# Strengthening and Diversifying the Federal STEM Workforce

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# Chapter 1: Introduction

From 2016 to 2020, thousands of scientific experts left, retired, or were forced out of the federal agency workforce—at least in part because of challenges faced under a science-unfriendly administration—and were not replaced by new hires (Carter, MacKinney, and Goldman 2021). The federal government's ability to fully staff its scientific workforce affects the nation's health and safety, because government scientists inform important decisions that keep the air and water clean, ensure access to vaccines to stave off serious illness, and make communities more resilient to natural disasters like floods and wildfires.

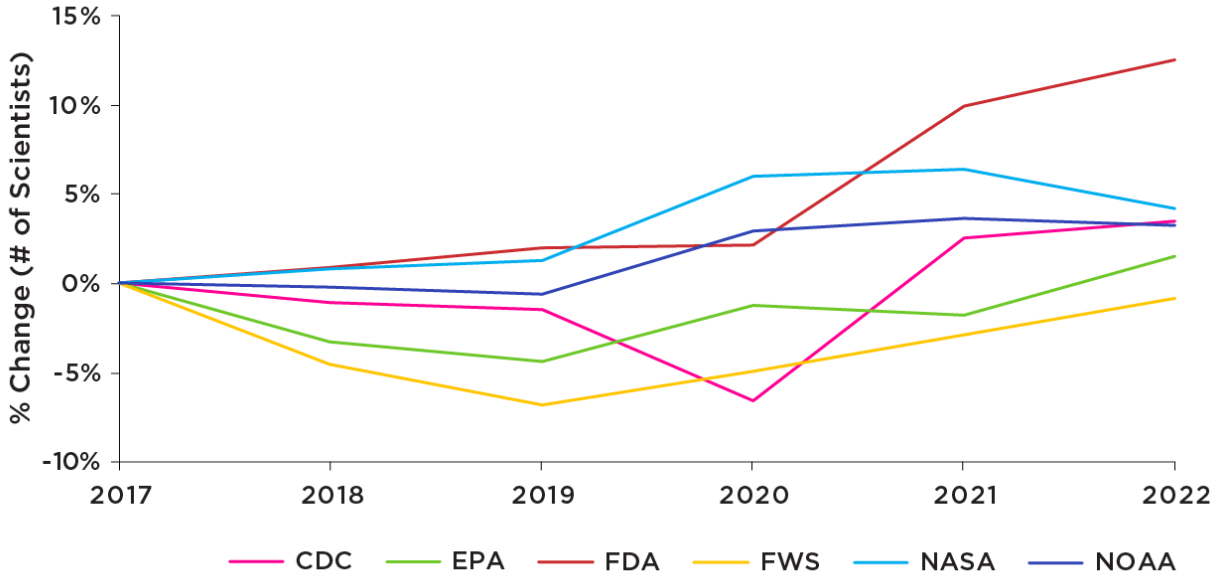
A loss of federal scientific capacity not only impacts government decisions that affect public health and safety, but also affects the quality of scientific work. When organizations lose employees, the workload does not decrease. Without enough staff, an organization's existing employees are often burdened with a heavier workload that can result in burnout, higher levels of stress, lower performance, and lower quality of work (Maslach and Leiter 2016). Maintaining the integrity of scientific research also is challenging under conditions of high workloads, limited capacity and tools, and fast turnaround.

## Current State of the Federal Government's Scientific Capacity

Recently, there has been good news for the federal government's scientific capacity since losses began during the Trump administration. A new Union of Concerned Scientists (UCS) analysis using data from the US Office of Personnel Management (OPM 2022a) found that the number of federal scientists increased across six major science-based federal agencies from 2017 to 2022 (Figure 1). However, some agencies, such as the Environmental Protection Agency (EPA) and the Fish and Wildlife Service (FWS), needed five years to rebuild its scientific capacity back to 2017 staffing levels. In other words, it took five years for these federal agencies to restaff after losing scientific experts during the Trump administration.

While it is a positive development that staffing levels for science, technology, engineering, and mathematics (STEM) personnel have returned to 2017 levels, evidence suggests that there is currently not enough scientific capacity for federal agencies to meet their missions effectively. According to a survey of federal scientists released in 2023 by UCS, the scientific workforce struggles to meet work demands (Desikan and Carter 2023). Fifty-nine percent of surveyed scientists (982 respondents) reported noticing staff departures and retirements, or hiring freezes, in the past two years. Of these respondents, 88 percent (868 respondents) agreed that a lack of capacity made it difficult to fulfill their agencies' science-based missions.

Figure 1. Percent Change of STEM Professionals since 2017 at Six Federal Agencies




*From December 2020 to December 2021, both Centers for Disease Control and Prevention and Food and Drug Administration experienced sharp increases in the hiring of scientific experts (9.8 and 7.6 percent, respectively). However, both EPA and FWS first experienced a loss of scientific experts, with a low point in 2019, and then a recovery period, requiring until 2022 to get back to staffing levels seen in 2017.*

*Note: Years represent December 2017 to December 2022. Please see the appendix for a more detailed description of the methodology.*

*SOURCE: OPM 2022a.*

Across the majority of agencies surveyed, respondents chose limited staff capacity as the greatest barrier to science-based decision-making, selecting it over 15 other possible answers. At the Food and Drug Administration (FDA), an exception, limited staff capacity ranked as the second greatest barrier. According to OPM data, the FDA's number of scientists grew far more than any other agency observed from 2017 to 2022 (Figure 1).

Sixty-two percent of federal scientists surveyed said that they experienced burnout in the past two years, and 70 percent of those who reported burnout said it was because of staff capacity (Desikan and Carter 2023). These results appear to mirror findings showing widespread burnout among academic scientists. A 2021 study by *Nature* found that 42 percent of 3,200 scientists who responded to the journal's survey had sought help or wanted to seek help for job-related anxiety or depression (Woolston 2021).

Workplace morale for federal scientists may be tied to an agency's culture of scientific integrity, that is, whether an agency has safeguards in place to protect scientists and their work from inappropriate political interference. A 2022 report by the White House's National

Science and Technology Council stated that "an environment characterized by weak scientific integrity can further undermine federal science by making it more difficult for federal agencies to attract, recruit, and retain a diverse workforce of highly qualified scientists and engineers" (SI-FTAC 2022).

Goldman et al. (2020) surveyed over 4,200 federal scientists in 2018 and found that federal scientists' perceptions of scientific integrity appeared to be influenced by the degree to which that they felt valued and effective in their workplaces and by their perception of the trustworthiness and competence of agency leadership. A follow-up study in 2022 of over 1,800 federal scientists similarly found a positive link across job effectiveness, perceptions of scientific integrity, and workplace morale (Desikan and Carter 2023).

Taken together, this evidence indicates that strengthening scientific integrity policies at federal agencies may have a knock-on effect of making a federal agency a more attractive environment for recruiting federal scientists and increasing retention.

## Diversity, Equity, Inclusion, and Accessibility in the Federal STEM Workforce

On June 25, 2021, President Joseph Biden signed the Executive Order on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce (Office of the US Presidency 2021a). It states, "The Federal Government should have a workforce that reflects the diversity of the American people. A growing body of evidence demonstrates that diverse, equitable, inclusive, and accessible workplaces yield higher-performing organizations."

Among the many good, actionable steps this executive order outlines is a government-wide approach to diversity, equity, inclusion, and accessibility (DEIA). It charges the executive branch with doing better in partnering with academic institutions and organizations representing early career scientists from historically excluded populations.

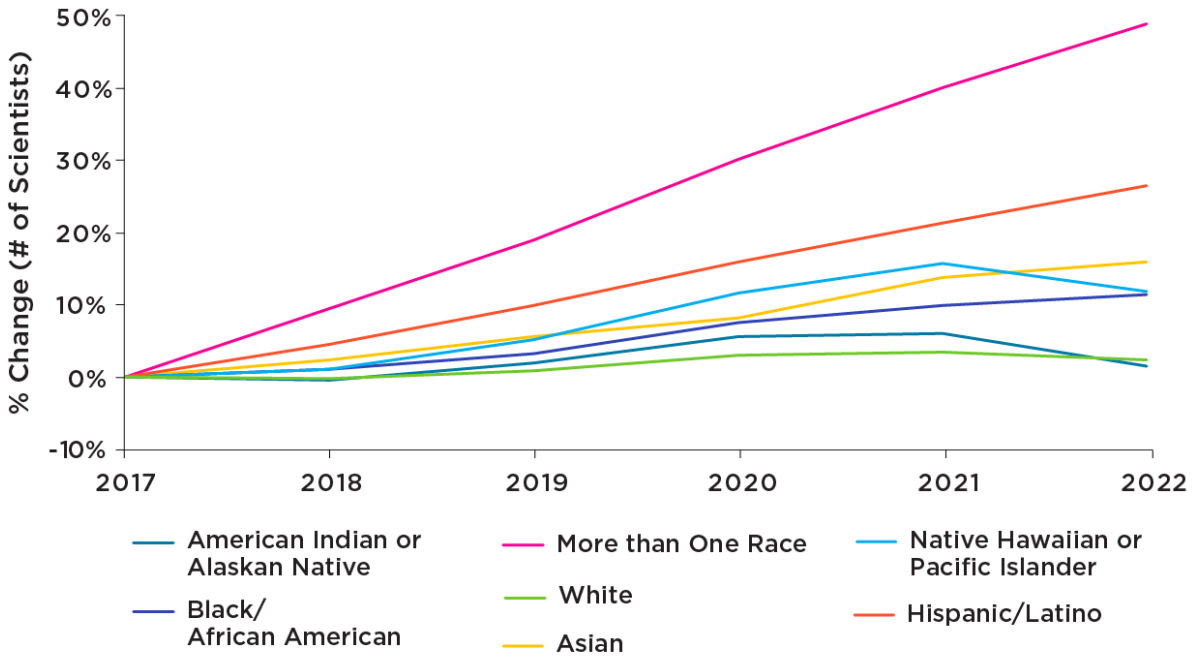
The executive order put several initiatives into action, including those assessing the current state of DEIA within the workforce, developing strategic plans to eliminate barriers faced by historically excluded employees, expanding DEIA training throughout the federal workforce, addressing workplace harassment, advancing pay equity, and building a more diverse pipeline through recruitment partnerships with minority-serving institutions (MSIs; Office of the US Presidency 2021b).

In the United States, the STEM workforce is gradually diversifying, with increasing representation of women and individuals identifying as Black, Indigenous, and people of color (BIPOC; NCSES and NSF 2023). However, evidence suggests that the scientific workforces at federal agencies, to varying degrees, continue to lack representation of staff who identify as BIPOC; lesbian, gay, bisexual, transgender, queer, questioning, intersex, asexual (LGBTQQIA) LGBTQQIA; people with disabilities; women; and other historically marginalized groups. These inequities have existed for a long time. For instance, the Department of the Interior (DOI) has known that it had a lack of diversity in its staff since at least the 1930s (Jacobs and Hotakainen 2020).

A 2021 report from the US House of Representatives Science, Space, and Technology Committee concluded that racial and ethnic employment gaps exist within the federal agency

STEM workforce. The report also found that gender employment gaps are more pronounced within the federal STEM workforce than in the larger federal workforce, especially within the engineering fields (HCSST 2021).

Figure 2. Percent Change of Agency STEM Professionals from 2017 to 2022 by Race and Ethnicity




*BIPOC-identifying scientists increased as a percentage of STEM professionals, with the largest gains observed for individuals who identified as more than one race, Hispanic/Latino, or Asian (49.0, 26.5, and 16.0 percent, respectively). However, from December 2021 to December 2022, agencies experienced a sharp decrease in the percentage of STEM professionals from two groups: American Indian or Alaskan Native and Native Hawaiian or Pacific Islander (4.2 and 3.2 percent, respectively).*

*Note: Data are from all federal agencies, from December 2017 to December 2022. The "unspecified" group had inconsistent reporting across agencies; these data are not shown in the graph (the category made up 0.5 percent or less of STEM professionals every year). Please see the appendix for a more detailed description of the methodology.*

*SOURCE: OPM 2022a.*

Inequities in the federal STEM workforce can differ across regions. Arismendi and Penaluna (2016) found that the Midwest had the largest representation of BIPOC scientists in the fisheries department of federal agencies, while the West had the lowest representation. However, the South and Midwest had the lowest representation of female scientists in the fisheries department, while the Northeast had shown the most progress in the inclusion of female scientists. The study defined the scientists who work at the fisheries department of federal agencies as white-collar US federal employees between General Schedule-11 (GS-11)

to GS-15 employed as a Fish Biologist at any agency or who worked at FWS. It is not clear from current research why such regional discrepancies exist, but bias, cultural and socioeconomic factors, and discrimination have played a role when this phenomenon has been observed across other work sectors (OSTP and OPM 2016; IWGIS 2021; GAO 2020a).

Data on LGBTQQIA individuals and people with disabilities in the federal scientific workforce are lacking, but research from academia indicates that people who identify as LGBTQQIA or who have disabilities have long been marginalized in STEM professions (Freeman 2020; Bernard 2021).

The civilian labor force has become more racially and ethnically diverse and shown an increase in the number of women during the past three decades, though staff diversity varies across occupations and workplace sectors (Lam 2015). Recent data from OPM show that the federal STEM workforce has diversified since 2017 (Figure 2). However, these numbers do not reflect where staff from historically excluded populations serve in the federal government, an important consideration given that BIPOC individuals are typically hired into lower-paying roles, compared to their White counterparts (Williams 2019). This is also the case for federal STEM jobs (Edwards et al. 2021).

