Room for optimism: Editor-Reviewer interaction networks reveal positive outcomes of enhanced board diversity

Martin A. Nuñez 1*✉, Agustin Vitali2*, Lorenzo Marini3, Rowena Gordon4, Lydia Groves4, Romina Rader5, Cate Macinnis-Ng6, Kulbhushansingh Suryawanshi[7], Tadeu Siqueira8, & Jos Barlow9

1. Department of biology and biochemistry, University of Houston, Houston, TX.
2. Department of Life Sciences, Ben-Gurion University of the Negev, Be'er Sheva, Israel
3. DAFNAE, University of Padova, Viale dell'Università 16, Legnaro, Padova, Italy
4. British Ecological Society, London, UK
5. School of Environment and Rural Science, University of New England, Armidale Australia 2350.
6. School of Biological Sciences, Waipapa Taumata Rau, The University of Auckland, Auckland, New Zealand
7. Nature Conservation Foundation, Mysore, India; Snow Leopard Trust, Seattle, WA, USA; CIFAR Fellow in Future Flourishing Program, MaRS Centre, Toronto, ON, Canada
9. Lancaster Environment Centre, Lancaster University, UK.

*co-first authors.

✉ nunezm@central.uh.edu

Summary

1. Scientific publishing has been historically dominated by a limited number of countries and demographics. Here we examine whether diversification of the editorial board of Journal of Applied Ecology propagates to its reviewer community.
2. Using data from 2004, 2014, and 2024, we constructed tripartite networks linking senior editors, associate editors, and reviewers, and quantified gender ratios, geographic diversity, and network modularity. We also fitted generalized linear mixed models to test whether associate editors preferentially invited reviewers of the same gender or region, and whether these patterns changed over time.
3. As associate editors became more gender-balanced and geographically diverse, reviewer diversity increased: the reviewer gender ratio (number of men divided by number of women) halved, the number of countries represented rose from 33 to 52, and the Simpson's index for geographic diversity increased from 0.60 to 0.75. Network modularity and the number of smaller modules increased, indicating a more segmented and specialized editor-reviewer structure.
4. Men editors showed a declining tendency to invite men reviewers, while women increasingly invited women; only Western European editors showed significant regional homophily, although effect sizes were small. Overall, increased diversity among associate editors was associated with a more globally representative, structurally complex reviewer network.
5. Synthesis and applications. Our results show that editorial diversification is a practical lever for making peer review more inclusive and better aligned with the global distribution of ecological research. These changes make the publication process fairer and improve the quality and global impact of the papers published.

Introduction:

Science is a global endeavor, but historically it has been dominated by a limited number of countries and by a relatively homogeneous group of researchers (Nunez et al 2021, Maas et al. 2021). Making science more diverse is fundamental in disciplines like ecology to get a more complete and unbiased understanding of natural phenomena and solutions for environmental problems. Many factors affect these global asymmetries, from lack of funding to a limited number of researchers in some locations (Nunez et al 2021). Similarly, ecological research is dominated by men (Maas et al. 2021). While scientific journals can maintain and exacerbate these biases several strategies can be employed to make science more global and inclusive (Pettorelli et al 2021).

Over the last 20 years the Journal of Applied Ecology has been working to promote a more diverse and inclusive review process. For example, it developed an open call process since 2015 aimed at recruiting beyond existing research networks and broadening the geographic and demographic diversity of senior and associate editors. From 2021, the journal also made the decision to only recruit participants from the Global South to its associate editor mentoring scheme in a bid to better-connect researchers from this region with international networks. As such, we incorporated 2.3 and 7.5 times more senior and associate editors from 2004 (3 and 10) to 2014 (7 and 75), and almost 2.3 and 10.9 times more by 2024 (7 and 109), respectively. In 2004, 100% of senior editors and 80% of associate editors were men, representing 5 countries, with the majority from the UK. By 2014, the percentages of men senior and associate editors were reduced to 71.4% and 78.6%, and by 2024 to 71.4% and 63.3%. In addition, the number of countries represented by affiliated institutions increased to 15 and 27 over the years. These changes, and resulted in greater gender equality and a more

diverse representation of countries among editors over time. By broadening the talent pool, we would argue we also improved the quality of applicants and those recruited.

