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Perspective: toward an inclusive, diverse, and equitable scientific system

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ABSTRACT

Despite efforts to address disparities, entrenched inequalities persist within the scientific system. This article explores the multidimensional nature of these inequalities and outlines targeted strategies to foster a more inclusive and equitable scientific community. It serves as a call to action for all members of the research ecosystem—including researchers, publishers, editors, universities, scientific societies, and governmental bodies—to implement concrete steps toward diversity and inclusion. Without a fundamental paradigm shift towards an inclusive and diverse scientific system, achieving the environmental goals essential for both humanity and Nature will remain out of reach.

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Despite extensive discussions, analyses, and interventions, inequalities continue to persist in the scientific system. This endurance is partly due to the multidimensional nature of equality, with disparities emerging from complex interactions and feedback across individual, family, workplace, and societal levels (O'Brien et al. 2019). In this essay, I offer reflections on why such inequalities remain entrenched, the factors that sustain them, and suggest pathways to promote a more inclusive and equitable scientific system.

Our right to science

Article 27.1 of the Universal Declaration of Human Rights proclaims that "Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts, and to share in scientific advancement and its benefits" (United Nations 1948). This foundational principle affirms both our collective right to science and the responsibility of science to help uphold other basic human rights, including access to food, health, security, clean air, and water. Yet, despite this universal right, many groups—including women, women of color, researchers from low- and middle-income countries, and non-Caucasian scientists—have long been underrepresented or excluded in science, technology, engineering, and mathematics (STEM) fields, including marine, fisheries, and aquatic sciences (Downes and Lancaster 2019, King 2023).

The gender gap is particularly persistent: women account for roughly one-third of the global research workforce, a ratio that has remained largely unchanged over the past 2 decades (UNESCO 2024). Even as more women enter science, they face greater obstacles to retention, advancement, and recognition than their male counterparts (O'Brien and Hapgood 2012, Downes and Lancaster 2019), with more frequent barriers along equivalent career paths (Genua-Olmedo et al. 2025). This imbalance is evident across metrics of productivity, award recognition, and leadership roles in academia (Downes and Lancaster 2019, Diversity in science prizes 2022, Hughes et al. 2023, Genua-Olmedo et al. 2025). For example, 83% of top researchers in ecology and evolution (h-index >30) are concentrated in just 12 high-income countries—including the USA, Australia, and several European nations—while only 14% are women (Hughes et al. 2023). Additionally, a 2025 Nature portfolio report highlights that women comprise an even smaller fraction of corresponding authors, ranging from 10% to 30% depending on the journal discipline, with representation dropping further in the most selective journals (Gender equity in publishing 2025). When it comes to awards—which serve as career accelerators and offer important role models—women are nominated less often and receive less recognition than men (Gender equity in publishing 2025). Only 15.4% of the 8747 recipients of 345 scientific prizes and medals, including Earth Sciences, have been women (Gehmlich and Krause 2024).

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These statistics expose entrenched inequalities in the scientific system. While gender disparities are most frequently documented, similar patterns of marginalization affect other underrepresented communities. Many researchers must also navigate intersectionality—facing compounded disadvantages based on race, gender, religion, income, ethnicity, or other aspects of identity (King 2023, Genua-Olmedo et al. 2025).

Science stands as a remarkable accomplishment of humanity, yet it inevitably reflects the flaws and biases present in any social system (Graves et al. 2022). Recognizing, challenging, and remedying these shortcomings is essential to fostering a truly inclusive and diverse scientific culture.

To achieve environmental goals, an inclusive scientific system is needed

The right to science not only highlights the imperative for research to serve societal needs, but also calls scientists to embrace broader social responsibility (Graves et al. 2022). At the same time, the planet is experiencing an acute biodiversity crisis—especially in freshwater ecosystems, which have suffered an 85% loss in biodiversity (WWF 2024) and extensive degradation of inland waters. Addressing these challenges requires immediate, coordinated, and integrated responses across local, regional, and global scales to reverse negative trends, restore ecosystems, and safeguard aquatic diversity. Crucially, these environmental objectives are unattainable without genuine inclusivity. For example, how can we tackle the decline of inland water biodiversity when much global diversity is concentrated in countries with developing economies (for instance, Colombia contains 10% of the world's diversity), yet researchers from these regions are persistently underrepresented? How can we make robust assessments of global lake responses to climate change or water quality if data from the Global South are missing? How can we claim environmental justice when lakes surrounded by marginalized populations are monitored disproportionately less (Díaz Vázquez et al. 2025)? How can we reach net-zero emissions if African datasets are omitted from climate models (Mutiso 2022)? Clearly, meaningful progress and environmental justice will remain elusive unless the entire research ecosystem—including scientists, publishers, universities, governments, and non-governmental organizations—undertakes bold, transformative action to foster a more inclusive scientific culture.