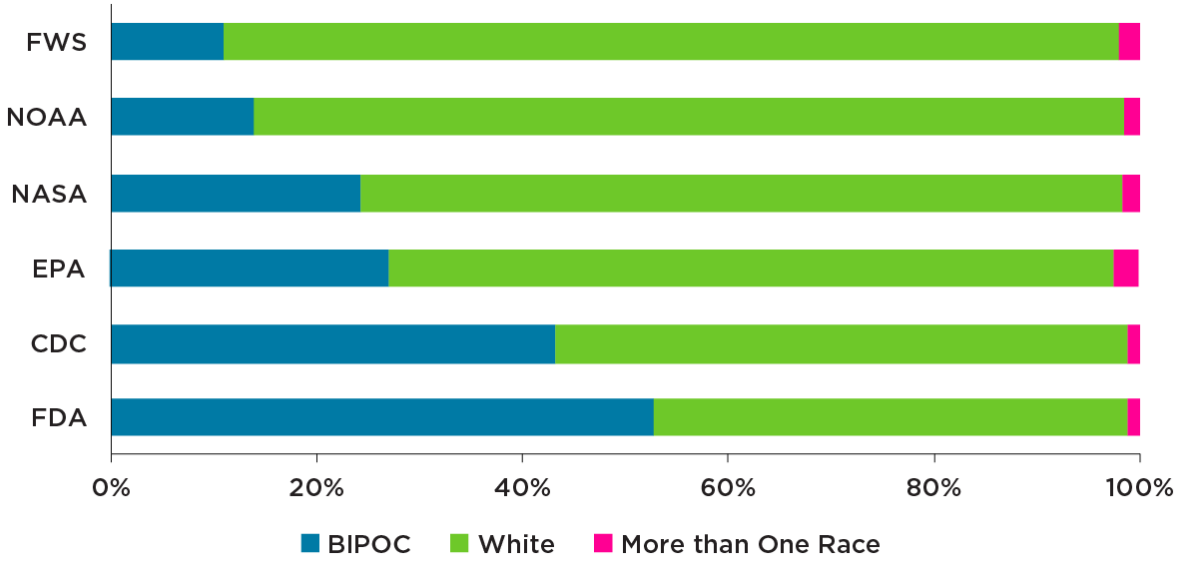
Furthermore, these numbers do not reveal whether some federal agencies are more diverse than others—an issue elucidated by UCS's 2023 federal scientists survey. Seventy-four percent of FDA scientists surveyed perceived the STEM workforce at their agencies as reflecting the nation's diversity. However, scientists surveyed at FWS and the National Oceanic and Atmospheric Administration (NOAA) perceived that their agencies lacked a diverse STEM workforce, and most scientists surveyed did not perceive their senior leadership as diverse (Desikan and Carter 2023).

The UCS analysis of the latest demographic data available from OPM, from December 2022, also reflects these findings and shows that racial and ethnic inequities continue to persist at agencies (Figure 3). In 2022, two agencies, FWS and NOAA, had an overrepresentation of White-identifying individuals within the STEM workforce (85 percent for both agencies), compared to the representation of BIPOC individuals (11 percent for FWS and 14 percent for NOAA). These findings may reflect a larger problem in geoscience and earth science, which are among the least diverse across all scientific fields; for instance, nearly 90 percent of people receiving doctoral degrees in geoscience are White (Goldberg 2019).

In comparison, the Centers for Disease Control and Prevention (CDC) and FDA both had a strong representation of BIPOC-identifying individuals within the federal STEM workforce (43 and 52 percent, respectively; Figure 3). For context, a Pew Research Center study found that 33 percent of scientists in health-related STEM occupations identify as BIPOC or mixed race (Fry, Kennedy, and Funk 2021). Taken together, this research appears to indicate that the CDC and FDA STEM workforces may be more diverse than their academic counterparts in health-related STEM professions.

The US Census 2020 showed that White individuals who did not identify in any other racial and ethnic category made up 64 percent of the adult population (18 years and older; Jones et al. 2021). The last time that the White population not of Latine origin represented more than 80 percent of the US population was during the 1970 census (Gibson and Jung 2002).

Figure 3. Percentage of BIPOC, White, and Multiracial STEM Professionals by Agency




*Percentage of STEM professionals who identify as BIPOC, White, or more than one race at six federal agencies. FWS and NOAA had an overrepresentation of White-identifying individuals within their STEM workforces (85.5 and 84.7 percent, respectively) compared to BIPOC individuals (10.8 and 13.9 percent, respectively). CDC and FDA both had strong representation of BIPOC-identifying individuals in their STEM workforces (43.2 and 52.7 percent, respectively).*

*Note: Data are from December 2022. Only EPA, FWS, and NOAA included the "unspecified" racial and ethnic group; data are not shown in the graph (the "unspecified" category made up 1.7 percent or less of STEM professionals at each agency). The BIPOC category consists of the following racial and ethnic groups: American Indian or Alaskan Native, Asian, Black/African American, Hispanic/Latino, and Native Hawaiian or Pacific Islander. Please see the appendix for a more detailed description of the methodology.*

*SOURCE: OPM 2022a.*

The government's workforce is not unique; diversity in the US STEM workforce has experienced very little change during the past decade. According to a National Science Foundation (NSF) report on diversity in the STEM workforce, only incremental changes in diversity have occurred from 2011 to 2021 (NCSES and NSF 2023). During this time, individuals identifying as Black have seen their representation increase in the STEM workforce, from 7 percent in 2011 to 9 percent in 2021, although the Black population represents 13.6 percent of the US population. The representation of people identifying as American Indian or Alaska Native—racial categories that together make up 1.3 percent of the US population—increased by only 0.2 percent over this same period, from 0.4 percent in 2011 to 0.6 percent in 2021 (NCSES and NSF 2023; US Census Bureau, n.d.).

However, efforts to diversify STEM fields have lagged behind those of other previously White male–dominated professions (Cech and Waidzunas 2021). According to a 2021 analysis by the

Pew Research Center, Black and Latine adults are less likely to earn degrees in STEM than in other fields, and they continue to make up a lower share of STEM graduates relative to their share of the adult population. The same analysis showed that while women make up half of those employed in STEM jobs, representation varied widely across different STEM professions, with women representing three-quarters of health-related jobs and only one-quarter or less of computing and engineering jobs (Fry, Kennedy, and Funk 2021).

Diversity in STEM professions also depends on whether the pipeline into the profession—that is, college or graduate students majoring in STEM—consists of a diverse student pool. Also affecting this issue, a 2023 US Supreme Court case that ended affirmative action for college and university admissions will likely decrease the diversity of student bodies, including students obtaining STEM degrees. Affirmative action ended at the state level in California in 1996, and ensuing state university representation levels allow a glimpse of the Supreme Court decision's impact. In 1996, California passed Proposition 209, which ended affirmative action in the state's public universities and negatively affected racial and ethnic diversity at public universities. The state's most selective universities—University of California, Los Angeles and University of California, Berkeley—saw nearly 40 percent declines in the enrollment of Black and Latine students. Evidence suggests that Proposition 209 decreased statewide workforce inclusion of people of color and women (NPR 2023; Sumner et al. 2008).

There is clearly room to increase the number of scientific experts employed by the federal government as well as the diversity of that workforce. Given the critical role that these experts play, by informing government decisions that impact the health and safety of all residents' lives, everyone benefits from a stronger federal STEM workforce. Research also shows that more diverse groups consider a broader set of information and make decisions that are more effective (Sommers 2006; Ellemers and Rink 2016).

The call for a more a diverse federal workforce continues to grow; for instance, in 2023 the EPA's largest union—the American Federation of Government Employees (AFGE) Council 238—pushed the agency to include a DEIA article in its union contract, a measure supported by 44 House representatives (Bogardus 2023). A stronger and more diverse federal STEM workforce is not only a moral imperative, but a transition with a lasting positive impact for public and environmental health.

## A Roundtable Discussion to Address These Issues

This report is the result of a UCS roundtable discussion held February 23–24, 2023, with the goal of bringing experts together to discuss the best practices for strengthening and diversifying the federal STEM workforce using equitable and evidence-based approaches.

The roundtable's panel of seven experts consisted of current and former federal scientists, individuals from academic institutions, and nonprofit experts. These individuals were brought together because of the diversity of their experiences on this issue, whether that experience involved their understanding of how university mentors coach students on their careers or their hiring of individuals into the federal government as leaders in a federal agency. Over two days, this roundtable of experts had open and honest conversations about the current challenges to strengthening and diversifying the federal STEM workforce, including issues such as compensation, mentoring, recruitment, retention, and salary. This report includes their recommendations for addressing these challenges.

While the report discusses various practices that can help recruit and retain diverse STEM professionals in the federal workforce, the authors have designated two areas as out of the scope of this report: human resource management processes and procedural challenges associated with navigating USAJOBS.gov. The panel felt that these areas merit an investigation and a concerted effort for revision and reform. For example, virtually all the experts noted the USAJOBS.gov tool as a major barrier to attracting new talent, based on their extensive contacts with early and midcareer scientists.

Chapters 2, 3, 4, and 5 summarize the current challenges and barriers to strengthening and diversifying the federal STEM workforce. These chapters reflect a comprehensive review of studies, reports, and federal programs on these issues. Chapter 6 provides issue-specific recommendations to address the challenges. Many of the experts who participated in UCS's roundtable discussion authored the subsections of chapter 6.

# Chapter 2: Diversifying the Federal STEM Workforce

With the US population continuing to diversify (Jones et al. 2021), recruitment of the best and brightest scientists into the federal government necessitates an equity-driven approach that centers the strong recruitment of historically excluded populations into the federal STEM workforce. Scientific agencies that fail to diversify are not only at risk of entrenching and exacerbating existing inequities but are also at risk of cultivating a workforce that is less capable of adapting to new opportunities and challenges.

Failure to diversify scientific workplaces can arise from—and further perpetuate—deeply ingrained cultural biases that favor White men over people with other racial or gender identities. Studies have shown that when scientific university faculty consider students for research positions (Milkman, Akinola, Chugh 2015) or postdoctoral jobs (Moss-Racusin et al. 2012; Eaton et al. 2020), they significantly favor White- and/or male-sounding names over names that signal the applicant is of another racial or gender identity.

The COVID-19 pandemic has likely exacerbated these inequities. Some preliminary evidence suggests that female scientists—especially early career professional women, women of color, and women with caretaking responsibilities—faced additional pandemic burdens or stressors that may have had negative long-term consequences on their STEM careers (NASEM 2022).

## Historical Injustices Account for the Lack of Diversity in Federal STEM Workforces

A lack of diversity in the federal scientific workforce is ultimately rooted in science's long and troubled history of entanglement with racism and colonialism (Nobles et al. 2022). The tools of science were once used to promote racist theories, such as eugenics (Rutherford 2021), that directly led to the dehumanization of and violence against BIPOC communities and other marginalized people. These kinds of theories went hand in hand with the practice of restricting the scientific profession to people who were cisgender male and White. People who did not fit in this narrow demographic window were, at best, viewed as people without the potential to become a scientist or, at worst, people whose only real value to the sciences was to be experimented on (McVean 2019).

When strict barriers on who could become a scientist began to fall in the 20th century, people from historically marginalized groups still regularly faced discrimination, harassment, intolerance, and other barriers that prevented them from being hired, staying on, or being promoted within scientific workplaces, including federal agencies. Even when scientists from marginalized groups managed to overcome these hurdles and make notable contributions to their scientific fields, they were often forgotten or ignored by popular culture and left out of books documenting science history (Dominus 2019).

While this report will not exhaustively cover the historical issues of DEIA in the federal workforce, it is important to revisit some examples of how the federal government has

approached these issues. The federal government has a long history of leading the way in hiring and promoting BIPOC and discriminating against historically excluded individuals, oppressing them, and keeping them in lower-paying government positions (Rung 2002). Covering diversity in the federal workforce from 1933 to 1953, the historian Dr. Margaret C. Rung noted that the federal workforce grew during this time from 51,020 to 2,435,804, becoming one of the largest US employers. Because of the period's intense economic and political crises, in the 1930s and 1940s, the federal government reformed the civil servant workplace, an effort that included promoting social justice and attempting to address discrimination. Dr. Rung (2002) wrote, "They rejected overt scientific racism; revisited their aversion to unionization and the hiring and promotion of women; and sought to elevate the prestige of civil service jobs."

The government has established several policies and practices since the 1930s to address harassment and discrimination in the federal workforce and to diversify the workforce. These strategies include affirmative action and the Equal Employment Opportunity Commission (EEOC, n.d.a). In the 1980s, Commissioner of the EEOC J. Clay Smith Jr. gave a speech titled "Managing the Federal Workforce: A Quest for Diversity" to the Department of Health, Education and Welfare in Marriottsville, Maryland (Bernstein 2018; Smith 1980). In this speech, Smith discussed why the Civil Service Reform Act mandated the Federal Equal Opportunity Recruitment Program, even with affirmative action requirements in federal hiring: "The answer is that although affirmative action has been required in the Federal government since 1972, some problems still exist. For example, minorities and women are still to a great extent, concentrated in lower grades and non-professional occupations. Some groups such as the American Indian—are almost absent from the Federal workforce" (USDA 1984; GAO 1980). He went on to state, "There are still systemic, non-job-related barriers to equal employment opportunity in the Federal sector" (Smith 1980).

## DISCRIMINATION IN THE ENVIRONMENTAL MOVEMENT

One clear example of the field of science's discriminatory legacy can be seen in the conservationist movement of the early 20th century and its impact on federal policy. The movement's leaders not only advocated for federal efforts to conserve and manage natural resources, but also were racist eugenicists and frequently declared that the country's natural wonders were for the White aristocracy only (Jacobs and Hotakainen 2020).

Many of these leaders had close ties to President Theodore Roosevelt and influenced his conservation efforts, such as the establishment of the National Park System (Purdy 2015). The Roosevelt administration's conservation efforts directly led to the displacement of Indigenous peoples from their lands; according to environmental historian Theodore Catton, 86 million acres of Indigenous peoples' lands were transferred to the National Forest System, with much of that transfer occurring during President Roosevelt's administration (Evans 2022).

The field's racist history continues to impact federal agencies involved in conservation science. For instance, in 2021, DOI Secretary Deb Haaland—the first Indigenous person to serve in the US cabinet—had the department remove a derogatory word for Indigenous peoples from more than 650 place names for creeks, lakes, valleys, and other sites on federal lands (Chappell 2021).

The defining, conceptualization, and management of national parks by powerful White elites with racist ideologies contribute to current injustices in park accessibility (Jerry Lee et al. 2023). The National Park Service reported in 2020 that over the past 10 years, the racial makeup of visitors to national parks skewed heavily toward White individuals (77 percent) compared to people of color (23 percent; Ebbs and Dwyer 2020). This finding likely reflects a long history of the National Park System excluding and, in more modern times, failing to include BIPOC communities. And while there are current efforts at the National Park Service to examine and address these racial inequities, evidence suggests that structural patterns of procedural injustice at national parks continue to play a role in the decreased number of BIPOC visitors (Jerry Lee et al. 2023).

