

1 **Distinct biogeographic phenomena require a specific terminology – a reply to**  
2 **Wilson and Sagoff**

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1 **Abstract**

2 In a recent publication, we proposed that the increasing number of range-expanding species  
3 that track human-induced environmental change warrant specific recognition in science and  
4 biodiversity management, and we proposed the term ‘neonative’ for these taxa. Here, we  
5 reply to two letters (Wilson 2019, Sagoff 2019) that criticised specific, yet different aspects  
6 presented in our publication. While we disagree on several points with both authors, we agree  
7 that a broader discourse is needed for developing robust and widely accepted definitions and  
8 terms for the ever more important phenomenon of neonative species.

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11 Our recent publication on range-expanding species tracking human-induced environmental  
12 change (Essl et al. 2019) has led to questions regarding the validity of the concept we have  
13 put forward. Wilson (2019) raises several important issues about the usefulness of the term  
14 “neonative”, which we proposed as a short-hand to describe range-expanding native species  
15 that track human-induced environmental change. In another letter, Sagoff (2019) argues that  
16 species’ origin does not matter, as it is not associated with biologically or ecologically  
17 relevant differences.

18 We disagree with Wilson (2019) that the inherent difficulties and uncertainties in identifying  
19 neonatives invalidate the concept. If we consider a phenomenon distinct (and important) we  
20 should denote it by a distinct term. This is not only prerequisite to classifying real cases,  
21 however difficult this may be, but also clarifies thinking and fosters inclusion of such  
22 phenomena into the development of hypotheses and theory. In fact, making current  
23 uncertainties and knowledge gaps in delineating neonatives explicit will promote research on  
24 these topics and will ultimately lead to better science and also support more focused decision  
25 making. Giving up the development of standardized protocols (e.g. for assessing the impacts

1 of alien species) in the face of large uncertainties has been suggested several times in invasion  
2 science (e.g. Ojaveer et al. 2015), but giving up to study such challenges would hinder the  
3 advancement of knowledge (Blackburn et al. 2015). The need to name such species is also  
4 evident in other studies, especially when dealing with the predicted massive range shifts or  
5 increased abundance caused by climate change (Carey et al. 2012, Scheffers & Pecl 2019) and  
6 the need to manage their impacts (Latombe et al. 2019). For example, for many people, native  
7 invaders are species that become abundant within their natural range after an anthropogenic  
8 disturbance (e.g. Simberloff et al. 2012), whereas neonatives expand to a range where they  
9 have not been present, at least not in the current interglacial. Having a clear terminology to  
10 distinguish both phenomena will promote efforts to monitor species redistribution from local  
11 to global scales, help managers in developing strategies for dealing with these newly arriving  
12 species and will permit to develop focused policies in the future.

13 Wilson (2019) also suggests that we should focus on impacts instead of biogeographical  
14 origin of species when prioritizing interventions. This argument echoes long-standing  
15 disputes in invasion science (e.g. Davies et al. 2011, Gilroy et al. 2017; but see Simberloff et  
16 al. 2011). However, there is clear evidence that species of different biogeographic origin – i.e.  
17 alien, neonative and native species – differ in many crucial characteristics (Engelkes et al.  
18 2008, Essl et al. 2019), and that the rapidly increasing number of alien (Seebens et al. 2017)  
19 and neonative species (Scheffers & Pecl 2019) makes this distinction ever more important.  
20 Further, waiting until impacts become apparent is unwise, as species management might then  
21 come too late to be efficient or even feasible (Pluess et al. 2012). We re-emphasise here that  
22 our term neonative does not come with any negative connotations; it therefore does not a  
23 priori call for active management actions to control these species or to stop their spread.  
24 Decisions on which species to manage will be context-dependent and will require ecological,  
25 social and economic considerations.

1 Wilson (2019) also questions the usefulness of defining specific thresholds for applying the  
2 concept of neonative species as he argues it is pointless “...drawing a line through a  
3 *continuous process*”. We agree (and explicitly state in our publication) that the processes  
4 involved in range-expansions of native species tracking human-induced environmental  
5 change are continuous. However, this is also the case for many other phenomena in ecology  
6 and other disciplines such as endemism (What is the maximum area of occurrence to qualify a  
7 species as endemic?), alien species (What is the level of human assistance to qualify a species  
8 as alien?), or Anthropocene (At which point in time has the human impact on Earth systems  
9 become so pervasive that a new geological epoch should be denoted?). Therefore, the fact  
10 that underlying processes are continuous does not mean that it is not useful to define different  
11 categories along this continuum. Such definitions come with thresholds and are the basis for  
12 investigating separate phenomena on the continuum. Otherwise, these differences would be  
13 ignored.

14 Finally, Wilson (2019) states that the term “neonative” has been used previously in different  
15 contexts, and thus argues applying it may cause confusion. We explained that the term  
16 neonative has indeed been used in other contexts, but that it has not gained widespread usage  
17 in other fields. There are many essential terms in ecology (e.g. invasive, endemic) that have  
18 other meanings in other fields (e.g. in these cases, medicine, epidemiology) and which were  
19 used well before they were taken up in invasion science; there is little evidence that this  
20 caused confusion among scholars.

21 Sagoff (2019) raises the question of whether the native/alien distinction, however refined,  
22 correlates with any biological or ecological difference. We believe that his interpretation is  
23 unhelpful in resolving the debate. Of course, the mode of relocation and subsequent range  
24 expansion (directly or indirectly assisted by humans or naturally, i.e. on their own means)  
25 may differ, and that these can also result in evolutionary change of the properties of

1 individuals (post-invasion niche shift, see e.g. Colautti & Lau 2015). Furthermore, the non-  
2 randomness of transport leads to propagules with certain characteristics being more likely  
3 picked up and relocated than others. Accordingly, species of different biogeographical origin  
4 and modes of introduction do differ in their characteristics from species that originated at a  
5 location. This has been clearly elucidated in many studies and for many taxa (Engelkes et al.  
6 2008, Simberloff et al. 2013), although this might not be true in every case, such as in  
7 Sagoff's example. In addition, ecological novelty, more specifically the lack of eco-  
8 evolutionary experience of resident species (Saul & Jeschke 2015), has been shown to cause  
9 increased impacts on resident biota (Ricciardi & Atkinson 2004, Richardson & Ricciardi  
10 2013).

11 Given the high and increasing relevance of species tracking human-induced environmental  
12 change, we are pleased that our publication has initiated this debate. The question how to  
13 define, identify and possibly manage neoinvasives where appropriate in our human-dominated  
14 world will be crucial. In our view, an explicit recognition of this phenomenon in science,  
15 conservation management and policy making is urgently needed. Our publication has laid the  
16 foundation for this discourse. Importantly, we believe that this debate should become a broad  
17 one, involving scholars from different disciplines, and environmental managers and decision  
18 makers, so that arguments from different perspectives will be put forward. We also believe  
19 that this process should finally lead to the development of widely accepted standards and  
20 definitions – ideally overseen by relevant international bodies such as the IUCN, CBD and  
21 IPBES. We see this debate as a contribution towards this goal.

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