Multiple barriers to overcome

Multiple, intersecting barriers continue to reinforce inequalities for researchers from underrepresented groups. These obstacles span hostile institutional cultures, inequities in funding and publishing, and language barriers.

Cultural and behavioral norms within the scientific system have historically concentrated power among white men. In addition to the persistent gender gap, groups such as women of color or lesbian, gay, bisexual, transgender, and all LGBTQ+ persons frequently encounter unwelcoming professional environments. They must navigate microaggressions, safety concerns, stereotype threat, tokenism, and unfair authorship practices (Chen et al. 2022, King 2023), all of which discourage their full participation in STEM disciplines, including aquatic sciences.

Funding barriers arise from racial discrimination or inequities in the percentage of national expenditure devoted to research. Racial discrimination and uneven national investment in research continue to limit opportunities for many. For example, a recent study revealed that Asian and Black or African American principal investigators in the U.S. National Science Foundation system have experienced the greatest funding inequities, persistent for over 2 decades (Chen et al. 2022). Globally, countries in the Global North dedicate an average of 1.44% of gross domestic product (GDP) to research and development while Southern countries allocated just 0.38% during 2005–2014 (Blicharska et al. 2017). This gap results in weaker infrastructure, ongoing operational difficulties, smaller research budgets, and limited public funding access in Southern countries. Access to international or multilateral funding, such as that available in the EU or USA, is also far more restricted in Southern countries (Turba et al. 2026). These limitations not only constrain research efforts but also hinder participation in conferences, professional societies, and the dissemination of research findings (Turba et al. 2026). Collectively, these disadvantages diminish the global competitiveness of researchers from the Global South.

Open Science is defined as an inclusive construct that aims to make multilingual scientific knowledge openly available, accessible, and reusable for everyone, to increase scientific collaboration and the sharing of information for the benefits of science and society (UNESCO 2021). Thus, Open Science seeks to democratize knowledge and make scientific findings accessible to all. While open access (OA) publishing increases information availability, it has also introduced new layers of complexity and inequality. Article processing charges (APCs) for gold and hybrid OA often reach several thousand dollars, creating a substantial barrier for researchers, especially those in the Global South. For many, these fees can exceed their annual research

budgets or force them to divert already scarce resources from essential research activities. Although OA fee waivers exist, they benefit only a limited number of gold OA articles and are primarily targeted at researchers in lowest-income economies, often excluding those from middle- and low-income countries (Hughes et al. 2023, Nobes and Harris 2023). A recent study quantified the percentage of a starting grant required to pay APCs for Nature publications, representing 35.19% in Chile, 64.95% in Peru, 585% in Iran, and only 3.56% in Europe (Turba et al. 2026). These results illustrate how the current publishing model exacerbates inequalities, reducing both the diversity and inclusiveness of published research and biasing the literature toward evidence generated in the Global North. A critical consequence is that this bias does not contribute to achieving environmental goals and implementing mitigation strategies in the Global South, owing to a lack of region-specific data and the inability to generalize results from the Global North to other contexts.

Furthermore, the evolution of OA has dramatically increased publisher profits. From 2019 to 2023, the revenues of major publishers have tripled, with profit margins reaching 30–40%, far exceeding those of most industries (Haustein et al. 2024). Ultimately, the shift to OA has enriched publishers but left science less equitable and representative.

English has become the universal language of science, yet this poses substantial challenges for non-native speakers. Although digital platforms such as Grammarly or DeepL can assist with grammar and translation, scientific writing remains a demanding, creative process that requires extensive time and cognitive effort—especially more for those who must first formulate ideas in their native language and then translate them into English (Nawal 2018). As a result, non-native English speakers spend, on average, 51% more time writing scientific papers, must devote additional time to thoroughly reading scientific articles, and encounter 2.6 times more manuscript rejections due to language issues compared to native English-speaking peers (Amano et al. 2023). These language-related hurdles intersect with financial, gender, and ethnic barriers, further amplifying disparities in scientific productivity. For instance, women from low-income countries who are non-native English speakers may produce up to 70% fewer scientific outputs compared to native English-speaking men from high-income countries—the demographic with the highest productivity in science (Amano et al. 2025). While new language-support tools are available, they cannot fully compensate for the persistent and multifaceted nature of language barriers in science.