Despite the efforts made to make the Journal more diverse and global, it remains unclear how this increased diversity among editors might influence the diversity of the reviewer community. Here, we aim to understand if the community of reviewers selected by editors is becoming more diverse over time as editors themselves become more diverse. Specifically, we tested whether more diverse associate editors (in terms of gender and region of affiliated institution) increase the diversity of reviewers and the complexity of community structure using a network approach. In addition, we assessed whether associate editors tend to contact reviewers of the same gender and from the same region, to evaluate how increasing associate editor diversity may affect the structure of the editor-reviewer network.

Methods

Data

We analysed a dataset comprising information on the review process at three different time points in the Journal: 2004, 2014, and 2024 to capture two decades of change. Manuscript IDs, the final decisions on the manuscripts, and details of the participants in the review process (senior editors, associate editors, and reviewers) were incorporated into analyses. Only reviewers who accepted the review invitation and returned their reports to the associate editor were included. For each participant, we had information on their names and the country of their affiliated institution. This dataset was used to determine the participant's gender and the region of their affiliated institution. Gender was determined based on the participant's name using an online tool (genderize.io), however, it is important to notice that some names may be mislabeled. We defined a total of eleven regions according to the

proximity of countries and cultural practices (e.g., Latin America, Sub-Saharan Africa, Western Europe, etc.; Appendix Fig. 1).

Network construction

We constructed a tripartite editor-reviewer network for each year to evaluate how the editorial community changed over time, resulting in three networks (Appendix Fig. 2). A network represents a system in which entities (nodes) are connected by relationships (links), allowing for the analysis of structure and interactions (Newman 2010). Each network included two components:

- Nodes representing senior editors, associate editors, and reviewers. We assigned different characteristics to each node: gender, and the country and region of their affiliated institution.
- Weighted links connecting senior editors with associate editors and associate editors with reviewers. For example, a link with a weight of two between an associate editor and a reviewer indicates that the editor contacted the reviewer twice to review papers.

Analysis

For each network, we estimated the gender ratio, geographical diversity, and the extent to which the network was organized into distinct groups (i.e., modularity). We calculated the gender ratio for associate editors and reviewers as the number of men divided by the number of women. To measure geographical diversity, we used Simpson's Diversity Index (1 – D), which in our case, accounts for the number of affiliated regions present (richness) and the relative abundance of each region (evenness) in the network (Mcdonald & Dimmick 2003).

This index is less sensitive to changes in region richness, focusing more on the evenness of regions within the community. Values closer to 0 reflect low diversity and dominance by a few regions, while values closer to 1 reflect high diversity and evenness. In addition, we identified groups of tightly connected senior editors, associate editors and reviewers in each network (i.e., modules) using community detection algorithms (Infomap) to describe if the structure of the network changed across time (Rosvall and Bergstrom 2008). These tightly connected groups could be composed of senior and associate editors and reviewers, of senior and associate editors, or of associate editors and reviewers. Higher values of modularity indicate that the network is organized into more distinct groups or clusters. We performed the analysis with igraph and infomapecology package in R software (Csardi and Nepusz 2006; R Core Team 2021; Farage et al. 2021).

