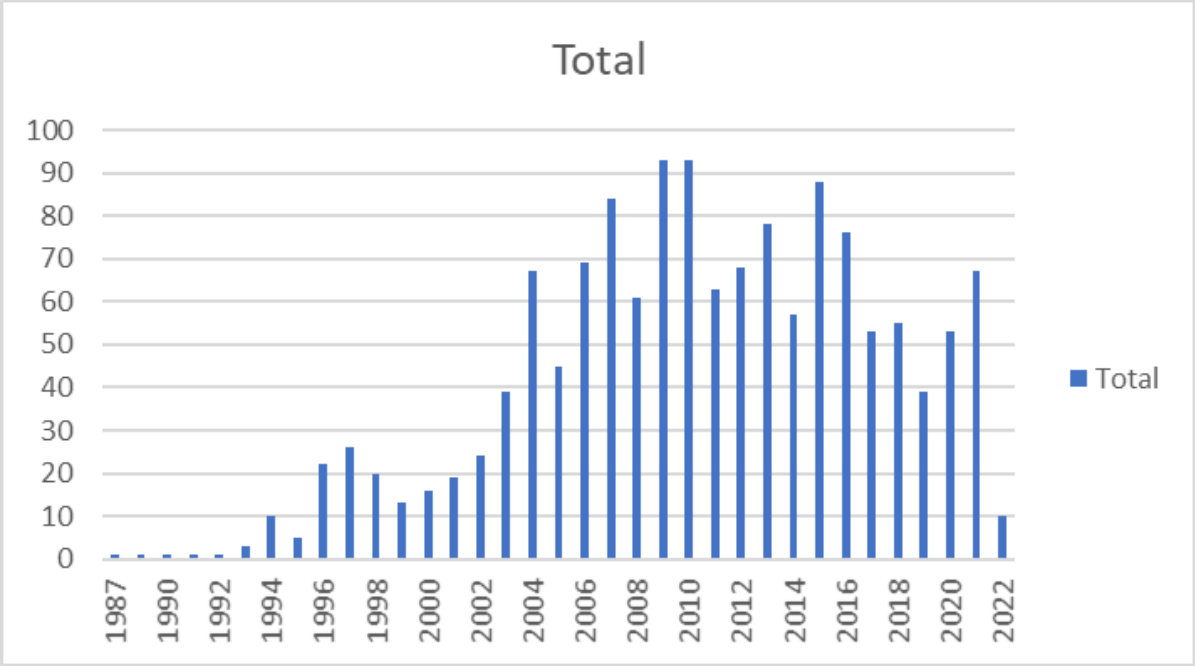

Figure 4. Numbers of OPP grants including Broadening Participation goals, by year.

The 1,421 awards covered all disciplines of polar research and were divided between the Arctic (n=793), Antarctic (n=576), and both (n=52) (see Appendix B).

BP activities funded by OPP grants included conferences, workshops, engagement with local communities and public schools, training tribal members in cultural research, creation of STEM learning materials, community-based monitoring, knowledge co-production, and a variety of other research and educational collaborations. These activities aimed to increase the participation of women, Indigenous Peoples of Siberia, Alaska, Canada, and Greenland, underrepresented U.S. groups including Black and Hispanic scientists, students at all levels from high school to postgraduate, students who were the first in their families to go to college, and

early career scientists. In particular, the main Arctic Research Opportunities solicitation encourages collaboration with Indigenous communities in Arctic Research Coordination and Policy Support, Social and System Sciences, although not in Natural Sciences, Arctic Observing Network and Polar Cyberinfrastructure (https://www.nsf.gov/pubs/2021/nsf21526/nsf21526.htm).

Many types of collaborations and partnerships were specified including with MSIs, the Women in Science and Engineering Program, the Society for the Advancement of Native Americans and Chicanos in Science, the Oregon State University STEM Research Center, the National Center for Atmospheric Research (NCAR) minority serving education effort, SOARS (Significant Opportunities in Atmospheric Research), the California Alliance for Minority Participation in Science, Engineering and Mathematics, the Alaska Native Science & Engineering Program (ANSEP), the Louisiana State University Geoscience Alliance, American Indian Research Opportunities (AIRO), Benaroya Research Institute, the Student PARTNERS project, and the Center of Excellence in Remote Sensing, Education and Research (CERSER), Teachers and Researchers Exploring and Collaborating (TREC), Minority Undergraduate Scholarship and Training REUs, and the ODU-Hampton University-Virginia Institute of Marine Sciences' Hall Bonner Program for Minority Doctoral Scholars in Ocean Sciences.

NSF-wide BP programs were only occasionally referenced in the OPP award summaries including eight proposals for setting up REU sites, one INCLUDES proposal, one INSPIRE proposal, and eight that specified EPSCoR co-funding. In sum, most OPP proposals described *ad hoc* ideas specific to particular projects, rather than being linked to NSF guidance or coordinated with broader NSF initiatives.

This preliminary analysis of Broadening Participation efforts in OPP shows that nearly 20% of grant awards since 1987 have included activities and objectives aimed at increasing diversity, equity, and inclusion in the polar sciences. Although willingness to engage in DEI efforts was thus demonstrated, few projects included BP as a primary emphasis. This suggests that greater encouragement, intentionality, and investment by OPP in offering both BP/DEI-focused funding as well as guidance would be met with a positive response by researchers and could lead to significant advances.

2.3 Research with Indigenous Peoples and Co-Production of Knowledge

NSF has specific requirements for research conducted near local and Indigenous communities or their lands (https://www.nsf.gov/geo/opp/arctic/ace/community.jsp). Significant efforts to converge different sources of knowledge and perspectives have been made in the Navigating the New Arctic (NNA) program. NNA encourages proposals for projects that leverage partnerships with stakeholders, dedicate budget and time to collaboration, and work closely with community partners. It allows exceptions to the data reporting requirements for social science data and Indigenous knowledge. Communication with communities is emphasized: “Researchers should coordinate their field activities with nearby communities and are expected to share results with the community following each field season and/or at the end of the project. Investigators should include travel funds for this in their proposal budget. Some projects may require discussion with Indigenous or subsistence co-management organizations. Time for dialogue should be included in the project schedule and funds for these meetings, both

in person and virtual, should be included in the proposal budget" (https://www.nsf.gov/pubs/2022/nsf22520/nsf22520.htm).