How can we change the science culture?

Tackling disparities and promoting diversity in science requires a transformative agenda—a genuine cultural shift that involves the active participation of all stakeholders. Although freshwater science often demonstrates higher levels of international collaboration than many other fields (Resh and Yamamoto 1994), global surveys still frequently lack adequate representation from the Global South. Strengthening partnerships between researchers in the global North and South is vital for building research capacity and fostering knowledge exchange, both essential for achieving environmental goals and creating a more equitable scientific system. For these collaborations to succeed, responsibilities and decision-making must be shared equally, with both Northern and Southern partners actively shaping research agendas and ensuring transparency and mutual respect in project management (Ishengoma 2017). South-South collaborations are also key, often addressing regionally relevant issues and resulting in high scientific output (Ordóñez-Matamoros et al. 2020).

Researchers in emerging economies also need expanded support for capacity building and greater access to information resources. Scientific societies (discussed later) and universities can work together to curate and disseminate e-resources, job opportunities, and funding portals, further empowering researchers from underrepresented groups.

Transforming academic publishing is fundamental to fostering a more inclusive and diverse scientific environment. Increasing representation on editorial boards—by appointing editors from a wide array of gender identities, ethnicities, and geographic regions—and establishing mentorship programs for those from underrepresented groups are critical steps (Gender equality in publishing 2025). Adopting double-blind or even triple-blind peer review—in which author identities are concealed from reviewers and, in the case of triple-blind, also from editors—can further reduce bias throughout the publication process (Brodie et al. 2021, Hughes et al. 2023).

Additionally, the financial barriers to publishing must be addressed. Lowering APCs, offering meaningful waivers to researchers from low- and middle-income countries, and shifting toward diamond OA, a model in which authors and readers both access content free of charge, are essential for broadening participation and equity in science (Haustein et al. 2024). Diamond OA journals are typically funded by national or international organizations (e.g., Peer Community In) and maintain high-quality standards, with 67% using double-blind peer review (Bosman et al. 2021). However, major

challenges persist around indexation and visibility in leading international databases (Bosman et al. 2021). The Directory of Open Access Journals (DOAJ; https://doaj.org/) remains a valuable resource for identifying high-quality, peer-reviewed open access journals.

Advancing toward a truly inclusive, equitable, and diverse scientific culture requires proactive engagement and visibility of underrepresented groups across academic and research settings. To foster genuine representation, it is essential to actively promote these groups as speakers, committee members, and leaders at conferences and chairs of sessions, and within scientific organizations (Dewidar et al. 2022). Similarly, evaluation processes for candidates in academia and scientific societies should move beyond a narrow focus on metrics like the h-index or journal impact factor, which perpetuate a "success to the successful" mindset (O'Brien and Hapgood 2012). Instead, institutions should adopt holistic assessment frameworks, such as those outlined by the Declaration on Research Assessment (DORA; https://sfdora) that value the full range of scholarly contributions, including research quality and impact, mentorship, peer review, and outreach. Revising assessment criteria to better align with Open Science principles is critical for enabling meaningful change (Turba et al. 2026). Reference letters and applications for promotions or awards should require specific evidence of the skills being evaluated, helping to reduce implicit bias in review processes. Additionally, the broader scientific ecosystem must implement a variety of targeted initiatives—such as flexible training programs, research grants, scholarships, and seed funding—designed to support not only women but also other underrepresented groups, thereby dismantling persistent barriers to participation and advancement.

The role of scientific societies and the International Society of Limnology (SIL)

Scientific societies are crucial agents of change, serving diverse communities and shaping the culture within their fields (Meyer-Gutbrod et al. 2023). Individuals on boards, committees, or task forces should act as "regenerative gatekeepers" (Lewis et al. 2022) by actively questioning established norms, revising policies and practices, welcoming new perspectives, encouraging broader participation, and placing justice, equity, diversity, and inclusion (EDI) at the center of their work. In this way, societies can become catalysts for meaningful transformation.

