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Wildlife habitat enhancements for grizzly bears: Survival rates of planted fruiting shrubs in forest harvests

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ABSTRACT

Productive grizzly bear foraging habitats are lost as the prevalence of natural forest openings declines. We assessed the effectiveness of using wildlife habitat enhancements to increase food supply for grizzly bears in recent forest harvests by conducting planting trials of containerized shrub seedlings for three important late-season grizzly bear foods (fruiting shrubs): *Shepherdia canadensis* (Canada buffaloberry), *Vaccinium membranaceum* (mountain huckleberry), and *Amelanchier alnifolia* (saskatoon). We monitored seedling survival over two growing seasons and considered the effects of soil nutrient amendments, exclosures, initial seedling condition, and environmental factors (elevation and terrain). *A. alnifolia* had the highest survival rate, although it may not be as effective in the long term due to being preferred ungulate winter browse. Soil nutrient amendments reduced survival rates of all three species, perhaps due to competition with grasses, whereas exclosures increased survival rates. Survival rates across an elevation gradient for *S. canadensis* and *A. alnifolia* were inversely related to local occupancy rates, demonstrating that knowledge of their realized niche space is not consistent with early establishment rates of seedlings. As the amount of natural forest openings declines, wildlife habitat enhancements in disturbed sites with open canopies, including forest harvests, have the potential to locally increase late-season food supply for grizzly bears.

1. Introduction

Grizzly bear (*Ursus arctos*) populations are under threat across much of their North American range, primarily due to anthropogenic habitat loss and habitat alterations, as well as increases in human-caused mortalities associated with increases in human access (Mattson and Merrill, 2002; Linke et al., 2013). Current management efforts to recover and sustain populations focus on reducing human-bear conflicts and human-caused mortalities, as well as identifying and maintaining grizzly bear habitats (Alberta Grizzly Bear Recovery Team, 2008). There is a growing need for strategies to improve habitat to balance habitat losses and habitat alterations (Nielsen et al., 2006). Along with human-caused mortality, food availability is a critical component of grizzly bear habitat quality (McLellan and Hovey, 1995, 2001; Merrill et al., 1999; Merrill and Mattson, 2003; Nielsen et al., 2010) and thus a central focus of strategies aimed at creating or improving habitat. Grizzly bears consume plant matter throughout much of their active period (McLellan and Hovey, 1995; Munro et al., 2006), particularly during hyperphagia (late summer to early fall) when they forage on fruit-producing species to help accumulate fat reserves for hibernation (Martin, 1983; Hamer and Herrero, 1987; Hamer et al., 1991; Hamer, 1996; Munro et al., 2006; Holden et al., 2012; Mowat et al., 2013).

One of the most important factors regulating the availability and productivity of certain grizzly bear foods is forest disturbance (Nielsen et al., 2004b). In Alberta, natural disturbance regimes that were historically dominated by fire have been disrupted over the past century (Hamer and Herrero, 1987; Johnson et al., 2001; Linke et al., 2013). In place of wildfire, forest harvesting has become the most prevalent source of disturbance within the forested areas of Alberta's grizzly bear range (Nielsen et al., 2008; Festa-Bianchet, 2010; Stewart et al., 2012; White et al., 2014). Forest harvesting can increase local food supply for bears under certain conditions, especially in areas where fire suppression limits the availability of natural forest openings (Nielsen et al., 2004a; Stewart et al., 2012). However, forest harvests can also negatively affect the recovery of some fruiting species, including *Shepherdia canadensis* (Canada buffaloberry; Nielsen et al., 2004b) and *Vaccinium membranaceum* (black huckleberry; Anzinger, 2002),

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which are important late-season food sources for bears (Hamer and Herrero, 1987; Hamer et al., 1991; McLellan and Hovey, 1995; Munro et al., 2006). Silvicultural practices such as scarification can disrupt the roots or rhizomes of these species, thereby limiting their vegetative recovery post-harvest (Anzinger, 2002; Nielsen et al., 2004b). Thus, even with the removal of canopy during forest harvest, which should promote fruit production (Hamer, 1996; Nielsen et al., 2004b), some key bear foods vital for developing body mass prior to hibernation are not available. Because of this, the late-season food supply for bears in these areas is reduced (Nielsen et al., 2004b) and may lead to bears using high human-conflict zones in search of alternate food resources.