To understand the importance of increasing the number and diversity of associate editors on the network structure, we assessed the number of agreed reviewers and handled manuscripts per associate editor over time and their tendency to contact reviewers from the same gender and affiliated region as themselves. First, we fitted generalized linear mixed-effects models (GLMMs) using the number of contacted reviewers and handled manuscripts per associate editor as the response variables and year as the explanatory variable. We used "Associate editor ID" as a random factor and specified a Poisson distribution with a log link function for the response variables (Zuur *et al.* 2009). Second, we fitted two additional GLMMs to test whether associate editors showed an affinity for contacting specific types of reviewers. To accomplish this, we incorporated extra information about potential reviewers who were contacted but declined to review into the existing dataset. In these models, the response variables indicate whether the contacted reviewer is from the same gender or region as the

associate editor (1) or not (0). We used the region or gender of the associate editor as the explanatory variable. "Year" and "Associate editor ID" were included as random factors (R syntax: (1|Year) + (1|AssociateEditorID)) to account for temporal variation and individual differences. We used a binomial distribution because the response variables were binary. After fitting the models, we compared different levels of the explanatory variables in the models using a multiple comparison test. The analyses were performed with the lme4 and emmeans packages in R software (Bates *et al.* 2014; Lenth 2016).

Results and discussion

Measures taken to enhance the diversity of the editorial board positively impacted the diversity of reviewers. During the 2004-2024 period, the gender ratio of reviewers decreased from 4:1 to 2:1, and the number of countries represented by reviewers increased from 33 to 52, indicating greater participation of women and reviewers from different countries in the review process (Fig. 1A). In addition, the geographical diversity of reviewers (Simpson's Diversity Index) increased from 0.60 to 0.75 between 2004 and 2024, indicating a more even distribution of regions For example, in 2004, the majority of reviewers were from Western European institutions. Nowadays, the participation of reviewers is balanced between North America and Western Europe, with an increasing presence from minority regions such as

Eastern Asia and Latin America (Fig. 1B).

