How to do biodiversity-related science communication

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Abstract:

Biodiversity is the foundation of our lives. Yet we destroy ecosystems and drive species to extinction. Human-induced biodiversity loss does not yet receive sufficient public attention, although biodiversity is fundamental for dealing with global environmental crises. Effective communication of biodiversity-related knowledge is challenging but crucial and should contribute to evidence-based decision-making transparent to the public. It is essential to promote science communication on biodiversity, and to stimulate dialogue between science, policy, and society. We emphasize the role of science journalism in critically mediating the complexity of scientific knowledge and suggest Dos and Don'ts for scientists to guide biodiversity-related science communication.

One-Sentence Summary:

Science journalism and an active science-policy-society dialogue are needed to foster public awareness for biodiversity and its conservation.

Keywords:

Communication; Journalism; Media; Dialogue; Science-policy-society; Public awareness; Mainstreaming

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Main Text:

Science communication provides a link between scientific and non-scientific actors. It is often understood and practiced as a one-way broadcast service, which, however, should not be. Instead, one should understand science communication as complex interactions between science, media, the public, and policy, as well as their respective and heterogenous institutions.

As was clearly seen during the COVID-19 pandemic, political decision-making heavily relies on scientific expertise. Scientists are asked to communicate and discuss novel scientific findings in a fully comprehensive and understandable way. Not only politicians and media but also the wide public need to understand how scientists come to their assessments and conclusions.

With this, science faces an increasing expectation and responsibility to provide evidence-based knowledge and develop policy options to the pressing questions of society. At the same time, science is expected to foster dialogue and public engagement, objectify debates and inform about challenges and opportunities of scientific developments (BMBF – Federal Ministry of Education and Research, 2019; Leshner, 2007). The German Federal Ministry of Education and Research, for example, seeks to promote science communication with the aim of reaching out to society at large as well as children and youth in particular (BMBF – Federal Ministry of Education and Research, 2019). The European research funding program Horizon 2020 asks its "beneficiaries [to] promote the[ir] action and [their] results, by providing targeted information to multiple audiences (including the media and the public)" (Art. 38, European Commission, 2017). In times of 'fake news' and conspiracy theories, scientists are supposed to play a major role in helping to ensure that policy discussions are based on comprehensive scientific findings (Jamieson, 2021). At the same time, scientists are confronted with the classic – and improper – understanding of science-policy interactions as "speaking truth to power" (Wildavsky, 1979) including denying uncertainties rather than using those as a starting point for discussing how to deal with them (Versluis, van Asselt, & Kim, 2019). Additionally, scientists have to juggle their multiple tasks of scientific and administrative management, research, teaching, scholarly publishing their research and communicating with an ever broader, non-scientific audience.

In biodiversity-related sciences, scientists have the particular challenge that biodiversity itself is a highly multifaceted and complex field of study. For example, not all facets of biodiversity drive the functioning of an ecosystem, as sometimes one particular or a few dominant species are key for the provisioning of ecosystem services and not necessarily the largest possible number of species (Kleijn et al., 2015; Pysek et al., 2020). Consisting of the diversity within species, between species and of ecosystems (UN, 1992), biodiversity should both technically and politically not be reduced to a single number (Purvis, 2020). Consequently, science communication related to biodiversity is similarly complex. For this reason, possibly, and compared to climate change, the role of biodiversity has frequently been neglected in the media discourse about global environmental crises since 1992 (Legagneux et al., 2018). Also, the importance of biodiversity is often framed in over-simplified or unrealistic narratives. For example, the extinction of bees would not lead to completely empty supermarket shelves, as not all crop species are completely dependent on pollinating insects (Klein et al., 2007) and many insects other than bees pollinate crops (Rader, Cunningham, Howlett, & Inouye, 2020). Pictures of hand pollination in China may reflect reality in certain regions, but we know of no original peer-reviewed study showing that this is only related to pesticide use (the shortcut

storyline in media: pesticide spraying, dying bees, and hand pollinating humans). Also, there is no evidence supporting the often-used quote "If the bee disappears from the surface of the Earth, man would have no more than four years left to live." Notwithstanding such exaggerations, imminent threats to biodiversity exist and scientists must not fail to convey both the complexity of biodiversity and its importance for planetary health and human wellbeing.

