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Building community to advance women in the geosciences through the Earth Science Women's Network

Rebecca T. Barnes
Colorado College, Environmental Program, 14 E. Cache La Poudre, Colorado Springs, Colorado 80903, USA

Erika Marín-Spiotta
University of Wisconsin–Madison, Department of Geography, 550 North Park Street, Madison, Wisconsin 53706, USA

Aisha R. Morris
UNAVCO, Inc., 6350 Nautilus Drive, Boulder, Colorado 80301, USA

ABSTRACT

Informal networks play a critical role in advancing careers by providing peer support. This is particularly important in fields where women are grossly underrepresented, because peer networks can reduce feelings of isolation and provide access to information and opportunities for professional development. The power of networks lies in their ability to mobilize people and information for educational and institutional change. Here we highlight the example of the Earth Science Women's Network (ESWN), which grew from a group of six female graduate students and postdocs to a non-profit organization with more than 3,000 members worldwide in 15 years. ESWN's activities support women at all career stages and include a program for undergraduate students. Today, ESWN is partnering with larger professional societies to improve work climate conditions and shape a more inclusive society, particularly in light of incidences of sexual harassment. We describe the evolution of ESWN in response to membership needs and as a model for online and in-person community building. The ESWN community supports peer mentoring that builds upon personal connections to catalyze cultural and institutional change for the advancement and promotion of women in the geosciences.

INTRODUCTION

Geoscientists tackle problems concerning a wide range of topics, from natural hazards, food, and nutritional security to energy, climate, and water—all fields at the center of many of society's global challenges. Despite the importance of these challenges for the livelihoods of communities in the United States and abroad, the geosciences workforce is one of the least diverse in the science, technology, engineering, and mathematics (STEM) fields (Gonzales and Keane, 2011). Women receive 39% of undergraduate degrees in the earth, atmospheric, and ocean sciences in the United States (National Center for Science and Engineering Statistics, 2015), yet they make up less than 16% of the workforce (Gonzales, 2010) and only 20% of academic

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faculty in the geosciences (Glass, 2015). Gender bias is prevalent in the geosciences and other disciplines with low gender diversity, and has been documented in recommendation letters for postdocs (Dutt et al., 2016) and early career faculty (Madera et al., 2009), in student evaluations (MacNell et al., 2015), and in faculty hiring and promotion (Hill et al., 2010; NAS et al., 2007). This bias is not exclusive to academia and permeates industry, government labs, and other workforces. In addition to disadvantaging individual careers, the lack of diversity has negative societal consequences. Not only do more diverse groups make better problem solvers (Cox and Blake, 1991), they also increase the participation of women, especially women of color, enhance the societal relevance of STEM work, and contribute to building a more inclusive society where all groups have the opportunity to pursue STEM learning and employment.

The Earth Science Women's Network (ESWN; eswnonline.org) is an organization dedicated to diversifying the earth and environmental science workforce and improving the retention of women by promoting career development, building community, providing opportunities for mentoring and support, and facilitating collaborations (Fig. 1). Informal networks like ESWN play an important role in advancing the careers of women in fields where they are underrepresented by reducing feelings of isolation and providing access to information and opportunities for professional development. We describe the evolution of the ESWN model for online and in-person community building and peer mentoring that builds upon personal connections to identify challenges and opportunities for the advancement and promotion of women in the geosciences and catalyze cultural and institutional change through societal partnerships.

HISTORY OF ESWN

ESWN's origins trace back to an informal network created by six early career female atmospheric scientists who, at a 2002 Spring Meeting of the American Geophysical Union (AGU) in Washington, D.C., decided to create an email list to stay in touch and help each other navigate life as they finished their Ph.D.s and explored career options. The group grew via word of mouth, with members adding their friends and colleagues. Once the group was large enough, online communication was moved to a listserv hosted by the National Center for Atmospheric Research (NCAR), ESWN's earliest and longest supporter (Fig. 2).