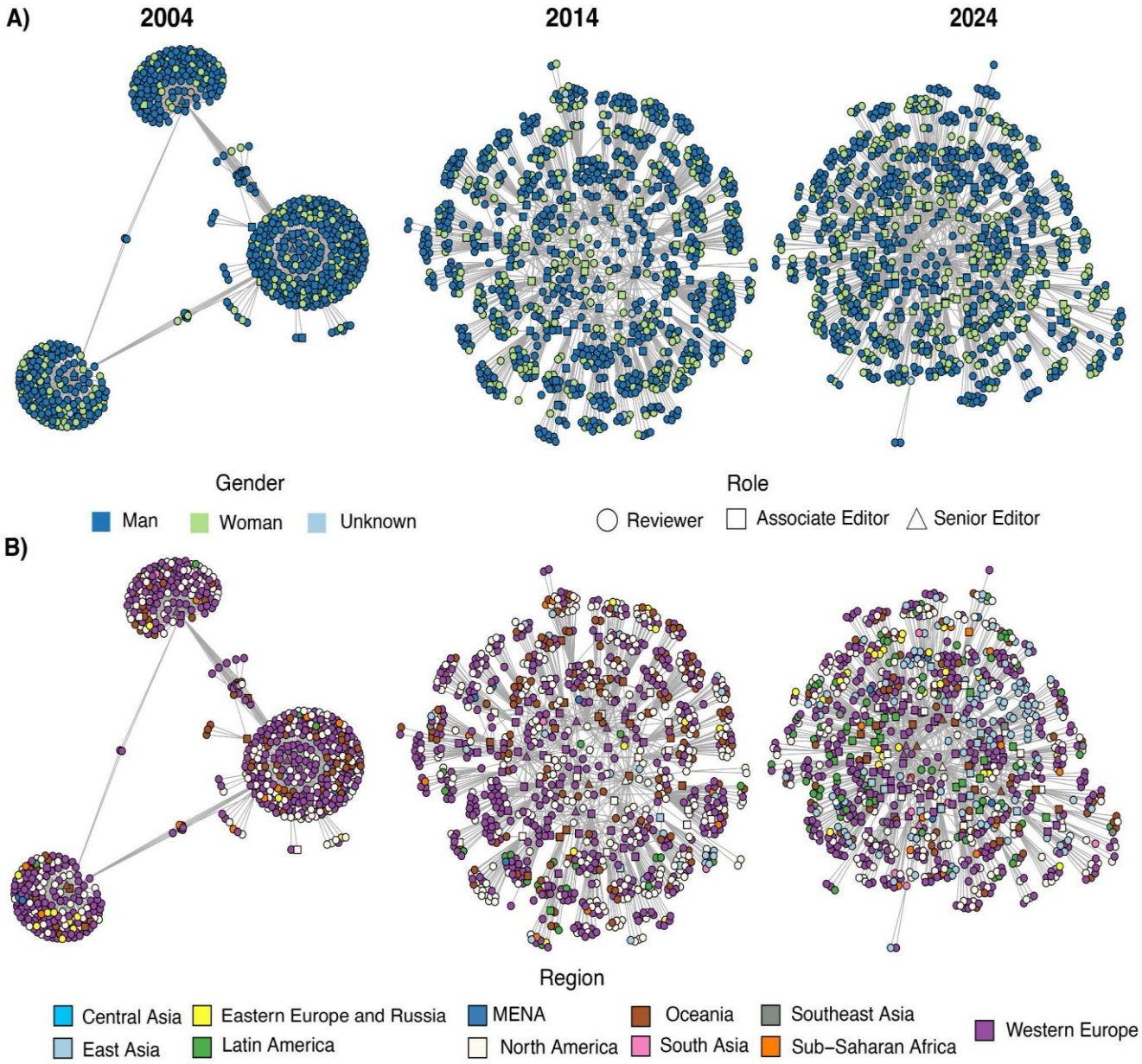


Figure 1. Senior editor- associate **editor-reviewer network over time.** Each panel highlights a different type of diversity: gender (A) and region of the affiliated institution (B). In both panels, each network represents a different year (2004, 2014, and 2024) and includes two components: nodes and links. The nodes represent reviewers (circles), associate editors (squares), and senior editors (triangles), while the links represent their interactions. Node color indicates the gender (panel A) and the region of the affiliated institution (panel B) of individuals. In 2024 there are more and smaller clusters. MENA stands for Middle East and North Africa.

Over the years, the community's structure has become more compartmentalized, as evidenced by the increase in the number of groups identified in the network (Fig. 1 and 2). Between 2004 and 2014, the number of groups increased 2.6 times, and by 2024, it had increased 3.5 times. In 2004, the network consisted of three large groups (based on each of the three senior editors) encompassing 91% of the editors and reviewers, along with 27 small ones (average size of groups: 24.6±73.2; mean ± sd; Fig. 3). By 2024, the network had expanded to 105 groups, which mainly comprised a smaller number of editors and reviewers (11.2± 6.1; mean ± sd; Fig. 3). This increase in the number of groups, along with their smaller sizes, suggests a growing segmentation and specialization in the editorial process as the number and diversity of associate editors increase. Diverse editors might select from different pools of reviewers based on shared topics, geographic regions, gender, or professional networks, resulting in more specialized and cohesive groups of editors and reviewers and senior and associate editors. For example, in 2024, some groups exhibited a predominance of editors and reviewers affiliated with institutions in Latin America and South Asia. Higher compartmentalisation may also reflect the inclusion of broader expertise among reviewers, enhancing the Journal’s ability to handle a wider variety of topics and research methods.