Co-production of knowledge with Arctic Indigenous communities is supported in NNA and Arctic Research Opportunities (ARO) program as "the integration of different knowledge systems and methodologies to systematically understand the phenomena, systems, and processes being studied in a research project. In the Arctic, this often takes the form of Indigenous knowledge holders working collaboratively as part of project teams to identify, develop, and address shared research questions; shape methodologies; and agree upon appropriate outreach and data sharing activities." The Navigating the New Arctic Community Office is an example of new efforts to build sustained connections between Indigenous communities and researchers. However, there are some challenges with its implementation in practice.

2.4 Collaborative STEM Education

Starting in 2014, OPP developed a new approach to support polar education in collaboration with NSF's Education and Human Resources directorate (EHR). This effort has been promoted by a series of Dear Colleague Letters that encouraged the community to submit proposals to EHR's Division of Undergraduate Education and the Division of Research on Learning, including programs that spanned K-12, undergraduate, and informal education. OPP supported or co-funded these awards, helping to ensure that polar logistics were adequately resourced and that the proposals were not declined due to a lack of understanding about the high costs of implementing polar STEM. During the 2015–2021 period, EHR awarded over $20M in polar-related projects with $7M of OPP support or co-funding. This collaboration has benefitted the polar community and supported important DEI efforts and educational products that OPP could not have funded alone.

2.5 External Models of Successful DEI Programs

The NASA Minority University Research and Education Program (MUREP) model was documented during the SC's Learning Activity (LA) 11: Best Practices for Broadening Participation at NASA, led by James L. Harrington. Mr. Harrington's work demonstrates the impact that a program officer who is committed to the DEI effort can have. One take-away was the strong benefit of working with MSIs to prepare them for future solicitations. A second take-away was the success of the Network Resources and Training Site (NRTS) model for developing MSI infrastructure (see Appendix C). The NRTS program was an ambitious effort to reach hundreds of MSIs and Tribal Colleges and to insure they had the infrastructure and training to bring them onto the information superhighway. All MSI institutions responding to the solicitation were funded as NRTS lead sites or as satellite institutions assigned to one of the leads. The solicitation required an industrial partner to provide the technical expertise and support for this challenge. One NRTS site partnering with NASA GSFC and NSF CReSIS identified a new world feature in Antarctica that is now named for that university. This subcommittee encourages future partnerships between NSF and NASA and encourages coordination with Mr. Harrington to facilitate these partnerships.

GLOBE (Global Learning and Observations to Benefit the Environment) is an educational partnership between NASA and NSF that impacts thousands of precollege students and teachers worldwide. Through interdisciplinary activities and inquiries into the various Earth spheres, GLOBE gives students a hands-on approach to the scientific method. GLOBE protocols are developed by the scientific community and validated by teachers. These protocols currently include lessons, activities, and assessments related to the Atmosphere, Biosphere, Hydrosphere, and Pedosphere. This subcommittee suggests that OPP invest in development of GLOBE protocols for the polar regions, building on GLOBE as a highly successful model. An OPP effort to develop polar protocols for GLOBE would give immediate exposure to thousands of students and teachers.

Other mature agency models that facilitate and support DEI efforts include UCAR, NOAA, and the Texas Academic Computing Center (Table 2). These programs may be useful as resources for future OPP efforts.

Agency	Name of Program/ Description/URL
National Oceanic and Atmospheric Administration (NOAA)	José E Serrano Educational Partnership Program with Minority Serving Institutions (EPP/MSI) is a multifaceted approach involving scholarships, science centers, and mentors. 2,514 post-secondary degrees have been awarded to students supported by EPP/MSI programs since 2001 https://www.noaa.gov/office-education/epp-msi/undergraduate-scholarship
Center for Science Education (UCAR SciEd)	The UCAR Center for Science Education (UCAR SciEd) serves the geoscience community by amplifying and complementing the work of the National Science Foundation's National Center for Atmospheric Research (NCAR) and University Corporation for Atmospheric Research (UCAR). It targets K-12 educators, university faculty, students, and the public through excellence in educational programs and experiences. The Significant Opportunities in Atmospheric Research and Science (SOARS) Program is also a UCAR program. A primary goal is to support and build research partnerships with underrepresented communities based on culturally responsive practices. This is achieved by 1) building on existing collaborative research partnerships with underrepresented communities; and 2) a commitment to foster and expand new, mutually beneficial collaborative research relationships with communities beyond the academic community. https://scied.ucar.edu/ https://www.ucar.edu/sites/default/files/documents/related-links/2020-12/ODEI_StrategicPlan_Final.pdf
Texas Academic Computing Center (TACC)	TACC offers K-12 outreach for teachers and students; undergraduate and graduate student opportunities for continued education; and industry training for professionals. The structure of the TACC Computing Educator Diversity Initiative (CEDI) program is intentional at every turn. CEDI ensured that historically underrepresented groups were provided funding to partake in professional development. The program was thoughtfully designed — from recruitment to completion — to make participants feel welcomed and empowered to succeed. Half of the students are African American and 35% are Hispanic. https://www.tacc.utexas.edu/education- https://www.tacc.utexas.edu/-/changing-the-face-of-cs-education

Table 2. Examples of DEI efforts in other agencies.

3.0 STRATEGIES TO ENHANCE DIVERSITY, EQUITY, AND INCLUSION IN THE POLAR SCIENCES

Recommendations for increasing DEI in polar research include *long-term strategies* requiring extended time frames and higher levels of commitment, policy development, and funding; and *near-term strategies* that can be implemented more quickly and with immediate impact. Many of the short-term strategies build on existing programs.

3.1 Long-Term Strategies

3.1.1 Support and Increase the Inclusion of Indigenous Knowledge and Local and Indigenous Communities in OPP Science

The geographic domain of the OPP encompasses areas in the Arctic that have been home to Indigenous Peoples since time immemorial. Alaska Native peoples have successfully stewarded their environment through hundreds of generations (Barnhardt and Kawagley 2005); however, through colonization and the paradigm of western science, Native Peoples have been excluded from positions of power that would allow their input to be incorporated into scientific endeavors that take place in their ancestral homelands or impact their cultural practices (David-Chavez and Gavin 2018). Indeed, scientists and researchers generally agree that the inclusion of Indigenous Peoples in decision making is critical for safeguarding and maintaining their long-term cultural security (Adger et al. 2014). Furthermore, the United Nations Declaration on the Rights of Indigenous Peoples states in Article 31: "Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge, and traditional cultural expressions, as well as the manifestations of their sciences, technologies, and cultures" (UN General Assembly 2007).