In 2004, the group formally became the Earth Science Women's Network (ESWN). In response to a growing membership, the informal governing structure was replaced by a Leadership Board in 2005. A successful ~US$1 million award from the National Science Foundation (NSF) (ADVANCE PAID, 2009–2013) launched ESWN into a new phase of exponential growth with the creation of a professional website, hosting of career development workshops, and diversification of the network's activities (see Hastings et al., 2015).

Figure 1. Logo of ESWN.

The ESWN leadership board voted unanimously to become a non-profit in 2013, with the goals of serving a growing membership and sustaining the professional development programs developed with NSF support. To fund the costs associated with non-profit formation, ESWN hosted its first crowd-funding campaign and was officially approved as a 501(c)(3) organization in 2014. Organizations with "501(c)(3)" status in the United States have been designated by the federal government as nonprofit charitable organizations.

The current leadership board has 12 members who represent a diversity of disciplinary and professional backgrounds and experience working with historically underrepresented groups at different career stages. ESWN recently was awarded a matching grant from the Madison Community Foundation to build an endowment, which will cover the basic operating costs of the organization for the long term (eswnonline.org/give). With the stability from our target US$150,000 endowment, ESWN will be able to launch new initiatives to serve the scientific community, support women in the earth sciences, and broaden our activities to support science education and the broader STEM pipeline.

A NETWORK FOR PEER MENTORING

In fifteen years, ESWN grew from an informal advice group of six women to an organization with more than 3,000 members working in over 50 different countries (Fig. 2). ESWN's success is largely due to the creation of an online community for sharing resources for women and other early career researchers. ESWN takes a community-driven approach to mentoring (see Adams et al., 2016). To date, the group has not established formal mentoring relationships. Rather, all members of the community can be mentors and be mentored at any given moment, in response to changing needs.

In contrast to more traditional one-on-one mentor-mentee pairings, when an ESWN member solicits advice through the online discussion boards, they receive feedback from a large community of people (Glessmer et al., 2015). In a 2013 survey, ESWN members reported that participation in the online network provided a venue for emotional support; facilitated learning about other women's experiences, concerns, or challenges; and decreased feelings of isolation (Archie and Laursen, 2013). The network also increased member confidence, knowledge, and perspective. For many, ESWN is the only work-related space where they are not the only woman; this environment allows for honest discussions of personal and vulnerable topics that may not occur in a mixed-gender environment.

Building Community Online and In Person

ESWN-sponsored in-person networking events and professional development workshops combine with online discussions to create a peer network community. Mirroring the dynamics of the broader scientific community, our members form connections by discipline, by region, and by topical interest. In some cases, members connect online over specific challenges, such as being the only geologist on their campus (e.g., the "Lone Rangers" group); these online forum conversations not only reduce feelings of isolation but also provide tools to address particular situations. Connections started online may translate into real-world meetings or collaborations; connections started in person can continue through the online community.

Leveraging the benefits of an online community, ESWN has few barriers to join: the network is free and open to individuals who identify as women and who are studying, working in, or have a strong professional interest in the earth and environmental sciences. The disciplinary focus of the network has broadened beyond the core of atmospheric scientist founders to include astronomers, geologists, biogeoscientists, ecologists, geographers, geophysicists, soil scientists, oceanographers, climate scientists, environmental and chemical engineers, etc., as well as professionals, educators, policy analysts, journalists, science communicators, and social scientists with links to the earth and environmental sciences. The broad umbrella ensures that sections of the membership will overlap at conferences and professional meetings where personal interactions strengthen the value of the online network.

The ESWN website was developed as part of the NSF ADVANCE PAID award and provides password-protected discussion boards where members can post questions, share information, and receive tailored advice. The website hosts member profiles, allowing ESWN members to search for colleagues and connections based on their field of interest, location, career stage, and other interests. Members report benefits from reading discussions and feel engaged even if they do not actively participate in conversations (Archie and Laursen, 2013). Beyond individual benefits, there are many examples of online conversations that result in institutional change. For example, an ESWN discussion led to the implementation of lactation rooms at a major conference via a member involved in professional society leadership. ESWN also maintains a private Facebook group that provides members with another way to share news, resources, and build community, along with a Twitter feed (@ESWNtweets) for public outreach.

