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OPINION ARTICLE

Expanding Shifting Baseline Syndrome to Accommodate Increasing Abundances

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Abstract

The shifting baseline syndrome suggests that our perceptions of previous conditions may change over time as ecosystems degrade. Although most discussion of the topic relates to decreasing species abundances, there are several reasons to think that abundances of many species will increase in response to anthropogenic disturbance. For example, increases in abundances of certain species are predicted after the removal of predators, as exotic and invasive species become established, and as habitat generalists proliferate. Because generational amnesia about historic conditions could influence the setting of restoration targets, restoration ecologists should explicitly consider the shifting baseline syndrome in reference to increases in abundances from historic levels.

Key words: **generalist, generational amnesia, invasive species, predator extirpation, reference conditions, shifting baseline syndrome.**

Introduction

A consistent problem facing restoration ecology is that perception of what is natural may become biased toward anthropogenically disturbed ecosystems (Pauly 1995; Vera 2010; Alagona et al. 2012). Consistent with the original work describing the phenomenon (i.e. the shifting baseline syndrome, SBS), the concept is most commonly evoked in reference to declines from previous levels in abundance or species diversity (Pauly 1995; Baum & Myers 2004; Papworth et al. 2009). As a consequence of SBS, targets for restoration or conservation may sink below historic levels (Baum & Myers 2004; Jennings & Blanchard 2004; Humphries & Winemiller 2009). The phenomenon of SBS is widespread (Papworth et al. 2009), occurs rapidly (Turvey et al. 2010), and may emerge as individuals forget prior conditions or because younger generations do not possess knowledge of these previous conditions (i.e. generational amnesia, Papworth et al. 2009).

Understanding societal perceptions of what is natural is particularly important considering the increasing recognition that both scientists and the general public can and should be integrated into formulation of management guidelines (Decker et al. 2012). Although SBS is typically associated with unperceived loss, populations of some species may actually increase in anthropogenically disturbed ecosystems (Gibb & Hochuli 2003; Sterrett et al. 2011), leading to societal tolerance for increases in abundance, additions to community assemblages, or otherwise altered ecosystem function. In this sense, there are two directions we can think of SBS impacting restoration ecology (Fig. 1). Three relevant examples include increases in prey abundance after the removal of predators, the establishment of exotic and invasive species, and the proliferation of habitat generalists in response to anthropogenic disturbance.

Top predators have important roles in ecological systems (Ray et al. 2005). However, extirpations of their populations are occurring globally (e.g. Friedlander & DeMartini 2002). The immediate and direct impact of these declines and extirpations is an increase in abundance of species that formerly experienced relatively high predation pressure (Leopold et al. 1947). For example, wildlife and habitat management guidelines that facilitated overabundances of *Odocoileus virginianus* (white-tailed deer) in North America worked in concert with predator extirpation to result in population sizes that exceeded previous carrying capacities (Côte et al. 2004). These increases in abundance may result in a shifting perception of what population sizes are acceptable in a given area (Rutberg 1997); this is likely to influence societal acceptance for managing populations to reduce abundances, a management action that will generate effects perceived by the general public (Henderson et al. 2000). When overabundant population sizes are considered natural, there is decreased incentive to understand why it is important to conserve or reintroduce top predators (Berger & Smith 2005).

Invasive species are one of primary threats to the conservation of biodiversity worldwide (e.g. Clavero & García-Berthou 2005). However, many invasive species have now been established in their new ranges for decades or more, occasionally leading to the perception that they are a normal, if not natural, component of native biodiversity. For example, exotic yet long-established species may engender considerable fondness

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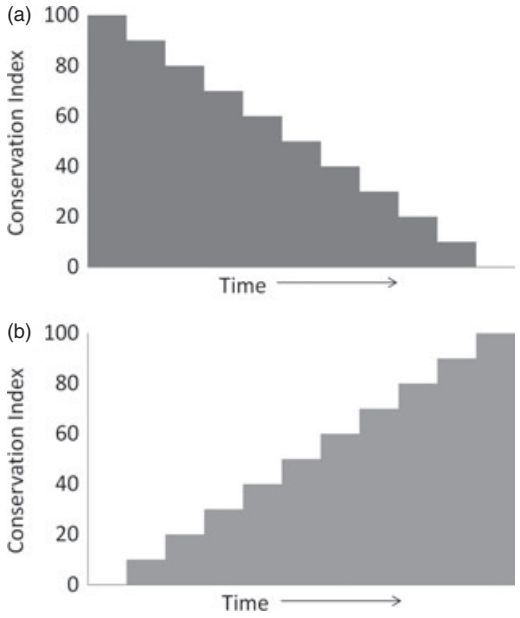