In another example of science's racist legacy, conservation and environmental science have traditionally failed to incorporate or have outright dismissed the Traditional Ecological Knowledge and scientific expertise of Indigenous peoples and local communities (Sax 2022). Indigenous peoples have been the stewards of biologically rich natural environments for millennia and have developed a wealth of knowledge and practices that can help with current environmental issues, such as climate change impacts, forestry management, and invasive species.

In 2021, the White House issued a memorandum on committing to elevate Indigenous Traditional Ecological Knowledge in federal scientific and policy processes (Office of the US Presidency 2021c). This memorandum marks one of the few times that the federal government has formally recognized Indigenous Traditional Ecological Knowledge as one of the many important bodies of knowledge that contribute to scientific understanding of the natural world.

## FAILURE OF SCIENTIFIC INSTITUTIONS TO REFORM AFTER GEORGE FLOYD PROTESTS

Science's history of systemic discrimination continues to play a fundamental role in why people from historically excluded and marginalized groups are less represented in STEM occupations. Even when scientific institutions promise that they will address long-standing injustices in their fields and create a more inclusive culture, these words often fail to translate into concrete actions.

The aftermath of the 2020 civil rights protests is a good example of this. In 2020, after the brutal killings of George Floyd and other Black Americans, a wave of protests occurred across the world, demanding a moment of reckoning regarding the entrenched, far-reaching, and violent nature of systemic racism. This reckoning included members of the scientific community who began to reevaluate their current and past roles in failing to address their fields' problematic legacies. A wave of scientific institutions in fields as varied as mathematics (American Mathematical Society 2023), physics (American Physical Society 2020), and psychology (American Psychological Association 2021) issued statements apologizing for their part in perpetuating injustices and pledging that they would do better.

These statements were understandably met with skepticism from Black and other historically marginalized scientists who have directly experienced the hardships of exclusion in the sciences and the false promises of scientific institutions pledging to reform. One analysis looked at 127 statements from scientific societies in the wake of the 2020 protests for racial justice and found that only 10 statements announced clear commitments to action (Tormos-

Aponte 2022). However, even among the 10 statements that listed concrete reforms, the commitments were not of a comprehensive nature and mostly consisted of forming committees and task forces, or conducting diversity trainings and meetings with senior leadership.

Another analysis that examined 56 statements from leading US medical schools came to the same conclusions (Kiang and Tsai 2022). Even in the aftermath of one of the most pivotal civil rights protest movements in recent years, scientific societies largely responded with only passive forms of solidarity.

## Diverse Workplaces Are More Efficient

The federal government has both a moral necessity and practical imperative to achieve a more diverse and inclusive STEM workplace. Failure to diversify STEM workplaces at federal agencies not only fosters inequity and prevents historically marginalized populations from accessing opportunities in the sciences, but also disenfranchises entire STEM fields by preventing people with unique perspectives from innovating in these professions in ways that can benefit everyone.

Diverse work environments can improve an agency's ability to serve the public, decision-making, and productivity. An extensive body of evidence suggests that diverse groups make fewer factual errors, process information more carefully, are less likely to succumb to groupthink, and are more likely to suggest innovative and creative solutions (Rock and Grant 2016). These skill sets are a boon to STEM professions, which often require a collaborative approach to develop unique ideas, innovations, and solutions.

Diversifying STEM workplaces can boost work performance and engagement, improve research quality and health care, and foster innovation and growth (NASEM 2019a). For instance, public health agencies that employ a diverse workforce yield more innovative public health approaches, develop a greater variety of effective solutions to help address health disparities, and are more likely to employ strategies for culturally and linguistically diverse communities (Coronado et al. 2020).

Scientists who come from historically marginalized populations may be especially well suited to contribute innovative ideas to STEM workplaces. For instance, people with disabilities often develop innovative solutions to navigate a world that primarily caters only to able-bodied individuals, and scientists with disabilities can develop creative, diverse, and unique ideas that advance research (Serrato Marks and Bayer 2019).

# Chapter 3: Barriers to Increasing Federal Agency Representation of Scientists from Historically Excluded Groups

Workplaces for scientists, like other US workplaces, have systems that center and privilege White, straight, able-bodied, cisgender male perspectives over those of scientists from other identities or backgrounds. Because discrimination in the sciences is systemic and entrenched, people from historically marginalized groups can face a minefield of barriers at every stage of their STEM career, which may drive them out of the sciences altogether.

Intersectionality plays an important role in this pattern of disenfranchisement, leading to a double jeopardy effect for scientists holding multiple marginalized identities. In one study, despite all candidates having identical résumés, scientific faculty were least likely to want to hire postdoctoral candidates whose names reflected the identities of Black women, Latine women, and Latine men, compared with all other racial or gender identities (Eaton et al. 2020). Another study found that in STEM professions, LGBTQQIA people of color and LGBTQQIA people identifying as women were more likely than LGBTQQIA White people and LGBTQQIA men, respectively, to experience professional devaluation and harassment at work (Cech and Waidzunas 2021).

Leaders, managers, and other workers in scientific institutions often fear engaging in uncomfortable conversations on the barriers to retaining a diverse scientific workforce. To navigate these difficult conversations, experts recommend that institutions first understand the nature of the problem—that is, the types of barriers facing scientists from marginalized groups—before moving on to strategies to address the problem (Livingston 2020).

In general, members of historically excluded groups tend to face three types of barriers when they pursue STEM careers: The less diverse or inclusive a scientific workplace is, the less likely that the contributions and perspectives of marginalized groups will be acknowledged, considered, or prioritized; the greater the hostility or harassment that members of marginalized groups experience while on the job; and the more people from historically excluded communities will feel a lack of support and inclusion.

## Ignoring the Contributions of Diverse Scientists

Strong evidence suggests that research ideas or innovations suggested by scientists from historically excluded groups are less likely to be acknowledged, funded, or incorporated in their workplaces. One study tracked approximately 1.2 million doctoral degree recipients in various scientific fields from 1977 to 2015 and determined the doctoral students' rates of innovation and whether these contributions to knowledge translated into successful academic careers (Hofstra et al. 2020). The results showed that scientists of color and female scientists had more novel ideas but that these ideas were less likely to be adopted by the scientific

mainstream, which in turn resulted in fewer women and people of color holding prestigious academic positions.

Several studies have previously reported that scientists from historically marginalized groups are less likely to receive National Institutes of Health (NIH) biomedical grants than are White researchers (GAO 2018). To determine why this was occurring, Hoppe et al. (2019) found that the NIH funded fewer biomedical studies submitted by Black scientists than those of White scientists. They examined several potential reasons for this disparity and found that the types of studies submitted by the scientists may have had an outsize effect on funding rates. They found that, compared to White scientists, Black scientists were more likely to propose approaches (such as community interventions) and topic ideas (such as adolescent health, fertility, and health disparities) that the NIH awarded at lower rates. This effect accounted for 21 percent of the observed disparity.

These data suggest that scientific institutions' systems devalue ideas and contributions from scientists representing historically excluded groups. This bias may pressure such scientists to adopt scientific priorities centered in White cultural norms to advance their careers (Mervis 2019).

## Hostility toward Diverse Scientists

Scientists from historically marginalized groups are more likely to face peer-to-peer interactions that are difficult to navigate, harmful, or stressful, which can have an outsize impact on whether scientists from historically excluded groups stay in their profession. According to a Pew Research Center study from 2018, more Black (62 percent), Latine (44 percent), and Asian Americans (42 percent) reported experiencing racial or ethnic discrimination at their STEM workplaces than did White Americans (13 percent; Anderson 2018). More women working in STEM fields (50 percent) reported experiencing gender discrimination at their workplaces than did women working in non-STEM fields (41 percent; Funk and Parker 2018).

In a study of ecologists surveyed by the Ecological Society of America, scientists from historically excluded groups (BIPOC, female, LGBTQQIA, and/or people with a disability) were, on average, 1.5 times more likely than White, male, and/or non-LGBTQQIA scientists to encounter negative workplace experiences, including those that involved insulting behaviors, interpersonal mistreatment, and sexual harassment (Primack et al. 2023).

Individuals who have experienced sexual harassment are more likely to subsequently leave their jobs (GAO 2021). Over one-third of LGBTQQIA physicists surveyed by the American Physical Society considered leaving their scientific institutions in the last year, especially after reporting or observing an uncomfortable workplace climate or exclusionary behavior at their workplaces (Atherton et al. 2016).

Sometimes, these difficult interactions take the shape of overt hostility or harassment. For example, scientific institutions that conduct field research have often failed to protect scientists from harassment. Scientists who identify as BIPOC, female, or LGBTQQIA, or who have a disability, have reported facing harassment or violence during fieldwork assignments—which can take place at isolated and remote locations—and dealing with the failure of their scientific institution to investigate these incidents and hold abusers accountable for their actions (Pickrell 2020).

Harassment can be reduced when leadership at scientific institutions uses proactive approaches to stop harassing behavior. NOAA's Commissioned Officer Corps and its Office of Marine and Aviation Operations reduced sexual harassment complaints by 92 percent from 2018 to 2021 under the leadership of Rear Adm. Nancy Hann (Hotakainen 2023). Hann carried out a series of aggressive strategies, including seeking out and listening to staff concerns, terminating 23 people for misconduct (many of them senior mariners), hiring a Federal Bureau of Investigation agent to investigate cases, and bringing ships back to port before the end of their missions when allegations of misconduct were filed.

## Failure to Create an Inclusive Work Environment

Workplaces for scientists can fail to establish systems of support, foster an inclusive work culture, or make science jobs more accessible, which in turn can alienate, isolate, or otherwise harm the morale of scientists from historically marginalized populations. For instance, nondiverse science workplaces can lead scientists from historically excluded populations to feel stress about "being the only one," about coworkers tokenizing them in their workplaces, and about higher-ups assuming that they will take on extra duties to act as a role model and mentor for coworkers from historically excluded communities (Arismendi and Penaluna 2016; GAO 2018).

Since scientists from historically excluded populations are not a monolith, what constitutes inclusion or exclusion can vary. Therefore, it can be helpful to look at three groups that are marginalized in the sciences: scientists who are Indigenous and LGBTQQIA, and who have disabilities.

Indigenous scientists not only are marginalized in STEM professions, but can face feelings of exclusion and a lack of belonging when STEM institutions teach and practice science in a way that is incongruous with their lived experiences. Many Indigenous scientists have STEM knowledge that is rooted in naturalist traditions and is arrived at through direct experience, and therefore they may feel alienated by approaches to STEM that are not grounded in direct experience (Nelson-Barber and Trumbull Estrin 1995).

One study found that 38 percent of the Indigenous STEM students surveyed would choose not to pursue a science major if they believed it would require them to violate important Indigenous beliefs (Williams and Shipley 2018). Another study showed that Indigenous STEM students were more motivated by communal work goals than were White male STEM majors. Indigenous STEM students also had feelings of uncertainty and low motivation, seemingly because their STEM programs traditionally have a noncommunal work culture (Smith et al. 2014).

LGBTQQIA scientists can experience a unique set of challenges in their workplaces that stems from trouble identifying allies, the need to suppress their sexual orientation or gender expression, and a lack of support from their scientific institutions (Boustani and Taylor 2020). LGBTQQIA scientists are 30 percent more likely to experience career limitations, harassment, and professional devaluation than their non-LGBTQQIA peers (Cech and Waidzunas 2021). Around 30–50 percent of LGBTQQIA individuals in both STEM and non-STEM workplaces are not out with their identity, and 35 percent report that they feel compelled to lie about their identity at work (Fisher 2021).

Scientists with disabilities often face a distinct set of structural and cultural barriers that can prevent them from engaging in, feeling supported at, or joining their workplaces. Some of these barriers involve ableist design structures that physically prevent scientists with disabilities from carrying out their duties—for instance, laboratories that are not designed for use of a wheelchair or other mobility devices (Vasquez 2020). Other barriers center on a failure to provide reasonable accommodations to people with disabilities—for instance, discouraging teleworking and remote work, even though it has long been known that electronic communications can help bridge accessibility gaps for scientists with disabilities (Burgstahler 1994).

Scientists with disabilities may feel defined by their disability, misunderstood, or undervalued, all of which may prevent them from disclosing their disability to their coworkers. People with disabilities may encounter the medical model explanation of disability at STEM workplaces, which implies that there is something wrong with a person who has disabilities, that they are not a complete person, and that they need to be fixed by innovations in medical science (Heidt 2021).

## Politicization of the Federal Workforce

Scientists from historically excluded groups may face an additional barrier when working in a STEM field in a federal agency: a presidential administration that undermines the efforts of scientific agencies to uphold DEIA principles. Politicization of DEIA efforts can impact staff morale and lead to more-exclusionary workplaces.

For instance, in September 2020, the Office of Management and Budget (OMB) issued a memo that ordered a review of agencies' racial sensitivity and implicit bias trainings, which it called "divisive, anti-American propaganda" (Dawsey and Stein 2020). Soon after, President Donald Trump issued an executive order that stopped DEIA trainings across the federal government (Office of the US Presidency 2020). Because of the executive order, DEIA programs—such as those at the Department of Justice and the Department of Health and Human Services—closed across the federal government. These closures also occurred at organizations that received government funding, including companies, institutions of higher learning, and nonprofit organizations (Spiggle 2021).

And while President Biden revoked the executive order on his first day of office, the politicization of DEIA trainings may have set a disturbing precedent for future administrations (Brownlee 2020). According to experts, racial and diversity trainings are essential steps to help rectify entrenched racial inequities in the United States and can improve morale and cooperation in the workplace (Dawsey and Stein 2020).

But political interference at agencies does not have to take the form of a direct attack on DEIA efforts to negatively impact the morale and retention of scientists from historically marginalized communities. In June 2019, the US Department of Agriculture (USDA) announced that two of its research divisions—the Economic Research Service (ERS) and the National Institute of Food and Agriculture (NIFA)—would relocate out of Washington, DC (GAO 2022). Both research agencies moved to Kansas City, Missouri, in September 2019. The ERS and NIFA required agency staff to make the move or be out of a job. The relocation led to a sharp decline in Black staff members at both research agencies. For instance, the proportion of Black staff at NIFA dropped from 47 percent to 19 percent.

# Chapter 4: Recruitment and Hiring Practices

The demand for STEM professionals continues to grow, and to remain competitive on a global playing field, the United States will need to cultivate a larger, more agile, and more diverse STEM workforce (NASEM 2019b). Therefore, agencies will need to employ innovative and equitable practices to encourage STEM professionals to join the federal workforce.