In this regard, the launch of the Global Assessment Report on Biodiversity and Ecosystem Services (IPBES, 2019), approved by the member states of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) in May 2019, set a milestone in outreach and media coverage to the biodiversity crisis (IPBES, 2021). For example, on Twitter, the conservation around biodiversity increased by 61% in 2020 compared to 2019 (Twitter, 2021). Building on the success of the Global Assessment Report, also the COVID-19 pandemic and the subsequently published IPBES Pandemics Report (IPBES, 2020) led to an increased publicity of biodiversity and its potential links with the different crises (IPBES, 2021).

Nevertheless, in the recent discourses about fundamental societal, global, and transformative changes needed to tackle crises such as the COVID-19 pandemic or climate change, the role of biodiversity is often still neglected. Therefore, we need to discuss how to strengthen biodiversity-related science communication in times of global crises.

While biodiversity-related sciences are experiencing a dynamic increase in activities of experts in science communication, for example with the 'Scientists for Future' initiative substantiating the "Fridays for Future" climate marches (Hagedorn et al., 2019), specialized science journalism is particularly needed. As currently promoted in France for example (Pain, 2020), science journalism, institutions specialized in science communication (e.g., science media centers) as well as science-PR and outreach departments of research institutions can play a key role in critically mediating the complexity of scientific knowledge between scientists and the public, and thus highlight the importance of biodiversity in all crises-related discourses touching diverse issues of sustainable development. Here, drawing on our experiences as biodiversity researchers and science journalists, we identify challenges researchers may face in science communication and present Dos and Don'ts to guide biodiversity-related science communication and to stimulate further dialogue between science, journalism, and society. By showcasing global differences in how to approach biodiversity-related science communication, our aim is to support the ongoing discussion on effective science communication and foster awareness of the role of biodiversity in times of global crises.

Challenges in biodiversity-related science communication and the role of science journalism

Most scientists from the biodiversity domain are not specifically trained to communicate (Eise, 2019) but to conduct research in their specific scientific discipline and to publish their new findings in the scientific literature. They are not experts in public communication and do not necessarily speak a widely accessible language, in which they would need to be trained (Leshner, 2007). However, we argue that scientists should not be pressured to become communication experts but be allowed to focus on their research. Biodiversity researchers work on complex questions and matters of concern. The answers they find and which they are expected to give are similarly complex. Often, a highly simplified way of wording an answer

would simply be wrong or might not be able to cover the whole scientific meaning of the answer.

At the same time, the public “doesn’t speak data” (Pain, 2013). Just as researchers are experts in their field of studies, people from the public are experts in their domains and are used to the language of these. The language needed for communication with the public therefore is plain, inclusive, and accessible to a diversity of people (Cormick, 2020) with different cultural backgrounds and different scientific and media literacy.

Similar to this multitude of backgrounds that need to be considered for effective science communication, there is a huge diversity of communication channels to interact with the society. Online social media channels are at the front of mass media. Scientists increasingly discover the functionalities and options social media offers ("Social media for scientists," 2018). However, many researchers do not have the capacity to comprehensively handle multiple social media channels ("Social media for scientists," 2018), or even know the wealth of social media channels available, the target audience they might reach with each or how to use them successfully. Nevertheless, social media channels are widely used for biodiversity-related science communication.

Irrespective of the communication channel selected for outreach, the key to a wide and attentive audience is a good story (Cormick, 2020). The public is interested in topics that connect to their lives, to individual interests (e.g., prominent people), or because of public discourses. For the latter, different topics work differently well (Legagneux et al., 2018) and remain in discourse only as long as they are of concern (e.g., sensations or disasters). Here, science journalists can support scientists, as they are specialists in press and outreach, with a unique perspective on hot topics, experience of when and how to position a topic in the media, and knowledge about the challenges scientists may have with effective science communication (Warren, Weiss, Wolfe, Friedlander, & Lewenstein, 2007). At the same time, science journalism can protect scientists from societal, political, and medial pressure. It is not a one-way broadcast service that science can or should use to be heard but it responds to scientific needs and can assist in identifying what – and especially how – the public wants to know. It is important that scientists are aware of when, where, and why their topic is socially relevant and what language the target audience expects from scientists. Here, science journalists build the bridge by taking into account essential communication criteria, such as competence, integrity, and public welfare orientation (Sperber et al., 2010). An important difference to make is between science-PR and outreach departments of research institutions and science journalists working for the free media. The latter are independent in their selection of topics, whereas science-PR communicators are often biased in promoting research findings and increasing media coverage of their institution.