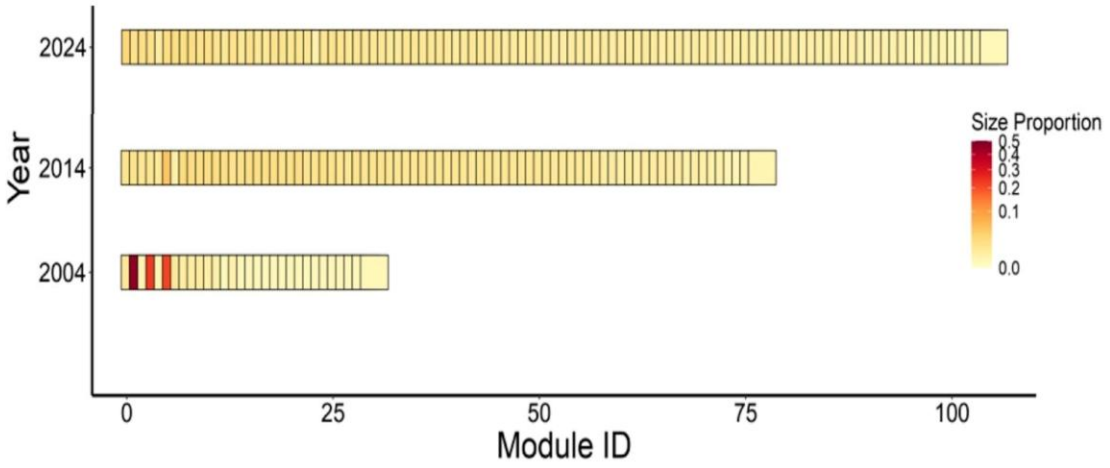


Figure 2. The modular structure of the Editor-Reviewer network across time periods. Each square represents the occurrence of a specific module in a year. The color of the squares indicates the proportion of nodes in the network (senior editors, associate editors, and reviewers) that were part of the group (module). Note that Module IDs are independent across years (e.g., module 1 in 2004 is not the same as module 1 in other years).

The highly compartmentalized network could be influenced by the large number of associate editors and their tendency to contact specific reviewers. In 2014 and 2024, each associate editor contacted 6.5 and 9.1 times fewer reviewers than in 2004 (GLMM, $z = 28.01$, $p < 0.001$; Fig. 3A). They also handled 5.0 and 5.9 fewer manuscripts (GLMM, $z = 17.46$, $p < 0.001$; Fig. 3B), respectively. This indicates a reduced but more evenly distributed workload among the associate editors as their numbers increased (from 10 to 75 to 109) and is due to the fact that in 2004 the journal was transitioning from a model where Senior Editors also acted as Associate Editors, to a model where Senior Editors assigned papers to Associate Editors to handle peer review. The shift to a system where a higher number of editors are contacting fewer reviewers has increased compartimentalisation; it seems likely that this is because increasing the number of associate editors has allowed each of them to handle papers

more closely aligned with their expertise, resulting in their usage of a distinct set ofreviewers with appropriate knowledge of that subject area. However, this hypothesis remains untested.