The launch of the website allowed ESWN to start highlighting our members and their accomplishments. Research on public perceptions of scientists has identified strong biases in what "a

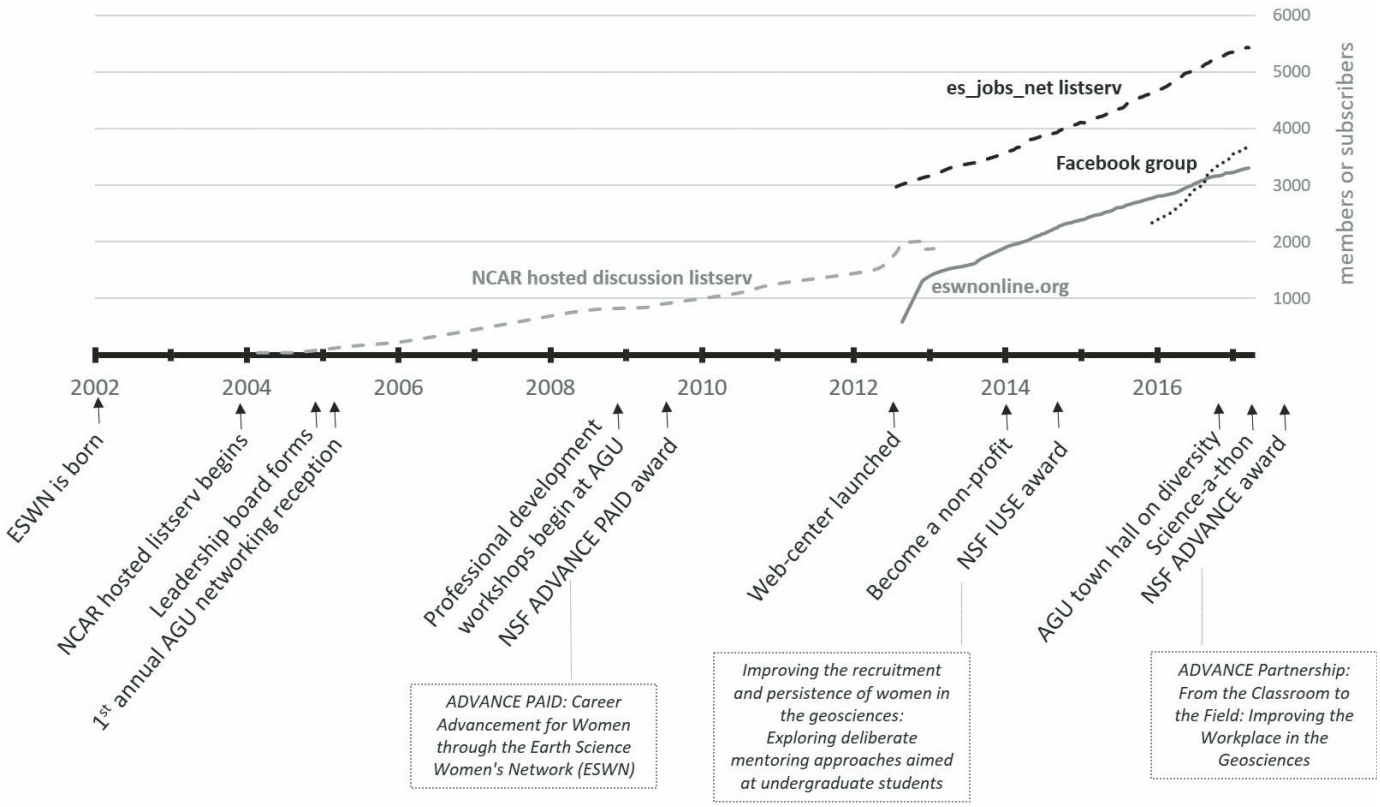

Figure 2. Membership numbers and participation in ESWN-sponsored online activities over time and a timeline illustrating the evolution of the organization.

scientist looks like" (Chambers, 1983). ESWN works to diversify the public perception of scientists by promoting our members and by working with professional societies to "level the playing field" in the competition for top scientific awards. Our Member Spotlights offer one mechanism to highlight the accomplishments of our members on the front page of the ESWN website. Spotlights have highlighted ~40 women in diverse career tracks and stages. This feature helps build member confidence, raises the visibility of early career women scientists, and is a resource for others seeking a diversity of candidates for invited talks, research collaborations, or job vacancies.

