

## With or without equations: what are the dos and don'ts of hunting?

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## Invited reply

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In Bischof *et al.* (2008), we evaluated the validity of the recommendation made by other authors (e.g. Loehr *et al.* 2007; Milner *et al.* 2007; Bergeron *et al.* 2008) that hunting mortality should mimic the patterns of natural mortality. We used simulations to show that biased harvesting (with respect to an arbitrary trait), added to similarly biased natural mortality (regardless of the order), will amplify the trait-shifting effect, whereas unbiased harvesting will leave the post-mortality trait distribution unchanged. Although these findings are not surprising and are based on principles well known to demographers and quantitative geneticists, they helped us to point out that a single strategy may be insufficient to address the need for 'ecologically responsible' harvesting regimes.

In his response to our paper, O'Hara (2009) provides a mathematical representation of the trait-shifting effect of multiple, potentially selective mortalities. That presentation helps to generalize our conclusions, which were based on a limited parameter space explored through simulations. In addition, O'Hara (2009) correctly notes that even unbiased harvesting can exert selective (and thus ultimately trait-shifting) pressures, although we point out that we did consider this in Bischof *et al.* (2008). As an example, we mentioned the potential for changes in life-history traits (e.g. age at first reproduction) due to temporal discounting of future reproduction when facing elevated mortality, even if it is unbiased for age (see our reference to Proaktor *et al.* 2007).

The primary merit in O'Hara's (2009) comment to our paper is, in our view, that it expands the needed discussion on the effects of hunting. However, O'Hara (2009) misinterpreted the intent of our work. In contrast to O'Hara's (2009) suggestion, we cautioned against recommending a universal strategy (harvesting that mimics natural mortality), rather than recommending one ourselves (i.e. unbiased harvesting). Careful reading of our original paper will reveal this point, as well as the fact that we were explicit that an unchanged post-harvest distribution of a given trait may just be one of multiple competing alternative objectives. Far from recommending that unbiased harvesting should be implemented indiscriminately, we simply pointed out that the generality of the recommendation for harvesting to mimic natural mortality was not warranted and had to be presented

with disclaimers, some of which we listed in Bischof *et al.* (2008).

O'Hara (2009) also questions the achievability of unbiased harvesting. Should unbiased harvesting be the goal, we agree that it at the best would be extremely difficult to maintain for most wild populations. That said, informed wildlife management in general entails the use of theory within the boundaries of reality (e.g. ecological, financial and political); in other words, it means compromising. Reducing, if not eliminating, selectivity can still be an achievable objective that might help decrease trait-shifting effects of harvesting.

To stimulate further discussion, we would like to close by posing the question 'what do we want hunting to be or not to be?'. As we learn more about the role of hunting (selective or not) in wild populations, we are gaining both the information needed to answer this question, as well as an appreciation of its complexity. A satisfying answer is yet neither within our grasp, nor is it likely to be a universal one, but the question about what it is that we want to achieve is a logical precursor to the one about how to achieve it.

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The accompanying comment can be viewed on page 211 or at <http://dx.doi.org/doi:10.1098/rsbl.2008.0666>.