To attract highly qualified STEM professionals, federal agencies will need to critically evaluate three aspects of their hiring and recruitment practices: the actions of federal agencies that contribute to negative perceptions of those workplaces, current federal agency efforts to diversify the workforce, and federal agency partnerships with MSIs.

## Perceptions of Federal Workplaces

While federal STEM workplaces offer opportunities to pursue meaningful work, perceptions of the federal government may deter STEM professionals from joining the federal scientific workforce. According to a 2021 Government Accountability Office (GAO) report, potential applicants to STEM positions may view federal work as too bureaucratic, lacking innovation, and less prestigious than the private sector. They may think it will be more difficult to see the immediate effect of their work (GAO 2021).

Federal agencies can employ off-putting practices during the recruitment and hiring processes, such as failing to clearly list skill requirements in job ads; neglecting to provide information on current practices for in-person work, remote work, and telework; and posing procedural delays in the hiring of STEM professionals that may delay the job interview or job offer process by several months (Heimbrock 2022; NRC 1990). At agencies like the Department of Defense (DoD), the long months of delay for federal scientists to obtain a security clearance—especially for people who are not US citizens—before they can start working presents a particularly challenging hurdle (NAE and NRC 2012; GAO 2021).

Negative perceptions of federal employment are especially effective at deterring BIPOC potential applicants with college degrees or postsecondary degrees. Research suggests that BIPOC graduates are less likely to apply to a federal job than are their White peers. An April 2022 study found that 60 percent of BIPOC graduates surveyed stated that they would not apply for a federal job (Qualtrics 2022; Heimbrock 2022). The study also found that while attending college or university, BIPOC students were about as likely as their White peers to say they would pursue a job in the public sector; however, after graduation, BIPOC individuals were far less likely than their White counterparts to report that they would pursue a career in government (a 9 percentage point difference). These data suggest that a potentially effective strategy to bring more BIPOC STEM professionals into the federal government would involve reaching out to them while they are still attending college or university.

Early career scientists may have less knowledge about what to expect while working at a federal STEM job compared to an academic STEM job, and therefore they may be less likely to consider a career in the federal government. Tools for educating early career scientists on

federal government career pathways vary across universities. Some universities provide their students with more information on applying or interviewing at federal agencies, offering the necessary training on the best way to apply to federal agencies and access to faculty or alumni networks with ties to federal agencies. But many universities lack these tools and connections.

## Efforts to Diversify the Workforce

Efforts to recruit and hire scientists from historically excluded groups into the federal STEM workforce have had mixed success (GAO 2018). In general, the federal STEM workforce is getting more diverse, though White men are still overrepresented. Edwards et al. (2021) found that from 2005 to 2018, the fastest growing gender and racial groups in the federal STEM workforce have been Black women (7.2 percent), Black men (5.9 percent), Latine women (4.8 percent), Asian men (3.6 percent), and Asian women (2.9 percent).

Many of the initiatives to diversify the federal STEM workforces are often not long-lasting or are not intentional in their focus. Efforts to diversify the STEM federal workforce can become stagnant or ineffectual, or need better coordination (GAO 2018). Dedicated attempts to diversify the workforce also can fade with a new presidential administration. In January 2017, President Barack Obama issued a memorandum promoting diversity and inclusion in the federal workforce. It applied to agencies involved in maintaining or protecting national parks and national forests, including the DOI, NOAA, and the US Forest Service (Office of the US Presidency 2017). However, these efforts stalled during the Trump administration (Jacobs and Hotakainen 2020).

Some agencies have taken steps to address a lack of diversity within their workforces. When NOAA administrator Richard Spinrad heavily emphasized recruiting BIPOC individuals and increasing diversity at NOAA in 2021, the agency increased its recruitment of Black scientists by nearly a third (Hotakainen 2022). However, because Black scientists represent a very low percentage of NOAA's total scientific workforce, these recruitment efforts only increased the percentage of Black Americans in NOAA's scientific workforce from 3.7 percent to 4.3 percent.

Because of the same NOAA efforts, students from historically excluded communities were inspired when agency leadership suggested that they could go into the sciences (Hotakainen 2022). Their experience reflects the importance of proactive outreach in historically excluded communities.

Federal agencies can employ several tools and strategies to improve recruitment and hiring processes for STEM fields. Some promising strategies are already being used and should be expanded to help recruit high-quality STEM candidates from diverse backgrounds into federal agencies.

Three promising strategies include direct hiring authorities, fellowship opportunities, and student loan forgiveness incentives. Direct hiring authorities allow agencies to fill positions that have a severe candidate shortage or a critical hiring need (GAO 2021). Agencies have used them successfully to fill STEM positions in a more efficient and less complex way. The talent exchange program under the Intergovernmental Personnel Act (IPA)—which allows individuals from academia, nonprofit organizations, and state and local governments to work in a federal agency for up to two years—could be further expanded and promoted at universities with STEM programs (Partnership for Public Service, n.d.a). Additionally, hiring

placements that offer student loan forgiveness incentives, such as the federal student loan repayment program, are likely to attract highly qualified STEM graduates to apply for federal positions (OPM, n.d.).

## Partnering with MSIs

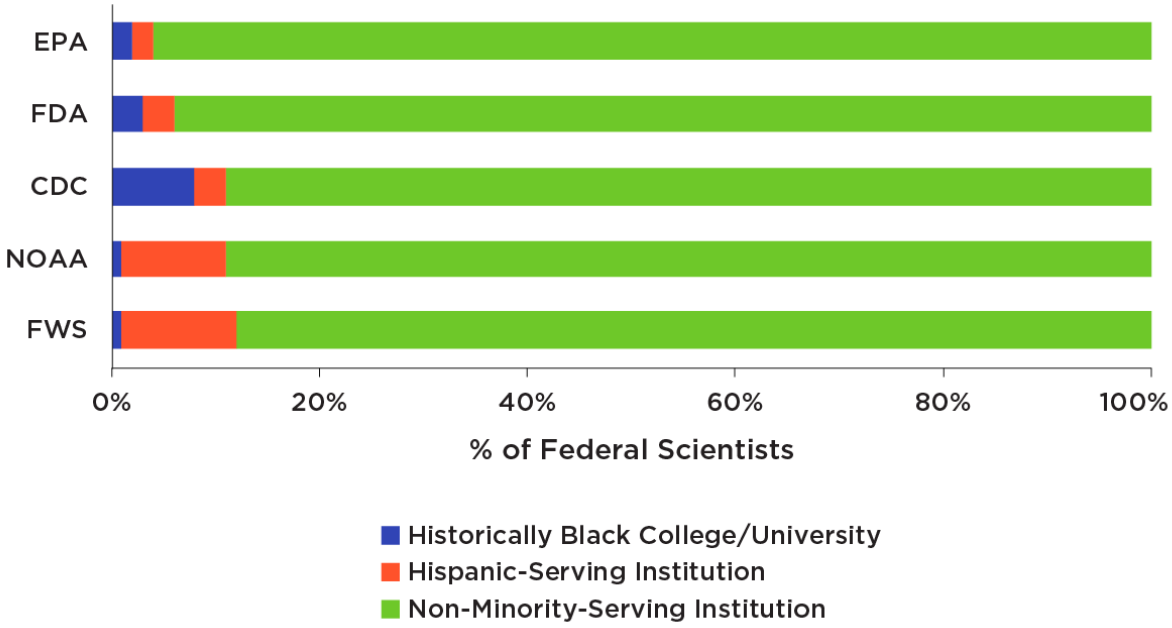
Evidence suggests that one of the most promising pathways for the recruitment of scientists from historically excluded groups involves federal agencies targeting their outreach efforts at Hispanic-serving institutions (HSIs), historically Black colleges and universities (HBCUs), tribal colleges and universities (TCUs), and other MSIs (IWGIS 2021). MSIs offer access to higher education for students who may otherwise not have had the opportunity, and they set an example of DEIA through diverse administration, faculty, and leadership (McKinley, George, and Skelly 2022). A sizable portion of BIPOC and people from other historically marginalized groups graduate from MSIs; for instance, 30 percent of Black Americans majoring in STEM fields graduate from an HBCU (Lopez 2023).

According to a 2019 report by the National Academies of Sciences, Engineering, and Medicine, MSIs are an underutilized tool to fulfill the needs of the nation's current and future STEM workforce (NASEM 2019b). Through a practice of intentionality, MSIs can help reestablish US preeminence in STEM innovation and bring more historically excluded communities into STEM professions.

However, federal agencies lack strong representation of STEM professionals who previously attended an MSI. In a new analysis for this report, UCS examined the LinkedIn profiles of 500 federal scientists working across five agencies (CDC, EPA, FDA, FWS, and NOAA) to collect data on the highest educational degree they obtained; only 11 percent of scientists reported obtaining their highest degree from an MSI (Figure 4). These data indicate that there is an overreliance on hiring federal scientists who come from non-MSIs, despite MSIs being a major source of the nation's STEM graduates. While data are lacking at the graduate level, evidence shows that MSIs produce one-fifth of the nation's STEM bachelor's degrees. Additionally, more undergraduate students are enrolled in STEM fields at four-year MSIs than at four-year non-MSIs (NASEM 2019b).

But hiring STEM professionals who attended MSIs does not always translate to a more diverse workforce. In the UCS analysis, NOAA and FWS had a higher representation of STEM professionals who attended an MSI than did other agencies examined (10 and 11 percent, respectively; Figure 4). However, the analysis also identified NOAA and FWS as agencies with some of the highest representation of White-identifying STEM professionals (Figure 3). These data suggest that developing partnerships with MSIs is a strong step, but not the only step when attempting to diversify the federal STEM workforce. Agencies also need to be intentional in their outreach to scientists from historically excluded and marginalized communities and ensure that their workplaces are welcome and inclusive environments for scientists from diverse backgrounds.

Figure 4. Type of Institution Issuing Highest Degree Obtained by Federal Scientists




*Of a randomized sample of 500 scientists from five federal agencies, the vast majority of scientists at each agency (89 to 96 percent) obtained their highest-level degree from a university that is not considered an MSI by the Department of Education. TCUs were included in the analysis, but none of the 500 scientists had attended them (i.e., 0 percent at all agencies). CDC had the highest representation of STEM professionals who had attended an HBCU (8 percent), while NOAA and FWS had the highest representation of STEM professionals who attended an HSI (10 and 11 percent, respectively).*

*Note: The names of federal employees were obtained either through online directories or Freedom of Information Act requests and were identified as scientists by their job titles. Educational information was obtained by using the scientist's name and job title to match scientists with their online LinkedIn profiles. Please see the appendix for a more detailed description of the methodology.*

Recruitment of MSI STEM majors needs to be more fully established and integrated into efforts to diversify the federal STEM workforce. For instance, federal training programs to diversify the NIH and NSF biomedical scientific workforces have failed to include funding and other forms of support to build MSIs' research capacities, an essential component in raising an institution's research classification (McKinley, George, and Skelly 2022). Additionally, for federal agencies that have partnered with MSIs, there is often an unclear link to employment opportunities. Jearld and Hayden (2005) observed that a higher educational center with a memorandum of understanding with NOAA provides federal internship opportunities for students, but after the internship ends, there are no defined steps for more permanent employment at the agency.

Federal agencies may be shifting to stronger partnerships with MSIs in the wake of President Biden's executive order advancing DEIA in the federal government, which specifies that federal agencies must develop new recruitment partnerships with MSIs (Office of the US

Presidency 2021b). This stipulation has led the DoD to establish a new research center at Howard University (an HBCU in Washington, DC; Lopez 2023), the EPA to establish an internal council to identity opportunities to partner with HBCUs (EPA 2022), the National Nuclear Security Administration (NNSA) to establish a partnership program with MSIs (NNSA, n.d.), and several federal agencies to announce funding opportunities for MSIs, including the Department of Energy (DOE; OIEPP 2023), National Aeronautics and Space Administration (NASA 2023), and NOAA (NOAA 2021).

# Chapter 5: Retention of STEM Professionals at Federal Agencies

Hiring and recruiting are not enough to ensure a large, diverse, and well-qualified pool of scientific professionals can meet agencies' scientific needs. Federal agencies also need to provide an equitable, supportive, and welcoming work environment that makes STEM professionals want to continue working at the agency.

However, STEM professionals working in the federal government can face many stressful challenges. Federal workers are subject to hiring freezes, pay freezes, and shutdowns—situations that negatively affect work and pay but are unrelated to an individual's work performance. Additionally, a change in presidential administration every four or eight years comes with a variety of institutional changes that may affect federal STEM workers' desire to stay on, such as changes in federal agency priorities and scope, the hiring of approximately 4,000 political appointees, staff turnover, and prolonged vacancies (Edwards et al. 2021).

Agency employees and officials have raised concerns about some challenges that affect the retention of STEM professionals in the federal government—such as difficulty getting promoted to more senior positions, excessive bureaucracy and paperwork for personnel decisions, and inadequate compensation—since the 1960s (NRC 1990). Agency officials have noted the difficulty in recruiting and retaining federal scientists from historically excluded populations since at least the 1980s (NRC 1990).

The option to work remotely has become an issue that can affect the retention of employees. The Biden administration took an "aggressive" stance to limit telework at federal agencies and bring federal employees back to the office in fall 2023 (Johnson 2023). The EPA union AFGE Council 238 has raised alarms about this process, calling it "highly detrimental" to employee recruitment and retention. Union members pointed to a survey of 9,000 EPA employees in which 65.9 percent of respondents said they would consider leaving if the agency reduces flexibility (Johnson 2023). Research supports these findings, suggesting that, especially in the aftermath of the pandemic, employees desire flexibility and remote work options, and are more inclined to leave their jobs if they do not receive those options (Bichsel, Fuesting, and McCormack 2021).

While many factors can affect the retention of federal scientists, three strategies may be particularly important to whether STEM professionals decide to leave or stay at federal agencies: To increase retention of federal scientists, agencies should establish salary compensation and benefits packages that are at least comparable to those in the private sector; employ organization-wide measures that more fully integrate DEIA into agency core operations; and enact measures to help bolster a positive work environment so federal scientists feel that management supports them and that their workplace contributions are valuable.

## Compensation and Benefits for Federal STEM Workers

Agencies may experience challenges in recruiting and retaining a diverse, highly qualified STEM workforce—especially scientists from historically marginalized groups—because of differences in pay compared to private sector employers.