In-person activities include member-led gatherings, meet-ups at scientific conferences and meetings, professional development workshops, and a suite of networking and training activities at the annual Fall Meeting of the American Geophysical Union (AGU). ESWN members organize meet-ups at smaller professional meetings and in regions with a critical mass of members. These gatherings provide a more intimate opportunity to build community. Larger networking receptions allow for members to meet each other, for new members to learn about the organization, and for real-world connections to grow from relationships online. For example, our largest reception, held on the evening of the first full day of the AGU Fall Meeting, serves as a friendly space for attendees to meet other conference goers early on in the week and is for many an introduction to the group.

While these in-person events reach a smaller percentage of the total membership, they increase the value of participation in the network. Those who attend feel more engaged and connected to the group and take a more active role in initiating and responding to online discussions and inviting others to join (Archie and Laursen, 2013). In-person events generally are followed by an increase in online activity and new member registrations.

Career Training Skills Development

Among the in-person activities offered by ESWN, the group has become well-known for a series of career development workshops. With funding from the National Oceanic and Atmospheric Administration (NOAA) and NSF, ESWN has created and offered multiple day workshops for 50–70 advanced graduate students, post-docs, and early career scientists on topics such as networking, successful communication, leadership and management skills, and establishing a research identity (Glessmer et al., 2015; Hastings et al., 2015). Workshop evaluations show these to be very effective, and participants reported gains in the content targeted, whether it be career planning, motivation and preparedness to pursue one's goals, learning ways to use professional networks to meet career needs, or improvements in leadership skills (Archie and Laursen, 2013).

> Due to one of the workshops, I realized I should negotiate a salary increase. Several ESWN members helped me and offered suggestions. I came back empowered. … I did some research, learned I was grossly underpaid compared to my colleagues, I asked for a salary increase during a time when academic budgets were being cut and I got it—no problem! Really made me feel valued. (anonymous survey respondent, reported in Archie and Laursen, 2013)

SERVING THE BROADER COMMUNITY

ESWN initiatives also serve the broader geoscience community, inclusive of all genders. ESWN manages the Earth Science Jobs listserv (es_jobs_net), generously supported by the National Center for Atmospheric Research (NCAR). Subscription and job posting to the list is free, and its searchable archives are available online. An average of 75 monthly job announcements reach more than 5,300 subscribers, growing from 3,000 in early 2013 (Fig. 2).

ESWN has developed two- to three-hour-long mini-workshops offered at professional society meetings, which 90% or more of participants rank "excellent" or "good." These short workshops raise awareness of the diversity of models for success in scientific careers, provide networking opportunities, and increase participants' confidence in their personal career advancement. The topics covered include publishing, succeeding on the tenure track, discovering non-academic careers, managing successful field research campaigns, and navigating funding opportunities. These activities target early career scientists and draw diverse audiences of ~40–100 participants, 50%–60% of whom are women and 45% identifying as non-white. ESWN-developed and -led workshops are a staple of educational activities offered at the AGU Fall Meeting, accessible to all participants.

Expanding the ESWN Model to Undergraduates

Extending the ESWN model of peer-mentoring and professional development to undergraduates, several ESWN board members are leading an NSF-funded project: PROGRESS (PROmoting Geoscience Research Education and SuccesS) (see www.geosciencewomen.org). The program, currently in its fourth year, is active in the Colorado/Wyoming Front Range and in North and South Carolina. PROGRESS introduces first- and second-year undergraduate women to careers in geoscience fields and provides them with same-gender mentoring. Developed with experts in gender and quantitative educational psychology, the program is following two cohorts of students to assess what happens when undergraduate women are provided a same-gender mentoring network and they are exposed to people and ideas that challenge traditional perceptions of women's ability to succeed in science.