To advance EDI, scientific societies can implement a variety of impactful initiatives, including lowering membership fees to remove financial barriers for underrepresented groups, forming EDI committees, developing mentoring programs, and ensuring gender-balanced events (Meyer-Gutbrod et al. 2023, Genua-Olmedo et al. 2025). Societies should also foster a welcoming conference environment by offering practical supports, such as clear presentation guidelines, accessible equipment, and spaces for caregivers and children (see Meyer-Gutbrod et al. 2023, Genua-Olmedo et al. 2025 for more examples). Professional development should be supported through educational resources and online training, tiered registration fees to participate in events, travel grants for underrepresented participants, and accessible job and funding boards (Meyer-Gutbrod et al. 2023, Genua-Olmedo et al. 2025).

Recognition practices also need to be reframed. Despite some progress, substantial disparities persist in the distribution of awards, especially regarding gender and race or ethnicity (Catalán et al. 2023, Meyer-Gutbrod et al. 2023). Most early- and mid-career awards in ecology, evolution, and limnology still focus on "best paper" selection, rarely recognize underrepresented minorities, assess research in the context of opportunity, or honor diverse contributions (Catalán et al. 2023, Lagisz et al. 2023). Even the naming of awards matters: women are underrepresented among award recipients, especially for awards named after men, representing only 15.1% of awardees in Earth and Environmental Sciences. By contrast, when awards are named after women or are neutral, women's representation increases to 30% of awardees (Gehmlich and Krause 2024). To address these issues, societies should broaden nomination pools, allow self-nominations, make nomination data and criteria public, diversify award committees, create awards named after influential women or with neutral names, and recognize other important activities, such as outreach or engagement in advancing inclusion and diversity, to recognize people and activities previously disregarded (Catalán et al. 2023, Meyer-Gutbrod et al. 2023, Genua-Olmedo et al. 2025).

SIL (https://limnology.org/) has an international outreach, with 882 members in 2026 spread across 75 countries (Fig. 1) and a network of 56 Ambassadors linking SIL with national societies or regional networks. SIL, as part of the scientific culture, has reflected the dominant cultural values since its foundation in 1922 in Kiel, Germany. A review of SIL's history reveals a long-standing gender gap, with women remaining significantly underrepresented in leadership roles and recognition.

The path toward inclusion began in the 1990s, with Carolyn Burns as the first woman Vice President and then President of the society from 1995 to 1998, and Tamar Zohary as the first woman elected as General

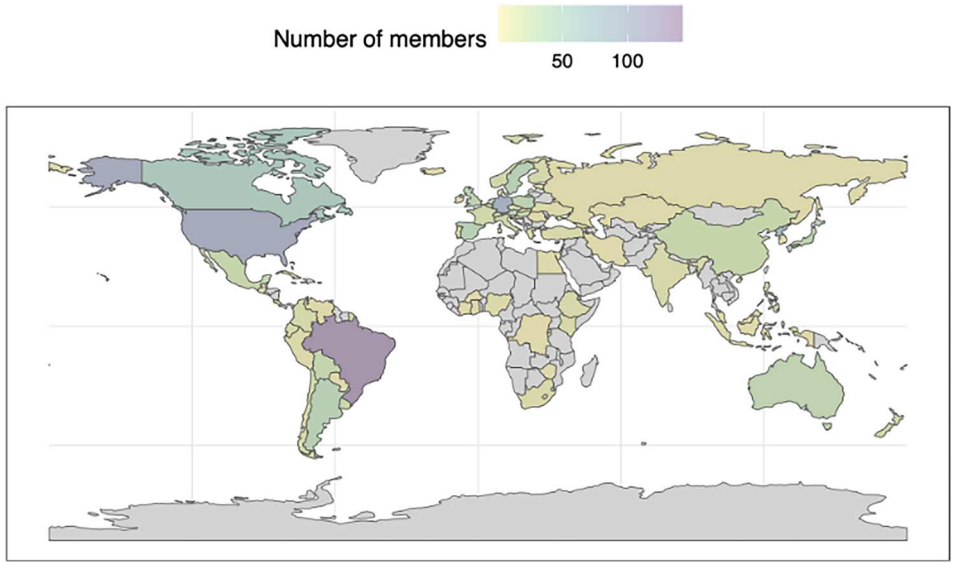

Figure 1. Worldwide distribution of SIL members and number of members per country.

