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LETTER TO THE EDITOR

Invoking denialism does not strengthen invasion science

Greg R. Guerin[1]

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To the Editor,

Kuebbing and Nuñez (2018) defend their meta-analysis of the impacts of non-native plant species on native biodiversity (Kuebbing and Nuñez 2016), one of the articles explored as examples of selection bias in a cautionary article about generalising impacts across species (Guerin et al. 2018). However, Kuebbing and Nuñez (2018) rebut statements that were never made, yet fail to address key points or take into account recent movement in the literature when they conclude that generalisation of negative impacts across non-native species is supported.

Guerin et al. (2018) recognised that non-native species can have significant individual and cumulative impacts (Boltovskoy et al. 2018). Guerin et al. (2018) offered no objection to managers and scientists focusing on problematic species, since understanding and effective control is clearly needed in those cases. Our case focused on the risk of generalising from a biased set of problematic training species to many potentially benign species. We argued that over-generalisation could lead to inappropriate management in some cases.

Guerin et al. (2018) never suggested that the average impact of non-native plant species is zero or positive, an erroneous claim made explicitly by Kuebbing and Nuñez (2018) as a lead-into a lengthy three-point rebuttal. Even so, axiomatic claims that negative impacts can be expected across non-native species are now becoming widely recognised as overly simplistic and unhelpful (Boltovskoy et al. 2018). Such viewpoints have been superseded in the literature with more nuanced interpretations of novel ecological communities, in which effects may be negative, positive or insignificant (Davis and Chew 2017).

While Kuebbing and Nuñez (2018) recognise that some non-native species have positive effects, I would question their notion that there is a dearth of evidence of positive effects from non-native species. Empirical evidence in particular systems exists for non-native floras collectively having positive interactions with native patch-level biodiversity (Martín-Forés et al. 2016), as there are findings of the opposite (Marcantonio et al. 2014). Peng et al. (2019) found that native and non-native species richness (based on 204 cases) were positively correlated from small to large spatial grain

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✉ Greg R. Guerin
greg.guerin@adelaide.edu.au

[1] School of Biological Sciences, The University of Adelaide, North Terrace, Adelaide, SA 5005, Australia

sizes, notwithstanding potential negative interactions not exposed within that pattern. Although correlative and based on observational studies of plot-level richness, the result reported by Peng et al. (2019) contradicts, or at least sits awkwardly with, the notion that effects are negative on average across non-natives. It is too early to generalise with any certainty.

Kuebbing and Nuñez (2018) present effect distribution data to show that their results can likely be generalised, given an expectation that few of the unstudied non-native species will be found to have beneficial effects. Guerin et al. (2018) argued that the known negative effects of well-studied and problematic invasive species cannot be generalised to all non-native species. This is true regardless of net impact—failing to make up for the impacts of a set of problematic species is not an argument for a given non-native to be assumed itself problematic. Nevertheless, Kuebbing and Nuñez (2018)'s assertion that "on average, non-natives have negative competitive impacts" must be tempered by selection bias as well as incomplete and sometimes contrary evidence (Peng et al. 2019).

Despite Kuebbing and Nuñez (2018)'s assertion that 'naturalised' species were no different in their effects than 'invasive' species fails to address to two of our original points: A staggering 44% of the species they examined were *native* to the study area. Secondly, many species classed as 'naturalised' could have been classed as 'invasive', while many 'invasives' could have been considered 'transformers'—they are not typical examples of the 13,000 + non-native plant species globally.

Contrary to the claim by Kuebbing and Nuñez (2018), our caution concerning generalisation of negative effects across non-native species relates to only one of the so-called 'misleading criticisms of invasion science' proposed by Richardson & Ricciardi (2013), who emotively refer to authors criticising invasion science as "naysayers". Perhaps that statement, "'positive impacts of non-native species are understated and are at least as important as their negative impact'" is not a 'misleading criticism' so much as a topic in need of investigation, given that it appears to be true in particular systems and of native/non-native species richness relationships generally (Sax 2002; Martín-Forés et al. 2017; Boltovskoy et al. 2018; Peng et al. 2019).

Kuebbing and Nuñez (2018) imply that Guerin et al. (2018)'s warnings against generalising from problematic species "venture into the realm of denialism". We suggest that genuine discourse is also hindered when an argument resorts to *ad hominem* reasoning (Boltovskoy et al. 2018). Invoking denialism (Boltovskoy et al. 2018) artificially paints Guerin et al. (2018)'s genuine scientific arguments as belonging to a 'camp' (with negative connotations), when in fact we were arguing for conclusions to be as objective as possible, recognising the complexity and diversity of species interactions.

Kuebbing and Nuñez (2018) further state that, "calls to halt all syntheses of the best available data are unwise and irresponsible." I wonder, to which such 'calls' might they refer? Guerin et al. (2018) categorically did not state that such meta-analyses should not be conducted (in fact, *the exact opposite is stated*: see Conclusion therein). Further generalisation, not meta-analysis per se, was cautioned against. What *is* unwise and irresponsible, then, is to incorrectly paraphrase a legitimate argument in order to more easily draw criticism to it.

In conclusion, I welcome on-going debate regarding the merits (or not) of generalising invasive species impacts. It is not useful, however, to invent and attribute viewpoints that were never given and then attack them as unscientific. Invasion science is strengthened by good quality studies that challenge accepted notions with new ideas and evidence, not by invoking denialism to suppress debate (Boltovskoy et al. 2018).

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