Student participation in the PROGRESS program begins with a weekend workshop where they meet other students with similar interests and learn about their personal strengths. Student learning is enhanced by understanding the relevance of the work (Su and Rounds, 2015); therefore, the weekend workshop starts with a discussion of the societal importance of geoscience research and employment and its team-oriented nature. Through a series of panel presentations and in-person discussions, students

are introduced to geoscientists from different backgrounds and degrees who work in a variety of fields. These panels aim to broaden the image of what a scientist looks like. This is a critical step, because when students see others like themselves succeeding, they are more likely to feel like they belong (Good et al., 2012). The panels also serve to humanize the life and career of a scientist, with panelists discussing both the excitement and challenges of being a geoscientist. These activities provide students with exposure to a range of women succeeding in roles counter to the prevailing stereotypes, which helps to diminish these very same stereotypes (Zawadzki et al., 2014). Students are empowered with tools to recognize and address potential sources of implicit bias regarding gender and race. In addition, they reflect upon their own strengths and the idea that skills and knowledge are not innate and that ability is gained over time, a critical idea to building academic tenacity (Dweck et al., 2014). Finally, the students are exposed to the importance of building a network of peer and senior mentors (see e.g., Glessmer et al., 2015) and are then matched to a mentor or mentoring team.

While the program is only in its fourth year, early results suggest that PROGRESS is an effective and scalable program benefiting its participants. Results presented by Hernandez et al. (2017) illustrate that undergraduate women with larger mentoring networks are more likely to identify as scientists and more likely to pursue geosciences as a field of study post-graduation, highlighting the importance of making students feel they are part of a community.

WORKING TO DIVERSIFY THE GEOSCIENCE WORKFORCE

Despite progress in the representation of women in STEM, the U.S. geosciences continue to be overwhelmingly dominated by white men. Advances in the recruitment, retention, and promotion of white women have not been afforded to other racial and ethnic groups. The geosciences have the smallest representation of historically underrepresented minority groups. Black, Hispanic, American Indian, Alaska Native, and Asian Pacific Islander women together represent only 5% of bachelor's degrees and 7% of tenure-track faculty in the United States (National Center for Science and Engineering Statistics, 2015).

To address the problem of broader representation and participation in the geosciences, ESWN has been collaborating with other societies to identify how institutions and organizations can better provide access and support to more diverse communities. In 2016, ESWN led a town hall at the AGU Fall Meeting with the Association of Women Geoscientists (AWG), the National Association of Black Geoscientists (NABG), and AGU. The goals of this town hall were to (1) highlight successful programs for attracting and advancing historically underrepresented earth scientists at different career stages: undergraduate, graduate, and post-graduate; and (2) with participation of the audience, identify key strategies that AGU and its members can enact to broaden the participation of a diverse membership and workforce. Each speaker highlighted the particular components of their programs that successfully supported students and early career professionals, specifically those from backgrounds underrepresented in the geosciences. Key strategies identified by the town hall participants include demonstrated institutional and faculty/staff buy-in, incorporating multiple well-prepared mentors, facilitating the development of a community of support, and leveraging strategic partnerships with invested stakeholders. Institutional buy-in was a critical factor in the success of several of the programs represented by the panelists, including organizational support for research internship programs targeted toward underrepresented minority students at UNAVCO (a non-profit university-governed consortium facilitates geoscience research and education using geodesy) and Colorado State University. Every speaker outlined the critical role served by effective mentors in the preparation and continued professional development of the participants in their programs. Multiple panelists also stressed the importance of creating a supportive cohort of colleagues for their program participants and the lasting support network this often facilitates far beyond the duration of the program. The importance of partnerships among key stakeholders is another component highlighted by panelists, because exposure to a diversity of options within the geosciences provides students with a breadth of pathways within the field. Following the brief presentations, the town hall concluded with a question and answer session where attendees inquired about the mechanisms they could incorporate in their classrooms and activities to facilitate full representation within the geosciences. The town hall was followed up by a workshop in the 2017 AGU Fall Meeting, where participants had the chance to sit down and share effective strategies and learn from each other. The conversation was broadened to include strategies for making the geosciences more inclusive to people with disabilities.