In short, science journalism has the specific function of reporting independently, credibly, and competently on scientific content, and integrating science-related topics into socially relevant discourses. *Vice versa*, it also expresses the public's expectations towards science.

A glimpse into how biodiversity-related science is and can be communicated

To shed light on the complexity of global biodiversity-related science communication, we asked around 300 IPBES authors from all IPBES regions about their use of different social media channels and their biodiversity-related science communication habits.

Looking at social media channels used for biodiversity-related science communication (Fig. 1), Twitter is the most used channel in Europe and Central Asia and in the Americas, while Facebook is most used in Asia and the Pacific and in Africa. Instagram is most used in the Americas. Based on our survey, Reddit is solely used in the Americas. Youtube is globally used in an equal manner. Other channels frequently used are ResearchGate, emails and messaging services such as WhatsApp, Telegram and KakaoTalk.

As outlined by this globally diverse use of social media for biodiversity-related science communication, scientists should carefully decide which channel to choose for promoting their topics throughout the different regions of the world. In the future, also TikTok could become a channel to be considered.

To give biodiversity a stronger voice, we developed ten important Dos and Don'ts for biodiversity-related science communication (Box 1), complementing already available recommendations (acatech – National Academy of Science and Engineering, German National Academy of Sciences Leopoldina, & Union of the German Academies of Sciences and Humanities, 2017; Bickford, Posa, Qie, Campos-Arceiz, & Kudavidanage, 2012; Blastland, Freeman, Linden, Marteau, & Spiegelhalter, 2020; Cormick, 2020; Lees, Attwood, Barlow, & Phalan, 2020), and had them evaluated (Fig. 2). Agreement with them varies throughout the IPBES regions, indicating that compliance remains highly context specific and that there may be additional or different Dos and Don'ts to consider in the world regions. Therefore, they are not exhaustive but particularly suited to stimulate further discussion around robust science communication. They may also be applied to other scientific domains and subjects of interest for the wider public:

Presenting scientific findings without a good narrative most likely will not thrill people and will not make them remember your message. Provide your audience with an emotional and enthralling story, but ensure it contains solid scientific findings, as an insubstantial story may even put off listeners. Telling a spellbinding story based on scientific evidence can be a game changer. Strong metaphors (Väliverronen & Hellsten, 2002) and outlining personally relevant utilitarian benefits (Lees et al., 2020) may help, too. However, on the gradient from a "researcher who informs" to a "science communicator who persuades", carefully select your position and adapt your behavior respectively (Blastland et al., 2020).

When directly speaking to an audience, use the audience's (main) language. If you have many audiences, do not try to match them all but adopt your language to each of them. Science journalists can play a gatekeeping role (acatech – National Academy of Science and Engineering et al., 2017) and critically help in effectively addressing different audiences.

In case you do not want to communicate or do not have sufficient capacity for a media request, pass the opportunity on to a colleague. You may feel that you have no choice but to communicate, but you always do. Similarly, you always have the choice about what level of detail you take for your presentation. While a certain level of simplification may help convey your message, you may also want to focus on a certain detail (e.g., species loss projections,

Lees et al., 2020) that should specifically matter to your audience and that you want to make them hear.

Whatever kind of science communication you do, to effectively transfer your message, you should be convinced of it yourself. The best way in showing this is having fun with it, creating a positive notion and making your audience believe in you and your message. If you know from the start that you are uncomfortable with a presentation or talk, pass it on to a colleague who might enjoy it and therefore be a better fit this time. Last but not least, if someone fully intends to misrepresent what you have said, it is absolutely fair and should even be sought to correct such misrepresentations. Yet, this should be done on a content-related and not on a personal level (Lees et al., 2020).

