



## Toward a More Balanced View of Non-Native Species

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We thank Vitule et al. (2012) for responding to our review “The Potential Conservation Value of Non-Native Species for Conservation.” Although scientists have long known that non-native species could be benign or beneficial in some regards, in practice most scientists and managers have treated all non-native species by definition as problematic. Gross inefficiencies and misguided programs have arisen in cases where policy was driven by such dogmatic views on non-native species (Stromberg et al. 2009). We are happy to read that Vitule et al. are in agreement with us that such biases should be actively eliminated, and we whole-heartedly agree with the last sentence in their reply, which reads: “The issue of species’ invasions is complex and necessitates a cautious, balanced view, including consideration of short-term and long-term introduction effects, both positive and negative.” We look forward to such assertions being put into practice. Indeed, we maintain that the vast majority of studies on non-native species conducted to date fail to properly consider any potential positive effects.

We disagree with Vitule et al. on numerous other points. For example, we believe they erroneously interpreted our primary message when they stated: “Their main message is clear: non-native species should be used for conservation given their potential desirable contributions.” We do not believe *all* non-native species should be used for conservation, and we do not even imply such a notion in our paper. In fact, we argued that the desirable and undesirable aspects of any non-native species must be evaluated carefully when deciding whether (and how) it should be managed. We further argued that it is important to do so for the sake of scientific objectivity and effective policy. It may well be that many non-native species have a sum negative effect, but this cannot be asserted until both potential positive and negative effects have been estimated. Our main point is clearly summed up in the

last sentences of our paper: “In the past, risk analyses focused on negative events associated with non-native species, and a species was termed invasive if any significant negative effect was documented. Here, we suggest that both negative and positive potential effects of non-native species should be tallied. We also suggest that a more meaningful definition of an invasive species would be one for which there is a net negative effect. A dynamic view of nature that recognizes that species characteristics and human valuations thereof change over time, not only reflects ongoing evolutionary processes, but also leads to a more balanced and objective approach to the management of non-native species.” We, therefore, disagree with Vitule et al.’s interpretation of our main message.

We further believe that Vitule et al. misrepresent or misinterpret several points we raised in our article. We never discussed (explicitly or implicitly) the issue of intentional introductions. It is, therefore, a misrepresentation of our work to say that we put forth a “proposal to encourage introductions when predicted net effects are positive.” In fact, we believe that novel introductions—intentional and unintentional—are associated with great uncertainty and risk and that priority should, therefore, be given to preventing such introductions under most circumstances, with exceptions being granted, for example, to prevent extinction of certain species.

The authors also state we did not consider the uncertainty surrounding the long-term effects of non-native species, when they write: “. . . they do not acknowledge uncertainty - many effects are difficult to predict or occur only in the long term (Strayer et al. 2006).” In fact, in our abstract we state, “A fraction of non-native species will continue to cause biological and economic damage, and substantial uncertainty surrounds the potential future effects of all non-native species.” We also wrote, “The future effects of a non-native species are uncertain

because biotic interactions are notoriously difficult to predict and because current and future environmental conditions may differ substantially (Walther et al. 2009).” We, therefore, fail to understand how the authors reached the conclusion that this perspective was missing in our paper.

Finally, we disagree with their statement that “introductions have much more frequently caused loss of biological diversity, ecosystem functions, and ecosystem services . . .” They base these claims on the Millennium Ecosystem Assessment (2005), but much data has become available over the last decade that shows that these statements are not generally true. First, any discussion of loss or gain of biodiversity must be related to the spatial scale of interest (Sax & Gaines 2003). Although species diversity is declining globally, in part because of non-native species, the net effect of regional species introductions is generally an increase in diversity. Such an increase has occurred with plants, mammals, birds, fishes, and many other groups on both islands and continents worldwide (Sax et al. 2002; Sax & Gaines 2003). Locally the effects of non-native species on alpha diversity are likely to be more idiosyncratic, but net increases are still the expectation in most cases because of the positive association between local and regional species richness (Sax & Gaines 2003). Second, introduced species typically lead to an increase, not a decrease, in ecosystem function (Ehrenfeld 2010). Results of two recent meta-analyses show this to be the general case for most ecosystem functions that have been measured (Liao et al. 2008; Vila et al. 2011). Third, non-native species can provide many ecosystem services that are desirable to humans (e.g., clean water, erosion control, food provisioning). Although we are unaware of any study that has tallied the number of services provided versus amount of harm associated with introduced species (clearly not a small task), the provision of ecosystem services by such species certainly occurs and may be more frequent than is appreciated. Non-native species may produce many different undesirable effects, but it is important to use the existing data to distinguish between disproven assumptions and real consequences.

Vitule et al. criticize us on issues we did not address in our paper. For example, they claim we misrepresented the frequency of positive effects of non-native species. In our paper, we reviewed the numerous ways in which non-native species can potentially contribute to conservation efforts. We never wrote or implied that we quantitatively measured the number of studies documenting positive versus negative effects. We concede that a reader could come away with an incomplete picture of the field if our article was the first they ever read on the topic of non-native species. But our target audience was conservation professionals who read *Conservation Biology* and who, by contrast, have been hearing almost exclusively about the negative effects of non-native species for years or even decades. We even clarified that our aim

was “to catalog the possible ways in which non-native species can help achieve conservation objectives. We did not review all the known negative effects of non-native species because these have been described exhaustively (e.g., Mooney & Hobbs 2000; Lodge et al. 2006).” We are, therefore, uncertain how the authors concluded that our aim was to provide a quantitative measure of the number of each type of study. Such a comparison would be difficult given the historical bias in the literature that favors descriptions of negative effects of non-native species.

Vitule et al. also state that we “downplay reports of invasion effects in developing countries.” Given that we sought examples for our review indiscriminately and that our paper had no geographic or sociopolitical focus, we fail to understand the origin of this criticism. Nevertheless, the question of whether the nature and magnitude of positive and negative effects differ according to a country’s development path is an interesting one that should be pursued.

The world is rapidly changing, as are the ways we view non-native species. How we manage these species and whether we even chose to maintain a distinction between native and non-native species in the future is a wide-open question. On the one hand, the distinction may sometimes prove to be distracting from the larger issue of the positive and negative effects that both native and non-native species can have relative to any particular conservation goal (e.g., Davis et al. 2011; Carey et al. 2012). On the other hand, information on a species’ origin may provide useful information in some cases, for example, on islands and in other insular settings where non-native species regularly have negative effects on native biota (Sax & Gaines 2008). We look forward to future work by Vitule et al. and others as they carefully document both the positive and negative potential effects of non-native species, and we thank them for their contributions to this interesting debate.

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