This proclamation clearly outlines the need for the inclusion of Native Peoples in power structures that directly impact their cultural well-being, including scientific research. Moreover, given that the Arctic is experiencing anthropogenic climate warming at faster rates than any other region of the planet (Bonsell and Dunton 2018; Chan et al. 2019; Qi et al. 2017), Alaska Native people have been among the first communities in the U.S. to be directly affected. Changes in sea ice conditions that disrupt subsistence hunting (Downing and Cuerrier, 2011), coastal erosion driving the relocation of villages from ancestral sites (Palinkas 2020), and the emergence of novel diseases (Brubaker et al. 2011) are a few examples of how climate change has already altered Indigenous ways of life in the Arctic. These impacts further underscore the importance of including Native People in the governance of scientific research taking place in their regions.

The western scientific paradigm is responsible for tremendous technological advances and undeniable improvements to human well-being. Scientific research, education, and workforce development create opportunities for communities to thrive and connect with one another in ways that were unimaginable only a few decades ago. Yet at the same time, western science has a long history of trivializing or ignoring scientific knowledge developed and stewarded by Indigenous Peoples. Even though Indigenous knowledge systems collect and organize diverse information sources, test hypotheses, make predictions, and have sustained

communities for thousands of years, western science has often taken a dismissive view of Indigenous epistemologies while simultaneously extracting knowledge and resources from Indigenous communities in ways that can cause lasting harm (Marshall et al. 2015).

In parallel to efforts aimed at broadening participation of Indigenous Peoples in STEM education and in the workforce, the NSF should also promote ethical, respectful research to strengthen and support Indigenous knowledge systems. The co-production of knowledge, which pertains to weaving Indigenous ways of knowing into the dominant paradigm of the western scientific approach, has recently gained traction in STEM disciplines (Armitage et al. 2011). Attempts to bridge western and Indigenous knowledge systems have been challenged by differing epistemologies and perspectives on how successful outcomes are defined and characterized (Watson 2013).

Polar research, with a few exceptions, has not included the integration of Indigenous knowledge with western scientific knowledge (Latulippe and Klenk 2020). Given the current and projected impacts of climate change on Indigenous and local communities in the Arctic, particularly around food security (Moerlein and Carothers 2012), an "all hands on deck" approach including full Indigenous participation may yield important benefits that would otherwise be unobtainable As a path forward, we recommend that NSF fully support a co-production of knowledge approach, defined as the meaningful, equal integration of "Indigenous Peoples' knowledge systems with science, to generate new knowledge and understandings of the world that would likely not be achieved through the application of only one knowledge system" (Fig. 5) (Elam Yua et al. 2022). We recommend approaches highlighted in the most recent statement of the 10th International Congress of Arctic Social Sciences Indigenous Knowledge and Knowledge Co-Production Panel and Discussion Group, 20 July 2021 (Degai et al. 2022), as well as the Ottawa Traditional Knowledge Principles (Arctic Council 2015).

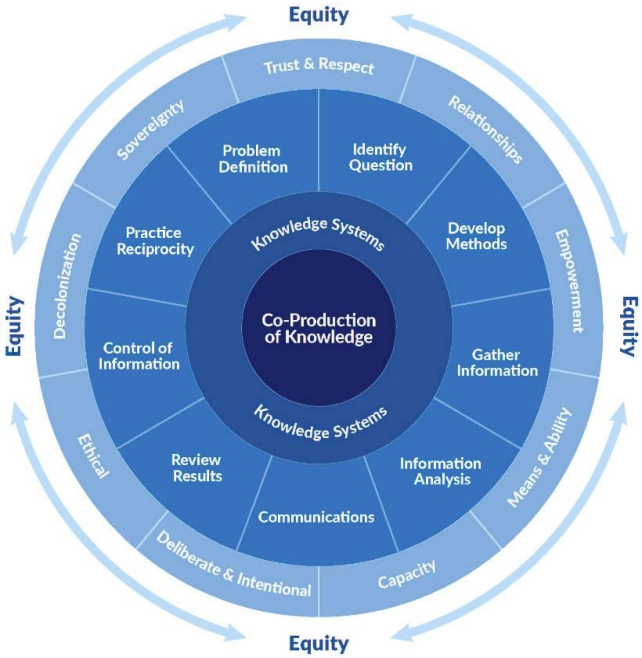

Figure 5. A framework for co-production of knowledge (Elam Yua et al. 2022).

Meaningful engagement with Indigenous communities in polar science research requires attention to cultural, historical, and epistemic issues. Scientists, program officers, and others involved in research must respect Indigenous knowledge systems, which exist in oral, written, and other forms. Indigenous epistemologies often offer different perspectives on the environment, socioeconomic systems, and relationships between humans and nature. NSF and others involved in polar science should also recognize that Indigenous scholars face systemic barriers to participation in STEM education, research, and employment opportunities as do members of other underrepresented groups. In addition, Indigenous scholars may carry responsibilities and burdens as members of communities that are impacted by climate change or other anthropogenic threats, and as individuals who are often called upon (fairly or not) to represent the views of their communities in research settings.

We offer several recommendations for fostering partnerships with Indigenous Peoples in the Arctic regions, integrating Indigenous knowledge into Arctic research, and building relationships that reflect principles of diversity, equity, and inclusion.

Recommendation 3.1.1.1

Provide the polar science community (OPP staff and PI's) with training, education, and resources on ethical principles for engaging with Indigenous communities and knowledge systems.

Researchers should be required to conduct their projects in accordance with CARE principles for Indigenous data governance (Collective Benefit, Authority to Control, Responsibility, and Ethics) (Carroll et al. 2020), community-based participatory research (CBPR) principles, Ottawa Traditional Knowledge Principles (Arctic Council 2015), and the Free, Prior, and Informed Consent (FPIC) guidelines (Anderson et al. 2018) when working on terrestrial and aquatic domains of Indigenous communities, especially those leading traditional ways of life. If the research project takes place in areas not federally recognized as tribal lands, researchers should identify and engage with representatives of Indigenous Peoples who may live there or who may have historical ties to the area. This is especially important in the geosciences since knowledge about lands and waters is preserved in perpetuity by local and Indigenous communities.