The future of biodiversity-related science communication

The importance of science communication increases throughout all research domains, including the communication of causes and consequences of biodiversity change. A comprehensive understanding of the consequences of human activities on biodiversity and its conservation requires multiple scientific disciplines. To strengthen the role of biodiversity in political decision-making and the public discourse, biodiversity scientists need to build trust with their audiences. They should communicate their level of evidence and about missing knowledge (Blastland et al., 2020) and explain why these matters. At the same time, they should closely listen to biodiversity-related ideas and knowledge forms from non-scientific actors, neither dismissing nor affirming but entering an appreciating dialogue. Therefore, the future of biodiversity-related science communication lies in joint efforts, such as interviews, panel discussions and (interactive) social media campaigns including various experts from different fields of study, and, where applicable, actors from civil society, creating and empowering a new form of environmental journalism. Most importantly, the future of science communication should build on strong cooperation between scientists from different disciplines trained in communication and well-trained science journalists, and their audiences in society.

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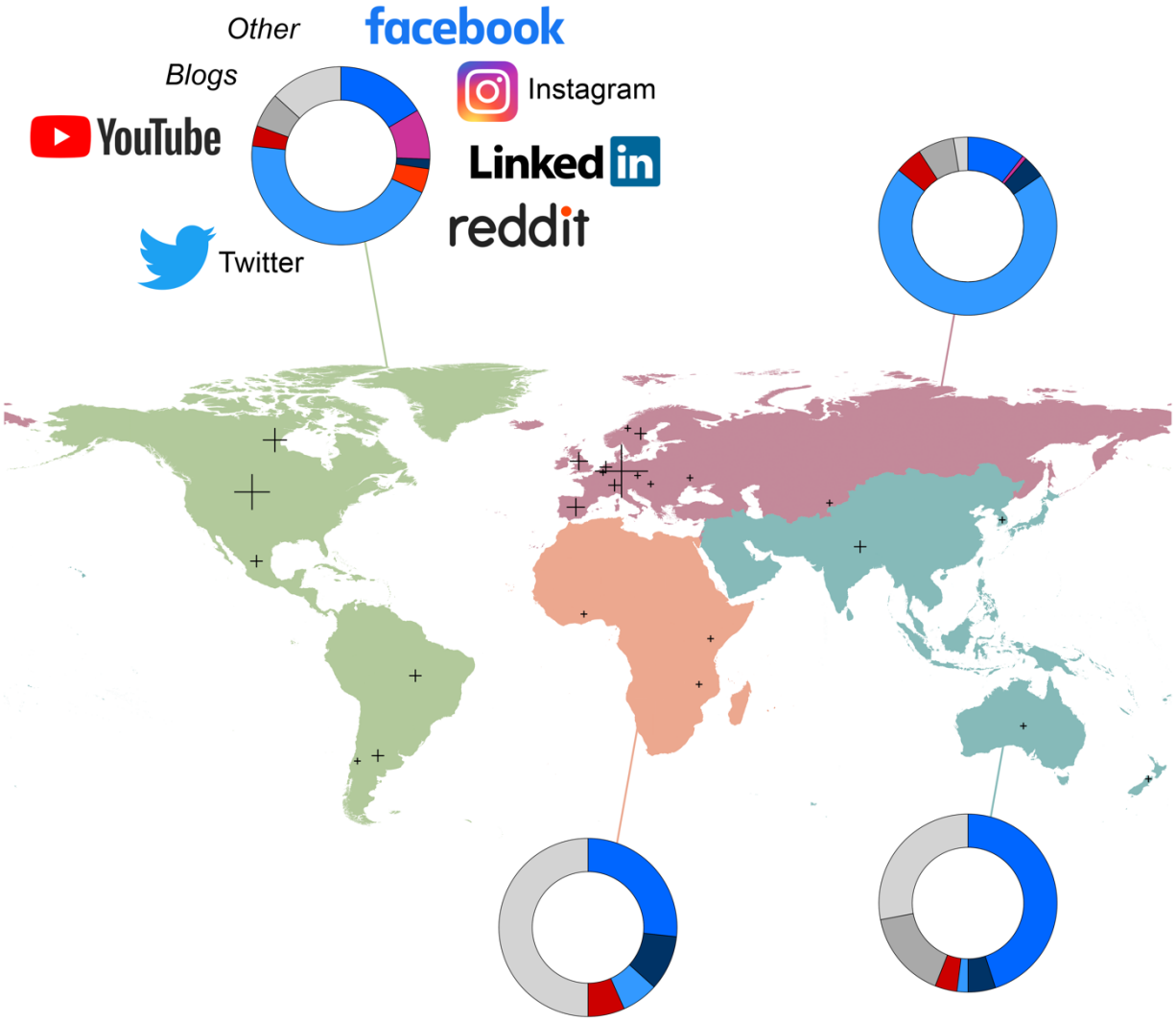