One area where women and historically underrepresented minorities are severely misrepresented is in scientific honors and awards, which predominantly are bestowed upon white men. ESWN board members have contributed to discussions related to increasing diversity in society awards, including recommendations to educate members about implicit and other biases and diversifying selection committees (American Geophysical Union, 2016; Ball et al., 2015). Our work was recognized by the AGU, and many members report being inspired to nominate themselves and their colleagues. Through ESWN initiatives, members are encouraged to announce award opportunities, solicit names of nominees, and organize teams to lead and initiate nominations. Successful nominations are publicly celebrated on our website as well as through various ESWN social media accounts.

Catalyzing Cultural and Institutional Change

Many factors play into the decisions of women to leave science (Holmes et al., 2015), including a hostile environment created by the prevalence of sexual harassment. More than half of almost 500 ESWN survey respondents indicated that they had

experienced sexual harassment sometime during their careers (Archie and Laursen, 2013). Little data exists for the geosciences on how sexual harassment affects women with intersectional identities (except see Clancy et al., 2017)—for example, women of color, women with a physical disability, or transgender individuals—resulting in a lack of recognition of the unique challenges faced by those who identify with multiple groups that experience discrimination or disadvantage in the discipline. The low numbers of women of color in the geosciences can lead to feelings of isolation and professional insecurity (e.g., Holmes et al., 2015) and increased vulnerability to sexual and racial harassment (Clancy et al., 2017; Davis et al., 2015; Tuitt et al., 2009). A recent study of workplace climate in astronomy and planetary science revealed that 40% of women of color reported feeling unsafe as a result of their sex or gender and 28% reported feeling unsafe as a result of their race (Clancy et al., 2017). This hostile climate can result in experiences of trauma (Davis et al., 2015; Tuitt et al., 2009) and manifests in the reduced participation of women in science. In the Clancy et al. (2017) study, 18% of women of color and 12% of white women reported deliberately skipping professional events because they did not feel safe.

Disciplines with research and training-related travel to remote field sites may be especially vulnerable to sexual harassment (e.g., Clancy et al., 2014; Gewin, 2015)—experiences that further contribute to problems of isolation (Gewin, 2015). In a 2014 field study, 71% of women and 41% of men reported receiving inappropriate comments, and 26% of women and 6% of men reported experiencing sexual assault (Clancy et al., 2014). Female students disproportionately reported unwanted sexual attention from their superiors. Few respondents were aware of how to report sexual misconduct. This problem needs to be addressed as student enrollment in field camps rises (American Geosciences Institute, 2013), especially given that field training was required in 99% of 300 U.S. geology programs (Drummond and Markin, 2008).

ESWN has been working with society partners since fall 2015 to address sexual harassment in the earth and space sciences. AGU, AWG, and ESWN leadership held a town hall session at the 2015 AGU Fall Meeting in response to recent sexual harassment scandals in the space science community with society leaders and experts in gender bias and harassment in STEM. An invited opinion piece published in AGU's Eos publication led by an ESWN board member in collaboration with two past presidents of the Association for Women Geoscientists (Marín-Spiotta et al., 2016) urged AGU to address sexual harassment in light of failed or inadequate efforts by academic institutions and outlined a number of steps professional societies can take to address hostile climates. In response, AGU convened a special task force, with participation of ESWN leadership, to review and revise their ethics policy. ESWN leadership helped convene an AGU-led workshop funded by the NSF Geosciences program in September 2016 that brought together academic leaders from across the United States and representatives from scientific societies and funding agencies to discuss a course of action. A key workshop outcome was a statement of common principles and guidelines for effective codes of conduct (see St. John et al., 2016; Wendel, 2016). In September 2017, AGU announced adoption of a new ethics policy that includes harassment, bullying, and discrimination in the definition of research misconduct (McPhaden et al., 2017). This is a huge step forward for the geosciences community and a model for other professional societies.