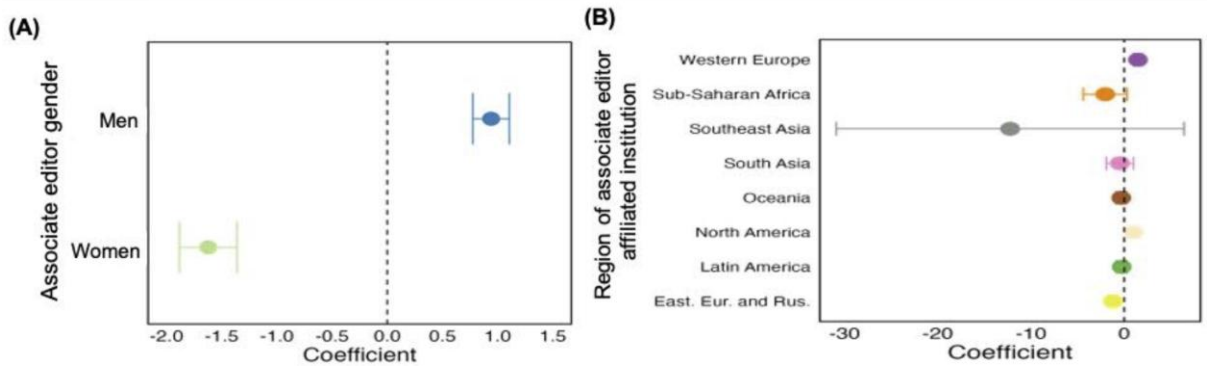


Figure 3. Tendency of associate editors to contact reviewers based on gender and region (panels A and B). Panels A and B show the coefficient plots from the GLMMs predicting the preference of associate editors to contact reviewers from the same gender (A) or region (B). A positive coefficient indicates that editors of a given gender or region are more likely to select reviewers who share that same attribute. Dots and error bars represent the estimated coefficients (log odds) and the 95% confidence interval. All years (2004–2024) were included as a random effect because the year-to-year variation was not a significant predictor; the overall pattern remained consistent across years.

Additionally, the tendency to contact specific reviewers varied according to the gender and region of the affiliated institution of the associate editor. The positive coefficient for men editors indicates a significant preference for contacting men reviewers (GLMM, z =6.62, $p <$ 0.001; Fig. 3C), while the negative coefficient for women editors indicates a preference for contacting men reviewers over women reviewers (GLMM, z = -19.04, $p < 0.001$; Fig. 4C). Similar gender bias has been reported in the journal *Functional Ecology*, where men editors selected more than 75% of reviewers from the same gender, and women editors selected between 30-35% of reviewers from the same gender (Fox *et al.* 2016). However, the strength of these effects has dissipated over time in *Journal of Applied Ecology*. The percentage of

men editors selecting men reviewers decreased from 81.3% in 2004 to 78.6% in 2014 and further to 62.1% in 2024, while the percentage of women editors selecting women reviewers increased from 0.18% in 2004 to 21.3% in 2014 and 37.8% in 2024. This is a promising trend and indicates both men and women are inviting increasing numbers of women reviewers. As the proportion of women in Applied Ecology continues to increase, these numbers will hopefully reach parity.

The region of the associate editors' affiliation significantly influenced the likelihood of contacting reviewers from the same region, although only editors from Western Europe were more likely than random to select reviewers from Western Europe (GLMM, $z = 2.935$, $p = 0.003$; Fig. 3D), although the effect size was small. This pattern did not emerge for other regions, although future research on larger set of journals could explore the possibility that regions previously identified as being under-represented in ecological research (Latin America, East Europe, Sub-Saharan Africa and South Asia – see Nunez et al. 2021) have negative tendencies (Fig. 3B). Finally, we are cautious in interpreting geographical diversity because our data relates to the region of the affiliated institution, not the origin country of the editors and reviewers. However, it is unlikely that this information could bias the results, since based on our experience it is more likely that researchers from the Global South end up working in global north institutions than vice versa.

Conclusions

Although we are unable to disassociate findings from more general trends changes in the academic community over time, the strength of the observed trends strongly suggest that increasing the diversity of associate editors contributes to a reviewer community with more balanced gender participation and broader international representation. The growing complexity and modularity of the network suggest a more specialized community, capable of

handling a wider variety of topics, contexts, and methods due to the broader expertise and diverse backgrounds of the reviewers. Furthermore, our results indicate the diversification of journal boards contributes to connectivity and inclusion for those who contribute to publication decision processes. We consider that all these changes are immensely positive for the journal and the scientific community, and we hope that other journals that have adopted open approaches to editor recruitment are seeing similar trends.

Between 2004 and 2024, the number of citable research documents rose by nearly 200%, from 1,515,000 to 4,793,000 (Data from Scimago accessed August 2025). During this period, research became more globally distributed: while researchers from Western nations produced over two-thirds of publications in 2004, their share dropped to about 40% by 2023 (Dhand , 2025). Our results strongly suggest that both the quality of the scientific process and inclusion can be enhanced by diversifying editorial boards. Clearly, this is only a start and much more that should be done so that editors and reviewers truly reflect the international research community and science addresses its colonial legacy (McCallister et al 2025).