Figure 1. Restoration efforts are based on data that show many ecological metrics in degraded systems (such as abundance, species diversity and ecosystem function) are in decline over time. Further, because the baselines from which we judge this decline differ with each generation (Pauly 1995; Papworth et al. 2009), we see a step-wise pattern of decline in identification of historic conditions, as predicted by the shifting baseline syndrome (a). However, in some systems and for some species, ecological metrics are on the increase. This potential is indicative of the need for a revised interpretation of shifting baseline syndrome (b), which could have important implications when identifying target conditions for restoration efforts.

to the point that they are considered part of the identity of their new range, such as is the case for *Equus ferus caballus* (feral horses) in Australia (Dawson et al. 2006) or *Phasianus colchicus* (ring-necked pheasant) in the United States (Davis et al. 2011). These perceptions erode support for eradication and control campaigns while obscuring the fact that invasive species in general are of widespread conservation concern (Nimmo et al. 2007). Introduced and invasive species may even hold economic or recreational value to society (Weller & Geihsler 1999; Gozlan 2008), further encouraging reluctance to instituting efforts to restore historic conditions.

Although anthropogenic disturbance may lead to population declines and extirpations of ecological specialists, widespread and generalist species may actually benefit from human-induced changes that occur across the landscape (McKinney & Lockwood 1999). The scale of the relevant disturbance may vary widely, from mesopredators taking advantage of altered resource levels (and absence of top predators, Prugh et al. 2009) in urban and suburban neighborhoods (e.g. Graser et al. 2012), to avian assemblages becoming more homogenous as generalist birds expand their range in response to climate change (Davey et al. 2012). *Molothrus ater* (brown-headed cowbird) provides an interesting case-study: this brood parasite has expanded its range to the east coast of North America as forested habitats became more fragmented and the species now represents a considerable and novel threat to both forest and disturbance-associated songbirds across their new range (Brittingham & Temple 1983; Suarez et al. 1997). As with invasive species, increased public acceptance of overabundances of these generalists may dilute support for habitat restoration or wildlife control efforts designed to benefit specialist (and imperiled) species.

We have outlined several reasons why our conceptualization of SBS should be expanded to incorporate the reality that abundances of many species will *increase* in response to human activity (Fig. 1). What restoration ecologists do with these contrasting patterns remains uncertain and will often be context and value dependent (Davis & Slobodkin 2004; Hobbs et al. 2004). For example, managers must increasingly ask what actions they should take in response to species invasions, considering that most do not have significant impacts and some exotic species have been suggested to play important roles in their new habitats (Schlaepfer et al. 2011; Bertness & Coverdale in press). Similarly, climate and other large-scale environmental change has become ubiquitous and in some cases, perhaps irreversible (Vitousek et al. 1997). As a result, restoration goals need to be formulated after explicit consideration of not only what was present historically, but what is realistic and achievable considering ongoing and anthropogenically-induced change.

We have discussed only how anthropogenic disturbance may result in overabundances of certain species. However, in addition to the increasing acceptance of unnaturally large populations of individual species, we may grow accustomed to associated larger-scale changes in community, ecosystems, and landscape-level functions; these changes may influence trophic cascades (Beschta & Ripple 2009), wildlife behavior (e.g. Palkovacs et al. 2011), interspecific interactions (Gaertner et al. 2012), and abundances of other affected species (Berger et al. 2001). Therefore, restoration ecologists should consider how both directions of SBS might influence the designation of reference conditions and restoration goals at both species-specific and ecological scales (White & Walker 1997, Hobbs & Harris 2001). A better understanding of how nature and change is perceived is essential for ensuring support among the general public and scientists alike for conservation projects attempting to restore historic conditions (Papworth et al. 2009).

Implications for Practice

- Reference conditions and restoration goals should be formulated only after explicit consideration of how our perceptions of historic conditions may be influenced by populations of some species increasing over time and in response to ecosystem degradation.

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