On average, federal STEM workers earn less than their nongovernmental peers. Edwards et al. (2021) compared the compensation and benefits for STEM workers in the federal government with those of STEM workers in the private sector. When the authors carried out a regression analysis that controlled for several variables associated with pay—e.g., educational attainment, occupation within the five broad STEM categories (social science; information technology (IT), computer science, and mathematical science; engineering; life science; and physical science), age, gender, location (urban versus rural), race and ethnicity, region, and year—they found that private sector STEM workers earned about $2,600 more in annual pay than federal STEM workers.

The pay gap between federal and private workers appears to widen for jobs with higher levels of educational attainment. A 2017 study by the Congressional Budget Office found that federal workers with a professional degree or doctorate earned 24 percent less, on average, than their private sector counterparts (CBO 2017). Considering that STEM professionals often enter the federal workforce with higher levels of educational attainment than other federal workers (Edwards et al. 2021), the 2017 study provides further evidence that federal agency STEM professionals are compensated at lower rates than STEM professionals in the private sector.

Lower rates of pay can be particularly challenging for scientists from historically marginalized groups. For instance, first-generation undergraduates often have greater college debt than students whose parents graduated from college, and with some STEM fields offering low pay to early career scientists, first-generation undergraduates may need to leave the STEM workforce to find higher-paying jobs (IWGIS 2021).

Despite using a standardized system of pay (i.e., the General Schedule classification), federal agencies exhibit racial and gender discrepancies in their compensation rates. Although the pay gap between male and female federal workers has narrowed from 19 cents on the dollar in 1999 to 7 cents in 2017, data from 2017 also showed that the gender pay gap is greater for Black women, Latine women, and Native American women, with these women of color earning 9 to 12 cents on the dollar less than White men (GAO 2020a).

In the federal STEM workforce, men outearn women over $10,000 annually, on average, and White workers outearn Asian, Black, and Latine workers over $6,000 annually, on average (Edwards et al. 2021). Similar racial and gender pay inequities can be observed in STEM professions outside of the government (NCSES and NSF 2023; Funk and Parker 2018; Edwards et al. 2021).

Diminished compensation can have a noticeable effect on federal employees' well-being. OPM's Federal Employee Viewpoint Survey—one of the largest surveys used by the federal government to assess the current state of the federal workforce—observed dissatisfaction with employees' rates of pay in 2022 (OPM 2022b). The Global Satisfaction Index of the 2022 survey notably dropped compared to past years, which the authors linked to decreased pay

satisfaction. The authors speculated that the results reflected circumstances in which living costs rose for federal employees without a corresponding increase in pay for most employees.

On the other hand, federal workplaces offer more attractive benefits packages than private sector workplaces. Federal STEM workers tend to work shorter hours, on average, and are more likely to have access to benefits than private sector STEM workers (Edwards et al. 2021). Scientists from historically excluded populations may find these benefits particularly attractive. For instance, the family friendly benefits associated with NIH employment—such as reimbursement for childcare expenses and parental leave—could help address work-life balance issues that can cause female investigators to forego research duties to take care of young children (GAO 2018). Benefits packages may help retain STEM professionals in the federal workforce, and therefore agencies should work to ensure that their employees are aware of and can easily access benefits packages.

## Organizational Efforts to Advance DEIA

Currently, limited data exist on the systemic and individual factors that can decrease the retention of federal scientists from historically marginalized populations (IWGIS 2021; Edwards et al. 2021; GAO 2020a). However, evidence suggests that certain factors can negatively affect the retention of diverse STEM professionals at federal agencies.

When federal agencies fail to address deep-seated inequities in organizational structure, they can make it less likely that diverse employees will feel welcome and be willing to continue working in such an environment. According to data from the OPM's Enterprise Human Resources Integration database, analyzed by the GAO, while the number of people with disabilities hired by federal agencies increased between fiscal years 2011 and 2017 and exceeded federal government goals, 60 percent of people with disabilities departed federal employment within two years (GAO 2020b; GAO 2023).

Since structural inequities that marginalize diverse staff can be complex and based on long-standing practices, agencies need to be intentional in implementing evidence-based practices that can reduce these inequities. The NIH's UNITE program may be a promising model, as its primary focus is to identify and address systemic racism that may be present within the NIH workforce (NIH 2023).

Failing to enact measures that identify and address structural inequities can lead to further marginalization of staff from historically marginalized communities. In 2020, a letter to the CDC director signed by more than 1,200 CDC employees—more than 10 percent of the agency's workforce—called for the agency to address "ongoing and recurring acts of racism and discrimination" against Black employees, including the lack of hiring and promotion of Black employees (Simmons-Duffin and Huang 2020). Specifically, the letter states that despite "decades of well-meaning, yet under-funded, diversity and inclusion efforts," there has been little progress in addressing some of the real challenges that Black employees face at the CDC, including "the lack of inclusion in the agency's senior ranks and leadership pipeline programs; a pernicious 'old boy/girl' network that stifles Black talent and blocks opportunities for professional advancement; [and] a pervasive and toxic culture of racial aggressions, bullying and marginalization" (Simmons-Duffin and Huang 2020).

In particular, retention at federal agencies appears to be linked to organizational justice, that is, whether employees feel that their organizations treat them fairly and equitably. Choi (2011) used data from the Merit System Protection Board survey to assess federal employees' perceptions of organizational justice and their evaluation of their workplaces. The study found that a positive perception of organizational justice at an employee's federal workplace was associated with higher rates of job satisfaction, more trust in a supervisor and management, and lower rates of turnover intention.

Additionally, an organization's workforce may be diverse only for low-level jobs but not upper management (Wilbur et al. 2020). Kern, Kenefic, and Stout (2015) examined the demographic makeup of scientists at the USDA's Forest Service Research and Development and compared it to the demographics of scientific faculty at a subset of US universities most closely affiliated with forestry and related natural-resource fields. While the authors found that the Forest Service Research and Development had a greater representation of female scientists than comparable university forestry programs, the representation of women declined for more senior scientist positions at both federal and academic workplaces.

STEM workforces appear to be especially uninviting for STEM professionals with child-rearing and caretaking responsibilities. Cech and Blair-Loy (2019) found that one-half of new mothers and one-quarter of new fathers leave full-time STEM employment after the birth or adoption of their first child. Women with or intending to have children are especially affected. One study found that female professors in STEM professions had been previously told by their academic advisors that parenthood is incompatible with STEM professions and that becoming a parent will lead to them being viewed as less serious in the profession (Thebaud and Taylor 2021).

Some federal agencies have recognized the role implicit bias plays in career development opportunities, hiring, performance evaluations, and promotion and have tried to implement practices to improve objectivity. For instance, the EPA has developed Technical Qualifications Boards based on a substantial body of research indicating that when evaluators establish criteria before review, they apply less bias to their evaluations of people or their accomplishments. These panels review and evaluate the qualifications and contributions of all candidates for promotion to senior-level research positions against published guidelines, in an attempt to ensure consistent and equitable treatment throughout the EPA's research organization (OSTP and OPM 2016).

Implementation of a diverse mentorship system is another promising strategy to retain scientists from historically excluded groups and allow them to feel more supported at an agency. Research suggests that mentoring STEM students and professionals from historically marginalized groups can help them build an identity that is more strongly connected to science and help lessen feelings of isolation or invisibility in a workplace (NASEM 2019a; IWGIS 2021).

## Morale and Job Satisfaction

Worker retention often correlates with morale and job satisfaction. When employees have positive assessments of their workplace environments, they are more likely to stay in their position (Raziq and Maulabakhsh 2015). Strong employee engagement—a positive feeling about one's employer and its mission—tends to help federal agencies hire and retain

employees. A GAO analysis using data from the OPM's Federal Employee Viewpoint Survey identified six key drivers of employee engagement: career development and training, communication from management, constructive performance conversations, employee involvement, inclusive work environment, and work-life balance (GAO 2016).

While there is limited research on how workplace morale affects the retention of scientists, factors that hinder the ability to carry out scientific work and a negative perception of managers and supervisors appear to play an outsize role in a scientist's decision to stay or leave their workplace. Jindal-Snape and Snape (2006) found that scientists are especially motivated when management encourages them to carry out high-quality, curiosity-driven research, but they are demotivated when they face constant review and change, difficulty collaborating with colleagues, or a lack of feedback from management. These patterns also appear to apply to federal STEM professionals. Myers (2022) surveyed over 70 STEM professionals who had left a federal agency position and found that the attributes most strongly associated with retention were meaningful work, a positive relationship with a supervisor, and self-authority to complete work.

The COVID-19 pandemic led to burnout and workplace stress for workers across the world, including widespread burnout for both academic (Woolston 2021) and federal scientists (Desikan and Carter 2023), which may play a role in scientists' retention decisions. For instance, a 2021 *Nature* survey observed that compared to results from its 2018 survey, a higher percentage of scientists reported symptoms of stress and burnout, a lower percentage of scientists reported satisfaction with their jobs, and a lower percentage of scientists said that they would recommend a research career to students (Woolston 2021).

Because science is a collaborative process, one particularly strong source of demotivation occurs when federal agencies restrict scientists from engaging with or pursuing professional development opportunities with their scientific peers outside the government. When the DoD and the DOE implemented a senior-level review to attend conferences, the change caused a noticeable drop in DoD and DOE staff attendance at scientific and technical conferences and led to more difficulty in recruiting and retaining qualified scientists and engineers at these agencies (GAO 2021). Nine staff members who resigned from the Naval Research Laboratory stated in exit interviews that constraints on conference attendance contributed to their resignations.

# Chapter 6: Recommendations

To ensure that agencies continue to use evidence-based approaches to strengthen and diversify the workforce, the authors have compiled a series of recommendations.

## Create More Pathways to Enter the Federal STEM Workforce

Providing multiple entryways into the STEM workforce is key to maintaining a thriving STEM ecosystem. Currently, STEM professionals have a couple of paths to enter the federal workforce, from summer internships to fellowships such as the Presidential Management Fellows Program. However, these pathways have not increased diversity in federal STEM positions enough to match the demographic diversity of the nation (EEOC, n.d.b). Women and individuals from historically excluded groups continue to remain underrepresented, constituting only 29 percent and 10 percent of the federal STEM workforce, respectively (IWGIS 2021).

To diversify the federal STEM enterprise, the government must implement measures to expand entry points. Federal agencies should model those agencies leading in employing STEM professionals, such as the DoD. DoD STEM leadership uses evidence-based practices in contexts from K-12 to graduate education to train STEM professionals into the agency's pipeline, offering a variety of outreach, internship, hands-on learning, and K-12 educator training opportunities (DoD STEM 2023).

MSIs are trailblazers in producing STEM graduates from historically excluded racial groups. Combined, these approximately 700 institutions produce one-fifth of the nation's STEM bachelor's degree recipients (NASEM 2018). Tapping into this network of STEM talent through achievement program partnerships could greatly expand federal workforce diversity. Achievement programs — programs designed to develop and enhance the academic and leadership potential of students from historically excluded communities —have demonstrated promise in diversifying the broader STEM enterprise.

In addition to forming strong partnerships with diverse institutions, federal agencies must rethink the STEM workforce pipeline pathways, which are currently thought of as linear. However, programs such as the NIH's Re-entry Supplements Program give scientists who have left the scientific enterprise a chance to return to a scientific career after a hiatus due to extenuating circumstances (e.g., caregiving, or loss of a loved one; NIH, n.d.b). Furthermore, the National Science and Technology Council should update the *Best Practices for Diversity and Inclusion in STEM Education and Research* report (IWGIS 2021) to recommend re-entry programs as a viable retention method.

Having strong partnerships and rethinking the candidate pipeline pathways are good starts, but the recommendations below also should be adopted to further expand entryways into the federal STEM workforce:

- Agency heads should instruct their recruitment and hiring teams to use existing MSI networks through achievement program partnerships.

- Agencies should use federal STEM programs, such as the NIH's Maximizing Access to Research Careers, a program that has successfully trained thousands of biomedical scientists (National Institute of General Medical Sciences 2023).

- Federal agencies such as the EPA should establish pipelines with MSIs, like the NNSA's Minority Serving Institution Partnership Program (NNSA, n.d.), the College/Underserved Community Partnership Program (CUPP) and the DoD HBCU/MI Summer Research Internship Program (DoD, n.d.).

- Agency heads should review existing partnerships with formal externships and expand them where possible.

  - Expand funding mechanisms—like those at the NSF (NSF, n.d.) and the NIH (NIH, n.d.a)—that allow undergraduate students to have immersive science policy experiences with agencies.

  - Partner with established programs to provide mentorship opportunities to students and expose them to careers in the federal government.

- Agency heads should instruct appropriate staff to research and begin partnering with existing affinity groups to diversify their STEM workforces. While many groups exist as nonprofit organizations, there are grassroots efforts organized through social media. These affinity groups—such as Black in X (2021), Disabled in Higher Ed (2021), and Latinx in STEM (2023)—are highly organized and have annual meetings. Federal agency representatives should attend these meetings, present sessions at them, and partner with them.

  - The Department of Education should create more programs to engage with middle school and high school educators and attract students to STEM at an earlier age.

- The federal government should begin recruitment efforts earlier by expanding its STEM apprenticeship programs to the EPA, NSF, and NIH (Department of Labor, n.d.).

- Initiatives that introduce K-12 students to federal STEM opportunities should include more hands-on learning.

  - Federal agencies should partner with the annual USA Science & Engineering Festival, a free STEM conference providing students with hands-on learning experiences (USA Science & Engineering Festival 2023).

## Attract New Talent to the Federal Science Workforce

Recruitment of scientific staff is at the heart of rebuilding the federal scientific workforce. Reforming and refreshing the recruitment approach can reinvigorate each agency's science enterprise (Wright 2021). New recruitment methods are key to diversifying the scientific staff and to gaining the huge benefits that diversity has been shown to bring to scientific work (Urbina-Blanco et al. 2020). Additionally, a reformed recruitment effort can begin to change

the culture, perception, and reputation of federal scientific efforts in the eyes of the scientific community and the public.

One of the report's authors (Andrew Rosenberg) has a wealth of personal experience regarding STEM diversity from his tenures in senior-level positions at NOAA as well as in the academic, nonprofit, and for-profit sectors. Rosenberg has observed that the broader scientific community too often sees the federal scientific workforce as stilted and lacking the creativity of their academic colleagues. Academics often view federal scientists as being stuck in a bureaucratic system where they cannot pursue their most promising ideas and are instead required to "meet the mission" of a federal agency or carry out tasks as directed by management.