To facilitate this approach, we suggest that an Indigenous Steward be recruited whenever possible for OPP-funded Arctic projects. The Indigenous Steward would ideally be a tribal representative acknowledged by the governing body of the tribe/nation or community whose interests they will represent. The Indigenous Steward would provide PIs feedback to ensure the representation of Indigenous priorities and perspectives during all stages of research. Stewards would be financially compensated for their contributions of time and expertise. Each specific tribe/nation, village, or community would be free to decide whether they want to participate in this process. Canada's Tri-Council agreements provide examples of co-management of projects taking place on First Nations, Inuit, or Métis lands. Even in the natural sciences "funding program guidelines and licensing requirements in the North may impose obligations to engage communities" (https://ethics.gc.ca/eng/tcps2-eptc2_2018_chapter9-chapitre9.html). Training for grant awardees on CARE principles will facilitate community engagement, including methods

such as talking circles that differ from the structured workshops that are more familiar to western scholars. We further encourage evaluation by a community member from the geographic area where research is planned to be included in proposals and project reporting.

Recommendation 3.1.1.2

Increase funding and programmatic support to broaden the participation of Indigenous Peoples in NSF-sponsored polar science and education.

OPP should enhance support for Indigenous scholars, students, postdocs, educators, and researchers to build a critical mass of polar scientists who are equipped to amplify the priorities and perspectives of Indigenous Peoples over the long term. Additionally, including local and Indigenous community members as coauthors is a promising practice that could serve as a criterion for project evaluation. See David-Chavez and Gavin (2018) for a discussion of Indigenous evaluation of research prior to or as part of peer review.

We recommend that OPP seek ways to involve more Indigenous students in OPP research, taking a broad view of participation from undergraduate to postdoctoral levels. The Alaska Native Science and Engineering Program (https://www.ansep.net/) has developed a successful model that has increased retention, improved academic outcomes, and increased the number of Alaska Native scientists and engineers by creating opportunities for research and learning spanning multiple levels of the educational system. Such programs are long-term investments in building equity in polar science. NSF has funded other successful programs that might serve as models, such as Columbia University's Bridge to the Ph.D. Program in STEM (https://bridgetophd.facultydiversity.columbia.edu/#:~:text=The%20Bridge%20Program%20is%20an,have%20gone%20on%20to%20Ph.) and the American Indian Science and Engineering Society's Lighting the Pathway to Faculty Careers for Natives in STEM (https://www.aises.org/content/lighting-pathway).

Recommendation 3.1.1.3

Provide funding and other support for activities that focus on strengthening Indigenous knowledge systems and the co-production of knowledge.

NSF should encourage projects to strengthen Indigenous knowledge and the co-production of knowledge (Alexander et al. 2019; Kovach 2010). As one example, NSF currently funds the Tamamta program (https://www.tamamta.org), a first-of-its-kind initiative aimed at increasing the participation of Indigenous scholars in fisheries and marine science with a cross-disciplinary, co-production approach.

NSF should also encourage models that focus on sharing and learning between communities, such as the National Park Service's Shared Beringian Heritage Program (https://www.nps.gov/subjects/beringia/index.htm). These types of projects can be supported by the Accelerating Research through International Network-to-Network Collaborations (AccelNet) program, which allows both formal and informal networks to develop. OPP can encourage engagement with and expansion of already existing collaborative networks such as Local Environmental Observer (LEO) Network (https://www.leonetwork.org/), Alaska Native

Knowledge Network (Alaska Native Knowledge Network (http://www.ankn.uaf.edu/), and Indigenous Sentinels Network (https://www.beringwatch.net/). OPP may consider prioritizing those proposals that have already established long-term collaboration with communities (like LTERs) while at the same time ensuring that these projects welcome new members with diverse social and cultural backgrounds.

Opportunities to strengthen Indigenous knowledge systems and knowledge co-production may also be found through OPP collaboration with the Polar Cyberinfrastructure program. For example, projects might seek to incorporate Indigenous knowledge into polar natural science databases and geographic information systems, make cyber resources more accessible to Indigenous communities to aid in environmental monitoring, or increase community access to scientific data through improved internet connectivity.

Recommendation 3.1.1.4

To further promote equity and inclusion in polar science, NSF should consider establishing an Arctic research facility to support multidisciplinary work that aims to, in part, characterize climate change impacts on Indigenous Peoples and the ecosystems they depend on for their cultural and physical well-being.

Currently, there is no dedicated, land-based infrastructure in the U.S. Arctic to support culturally relevant science in partnership with Indigenous communities, such as studying climate change impacts on important subsistence species or coordinating western and local ecological knowledge and observations. In contrast, OPP's Antarctic Program boasts world-class research stations (Crary Lab at McMurdo Station and the Amundsen–Scott South Pole Station) where hundreds of scientists work year-round. The disparity in terms of financial and infrastructural support between the poles is striking. However, implementation of this recommendation as a long-term strategy would help to alleviate this imbalance and provide critical information sharing with Alaska Native communities to support climate adaptation and mitigation strategies.

3.1.2 Collective Impact Model

The Collective Impact (CI) model, currently employed by NSF INCLUDES, provides a framework to enable a community to organize to advance a program or goal. OPP should adopt the CI model with a focus on diversity, inclusion and equity in polar sciences (Kania & Kramer 2011). In application to polar programs, the five elements of collective impact would be:

- Common agenda. Equity needs to be an integral part of the agenda for polar programs. Within OPP there needs to be a shared understanding of what equity means in the context of polar programs, and how polar programs will know equity has been advanced or achieved.
- Centralized support. Polar personnel (distributed across all program areas) need to be aligned within an acknowledged polar organization focused upon improving DEI results. This OPP DEI organization should be led by the DEI Program Officer (see recommendation in 3.1.3 below). The DEI Program Office will set the DEI program agenda, help define DEI programs and processes, and

communicate across OPP and its research community to align actions that improve DEI results.