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336 **Fig. 1: World map with donut charts of most frequently used social media channels for**
337 **biodiversity-related science communication.** Illustrated per IPBES region: the Americas (top
338 left), Europe and Central Asia (top right), Africa (bottom left), Asia and the Pacific (bottom
339 right). Social media channels in the donut charts from the top center to right: Facebook,
340 Instagram, LinkedIn, Reddit, Twitter, Youtube, Blogs and Other (i.e. ResearchGate, email,
341 WhatsApp, Telegram, KakaoTalk). The cross size in the world map indicates the number of
342 responses per country, given by scientists engaged in IPBES; n = 17 (the Americas) / 27 (Europe
343 and Central Asia) / 3 (Africa) / 5 (Asia and the Pacific).
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Box 1: Non-exhaustive list of potential Dos and Don'ts for biodiversity-related science communication.

Do …

1. **Do tell a story:** People do not remember scientific findings; people remember a story. Therefore, before you talk to your audience, make sure you know what narrative you are going to tell. The most important elements of a story are conflict and protagonist. Which are they in your case? It can be about the hardship of getting data, the personal fight for an endangered species, or the unlikely heroism of a community that protects an ecosystem against all odds.
2. **Do use target audience language:** Carefully study the audience you want to reach and adopt your language accordingly. Most audiences do not care about the nitty-gritty of your research, and most communication formats do not allow for details; only sometimes a quick glimpse on genuine science and details on methods may still be helpful. Aim to link your findings to your audience's lived experience to make it real for them.
3. **Do put key findings first:** Similar to the abstract of a paper, an audience wants to hear/see/read the headline straight away, so they can decide whether to continue with the details or not. Details of methods and caveats should come later. For effective, memorable communication, hit them with the top line. You can also repeat this later, once you've explained how you got there. If possible, use examples of your own research to illustrate your key messages.
4. **Do prepare take-home messages:** Clear, easy to understand and consistent take-home message(s) help a lot to convey your message. Practice saying them. Learn them or have them in front of you, to help you get them clearly across. Questions from your audience will seldom be exactly what you expected.
5. **Do clarify your expertise and limits of knowledge:** Specify your expertise and indicate when you are leaving your core area of research. Address uncertainties and the limits of your knowledge. Also, in the broader sense, you can point out the limits of understanding – stating what science does not know might just be as important as what it does, especially in the field of biodiversity where there are still huge gaps in our understanding of the natural world.
6. **Do listen to your audience and enter into a dialogue:** Take your audience seriously, explaining why you think some of their concerns are justified or not. Communicate in a dialogue with your audience, actively listening and responding to your core target audience. Manage emerging discussions with individuals so that you do not spend too much time discussing individual opinions.
7. **Do find new audiences:** Communicate with new audiences and proactively approach new target groups, especially those with a high potential to act as multipliers. Although it is much harder to convey knowledge on a topic to a less informed and not already convinced audience, which needs additional preparation and specific approaches, too, this is especially rewarding.
8. **Do be yourself:** You can speak as a scientist and as someone personally affected at the same time as your audience is also interested in your personality. But it is important to clearly indicate what role you are in at any given moment, what institution you are

representing and what messages are based on your personal perspective. Explain how potential conflicts of interest affect your work.