Secretary (2013–2022) after Robert Wetzel. Achieving gender parity on the SIL Board took considerable time, only being attained after 2013 (i.e., within the last 13 years). Equally important was the increase in representation of Vice Presidents and Early Career Researchers from different geographical areas and developing economies after 2022. However, the SIL presidency was dominated by men for a century, with only one female president until 2024, when I was elected. As the SIL President, I serve all members; however, as a woman from a developing economy (Argentina, South America), I also stand for underrepresented groups. Being a female President from a developing economy represents a major change in the SIL structure and culture and a path toward diversity and inclusion. From the creation of SIL after the first congress in Kiel (1922), when only 6 women participated in the congress photograph out of 58 participants (https://limnology.org/about-sil/sil-timeline/), we have proudly increased women's representation, currently accounting for 41% of our members (males 44%, data not available 15%).

SIL has implemented numerous initiatives to support its members, including structural changes to the SIL Board and enhanced financial and visibility support for underrepresented groups. The Board was expanded to include Vice Presidents and Early Career Researcher (ECR) representatives focused on Developing Economies, Education, Global Outreach and Communication and Publication. The Tonolli Fund (established in 1985) and the Wetzel Award (established in 2005) provide critical support to young limnologists from developing economies, enabling them to conduct research and participate in SIL congresses, respectively. To foster a more diverse and inclusive membership, the fee structure was revised to reduce costs for members from low- and very low-income countries, introducing 5 categories based on GDP per capita for students, ECRs, regular members, and emeritus members with a journal subscription option. Several special publications have also highlighted the research of underrepresented groups, such as the series "Limnology in Developing Countries" (https://limnology.org/publications/limnology-in-developing-countries/) and special issues of Inland Waters focusing on "Limnology in Latin America and the Caribbean" (https://www.tandfonline.com/toc/tinw20/14/4) and "Indigenous Peoples: Rights, Threats and Challenges for the Future" (https://www.tandfonline.com/toc/tinw20/14/3). Our newsletter, SIL News, regularly features voices from the global limnological community and highlights research from around the world.

In terms of professional development, SIL has launched 2 key programs. The Associate Editor Mentoring Program for Early Career Researchers, initiated in 2021, trains the next generation of Inland Waters editors and has successfully recruited ECRs from diverse geographic regions. The Mentorship Program pairs students and ECRs with experienced limnologists for 3 years, including support for membership. The Education Committee has also developed e-resources, such as the Wetzel's Limnology video series, available through our social media channels.

A significant milestone was the creation of the Equity, Diversity, and Inclusion (EDI) Task Force (2024), with members representing nearly every continent. This group developed the EDI Mission Statement and Core Principles and offered recommendations to

create a welcoming and safe environment at SIL congresses. They also set new criteria for the Kilham and Baldi Awards and the Naumann-Thienemann Medal, ensuring these were shared and agreed upon by all committee members. Each award committee now achieves gender balance and includes researchers from diverse geographic backgrounds, thereby broadening representation. As a result, many recent awardees have been women, including, for only the second time in SIL history, a recipient of the Baldi Award.

At the International Society of Limnology, we have made important strides in advancing EDI principles, but continued self-reflection and improvement are essential. Board members must embrace their roles as "regenerative gatekeepers," helping transform the society toward pluralism and supporting the sustainable management of freshwater ecosystems. Priorities for the future include expanding practical support and congress participation for members, creating new, neutrally named, or women-honoring awards that recognize active contributors, advocating for the sustainable management of inland waters worldwide and furthering diversity and inclusion efforts. Lowering the APCs for Inland Waters would also be a significant step forward.

Concluding remarks

Graves et al. (2022) remind us that "there will never be science for the people until all the people are in science." As members of the research ecosystem, we must confront the realities of inequality and actively drive cultural change toward a more diverse and inclusive scientific system. Persisting with the current model only reinforces disparities and jeopardizes our collective ability to achieve the environmental goals essential for both humanity and nature. Every decision and action —no matter how small—can help shape a better future. At this crossroads, we must choose: remain passive and complicit in the status quo, or step up as researchers, leaders, editors, and publishers to propose and implement alternatives that foster a more inclusive and equitable scientific community.

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CRediT: **María de los Ángeles González Sagrario:** Conceptualization, Writing—original draft, Writing—review & editing.

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