- Continuous communication. There needs to be regular, continuous communication across OPP about the DEI Program. Involving multiple stakeholders in different content areas of polar programs who also communicate the program message is critical. Communication could include sharing equity strategies and establishing a common language around equity. Continuous communication may include email updates, conferences, All-Hands meetings, research meetings (i.e., a line on the agenda of every research meeting), etc.
- Mutually reinforcing activities. In addition to the DEI program officer who leads the OPP DEI effort, each OPP office should establish DEI advocates to champion DEI opportunities within their team. The DEI advocates will help communicate program initiatives, measure progress, share strategies, solicit feedback and lessons learned, and work toward formative improvement.
- Shared measurement. Each DEI component should have a defined measure of success. The DEI Program Officer can help create the defined measures and methods to obtain measured results. For example, in the Computing Alliance at Hispanic-Serving Institutions, the shared measurement involves parity in representation according to race, gender, and gender within race (intersectional approach) in computing departments (i.e., the share of Latinx students enrolled in computer science resembles that of overall Latinx representation on campus).

Recommendation 3.1.2.1

Employ the Collective Impact (CI) model to set, measure and sustain the OPP DEI agenda and to drive results.

3.1.3 OPP DEI Program Officer

Other organizations that have been successful in reaching greater diversity, equity, and inclusion have established dedicated staff to oversee their programs. OPP should similarly consider hiring a senior program officer (PO) to lead its DEI efforts. The DEI officer would have an appropriate budget to develop activities and intentionally drive change within OPP, serving in effect as the leader implementing the Collective Impact model described in Section 3.1.2 above. The OPP DEI PO would report to the OPP Director and be fully engaged in tracking DEI progress within the program. We envision that this PO would: (1) work to build partnerships with MSIs, especially focusing on those institutions that have never received OPP funding; (2) support the efforts of polar PIs in developing high quality Broadening Participation and Broader Impact components; (3) seek to build and facilitate articulated polar career pathways; (4) actively cultivate entry points into polar science for early career scientists; (5) develop and support outreach to marginalized groups including Indigenous communities; and (6) work to implement the near and long-term recommendations outlined in this report. In addition, the recent creation of a new NSF Directorate – Technology Innovation and Partnerships (TIP) – might open new avenues for OPP to collaborate across NSF on DEI issues, and the new PO would be on point to explore these opportunities.

Recommendation 3.1.3.1

Recruit and hire a new program officer responsible for DEI issues in OPP. This individual would have a budget and portfolio of activities to advance DEI efforts in OPP.

3.1.4 Improved Tracking of Broadening Participation

Broadening Participation (BP) goals and activities included in OPP proposals (discussed in Section 2.0) have not been systematically tracked or reported and could only be approximated for this report by running keyword searches on the NSF online awards database. Improving and regularizing BP reporting would establish a baseline and allow assessment of future progress. Principal investigators would be required to account for progress and outcomes in their annual and final grant reports, elevating commitment to DEI goals and genuine impacts.

Recommendation 3.1.4.1

Establish a new reporting system that better tracks and emphasizes expectations for BP outcomes. Sufficient funding, commensurate with stated DEI goals, should be provided for diversity and inclusion in awards where appropriate. The SC recommends requiring DEI reporting in annual grant reports. In addition, the "Result of Prior Funding" section of new proposals should be encouraged to articulate both research and DEI outcomes.

Researchers from historically excluded groups face multiple career obstacles that make their success in the polar sciences more challenging (Berhe et al. 2021). However, without adequate knowledge of structural barriers and their impacts on those who enter (or are prevented from entering) the polar science community, OPP (and NSF broadly) is not armed with the ability to make the changes most necessary to dismantle obstacles and serve these populations. Thus, we recommend a regular survey of OPP-funded scientists that aims to characterize the diversity in the population and to identify structural barriers to participation in polar science. In doing so, OPP would have tools that surpass simple demographic information and descriptive statistics about proposals submitted and awards granted. Data would be publicly available enabling research on the impact of policy changes.

Recommendation 3.1.4.2

Track demographic and social/career obstacles for polar researchers over time.

3.2 Near-Term Strategies

Recommended near-term strategies are options that OPP can implement more quickly and without major new financial or organizational commitments. The near-term recommendations include increased engagement with MSIs, support for early career researchers, institutional partnerships, training, REUs, and introductory field experiences.

3.2.1 Engaging MSIs to Diversify Polar Science

Efforts to diversify scientific disciplines should include engaging MSIs in mutually beneficial partnerships. MSIs enroll a large number and share of racially minoritized students

(National Academies of Sciences, Engineering, and Medicine 2019). Hence, the task force recommends inviting MSI scholars involved in polar science to identify strategies to support research and student opportunities at their institutions and at other MSIs. Information should be solicited from other agencies (e.g., NASA MUREP) that have experience in building connections and partnerships with MSIs. Other successful examples include NSFs HBCU Undergraduate Program (HBCU-UP), and the Computing Alliance of Hispanic Serving Institutions (CAHSI), one of the first large-scale INCLUDES projects. HBCU-UP is designed to enhance the quality of both undergraduate STEM education and research at HBCUs to broaden participation in the nation's STEM workforce.

The most underrepresented of the MSI community are HBCUs (Table 3). A review of OPP funding of HBCUs from 1987 to 2022 (see Appendix A) revealed that only 6 awards were made for a total of $2,353,792 (Table 2). No current awards to HBCUs were identified.

Award Number	University	Duration	Amount:
9713814	Howard University	Mar 15, 1998-1999	$20,751
1304684	North Carolina A&T State University	July 1, 2013 - 2017	$ 82,341
1543445	North Carolina A&T State University	Mar 15, 1998-1999	$396,414
0632210	Elizabeth City State University	Oct 1, 2007-2011	$142,417
0944255	Elizabeth City State University	April 1, 2010-2014	$627,115
1263061	Elizabeth City State University	July 1, 2013 -2017	$1,084,754
		Total	$2,353,792

Table 3: OPP awards to Historically Black Colleges and Universities (HBCUs) since 1987.

Recommendation 3.2.1.1:

Work collaboratively with NASA, HBCU-UP and CAHSI to build a polar component that identifies and nurtures participants who have interest in OPP related disciplines. OPP should examine ways to further invest in HBCUs with a history of OPP capabilities. OPP should explore mechanisms to create on-ramps to polar science and research at MSIs via institutional partnerships, encouraging new PIs, and engaging early career researchers with training opportunities (e.g., REUs or graduate training courses).