9. **Do prepare for criticism and to fight arguments of denialists:** It is easier to deal with criticism if you anticipate denial or criticism on your topic beforehand and develop a strategy for dealing with it.
10. **Do provide content-related links to other areas of concern:** Biodiversity cannot be separated from other planetary boundaries such as climate change, land use changes and pollution. Try to link your field of research to other fields of expertise and societal areas of concern.

Don't ...

1. **Don't communicate when you are not keen on doing it:** Science communication needs concentration, preparations, and enthusiasm about the topics you are communicating. If you do not really want to communicate, think carefully about whether you do it yourself or whether you can pass it on to a colleague.
2. **Don't wait to answer if you are keen on doing it:** Media requests for interviews or talk invitations are usually time-bound, so the window of opportunity to reach an audience may close quickly.
3. **Don't take every opportunity:** Only select opportunities if they suit to convey your message, and pass others to your colleagues. It is important for the public to know different experts for different aspects. Therefore, recommend colleagues if you think they have more time or expertise for the specific request.
4. **Don't leave your area of knowledge:** Do not communicate if you are not prepared or sure, or if e.g. journalists try to get a message, which is not yours. Focus on your evidence-based information and stop or withdraw quotes of yours if you feel uncomfortable with the situation or outcome.
5. **Don't make statements you cannot prove:** Avoid political or private statements that are not backed up by scientific evidence. When addressing societal or political relevant issues, but the evidence is inconclusive, make sure you clearly state that it is your private opinion, for example by saying "when you ask me as a private person...". Be extra careful with communicating new scientific findings that are not (yet) well supported by evidence, especially if they contradict with accepted knowledge, in order not to distort the agreed knowledge base.
6. **Don't always use technical terms:** Avoid technical terms for a general audience, and only use them if they are key terms in your research area. For example, "biodiversity" is fine for an audience that is used to listening to scientists but a brief explanation when first mentioning the term still helps. "Number of species" is a term that everyone understands, although scientifically it only covers one aspect of biodiversity.
7. **Don't overload with details:** Of course, the scientific findings and general notion have to be right but if that is the case, do not spam your audience with too many details. Only select the most important information, have courage for some simplification of your message, or look for specific formats allowing for more insights if you want to bring them to an audience. Remember that you are not talking to your colleagues but an audience in which some might have never heard of your field of research.

8. **Don’t forget to have fun:** When you communicate with a broader audience, remember that it is not just to share some data. It is about telling a story, infecting others with your passion and making them understand your messages. Do not be afraid to talk about passion, pain, fun and devotion – with genuine emotions, information will stick much longer.
9. **Don’t blame others for miscommunication:** Media builds its – and not necessarily your – stories around your quotes. In case of an interview, before doing it, ask if it will be possible to review the final product before publication to check your quotes (this is not always possible). If a quote other than yours is published, take it as it is or express your opinion, for example, in your social media account(s) or on your university website.
10. **Don’t talk down to people:** You can be provocative, but it is far more convincing if you express your evidence-based opinion in a polite way.