According to Rosenberg, some academics seem to believe that they carry out "real science," while federal scientists apply that science to agency processes without creativity. To the extent that those in academia and other science institutions hold this perception, it influences scientists at all career stages in their decisions about whether to pursue permanent or term-limited federal science positions.

Rosenberg once observed the leader of an elite academic institution giving a speech to a group of federal scientists in Woods Hole, Massachusetts, an important ocean science community. At one point, in calling for collaboration between the federal lab and the private research institution, the academic science leader said, "After all, we have the smarts and you have the money."

The public view of federal science, unfortunately, is too often similar to the negative public image of the federal workforce overall (Lardy 2023; Pew Research Center 2022). This false narrative of the federal government has intensified in recent years as part of the political discourse, which has included inaccurate and grossly misleading conjectures about the "deep state" (Clark, n.d.).

This image, too, affects recruitment into the federal science workforce (Hersher 2021). Rosenberg has also observed that in discussions with early career scientists, it becomes clear that they are not even considering applying for federal positions because they assume it is a dead end for a science career, an assumption that is deeply out of touch with the reality of the federal STEM workplace.

The perception scientists from diverse backgrounds have of federal positions can also be negative. Agencies can be viewed as "not welcoming or inclusive" despite programs that have attempted for many years to increase diversity (GAO 2023; Appah 2022). During his time at NOAA, Rosenberg observed that other scientists can view the hiring of a person of color as a "diversity hire"—that is, a person hired based on an affirmative action policy—rather than a skillful, competent, and capable asset to the team. The scarcity of other scientists of color in federal science programs further exacerbates this perception. And while this lack of diversity is also true of nonfederal science enterprises—including academic research in many fields—that does not improve the perception of federal scientific workplaces.

Recruitment into a reinvigorated, more diverse federal science workforce also should target scientists at all career stages. Often, the primary recruitment effort, particularly with regard to diversity, is aimed at entry-level, early career scientists, for more junior positions. While this should be an important part of recruitment—and is necessary—it is not sufficient. Many senior

leaders in the federal science enterprise are nearing retirement. This situation heightens the need to bring into federal science agencies midcareer and senior scientists from diverse and historically marginalized communities. A diverse leadership team provides an opportunity to bring in fresh perspectives as well as diversity to mid- and senior-level positions.

Recruiting for senior-level positions presents different challenges from entry-level recruitment. Agencies recruit established scientists for a portion of their careers, and this population expects certain compensation and working conditions. They want to fully use their creativity and maintain their credibility in the scientific community by publishing in academic journals. Such expectations are standard for scientists currently working in academia, industry, or the nonprofit sector.

Further, efforts to fill senior-level positions require aggressive headhunting for strong candidates. Agencies are beginning to use these tools and should be encouraged to do so. Agencies hiring for mid- and senior-level positions often need scientists with experience managing a science enterprise. The government needs to compensate appropriately for those skills. To address mid- and senior career recruitment, agencies should use rotational assignments, such as IPA assignments, and other methods to bring on scientists in academic or private institutions (e.g., industry and nonprofits workplaces), as well as those at state and tribal agencies.

There are agency culture issues to attend to as well. Some agencies are not that welcoming to those considered outsiders. Trying to understand internal federal agency processes can be daunting, though perhaps no more difficult than doing the same in industry, nonprofit, or university contexts. Political pressures can also be a worry in some fields—but by no means all fields. When recruiting at more senior levels, these challenges must be discussed and dealt with directly, not glossed over.

Federal science programs share with science programs everywhere a conservative approach to recruitment—e.g., hiring new staff from the same institutions from which existing staff came. In some programs, a disproportionately high number of science staff come from just a few universities—and, sometimes, from the labs of a small number of faculty. The agencies' rationale for such conservatism is that the favored programs or faculty are known to train good people who are ready to do the work needed. While that certainly makes sense, it is also a recipe for stasis and greatly limits the talent pool and its diversity. The federal government should focus more recruitment efforts outside the geographic areas or institutions it has historically gravitated toward.

In addition to recognizing implicit biases in recruitment efforts, federal hiring managers should be aware of tendencies to recruit known individuals when hiring needs are urgent. Federal hiring managers always face pressure to get someone on board to fill work gaps quickly. Contrary to public perception, federal science programs are usually understaffed and capacity is stretched with an ever-expanding workload. But urgency works against the aspiration for a more diverse workforce and against efforts to recruit from a wider circle of institutions. When under pressure, hiring managers might feel compelled to recruit from a known source.

The following recommendations emerged from the panel discussion as solutions to the above challenges:

- Lead agency scientists (e.g., chief scientists) should coordinate with human resources departments to ensure that their recruitment strategies make efforts to diversify positions at all levels.
    - Instruct recruitment teams to broaden efforts outside of the geographic areas they have historically focused on.
    - Ensure hiring committee members come from a more diverse range of institutions and backgrounds.
    - Train hiring managers on recruitment efforts that reach outside the areas and institutions that have been historically focused on. This training should also provide information on equitable recruitment practices, including acknowledging implicit biases in hiring.
    - Direct recruitment teams to conduct outreach to a greater diversity of institutions.
- Agencies should use alternative methods to reach scientists among more diverse institutions:
    - Use headhunters with a specific mandate to look for candidates with a diversity of experiences and backgrounds to fill senior-level positions.
    - Connect with diverse professional STEM organizations, such as the Indigenous Scientific Society, National Medical Association, National Society of Black Engineers, National Organization of Gay and Lesbian Scientists and Technical Professionals, and Society for the Advancement of Chicanos/Hispanics and Native Americans in Science.
    - Recruit using existing partnership programs and cooperative institutes, such as the NOAA Cooperative Institutes with HBCUs and NNSA Minority Serving Institution Partnership Program.
    - Make greater use of the MSI network, including HBCUs, HSIs, TCUs, and other universities and colleges that have more diverse student bodies in science. This work includes engaging MSI staff to ensure that they are familiar with federal science agencies and hiring practices and can mentor students during the application process for federal jobs.
    - Send representatives to job fairs and recruitment events.
    - Attend conferences and social events (e.g., the Annual National HBCUs Week Conference) and use them as major recruitment opportunities for open positions in multiple agencies.
- Agency heads should instruct appropriate staff to review hiring practices, to streamline and make the process more efficient and agile. Agencies should ensure easy access to position notices and do everything in their power to simplify the process to apply for a federal position.

- To improve the recruitment process, agencies should collaborate with each other to form an interagency taskforce that does the following:
    - Attends multiple agency job fairs
    - Uses another agency's cooperative agreement with academic institutions
    - Coordinates opportunities for agency staff to share experiences and best practices on the use of fellowships, internships and externships, IPA or term-limited appointments, and rotational assignments
    - Employs measurable and monitorable goals for recruitment
- Agencies that make real, measurable progress on recruiting new, diverse talent should be rewarded by being granted even more authority to try new approaches and fully implement tools that have helped them progress. Agencies that are lagging need to be directed to try proven approaches from other agencies, to open their thinking and culture and make progress.

## Enhance Retention and Mentoring

Once federal agencies have successfully attracted and onboarded new employees, they need to nurture these employees through effective retention and mentoring programs. In an analysis of fiscal year 2021 data, the Partnership for Public Service reported that the government-wide trend for attrition was 6.1 percent, slightly higher than the rate for fiscal year 2020. Attrition was higher for lower-graded positions, 14.5 percent for General Schedule-1 (GS-1) to GS-4 and 8.7 percent for GS-5 to GS-7 positions. Attrition for GS-10 positions and above was approximately 5 percent. The average attrition for STEM positions was also 5 percent. Some of this attrition could be because of age, education level, length of service, presidential administration transition, and other factors (Partnership for Public Service, n.d.b).

There are many barriers to employee retention, and roundtable participants discussed several factors. A key consideration is helping employees understand the value of public service and the impact they can and do have through their work. This importance can be reinforced if staff feel that they belong and that their contributions are meaningful. Having a feeling of belonging and contributing in a meaningful way are particularly important for underrepresented groups. Lack of recognition can lead to frustration and contribute to burnout.

Staff should be recognized and valued as collaborators, contributors, and thought leaders. A thought leader can be someone who is recognized as an expert or has a unique perspective. For example, BIPOC staff are not always invited to represent their agency or office, yet gaining perspectives from a diverse group with different experiences and perspectives often leads to better outcomes. Many types of expertise and experience should be valued and recognized by senior managers. Recognition could include rewards, training opportunities, promotions, rotational assignments, and verbal and written acknowledgment.

Another issue involves work environment. During the COVID-19 pandemic, work culture shifted, with virtual work becoming the norm and presenting new challenges. While this new

mode of working can be effective for many roles, it can require extra efforts from managers and senior staff to ensure newer staff feel welcome, connected, and supported.

Staff views of their positions also play a role in retention. Some staff view federal employment as "a job," while others may think it is a calling, believing that their actions benefit the greater good. False perspectives that all federal positions are based in Washington, DC, or that federal staff mostly work at a desk complicate efforts to encourage scientists to make federal employment a career. Media stories also tend to highlight instances in which federal scientists may have harmed communities more than helped. In addition, politicians sometimes demonize federal science when it conflicts with policy directions. Part of the task of increasing retention and mentoring new employees will need to include the showcasing and reinforcing of the positive aspects of federal science.

Throughout the roundtable discussion, participants highlighted employee mentoring as an essential tool. Mentoring can be a highly effective way to increase retention, especially for STEM roles, but managers often underutilize it. Mentoring can have many facets and may be viewed differently by different groups. The National Academies of Sciences, Engineering, and Medicine defined "mentoring for STEM professionals" as the "working alliance in which individuals work together over time to support the personal and professional growth, development, and success of the relational partners through the provision of career and psychosocial support" (NASEM 2019a). For BIPOC STEM professionals, a mentoring relationship can facilitate building a scientific identity, increase socialization and integration into the community, reduce implicit biases, and create a sense of belonging. Creating a positive, welcoming environment through a strong mentoring relationship will contribute not only to greater job satisfaction but to the individual's feeling of success in their work environment.

The roundtable panel identified several pathways to help energize and retain STEM employees:

- Agencies should establish a welcoming and informative onboarding process, highlighting the importance of public service and focusing on the mission of the agency and the employee's role in supporting that mission. It is important to create a sense of fun!
    - Consider assigning new STEM (as well as non-STEM) employees to a group of employees. For example, establishing communities of practice can foster innovation and collaboration while supporting career development.
    - Hold a retreat for entry-level junior employees within the first six months of service, so they can gather among a cohort of employees who can answer questions, determine what additional areas of support are needed, and troubleshoot small problems before they grow.
- Agencies should have staff with experience in equity-based research work.
- Agencies should use career readiness groups, job training and job placement, and nonprofits to support BIPOC populations.

- Some STEM positions can be very competitive; outside groups could offer larger salaries or benefits to lure staff away. Agencies should establish retention bonuses to retain highly trained or uniquely skilled STEM employees.

- Agencies should offer rotational assignments or temporary details to new work assignments, to help address issues of complacency or burnout and reenergize staff or broaden their skill sets and work experience.

- Agencies should establish a plan for cooperators, managers, and staff to clarify expectations regarding the procedures for accountability. Such clarifications will help institutionalize practices and provide transparency and consistency within the organization.

- Agencies should establish mentoring measures to foster DEIA and include them in performance agreements as well as organizational strategies where appropriate.

    - Establish mentorship programs through which staff can gain insight from those working in areas outside of their expertise, to help them navigate other agency issues outside of science.

    - Provide strong training for leaders who would like to provide mentorship—this training should have a strong focus on mentoring through a DEIA lens.

## Cultivate a United Organizational Culture and a Sense of Belonging

A welcoming environment is instrumental in retaining talent in the federal STEM workforce, especially for those from historically excluded groups. All federal agencies should seek to foster a workplace culture in which all staff feel a sense of belonging and see themselves represented. However, recent studies have found that some groups, such as women of color, are less likely to report a sense of belonging in STEM (Rainey et al. 2018).

The NIH UNITE initiative (NIH 2023) has created a model program which seeks to end structural racism and discrimination at NIH and aligns with President Biden's Executive Order on Advancing Racial Equity and Support for Underserved Communities through the Federal Government (Office of the US Presidency 2021d). The UNITE program follows the lead of NIH staff from historically excluded groups and uses evidence-based practices throughout all of its programming.

Federal agencies also may consider creating affinity groups. Interest groups for employees that come from similar backgrounds, or affinity groups, have been proven to assist in creating a sense of belonging in the workplace (Bastian 2019). In addition, affinity groups help to improve employee retention and to increase the recruitment of staff from historically excluded groups (Reynoso 2022).

Employees must feel welcome at the organization and must gain a sense of trust with the organization. To create a welcoming environment for all federal employees and adopt policies similar to the UNITE initiative, federal agencies should follow these recommendations:

- Heads of federal agencies should instruct appropriate agency staff or committees to assess employees' working environment through climate surveys. These surveys should gauge federal employees' sense of belonging and should be conducted such that data can be disaggregated by disability status, gender, GS level, race and ethnicity, and sexual orientation.
    - Consult with social scientists to create climate surveys on sexual harassment, racial and disability discrimination, and sense of belonging, to develop an evidence-based landscape of the federal workplace culture. Results of the surveys should be written into reports similar to those for the NIH 2020 Workplace Climate and Harassment Survey and shared with the greater scientific community, to build trust and accountability (NIH 2020).
- Federal agencies should recognize employees from historically excluded groups who have made significant contributions to the federal STEM enterprise. For instance, NIH's UNITE initiative inspired the Power of an Inclusive Workplace Recognition Project, which highlighted the rich diversity of NIH's administrative, scientific, and executive staff (NIH 2022).
- Federal agency communications teams should work to ensure that scientists representing the diversity of the nation, including those from historically excluded communities, are featured in blog posts, conferences, workshops, or other public-facing communications, while also working to ensure that employees do not feel tokenized in the process.
    - Provide or update implicit bias training with modules addressing systemic issues that lead to certain staff being seen as a token (Narishkin 2021).
- Federal agencies should use the tool kit for establishing affinity groups from the US Patent and Trademark Office as a guide for creating agency-specific tool kits for employees to establish affinity groups (USPTO 2020).

## Change the Public Perception of Federal Science to Improve Recruitment and Retention

A barrage of negative narratives have shaped the general public's perception of the federal government for decades. At least since President Ronald Reagan's famous quote, "Government is not the solution to our problem; government is the problem," there has been a concerted effort to demonize the federal government and, by extension, the federal workforce. Unfortunately, that effort has included the federal scientific workforce, and in recent years, governmental failures, inaction, and missteps during the COVID-19 pandemic have exacerbated this negative narrative. This messaging about the government did not develop organically; it was carefully crafted and marketed to serve a specific political agenda.