References

Bates, D., Mächler, M., Bolker, B. & Walker, S. (2014). Fitting Linear Mixed-Effects Models using lme4. *arXiv [stat.CO]*.

Blondel, V.D., Guillaume, J.-L., Lambiotte, R. & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *J. Stat. Mech.*, 2008, P10008.

Csardi, G. & Nepusz, T. (2006). The igraph software. *Complex Systems*, 1695, 1–9.

Fox, C.W., Burns, C.S. & Meyer, J.A. (2016). Editor and reviewer gender influence the peer review process but not peer review outcomes at an ecology journal. *Funct. Ecol.*, 30, 140–153.

Lenth, R.V. (2016). Least-Squares Means: The R Package lsmeans. *J. Stat. Softw.*, 69, 1–33.

Mallett, J.J. (2021). The resilience of scientific publication: From elite ancient academies to open access. *Learn. Publ.*, 34, 49–56.

Mcdonald, D.G. & Dimmick, J. (2003). The Conceptualization and Measurement of Diversity. *Communic. Res.*, 30, 60–79.

Newman, M.E.J. (2006). Modularity and community structure in networks. *Proceedings of the National Academy of Sciences*, 103, 8577–8582.

McAllister, T.G., Walker, L.A., Smiles, N.D., Jennings, L., Moggridge, B., Naepi, S., Kamai, B. and Milligan-McClellan, K., 2025. Decolonize scientific institutions, don't just diversify them. *Nature*, *644*(8076), pp.331-334.

Nuñez, M. A., Chiuffo, M. C., Pauchard, A., & Zenni, R. D. (2021). Making ecology really global. *Trends in Ecology & Evolution*, *36*(9), 766-769.

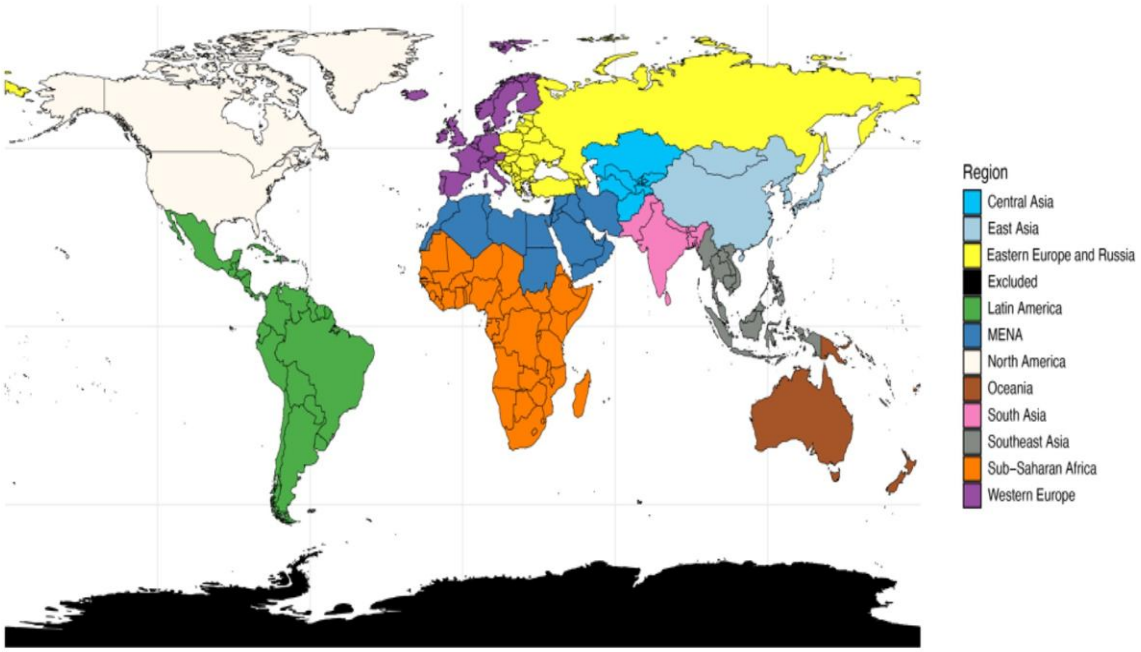
Nuñez, M.A., Barlow, J., Cadotte, M., Lucas, K., Newton, E., Pettorelli, N. and Stephens, P.A. (2019), Assessing the uneven global distribution of readership, submissions and publications in applied ecology: Obvious problems without obvious solutions. J Appl Ecol, 56: 4-9. https://doi.org/10.1111/1365-2664.13319