Following on these activities, members of the ESWN leadership, in collaboration with AGU and AWG, were recently awarded an NSF ADVANCE Partnership award (2017–2021; Williams, 2017) to research ethics training for academic leaders and faculty and develop a new community-based model for sexual harassment intervention. To address differences in perceptions of gender equity and harassment and in the experiences of men and women (Holmes et al., 2008; Lampman, 2015), our proposed training activities target all genders. Recognizing that underrepresented groups with intersectional identities may be more vulnerable to different types of harassment (Clancy et al., 2017), an important component of the ADVANCE Partnership will incorporate experiences of a diverse group of geoscientists to better serve the entire community.

The NSF ADVANCE program was designed to foster gender equity through identifying and eliminating organizational barriers that prevent the full participation and advancement of women faculty in academic institutions. A unique aspect of our team is the collaboration with professional societies that allows us to reach a national audience and provide resources beyond those available at any individual university campus or workplace. These collaborative efforts highlight the power of professional networks to mobilize people and information for institutional and cultural change.

MOVING FORWARD

ESWN is dedicated to connecting and advancing women in the earth sciences by providing innovative and practical recommendations for fostering a diverse and inclusive workforce. As the network has evolved from a small group of women with a close disciplinary background to more than 3,000 women with diverse professional and personal experiences, exciting new opportunities have arisen for broader impact. In the summer of 2017, ESWN launched a social media campaign, "Science-A-Thon," to expand our efforts to change the public conversation around "who" is a scientist. Using the hashtag #dayofscience, this initiative built upon past highly successful social media campaigns promoting women in STEM. The Science-A-Thon invited participants to share 12 photos over 12 hours of the day, including both personal routines and professional endeavors. More than 200 scientists participated, with the #dayofscience trending on Twitter (13 July 2017). Earth scientists represented the largest portion of participants, but the event engaged cancer biologists, computer scientists, and more, including scientists from more than 10 countries. Scientists who participated increased the size of their own network and raised over US$30,000 to support ESWN activities. The campaign provided diverse images of

scientists to shift the public perception of who scientists are, why they do what they do, and the importance of their work.

Through new activities and programs, ESWN aims to increase the value to existing members, ensure relevance to the next generation of geoscientists, and expand our role in undergraduate STEM education and public awareness of the geosciences. The PROGRESS and ADVANCE Partnership programs are increasing the impact of ESWN and contributing to the recruitment and retention of women in the geosciences. Additional opportunities exist to extend the historic center of ESWN membership activity in the United States and Europe, and foster connections across a broader range of geographic areas. Key to this growth will be an infrastructure to sustain new initiatives. To date, all ESWN activities have relied heavily on the volunteered time of members, especially the leadership board. As we grow, our priority is to ensure the stability of our current service to women in the geosciences. Our goal is to establish an endowment that will sustain our core operations: website, AGU events, and partial support for a student assistant. More importantly, this base of support will allow our leadership board to launch new initiatives and respond to changing member needs.

ESWN strives to educate its members and the broader community about structural inequalities and biases that affect the potential of every person to fulfill their careers and is committed to finding innovative ways to advance science for the benefit of humanity, while providing for the well-being of its practitioners. By providing resources and access to information, as well as mentors and sponsors, ESWN is contributing to the recruitment, retention, and promotion of women in the geosciences at all stages of their careers. New programs aimed at undergraduate women on college campuses will ensure that the next generation of scientists is better equipped to navigate its own scientific path. Our successful efforts collaborating with society partners to reduce discrimination and harassment in the geosciences through raising public awareness, transforming professional society codes of conduct, and a new project under way to develop training at a national scale illustrate the impact that networks like ESWN can have on the broader community. ESWN has the capacity to empower individuals through peer mentoring and to catalyze cultural and institutional change for a more inclusive and safe geoscience.

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