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Letter to the Editor

50/500 or 100/1000? Reconciling short- and long-term recovery targets and MVPs

An estimate of Minimum Viable Population size (MVP), or a credible proxy, is key to establishing recovery targets for endangered species. However, population viability analysis (PVA) to generate MVPs requires data that are unavailable for many endangered taxa; consequently, one prominent school of conservation scientists has advocated the use of rules of thumb based on meta-analysis of published MVPs to guide assessment and recovery of data deficient species (Reed et al., 2003; Traill et al., 2007, 2010). However, not all conservation scientists are comfortable with this approach. Jamieson and Allendorf (2012) have argued strongly that generic MVPs based on meta-analysis are inflated, lack the specificity for management of individual species, and that MVPs are typically in the hundreds, not the thousands predicted by meta-analysis. In their most recent contribution to this debate, Frankham et al. (2014) critically address whether generalizations based on PVA and the 50/500 rule (the minimum effective population thresholds for preventing inbreeding depression and maintaining long-term evolutionary potential, respectively) stand up to scrutiny under current theory. They make a strong technical case that a 100/1000 rule may in fact be more appropriate, and that most current PVA applications underestimate extinction risk – and therefore MVP, and associated recovery targets and thresholds for IUCN endangerment – because they fail to accurately account for inbreeding depression and maintenance of long term evolutionary potential. (Note that the census population size (the MVP) may be anywhere from 5 to 10 times the effective population size ($N_e/N_{census} = 0.1–0.2$) depending on the mating system or other factors (e.g. if dominance hierarchies in breeding males cause only 1 of 10 males to produce offspring); an $N_e/N_{census} = 0.1$ converts 50/500 into 500/5000 in terms of a census population, hence long-term MVPs in the thousands.)

Can these contrasting schools of thought be reconciled? Divergent views are valuable and often reflect different experiences. Jamieson is a New Zealand-based conservation biologist coming from a tradition of recovering species from the brink of extinction in an endemic fauna. New Zealand conservation biologists have been extremely successful at re-establishing populations from very low numbers by eliminating introduced predators or through innovative use of barriers and island refuges. Their field experience supports timely elimination of immediate threats (e.g. predation) as paramount in recovery, with loss of genetic diversity and evolutionary potential being largely irrelevant (Jamieson, 2007). In contrast, Frankham and associates focus on population genetics modeling and meta-analyses of published studies to extract quantitative insights of general value to guiding conservation; their goals focus on recovery targets needed for long-term persistence in perpetuity, rather than short-term prevention of extinction, which is the immediate purview of field biologists.

Arguably, these approaches are complementary, and support the need for both short- and long-term recovery targets in endangered species planning. Recovery targets that address only short-term threats (while vital) may not necessarily ensure species persistence without addressing the long-term threat of reduced adaptive potential in the face of future environmental change.

Frankham et al. (2014) do not appear to dispute the case made by Jamieson and Allendorf (2012) that most endangered species are rapidly declining as a consequence of human impacts that increase mortality (e.g. impacts of exotics, hunting, etc.) and that effects of inbreeding and reduced evolutionary potential are secondary. For recovery planning purposes, it is eminently sensible that the immediate causes of population decline be clearly identified and prioritized for conservation/management. However, consideration of evolutionary potential may be essential for setting long-term recovery targets, even if they are not the proximate driver of current endangerment. Correct identification of short-term threats may allow population recovery to several hundred individuals with minimal risk of inbreeding depression, but loss of evolutionary potential leading to increased risk of extinction may be a legitimate long-term concern if populations remain in the hundreds for an extended period.

Jamieson and Allendorf (2012) acknowledge that much of this debate concerns the time scale over which to plan for recovery and persistence, and the recovery targets that are likely to be economically or socially acceptable, rather than the science, which people seem to broadly agree on. For example, Jamieson and Allendorf (2012) state:

> *"Populations numbering in the thousands, and that have reduced evolutionary potential due to low levels of genetic drift, are not the sort of populations that concern most conservation practitioners."*

This statement is broadly correct – but it is consistent with the view that populations in the thousands are appropriate long-term recovery targets, i.e. because they are at levels where they are not a concern for long-term extinction, which is the goal of recovery. This statement indirectly highlights the value of rules of thumb that emerge from meta-analyses: their potential to extract generalizations that can be used proactively for interim management of data-deficient species (Cardillo and Meijaard, 2012). Because the demography and population dynamics of many threatened species are poorly understood – and will likely remain so because of limited resources – rules of thumb may provide valuable guidance, providing that associated uncertainties are clearly acknowledged. This application clearly has a precedent, since rules of thumb of one sort or another play a large role in IUCN listing

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criteria. As a fish biologist, many of the threatened and endangered species I regularly deal with do in fact number in the thousands. Resources to collect data on these taxa are limited, and consequently the mean MVPs reported in meta-analyses have been used for guiding recovery targets for endangered fish species in Canada (e.g. Pearson et al., 2008).

A desire to set recovery targets in the hundreds when faced with populations in the 10s is perfectly understandable given the monumental effort required to recover species. However, MVPs should be objectively determined based on science, and not selected to be in a particular size range for subjective reasons. It is perfectly reasonable to set interim recovery targets based on short-term PVAs, but it is important to be honest that these targets may not be sufficient for long-term persistence over longer time scales. Social or political unpalatability of long-term MVPs and recovery targets in the thousands may be a legitimate concern, but it needs to be addressed in other ways.

On the other hand, it is equally short-sighted to dismiss short-term MVPs and recovery targets as universally inadequate because of their limited time horizon. Management interventions can effectively reduce a MVP if they enhance demographic parameters (e.g. survival, growth, fecundity) or reduce environmental stochasticity. However, the persistence of a low MVP may become predicated on management intervention in perpetuity if cessation of management reverts demography to the larger pre-intervention MVP, and elevates extinction risk (unless a single intervention has permanent effects, e.g. through habitat restoration). Given the vagaries of funding for endangered species management, the preferred option is always to aim for a MVP that is sustained by natural processes, in a habitat area sufficient to maintain the population in perpetuity without intensive human intervention. This may not always be possible in impacted areas, and decisions to intervene and reduce the MVP through active management, like prioritization of recovery funds among species, should be a clearly rationalized trade-off among competing values.

Jamieson and Allendorf (2012) also express concern that Traill et al. (2010) implicitly link long-term MVPs in the thousands to a triage approach that may explicitly write off extremely rare species that are costly to recover. This concern seems well-founded, since long-term MVP and funding prioritization are separate issues that should not be conflated. Lower prioritization of rare species that are costly to recover does not necessarily follow as a direct consequence of long term MVPs in the thousands. Prioritizing species for recovery action should be based on transparently weighting a suite of relevant value-based criteria, including immediacy of threat, socio-economic costs, demographic feasibility of recovery, cultural value, taxonomic and ecological uniqueness, and functional role in the ecosystem.

Regardless of whether the conservation community fully accepts the proposition by Frankham et al. (2014) that the 50/500 rule should be revised to 100/1000, their arguments strengthen the case that long-term recovery targets are in the thousands. However, long-term PVAs that account for evolutionary potential are not at all incompatible with PVAs over shorter time horizons that identify priority threats to persistence and interim recovery targets. An explicit recognition of the value of both short-and-long term recovery targets, and the need to distinguish between them, goes a long way towards reconciling seemingly divergent viewpoints.

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