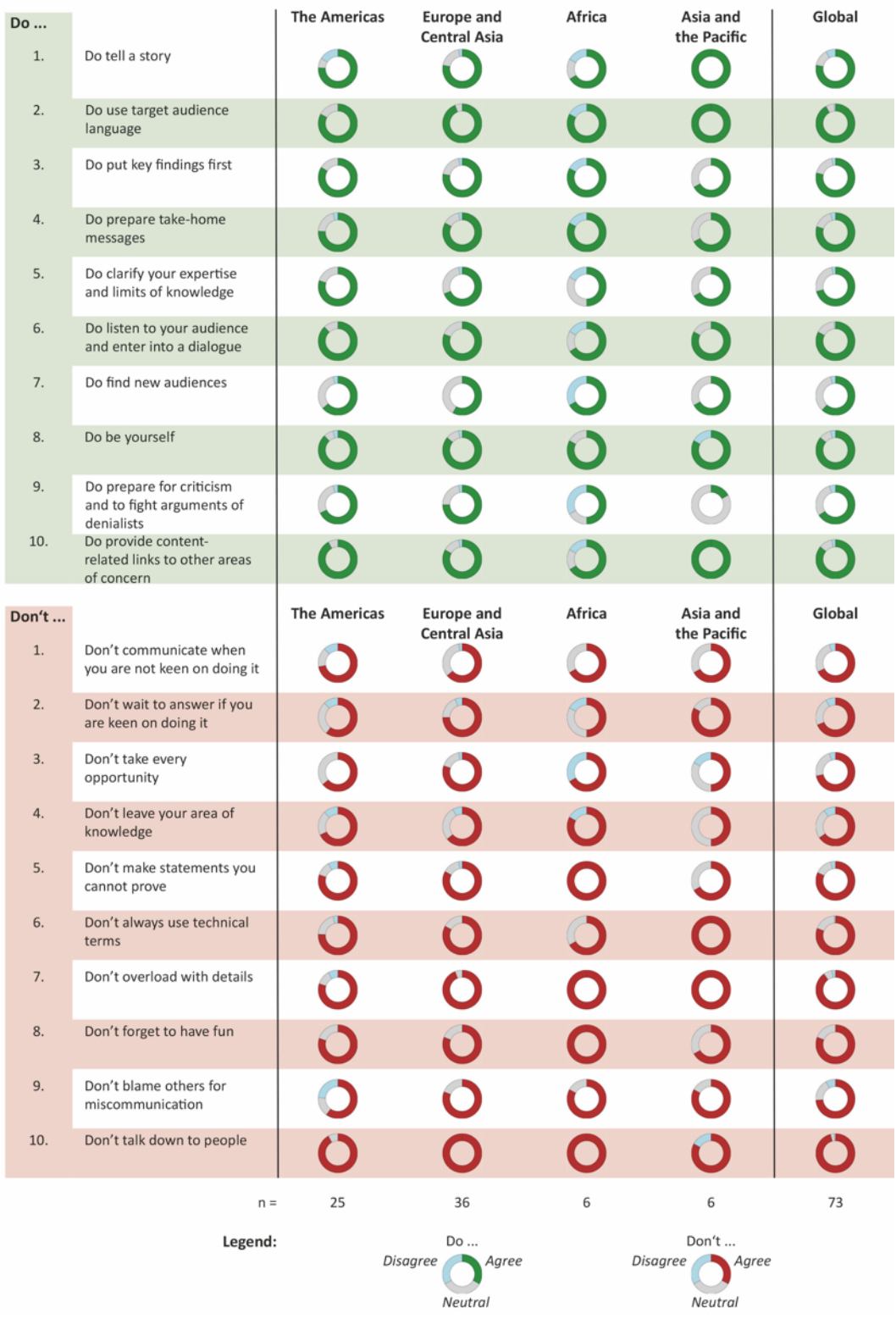

Fig. 2: Donut chart evaluation of the non-exhaustive list of potential Dos and Don'ts for biodiversity-related science communication, rated by scientists engaged in IPBES. Overall, they agree with the suggested Dos and Don'ts. Based on the given variance, however, compliance with them remains highly context specific.

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Author contributions: AMK and EMS organized the workshop, which was an activity of the DFG Permanent Senate Commission on Fundamental Issues of Biological Diversity. AMK initiated the Dos and Don'ts to guide biodiversity-related science communication, which then were further developed with contributions from all other authors. JG and AMK conducted the survey, with support of EMS, LVD and MF. JG and AMK wrote the manuscript with contributions from all other authors.

Research ethics: The figures presented are the result of a survey involving human subjects. There was no local research ethics committee that could have approved the proposed survey. Nevertheless, we worked hard to ensure that the rights of participants were respected during the survey participation and whole analysis process. The survey, which is provided as part of the supplementary information, was accompanied by a short introductory text outlining the survey cause and stating that there is no personal data collected. We did offer the submission of email addresses to receive the published survey results, this was however done through an external survey so that we could not link the addresses to any of the anyhow anonymous survey responses. Accordingly, as i. the participation was fully voluntary, ii. no personal data was collected, and iii. the separately collected email addresses could not be linked to responses, it did not appear necessary to seek an extra consent in writing. The participation in the survey was accepted as consent.
In response to the survey, we received messages entering a discussion about our proposed Dos and Don'ts in biodiversity-related science communication, which was and is the aim of the paper.