3.2.2 Early Career Researchers

Recommendations in this section would support early career researchers, increasing their success and retention in polar sciences. These include postdoctoral scholars, "soft money" researchers working in polar sciences, and new PIs writing proposals to OPP.

Effective Broadening Participation (BP) and Broader Impact (BI) elements can be difficult to design and incorporate into proposals, particularly for those entering the polar sciences for the first time. The creative but often *ad hoc* character of DEI aspirations in past OPP awards was discussed in Section 2.2. Further, there have been many recent attempts to involve Indigenous communities more deeply in research that is conducted on or has implications for their territories. To coordinate the involvement of Indigenous Peoples and to facilitate BP and BI more generally in polar programs, we recommend that NSF assemble a guide to strategies that PIs can consider in developing their proposals. Such a resource would highlight successful programs and promising practices that have been developed over time (many mentioned in this report) and help to avoid duplication of efforts while fostering long-term relationships with communities. The BP/BI information guide should identify model initiatives within OPP, under other NSF directorates, and in other agencies. If the proposed OPP DEI program officer position is created, that person would assume responsibility for managing and updating the BP/BI guide.

Recommendation 3.2.2.1:

Create a portfolio of Broader Impact and Broadening Participation opportunities. We envision this as a capability to reside with the new OPP DEI office.

The OPP Postdoctoral Research Program spans a crucial bridge between graduate school and full-time employment for researchers in the polar sciences. More and broader research experience with excellent mentors can supercharge the career of an early career scientist. Our subcommittee is pleased that the OPP resumed this important program. However, the two-year funding window may be overly restrictive for many prospective applicants who have child-care, elder-care, or other family responsibilities. Funding supplements for longer fellowship durations can broaden the pool of applicants by alleviating restrictions in these areas. Further, postdocs often lack community at their own institution and thus fall through the cracks in terms of professional and personal development and support. Such conditions provide barriers to diversification of postdoctoral scholars. Finally, most postdoctoral funding disincentivizes continuation at the applicant's doctoral institution, and while there are important reasons to move, there are also compelling reasons for early career scholars to stay put. These reasons may

be especially strong for Indigenous scholars, for example, many of whom desire advanced training but also want to remain close to their home communities and to community-based research.

We recommend several changes to the existing OPP Postdoctoral Research Program aimed at increasing our ability to attract, retain, and find academic employment for these polar researchers. First, we recommend extending the time window for support of postdoctoral researchers to three years, typical of most funded projects. This gives postdocs time to develop themselves for the job market while simultaneously making progress on their research. Second, we recommend that NSF provide programmatic support aimed at increasing a sense of community for postdocs within polar sciences as they move into the academic job market. Support could include consultations and workshops to prepare for academic interviews, grant writing, and leadership, and can take advantage of new funding from GOLD/GOLD-EN projects that might offer support aligned with postdocs' needs. Increased funding could facilitate cohort experiences, in which postdocs build community with one another and share knowledge and resources. In addition, OPP could facilitate a network of intra- and inter-generational scholars with diverse social identities. Third, we recommend that the career paths of these funded postdoctoral scholars be tracked for several years past their fellowship in order to get feedback on how the funding and programmatic support enabled their success. Fourth, we recommend that the review process for this program should not penalize polar scientists who wish to remain for a postdoc at their doctoral institution.

Recommendation 3.2.2.2:

Enhance programmatic professional development support for the OPP-Postdoctoral Program, make small changes to the operation of the program, and track postdoc career paths.

Scientific interest and societal relevance drive growth in the polar science workforce. For example, there are now more glaciologists employed in academic settings in the U.S. than ever before. This is in direct response to growing interest in sea level and the downstream impacts of melting snowpack and diminished sea ice cover. In addition, climate change makes the polar regions particularly vulnerable, elevating the importance of research funding. Despite these growing interests and needs, funding for OPP has remained essentially stagnant at ~7.5% of NSF's total budget since 2016. This squeeze in research funding is felt broadly by the entire polar community, but most acutely by researchers in soft-money positions. The goal of recruiting and retaining an increasingly diverse polar workforce is not likely to be successful where funding per researcher person is declining. Further, the stagnation of funding pits researchers against one another and creates a climate that is not conducive to welcoming new people into the discipline or establishing interdisciplinary collaborations. We recommend increased funding through actions such as an OPP-specific CAREER award (broadened to include soft-money research scientists) and supplements to existing grants in the form of support for students, diversity efforts, and REUs. In addition to more funding, increased transparency around existing funding opportunities is needed. While most OPP solicitations have removed deadlines, there are internal delays that can result in proposals sitting for six months or longer before being decided on. Such a wait is not tenable for soft-money researchers who may be out of a job if funding does not come through.

Recommendation 3.2.2.3:

Increase transparency of the proposal submission process and seek to expand funding opportunities for soft-money researchers.

3.2.3 Set-Aside Awards

Each Federal Agency has goals for awards to small businesses, including minority-owned, women-owned, and other types of small and disadvantaged companies. Small Business Program laws allow direct, sole source contracts to businesses that have been certified by the Small Business Administration, thereby reducing the barrier to entry into federal contracting programs for these emerging businesses. There is even a mentor-protégé program where large businesses partner with emerging small businesses to help foster their success. NSF and OPP should adopt a pilot program that supports direct awards to PI's or institutions that advance polar research while also supporting OPP DEI goals.

Recommendation 3.2.3.1:

Establish a pilot program for direct set-aside awards to Principal Investigators (PIs) and/or early career PIs at Minority Service Institutions. This set-aside program would be similar to programs that support small business participation in federal procurement.

3.2.4 Institutional Level Recruitment and Partnerships

The formation of institutional level partnerships can advance diversity and inclusion in polar science. Academic institutions or research institutes with a traditional strength in polar sciences could partner with PIs at MSIs and assist with developing proposals or including the MSI PIs in existing research projects. One important element of this recommendation is that OPP could invite groups to collaborate rather than to call for proposals. OPP could foster this approach through an inclusive workshop where the needs of minority or other underrepresented groups are expressed, emphasized, and supported.