It is not just political interests that promote a negative view of the federal government. While there are some examples of positive depictions of government, many novels, films, television programs, and other entertainment vehicles depict the federal government negatively—as being wholly political, corrupt, or incompetent, or as having secret agendas (if not all of the

above). A 2013 study showed that depictions of government in film are largely mixed (Pautz and Warnement 2013).

Negative narratives impact federal employee recruitment, retention, job satisfaction, and day-to-day work, including that of scientists. To counter this narrative, federal agencies need to craft a concerted, well-planned positive message.

As Michael Lewis's book *The Fifth Risk* points out, the government manages a vast array of critical services that keep communities safe and underpin daily life, and anti-government messages can undermine public trust in governmental institutions (Lewis 2018). Federal scientists often work at the top of their fields, are incredibly dedicated and hardworking, and believe deeply in public service. The federal government needs to communicate that message to a broader audience to change public perception.

One way to communicate the government's beneficial STEM work is to provide stories to external institutions that then use them in their everyday communication and work. Nongovernmental institutions and interests can play an important role in changing the negative perception of federal science. Trust in information and the need for public policy action are fundamental to many goals of a wide range of institutions, including private philanthropy. While the military can self-promote because it is starting with a positive public image, that will likely not be true for other parts of the government. It will take other voices and a long-term campaign to change the public's perception.

As federal agencies work to promote their stories to external institutions and the public, they should demystify how science is conducted and how scientists are trained. While there is great respect for STEM education in political circles and in the public, with authoritarianism on the rise, that respect may be waning for scientists. A senator once told report author Rosenberg, "You know we all have great interest in STEM education up here on the Hill, but somehow we don't want to listen to the STEM educated." The story of science, and great storytelling opportunities, is in how scientists train. The benefit of getting those stories into the public narrative is that they inspire but also demystify the process for prospective scientists. Demystifying scientific training is part of demystifying government science. The fact that federal agencies must base their actions on science, by law, is likely not clear to much of the public, and who does that scientific analysis is not clear either.

There is no shortage of image makers and image campaigns in US society. The federal government needs to engage image makers into focusing on the image of science and scientists—and on federal science in particular. There may be no stronger tool for rebuilding the federal science workforce. In particular, social media can be a powerful tool to tell STEM stories to a very wide audience. There are risks, given the challenges of an online world. The risks to scientists—particularly BIPOC, LGBTQQIA, and female scientists, who experience a disproportionate share of online attacks—should be confronted openly and directly, including with social media companies. But the stories of STEM work in and outside of government need to reach the widest possible audience.

The panel had some suggestions:

- Communications experts and teams who lead partnerships between the executive branch and the entertainment industry should develop guidance on how to clearly articulate the realities and positive nature of government work.

- Federal agencies should provide opportunities, training or otherwise, for federal scientists so they can effectively convey their work through storytelling.
    - Consider creating public stories of how STEM work has positively impacted communities around the nation and world. External institutions—such as nonprofit organizations, public schools, and universities—could use these stories.
- Agency communications teams should develop long-term campaigns that illustrate the benefits of STEM research to people across the nation.
    - Focus on demystifying how scientists are trained and how they conduct science, so the public is more aware of how the scientific process produces beneficial societal knowledge.
    - Partner with experts in academia to tell stories of how government science is conducted and how it informs decisions; highlight the government scientists behind that work.
    - Tell stories that dispel the myth that federal science is done only in Washington, DC. Long-term storytelling campaigns should focus on federal science conducted around the nation, highlight federal scientists' fieldwork away from the desk, and illustrate positive public impacts of good STEM work around the nation and world.
    - Tell the stories of younger and diverse agency scientists.

## Address the Needs of the Changing Workforce

The age gap in the federal workforce is large and continues to grow. According to the OPM (2022a), only 6.8 percent of full-time federal employees are under 30 years old, while 14 percent are 60 years or older. The generation gap between longtime federal workers and their millennial and Gen Z counterparts manifests in different needs and expectations for the workplace, with younger workers requiring greater work-life balance, flexibility in terms of scheduling and worksite location, and recognition for their work.

The post–COVID-19 workplace transition has highlighted the often divergent needs and expectations of federal workers at different life stages. According to the Partnership for Public Service (n.d.c), the average hiring time for new federal employees is 98 days, more than double the private sector's hiring time (Bergeron 2022). Often, new and early career workers cannot afford to wait more than three months to begin a new job, so they may accept positions in the private sector, which can employ them faster.

This potential loss warrants an upgrade to the 1960s-era federal human resources system, so it can be nimbler and more flexible—and help agencies avoid losing prospective new hires. Further, this outdated system exacerbates the challenge of bringing in early career scientists from diverse backgrounds, as entry-level job prospects suffer the most from the lengthy hiring period.

Similarly, early career employees often cannot afford to relocate to large cities where department and agency headquarters are located, because of the high costs of living. Thus, they not only may prefer to work remotely, but also may be unable to accept positions requiring in-person work. Therefore, clear policies that appropriately reflect the type of work that appeals to new hires—and policies that outline the appropriateness of remote and hybrid (versus in-person) work—are essential to creating an equitable workplace that welcomes employees of all socioeconomic backgrounds.

The following proposed recommendations seek to harmonize the changing workforce with federal agency conditions and culture.

- Agencies should survey employees to identify high-priority opportunities and help improve work-life balance. Opportunities might include offers of flexible and compressed work schedules or expansions regarding which employees are eligible for those options, student loan repayment and recruitment, and relocation and retention incentives.

- Agencies should continue working to reduce the duration of their hiring processes, following OPM guidance.

- Agencies should guide individual office directors to assess the appropriateness of remote and hybrid work and to develop policies that facilitate flexibility and workforce inclusion for those who may be unable to afford to live locally.

Publishing is an important consideration for scientists who want to advance both scientific understanding and their scientific careers, and a robust curriculum vitae depends on a strong publication record. Because of national security concerns during the Cold War, government scientists often needed prepublication review to publish, even when their research was unrelated to national security topics (Shattuck 1984).

The model of restricting publications for national security reasons gradually loosened with subsequent presidential administrations, culminating in the Biden administration's Office of Science and Technology Policy (OSTP) guidance for agencies to update their public access policies to make publications and research funded by taxpayers publicly accessible, without an embargo or cost (Nelson 2022). However, government scientists have been concerned with political appointees' suppression and censorship of scientific information for decades.

According to a 2022 survey by UCS, approximately 26 percent of government scientists said they were instructed to "omit certain words" that were "politically contentious." The percentage had increased three percent from 2018. In addition, 16 percent of scientists said they were told to avoid working on some science-based topics altogether because of their potential for political controversy. Twenty percent reported that they feared repercussions if they engaged in advocacy or self-expression (Desikan and Carter 2023).

The Biden administration has taken steps to curb scientific interference by government agencies, but more can be done to institutionalize such protections in federal policy and culture (SI-FTAC 2022). To address these challenges, agencies should continue to expand their scientific integrity policies and practices to ensure that scientists can freely publish their work products without fear of censorship. Agencies should also thoroughly investigate all claims of interference and suppression of work products in a timely manner.

## Reevaluate Compensation and Salary

Having a good salary is important to STEM professionals, but it is important to note that candidates do not often view salary as the most important factor when choosing a job in STEM. In a 2017 survey conducted by the Pew Research Center, respondents working in STEM listed "having flexibility to balance work/family" as the top factor that influenced their career choice (Funk and Parker 2018). Still, pay is a universal factor in recruiting and retaining talent.

The NSF's findings from its 2019 Survey of Doctorate Recipients (SDR) shows that pay gaps among the education, government, and private sectors still exist in STEM. Over 850,000 respondents in the SDR reported the field they work in and their corresponding salaries. Of those surveyed, 47 percent of respondents worked in the private sector, 44 percent in education, and 9 percent in government. Median salaries across the private sector, government, and education were $142,000, $120,000, and $93,000, respectively (Opsomer et al. 2021).

STEM careers in government pay marginally less than those in the private sector. How can the government make its pay and/or benefits more lucrative? What the government does with its pay system is critically important, and it should consider two key issues: how pay will impact the attraction and retention of qualified and skilled STEM professionals and how pay is managed based on individual performance and careers (Risher 2021). Furthermore, the government will need to grapple with a long history of lower pay for STEM professionals from historically excluded groups (NCSES and NSF 2023). Below are recommendations that will address both issues and lead to a stronger and more diverse federal STEM staff.

### POLICY SHIFTS

- Heads of agencies should direct appropriate staff to develop policies, processes, and structures that commit the agency to maintaining competitive pay rates and benefits for STEM positions.
    - Track market data for STEM careers and conduct pay analyses to fully understand what competitive salaries look like for the positions and skills for which the agency hires.
    - Institute a process and seek employee input to better understand what pay and benefits policies need strengthening. For example, does the federal government offer competitive maternity and paternity leave for STEM employees who are starting families? Does paying off student loan debt for STEM employees lead to better recruitment and retention of high-performing staff?
- Heads of agencies should direct appropriate staff to develop a policy that requires the agency to track salary data for its STEM employees and create a process and system for sharing these data publicly.
    - These data should be disaggregated by race and ethnicity, and other demographic information to determine whether pay among federal STEM employees is equitable across an agency.

- Chief scientists should consider using increased pay to recruit and retain top STEM talent.
    - To close critical STEM skills gaps, use the IPA Talent Exchange Program (Partnership for Public Service, n.d.a). While a short-term solution, IPAs can be used to staff programs and projects that require additional expertise. Chief scientists should ensure that IPAs remain lucrative to incoming experts by making compensation competitive with experts' prior positions.
    - For critical positions that need to be filled urgently, consider implementing signing bonuses.

**EMERGING SKILL DEFICITS**

- OSTP should lead a best practices benchmarking study to fully understand federal STEM employee concerns and needs regarding pay structure and process.
    - Develop focus groups to understand both manager and employee needs and concerns across a wide range of STEM disciplines and across federal agencies.
    - Form a diverse steering committee (e.g., representative of multiple STEM disciplines, agencies, and demographics) to review the input provided by focus groups and solicit any additional feedback on agency pay structure and process, including from union representatives.
    - Have the steering committee develop recommendations for federal agencies to update their existing pay structures and processes for STEM hires.

**BROADBAND PAY PROGRAMS**

- Heads of federal agencies should implement pay banding programs for STEM employees, allowing experts to excel in their careers and receive salary increases based on skills and performance through both managerial and nonmanagerial tracks (National Academy of Public Administration 2004).
    - Establish a steering committee to collect employee input and determine the best approaches for implementing a broadband pay system. Appoint at least one employee from OPM and OMB, to help ensure agency implementation plans align with government-wide policies and best practices.
    - Have the steering committee discuss the potential disparities in pay among STEM workers as an effect of implementing a broadband pay system (Weisner 2023). If an agency's senior STEM workforce is mostly White and male, for example, then a switch to a broadband pay system could result in furthering pay disparities across gender and race and ethnicity.

## Build DEIA into Agency Science

Historical DEIA practices have not driven fundamental change and, instead, have attempted to graft new guidelines to the status quo (Ely and Thomas 2020). Despite having diverse staff in scientific organizations, STEM workplace culture requires people of color to contribute only in ways most comfortable to White people or conform to the standards most often associated with Whiteness. This type of culture avoids discussions about racism and racialized narratives by characterizing this discourse as divisive or unproductive (Hecht 2020). The latter constraint mandates a change in people to fit the organization instead of transforming the organization to fit all people.

Building and maintaining a movement toward racial equity is a daily practice and requires an understanding that no organization ever fully arrives at the destination of complete equity, racial or otherwise. Never fully arriving at "destination equity" does not reflect a Sisyphean task; it represents the fluidity of equity, which is temporally and contextually conditioned. Racism and racialized narratives elicit a heavy toll and place a heavy burden on the shoulders of those who must navigate this narrative daily.

### DEFINING DEIA

According to the Society for Human Resource Management, the discipline of DEIA involves understanding the experiences, qualities, and work styles that make individuals unique (SHRM, n.d.). Moreover, DEIA incorporates that knowledge into an organization's strategies to support its programmatic objectives. Although an organization may develop its own definition of "diversity," diversity generally refers to individual similarities and differences within a group, accounting for every aspect of personality and identity. If diversity brings the opportunity for strategy and innovation, then inclusion enables an organization to realize the programmatic benefits of that potential. Inclusion speaks to the degree that members of the organization feel respected, supported, valued, and welcome.

Inclusion requires bilateral accountability; each party must offer inclusion to others and accept it from others. An organization that nurtures an inclusive environment provides a context for employees to feel more engaged and contribute to the organization's end products. An inclusive environment requires individuals from diverse backgrounds to appreciate one another's needs and viewpoints, and collaborate and communicate, activities that can inherently translate into a demonstration of cultural competence.

Equity refers to fair access, advancement, and opportunity for every individual. Equity aims to identify and counterbalance barriers with just treatment for historically marginalized groups. It applies to a wide spectrum, including team, organizational, and industry levels. Requisites for navigating change through an equity lens are understanding and acknowledgment of the intrinsic inequities within social structures, and the organizational workplace is no exception to such structures.

Accessibility is the foundation on which an organization builds diversity, equity, and inclusion for people with disabilities and others with unique circumstances. Organizations like the federal government must proactively, and consistently, design, construct, develop, and maintain facilities, programs, services, and technology so that all people, including people with disabilities, can fully and independently use them (GSA 2021).

## DIVERSITY IN THE SCIENTIFIC COMMUNITY

Diversity in the sciences is not just a matter of representation but a strategic imperative for driving scientific progress, addressing societal challenges, and ensuring a more equitable and inclusive future for all. The report *Leveraging Data for Racial Equity in Workforce Opportunity* focuses on using data-driven approaches to address racial disparities and promote equity in the workplace (Afolabi 2023). The report emphasizes the importance of collecting and analyzing relevant data related to workforce compensation, demographics, hiring practices, promotions, and retention rates.

Unintentionally—but no less important—the report invokes the concept of data justice and applies a data justice framework to address equity in the workforce (e.g., scientific workforce). As a concept, data justice is less concerned with the technological landscapes of interoperability between systems within the data enterprise or the degree of functionality between information systems and end users. Instead, data justice attempts to interrogate public data issues shaped by power dynamics and social-structural drivers (Dencik and Sanchez-Monedero 2022).