Pettorelli, N., Barlow, J., Nuñez, M. A., Rader, R., Stephens, P. A., Pinfield, T., & Newton, E. (2021). How international journals can support ecology from the Global South. *Journal of Applied Ecology* 58:4.

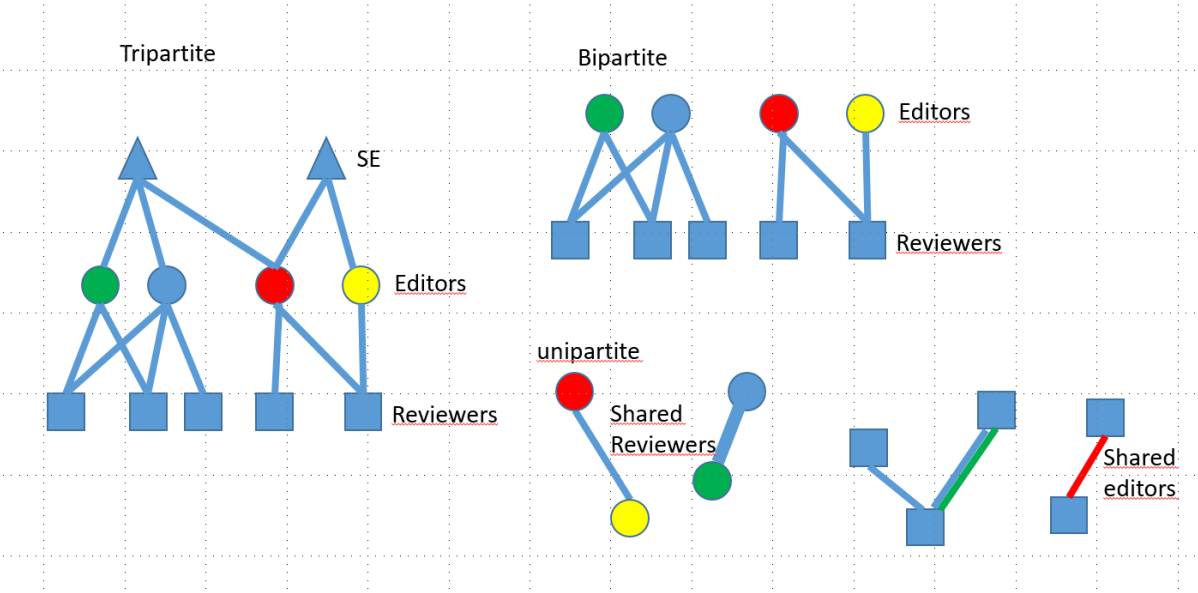
R Core Team. (2021). R: A language and environment for statistical computing. *R foundation for statistical computing Vienna, Austria*.

Zuur, A.F., Ieno, E.N., Walker, N., Saveliev, A.A. & Smith, G.M. (2009). *Mixed Effects Models and Extensions in Ecology with R*. Springer New York.

Appendix:



Appendix Figure 1. Region of affiliated institutions. Countries were classified into regions based on their proximity and cultural practices. Each color represents a different region. MENA stands for Middle East and North Africa.



Appendix Figure 2. Graphical representation of the unipartite, bipartite and tripartite networks used in the analysis.