The SC notes that in some cases well intentioned efforts to advance equity for marginalized groups can actually be harmful when processes are not set up for them to engage in spaces that were not created for them (Gonzalez et al. 2021). Therefore, efforts to incorporate perspectives of minority groups and institutions must involve intentionally structured prompts and a series of guidelines to ensure that all participants' voices are heard, or else DEI efforts will reproduce and perpetuate dynamics where dominant groups monopolize the creation of initiatives while overlooking minoritized perspectives.

Recommendation 3.2.4.1:

Form institutional level partnerships that are facilitated by OPP. These can include mutually beneficial partnerships between R1 and MSIs, a group of MSIs, or the development of an IDEAs-

type activities (see GOLD in Geosciences). In the style of Dear Colleague Letter NSF 20-112, the SC recommends the formation of these institution-level partnerships that would form strong partnerships with Arctic residents.

3.2.5 Training, REUs, and Field Experiences

One challenge is to increase the number of underrepresented students in REU site programs. The SC recommendations were developed by studying existing polar REUs and through two Learning Activities. The following REUs were examined:

1) University of Alaska Fairbanks (Award #1560372) Northern Gulf of Alaska Long Term Ecological Research REU Site Program (not hosting an REU in 2022).
2) Concord University REU Site Program (Award #1950842) hosts eight students each year in a program entitled "Architecture of Earthquakes in the Deep Crust: Arctic Expedition Science for Students."
3) University of Maine System (Award #1748137) Joint Science Education Project (JSEP) is a program for high school students from the U.S., Greenland, and Denmark.
4) Elizabeth City State University (Arctic and Antarctic REU #PLR-1263061 and CReSIS Glacial Exploration REU # ANT0944255) focuses on polar remote sensing data visualization with mathematics and computer science majors.

The two SC Learning Activities focused on Broadening Participation in GEO, presented by Brandon Jones and Lisa Rom, and on the CReSIS Arctic and Antarctic REU programs, presented by Linda Bailey Hayden. A minority professional organization, the Association of Computer Science Departments at Minority Institutions (ADMI), was a full partner in the CReSIS-AaA REU program with an appropriate budget.

Recommendation 3.2.5.1:

Establish new REU sites that focus on scientific areas where minorities are well represented such as computer science, biology, chemistry, remote sensing, and engineering. To increase participation from target groups, work to align these areas with OPP interest or offices.

Any model for new REUs should leverage a component of past programs that have a documented success in DEI, and further, REU programs that have expanded underrepresented participation (e.g., the Juneau Icefield Research Program, CReSIS-AaA, and JSEP).

Envision an articulated pathway for underrepresented students, which currently begins with REU to graduate school, be preceded by academic year training experiences hosted on MSI campuses. It is recommended that OPP explore opportunities to support academic year training programs housed on the campuses of the targeted HBCU/MSIs. Such programs should be designed to prepare students for the next level by providing them with exposure to the polar research community and building competency with relevant technology and language, including team-building skills. A pre-college component would enhance this effort allowing the impact to reach deeply into the targeted populations. Infrastructure components at these MSI host campuses should be anticipated. This includes need for student, staff, and curriculum development support.

Recommendation 3.2.5.2:

Set high DEI goals and prioritize a greater DEI outcome for all existing and future OPP large budget programs. The SC would like to draw attention to the success of the CReSIS-AaA REU and consider setting DEI goals for current and future STCs at the CReSIS-AaA DEI levels (e.g., women 42% to 63% and minorities 66% to 89% over a five-year period). Within these high-profile programs, both research outcomes and DEI outcomes should be equally impressive and worthy of front-page spotlights (Disseminating Science Research and Technology 2012).

Recommendation 3.2.4.3:

Expand opportunities for graduate students in both the Arctic and the Antarctic. Training programs that focus on the experience of the early career researcher, led by PIs trained in inclusive mentoring, would advance diversity in polar sciences, and over time would mirror the success of the undergraduate-focused site REU programs across NSF.

3.2.6 Graduate Fellowships

The NSF Graduate Fellowship Program (GRFP) provides a unique opportunity for students to obtain independent funding. Students who receive GRF awards are more competitive for graduate admission and have greater flexibility because they are not beholden to advisor-controlled funding. The GRF provides a means to counter implicit bias and an avenue to switch advisors or graduate programs to a more supportive situation.

Yet, the potential for the GRF to serve underrepresented groups is limited in several ways. First, students are notified of their awards in late April, near the end of the admissions cycle. By that date many graduate schools have completed admissions decisions and may not have space, even if they have interest. The late notification date was, evidently, implemented on the grounds that universities should first accept students on their merits and secondarily on funding, but this takes agency away from the student who has received a GRF award.

Second, the requirements that GRF applicants must have "completed no more than one academic year of full-time graduate study" and that their one application is submitted "either in the first year or in the second year of graduate school" severely restrict the type of student who can apply. They mean that a student cannot have a Master's degree when applying and would have had to have had an exceptional undergraduate research experience with great mentorship and guidance in order to be able to write a competitive GRF proposal so early in their academic career. A more equitable and inclusive set of application requirements would remove the restriction on the number of years a student has been in graduate school. This would allow a more varied path to academia for students from underrepresented groups or from a lower socioeconomic status, who could maintain eligibility to submit a GRF proposal when they are ready. The subcommittee notes that NASA does not restrict the number of years a student has been in graduate school when applying for the FINESST program, a funding opportunity similar to GRFP.

Third, GRF spending is restricted to full years; a student cannot, for example, use one year of GRF funding over two years, making it more difficult to take advantage of other funding

and educational opportunities. A student who, for example, wishes to gain teaching experience through a one-semester teaching assistantship or to join an austral summer field expedition separate from their main research, could not defer the GRF award for a semester; instead, they would have to delay it for an entire year. Similarly, they could not choose to take time off (e.g., to care for a relative) without either deferring the GRF for an entire year or expending the funds while not making progress on their research. While quantitative evidence specific to NSF-supported research is limited, there is clear empirical evidence showing, for example, that Black students in natural sciences and engineering are less likely than others to be supported with research assistantships, i.e., they rely more on TAs or are not funded (https://www.science.org/doi/pdf/10.1126/science.acx9691). Racial disparities in NIH funding are also clear (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3412416/) and have led to a recommendation for increased, targeted funding at all levels (https://acd.od.nih.gov/documents/reports/DiversityBiomedicalResearchWorkforceReport.pdf).