Through careful data analyses, the report aims to identify barriers and challenges faced by historically excluded racial groups in organizations. The report suggests setting clear goals and targets to improve racial equity, such as increased representation in leadership positions and reduced pay gaps. The report also emphasizes the implementation of targeted interventions, including diversity and inclusion training, mentorship programs, and revised recruitment practices.

To ensure progress, the report underscores the importance of the continuous monitoring and evaluation of implemented interventions, focusing on transparency and accountability. Collaboration with external partners, such as community organizations and experts in diversity and inclusion, is also encouraged, to support efforts toward racial equity.

As the DEIA discipline deliberatively looks inward and continues to develop, the definitional contours of equity expand. Procedural equity is a concept now being explored within equity. According to the Urban Institute, “procedural equity” can broadly be defined as an “approach to equity that ensures processes are fair for target participants,” particularly when it is connected to access to services (Balu et al. 2023). The idea is that in developing policies, procedures, and processes, there should be inclusive and authentic representation of the participants being served. Diversity in the sciences warrants procedural equity and, arguably, mandates the thoughtful incorporation of this principle and practice.

Diversity in the sciences is of paramount importance for several reasons:

- Broader Perspectives and Creativity: When scientists and researchers from diverse backgrounds come together, they bring unique experiences, perspectives, and ways of thinking. This diversity of thought fosters creativity and innovation, leading to groundbreaking ideas that may not have arisen within homogenous groups.

- Ways to Address Complex Problems: Many scientific challenges and research questions are complex and multifaceted. Agencies should have diverse teams to allow for a more comprehensive approach to problem-solving, as individuals from different backgrounds may offer varying insights and solutions.

- Better Research Design and Implementation: Diversity in the sciences ensures that studies and experiments are designed and conducted with a more inclusive lens. Such a lens can help avoid biases and limitations resulting from a narrow perspective and lead to more robust and reliable scientific outcomes.

- Increased Relevance and Impact: Scientific discoveries and advancements are intended to benefit society. Having a diverse group of scientists ensures that research is more relevant to a broader range of people and communities, increasing its potential positive impact on various populations.

- Representation and Role Models: Diversity in the sciences provides role models for aspiring scientists from historically excluded groups. When individuals see scientists who look like them and come from similar backgrounds, they are more likely to believe that a career in science is attainable and can be pursued.

- Enhanced Global Collaboration: Scientific collaboration often transcends borders in an increasingly interconnected world. Having diverse teams facilitates effective communication and collaboration with scientists from different countries and cultures, leading to fruitful global partnerships.

- Ethical Considerations: Diversity is not only about representation; it also requires ethical research practices. A lack of diversity can lead to unintended consequences and ethical issues, such as underrepresentation of certain groups in clinical trials or biased algorithms in artificial intelligence applications.

- Inclusivity and Equity: Emphasizing diversity in the sciences promotes inclusivity and equity within scientific institutions. Agencies should create an environment where individuals from all backgrounds feel welcome and supported, as such workplaces are crucial for attracting and retaining diverse talent.

- Economic and Social Benefits: A diverse scientific workforce contributes to economic growth and competitiveness. It allows societies to tap into the full potential of their talent pool, leading to increased innovation and productivity.

Therefore, the following recommendations seek to strengthen both internal and external perceptions and performance regarding diversity in the federal STEM workforce and the corresponding research being conducted:

- Federal agencies should demonstrate their efforts to diversify the STEM workforce to the public by making data on disability status, gender, race and ethnicity, and sexual orientation publicly available.

- Heads of federal agencies should direct appropriate staff to develop guidance that leads to more diverse committees within federal agencies.

    - Demonstrate publicly their guidance on diversifying work groups and committees and provide work group and committee data to show that they are following through with their commitments.

- Contract with external experts to study decision-making processes by diverse and less diverse work groups and committees. The results of this analysis should inform agency efforts to diversify teams and should be made publicly available.

- Chief agency scientists should provide guidance on how STEM staff should build equity into their work.

  - Conduct an annual assessment to better understand the equitable dimensions of scientific work.

  - Train federal scientists to better understand their own implicit biases so that they better understand how their research may not fully incorporate equitable dimensions. This training should make clear the serious ethical implications of implicit bias, such as underrepresentation of certain groups impacted by the researcher's work.

  - Train federal scientists on how to effectively and equitably partner with the communities who are most impacted by their work. These partnerships should help scientists better understand the relevance of their work to a broad range of people and communities across the globe.

## Measure Accountability and Progress

For years, agencies have committed to advancing DEIA in the workplace, and President Biden's Executive Order on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce charges agencies with increasing these efforts using a data-driven approach (Office of the US President 2021a). Under this executive order, agencies are not only charged with drafting strategic plans to advance DEIA in the workplace but also required to collect data and conduct research that can be used to evaluate whether agencies are successful in their efforts. Reports compiling the best practices on advancing DEIA for the federal STEM workforce have been drafted by interagency work groups for the National Science and Technology Council, OPM, and OSTP (IWGIS 2021; OSTP and OPM 2016), but it is difficult to determine if agencies use this evidence to reform their practices and develop measures that can hold them accountable.

Over the years, several GAO reports tasked with assessing federal agencies' attempts to diversify the workforce have pointed out that agencies often lack evaluation details, quantitative metrics, or time frames for evaluating progress on DEIA goals (GAO 2018; GAO 2021; GAO 2005). And even when agencies collect these data, they do not always use them to monitor or evaluate the success of current procedures. For instance, OPM collects data on the use of direct hiring authorities but does not use the data to analyze the impact of direct hiring authorities on the recruitment and retention of federal employees (GAO 2021).

Developing robust quantitative and qualitative performance measures would help federal agencies translate their diversity aspirations into tangible practice, track the return on investment of DEIA commitments like diversity trainings, and identify trends that can help them assess their progress (GAO 2005; IWGIS 2021). But to avoid a biased determination of what constitutes success, agencies need to develop performance metrics at the onset of their

DEIA commitments and develop procedures to ensure that these metrics are being properly used to evaluate their progress (GAO 2018). Below are recommendations that agencies can use to develop a robust set of methodologies for determining the best evidence-based approaches to hold themselves accountable to their DEIA commitments.

## INTERAGENCY PERFORMANCE EVALUATIONS

- It is a positive step that OPM's 2022 Federal Employee Viewpoint Survey included, for the first time, a DEIA Index (OPM 2022b). OPM officials should expand on these efforts and assess if employees, particularly STEM professionals, feel that their agencies are making progress on their specific DEIA goals and commitments.

- OSTP and OPM should develop a clearinghouse of research highlighting the best practices for advancing DEIA and make this research readily available to agencies and the public.

## INTRA-AGENCY PERFORMANCE EVALUATIONS

- Heads of agencies should collect data to evaluate whether their agencies' DEIA efforts are benefiting the STEM workforce:

    - Evaluate what is working and what is challenging, and determine if the programs that help bring in new, diverse scientists can be maintained.

    - Develop a mixed-methods research protocol that analyzes qualitative data (e.g., focus groups, interviews, and surveys) as well as quantitative data to determine an agency's progress toward its DEIA goals (GAO 2005).

    - Ensure that the data are disaggregated by citizenship, disability, geographical region, race and ethnicity, sex and gender, and sexual orientation so that the impact of an agency's DEIA efforts on scientists from historically marginalized populations can be properly assessed.

    - Develop protocols for using performance metrics to improve agencies' DEIA practices.

# Chapter 7: Conclusion

The Biden administration and future administrations must build on recent progress to strengthen and diversify the federal STEM workforce. Federal scientists play a fundamental role in ensuring that the best available science keeps medicines safe, air free of pollutants, and weather properly forecasted, among other things. However, with federal agencies recently taking on more duties to safeguard the public with passage of legislation like the Inflation Reduction Act, concerns about a lack of STEM professionals to do all the work have grown.

Federal agencies need to implement evidence-based recruitment and retention policies that help bring in more STEM professionals. As part of this strategy, federal agencies should ensure that scientists from historically excluded populations feel that their workplace is inclusive, that their contributions matter, and that they do not face additional barriers that hinder hiring, promotion, or other workplace processes. Diverse working environments are more innovative and productive, and therefore efforts to increase capacity at federal agencies need to be coupled with efforts to establish and follow through with DEIA commitments.

There has never been a more urgent time to ensure that the federal STEM workforce is strong. Climate change, new technologies such as artificial intelligence, and a pandemic are quickly changing the world, sometimes in drastic ways. The federal government will need to make science-informed decisions to best protect and support people in the United States, and it needs a strong and diverse STEM workforce to meet this challenge head-on. The recommendations offered in this report will help the federal government recruit and retain a top-tier STEM workforce fully prepared to meet the nation's most significant challenges.

# Appendix

## Analysis 1: Scientific Capacity at Federal Agencies

To determine capacity levels of the federal scientific workforce, we used data from the US Office of Personnel Management (OPM) FedScope database (OPM 2022a). This methodology corresponds with Figures 1, 2, and 3 in the report. Six federal agencies were chosen for this analysis: the Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the Fish and Wildlife Service (FWS), National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA).

From FedScope, we pulled data from the last calendar quarter (Q4) for the years 2017 to 2022 for each of the six agencies and recorded workforce numbers for people working in occupational series classified as science, technology, engineering, and mathematics (STEM). To determine racial and ethnic diversity, we used FedScope's ethnicity and race indicator, which consisted of one ethnicity category (Hispanic or Latino), five racial categories (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, and White), and a category of "more than one race." Some agencies (EPA, FWS, and NOAA) included the racial category of "unspecified," the data for which is not shown in our figures.

For Figures 1 and 2, the year-to-year percent change in the number of STEM professionals was calculated for the six federal agencies. Percent change was calculated by subtracting the number of scientists recorded in the initial year from the number of scientists in the following year, dividing this quantity by the number of scientists in the initial year, and then multiplying by 100.

## Analysis 2: Educational Backgrounds of Federal Scientists

To determine what types of universities were attended by federal scientists for their most advanced degrees, we matched the names and job titles of scientists employed at five federal agencies with their LinkedIn profiles and examined their self-reported educational backgrounds. LinkedIn is a popular employment-focused social media platform where people can self-report their employment and educational records for career development or professional networking purposes. Our methodology corresponds to Figure 4 in the report. Five federal agencies were chosen for this analysis: CDC, EPA, FDA, FWS, and NOAA. These agencies are the same ones examined in the prior analysis, with the exception of NASA, an agency for which we did not have staff directory data.

Information on the names and job titles of federal scientists came from federal staff directories. These data had been previously used by our team for a survey project, as documented in our report *Getting Science Back on Track: Voices of Scientists across Six Federal Agencies* (Desikan and Carter 2023). We obtained lists of federal agency staff through publicly available online staff directories and Freedom of Information Act requests. We filed Freedom of Information Act requests for government agencies that had incomplete online employee

directories or no directories at all. Staff directories corresponded to employment records that dated from February to June 2022.

From the staff lists, we identified employees holding scientific or nonscientific positions based on job titles, office and department names, and OPM's occupational series. For the purposes of the analysis, we considered a scientist a person whose job involved a significant level of science, including research, operations, modeling, inspection and oversight, and science policy. The analysis included full-time federal employees, contractors, associates, fellows, and students. When the specific office in which the employee worked was available, we used that to exclude large numbers of people who were unlikely to perform the above scientific functions. Common nonscientific offices usually excluded from lists include administration, finance, information technology, and facility maintenance.

Using the staff directories, we randomly selected 100 scientists from each of the five federal agencies and worked to ensure that the scientists represented different offices or departments within each agency (i.e., none of the 100 scientists came from only one agency office or department). Randomization was obtained using the Excel function "RAND" for each agency's staff directory.

The names and job titles of the 500 selected scientists were then matched with information found on LinkedIn. LinkedIn searches were carried out in July and August 2023. Data pertaining to each individual's educational attainment was collected from LinkedIn by entering the following text format into the website's search engine: first name, last name, full agency name, and agency abbreviation. If a federal scientist selected through our randomization process did not have a profile on LinkedIn or could not be matched via name and job title with any certainty—or if their LinkedIn profile indicated that they no longer worked at the federal agency or if it was unclear whether they obtained an undergraduate, master's, or doctoral degree from the college or university listed on their profile—we removed that scientist from the analysis and went on to the next randomly selected name until we reached our predetermined quota of 100 scientists from the five agencies.

However, there are some caveats to using the LinkedIn data that we were not able to control. It is possible that our process for matching the names and job titles of federal scientists from the agency staff lists to specific LinkedIn profiles was insufficient and instead captured profiles that were not created by the agency scientists we were investigating. Additionally, the LinkedIn profiles we examined may have been out of date or contained incorrect information. Finally, it is possible that agency scientists who did not create a LinkedIn profile, and therefore were not included in our analysis, differed from agency scientists that created a LinkedIn profile in a way that affected the outcome of our results.

The following information was recorded for each scientist in the sample: first and last name; job title as listed in the agency's staff directory; self-reported job title on LinkedIn; names of doctoral, master's, and undergraduate institutions; the state, territory, or city (if international) where the institutions were located; and whether the universities were public or private. Only university information on the highest degree obtained by each individual scientist was included in the final analysis.

Universities were categorized as Hispanic-serving institutions (HSIs), historically Black colleges and universities (HBCUs), or tribal colleges and universities (TCUs) based on the

Department of Education's list of designated or accredited universities. The Department of Education classified the three minority-serving institutions in the following ways:

- An HBCU was defined in accordance with the Higher Education Act, which stated that it is "any historically black college or university that was established prior to 1964, whose principal mission was, and is, the education of black Americans, and that is accredited by a nationally recognized accrediting agency or association determined by the Secretary [of Education] to be a reliable authority as to the quality of training offered or is, according to such an agency or association, making reasonable progress toward accreditation" (ED, n.d.a).

- An HSI was defined as an eligible institution of higher education that had an enrollment of undergraduate full-time-equivalent students of which at least 25 percent were Hispanic (ED, n.d.b).

- TCUs were defined through an accreditation process with either the Higher Learning Commission of the North Central Association of Colleges and Schools or the Northwest Commission on Colleges and Universities (ED, n.d.c).

If the universities did not fit into any of these three categories, they were classified as non–minority-serving institutions. None of the 500 federal scientists reported attending a TCU for their highest degree earned.

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