Finally, anecdotal evidence shows that all of these issues have impacted Fellows in polar research, with particularly strong impacts for underrepresented groups who have more limited resources, have had fewer extra training experiences such as fieldwork, and who are more likely to be primary caretakers. These stressors could be addressed by the following recommendations.

Recommendation 3.2.6.1:

Increase the flexibility of use of the NSF Graduate Fellowship through the following mechanisms: 1) establish earlier notification (e.g., February) for all NSF Graduate Research Fellowships; 2) encourage NSF to modify the strict requirements on the timing of GRFP applications; 3) allow NSF Graduate Research Fellows to use their fellowship funding more flexibly – for example, quarter-by-quarter or semester-by-semester rather than having to opt-in or opt-out for an entire year at a time; and 4) increase the total number of GRFs in polar science. OPP should explore avenues for directly funding a number of GRFs aimed at increasing diversity in polar research, similar to the recommendation for the Postdoc program, and 5) in order to create on-ramps to polar science, work with the NSF GRFP program to develop an OPP training experience comparable to Graduate Research Opportunities Worldwide (GROW) (https://beta.nsf.gov/funding/opportunities/graduate-research-opportunities-worldwide-grow) or the Graduate Research Internship Program (GRIP) (https://www.epa.gov/research-fellowships/nsf-graduate-research-internship-program-grip-graduate-research-fellowship-0).

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List of Learning Activities
Conducted by the OPP AC Subcommittee for Diversity, Equity, and Inclusion

Learning Activity 1:
Title: GEO Broadening Participation Programs
Presenters: Lisa Rom & Brandon Jones (NSF)
Date: 18-Dec-20

Learning Activity 2:
Title: NASEM: Minority Serving Institutions Report:
Presenter: Dr. Anne-Marie Nunez
Date: 19-Jan-21

Learning Activity 3:
Title: Overview of the Alaska Native Science & Engineering Program (ANSEP)
Presenter: Dr. Herb Schroeder
Date: 21-Jan-21

Learning Activity 4:
Title: Overview of the NSF Committee on Equal Opportunities in Science and Engineering CEOSE
Presenter: Dr. Ryan Emanuel
Date: 4-Feb-21

Learning Activity 5:
Title: Infusing Diversity into Arctic and Antarctic Programs
Presenter: Dr. Linda Hayden
Date: 18-Feb-21

Learning Activity 6:
Title: OPP Current Efforts in DEI
Presenters: Karla Heidelberg, Colleen Strawhacker, Renee Crain, Jennifer Mercer, Allen Pope, Dave Sutherland, Mike Jackson, Margaret Knuth, Mike Gencarelli
Date: 1-Apr-21

Learning Activity 7:
Title: Culture and Community
Presenter: Dr. Rebecca (Bec) Batchelor
Date: 27-Jun-21

Learning Activity 8:
Title: Indigenous Knowledge & Co-Production of Knowledge
Presenter: Dr. Carolina Behe
Date: 10-Jul-21

Learning Activity 9:

Title: Ensuring Equity in Incorporating Indigenous Knowledge into Research: Best Practices from Alaska
Presenter: Dr. Jessica Black
Date: 26-Aug-21

Learning Activity 10:

Title: GEOFORCE
Presenter: Leah Turner
Date: 8-Nov-21

Learning Activity 11:

Title: Best Practices for Broadening Participation at NASA
Presenter: Dr. James Harrington
Date: 6-Dec-21

Appendix A:
Analysis of Office of Polar Programs Awards to Minority Serving Institutions

The NSF online awards database (https://nsf.gov/awardsearch/advancedSearch.jsp) was searched for all awards (current and expired) made by the "OPP-Office of Polar Programs" ("NSF Organization" field), returning a total of OPP 7,419 awards from 1987 to 2022. These data were downloaded as three separate Excel spreadsheets because the download limit is 3,000 results, then combined.

All 7,419 OPP grants were individually cross-checked with a list of Minority Serving Institutions (Rutgers Graduate School of Education 2020; https://cmsi.gse.rutgers.edu/content/msi-directory) to determine if the awardee organization (as listed in the "Organization" field) was an MSI, and if so, which type (AANAPISI, ANSI, TCU, HIS, ANNH, NASNTI, HBCU, PBI) or combination of types. Awardees that were non-profit Alaska Native organizations were designated as AKN. The total number of awards to MSIs and AKNs was 1,588.

For purposes of the analysis, a new field for MSI/AKN type was added to each record ("Type"). A new field for calendar year award date ("Year") was also added to each record ("Year") based on the start date ("StartDate") as listed in the NSF download.

*There is currently no way to directly search the NSF online awards database for grants made to MSIs or AKNs; it is recommended that this field be added for future tracking of these awards.

Data and results of analysis are included in the separate Excel spreadsheet under the following tabs:

> Tab 1: Compiled data for all OPP awards to MSIs and AKNs, sorted by name of the recipient organization (n=1,588).
>
> Tab 2: Pivot table and chart of MSI awards, AKN awards, and non-MSI awards by year, 1987-2022.
>
> Tab 3: Pivot table and chart of total MSI and AKN awards, 1987-2022.

Appendix B: Analysis of Broadening Participation in Office of Polar Programs Awards

The NSF online awards database (https://nsf.gov/awardsearch/advancedSearch.jsp) was searched for all awards (current and expired) made by the "OPP-Office of Polar Programs" ("NSF Organization" field) with the keywords "broadening participation" in the title or abstract ("Keyword" field), returning a list of 1,421 awards from 1987 to 2022.

Search and analysis results are shown in the separate Excel spreadsheet under the following tabs:

Tab 1: The 1,421 results were downloaded in Excel and sorted by "Program." A new variable "Year" was added for sorting, derived from "StartDate."

Tab 2: A pivot table and graph were generated from the data in Tab 1 to show the number of OPP BP awards per year.

Tab 3: A pivot table was generated from the data in Tab 1 to show the number of OPP BP awards by type (standard grant, fellowship, interagency award, etc.).

Tab 4. Pivot tables were generated from the data in Tab 1 to show awards by program and area (Arctic, Antarctic, or both).

Appendix C: Map of the Network Resources and Training Site (NRTS) model for developing MSI infrastructure