To mitigate the effect of forest harvesting, habitat enhancements (wildlife food plots) have been proposed to accelerate the recovery of fruiting species in forest harvests (Nielsen et al., 2004b). Planting fruiting shrubs in forest harvests (or other anthropogenically-created disturbances such as reclaimed mine sites; Cristescu et al., 2012) where there is no canopy cover could generate significant increases in late-season food supply for grizzly bears. This, coupled with access restrictions and silvicultural forest thinning to maintain or enhance fruit production over time, could be used as management tools to improve habitat quality and hasten population recovery (Braid and Nielsen, 2015). However, little is known about whether habitat enhancements represent a feasible option for improving grizzly bear habitat quality. In particular, tests of the effectiveness of planting seedlings of different fruiting shrub species in forest harvests are lacking.

In southwestern Alberta, the confluence of extensive forest harvesting with a diverse array of climatic zones presents a unique opportunity to test across an elevation (climatic) gradient the viability of using habitat enhancements to boost grizzly bear food supply in forest harvests. We conducted short-term planting trials for three important late-season grizzly bear foods – *V. membranaceum*, *S. canadensis*, and *Amelanchier alnifolia* (saskatoon) – to evaluate initial establishment (survival) rates of seedlings. Specifically, our objectives were to: (1) test whether a soil nutrient amendment and/or fencing treatments affected seedling survival; (2) test whether seedling size (vigour) affected survival rates; (3) test whether patterns in seedling survival rates along an elevation (climatic) gradient were consistent with local patterns in occupancy rates (expected niche spaces); and (4) test whether local variations in terrain (solar radiation) affected seedling survival.

2. Methods

2.1. Study area

We established planting trials across a 5065 km^2 study area in southwestern Alberta (Fig. 1). At higher elevations (alpine and subalpine zones), summers are short and cool, and precipitation (particularly snow) is high (Natural Regions Committee, 2006; Government of Alberta, 2010b). At lower elevations and foothills, summers are short and warm with less precipitation across all seasons (Natural Regions Committee, 2006; Government of Alberta, 2010b). At the highest elevations, plant communities are generally herbaceous meadows or open conifer stands, whereas closed conifer, mixed-wood, and grassland communities occur at moderate to low elevations (Natural Regions Committee, 2006). Common conifer species include *Pinus contorta* (lodgepole pine), *Pinus flexilis* (limber pine), *Picea engelmannii* (Engelmann spruce), *Picea glauca* (white spruce), *Abies lasiocarpa* (subalpine fir), and *Pseudotsuga menziesii* (Douglas fir). The most common deciduous species are *Populus tremuloides* (trembling aspen) and *Populus balsamifera* (balsam poplar). The primary source of natural forest disturbance in the region is fire, although aggressive fire suppression and long-term climatic cycles have diminished the occurrences of fire (Johnson et al., 2001). Timber harvesting is prevalent in the area, replacing fire as the primary source of forest disturbance (Government of Alberta, 2010a; Stewart et al., 2012). In some areas, large amounts of unmerchantable timber lead to substantial logging debris. Regeneration of these sites often necessitates the use of scarification treatments to expose mineral soil (Government of Alberta, 2010b).

2.2. Trial species

Trial species included *S. canadensis*, *V. membranceum*, and *A. alnifolia*, three fruiting shrubs that are important food sources for bears during hyperphagia (late summer to early fall). Fruit from *S. canadensis* and *V. membranceum* comprise the majority of grizzly bear diets in the southern Canadian Rockies during hyperphagia (Hamer and Herrero, 1987; Hamer et al., 1991; McLellan and Hovey, 1995; Munro et al., 2006), and in some cases *A. alnifolia* also features prominently in the diet of bears (Hamer et al., 1991). *S. canadensis* is a nitrogen-fixing shrub that is able to thrive on nutrient-poor sites (Walkup, 1991). Vegetative reproduction is generally slow (Walkup, 1991). In the southern Canadian Rockies, *S. canadensis* is typically found at low to moderate elevations (Walkup, 1991; Nielsen et al., 2003, 2004b; Roberts et al., 2014), and fruit production is inversely related to canopy cover (Hamer, 1996; Nielsen et al., 2004b). *V. membranaceum* is an understory shrub species that most often reproduces vegetatively via extensive systems of rhizomes. It typically thrives on cool, mesic sites with fruit production peaking in forest openings (Simonin, 2000). *V. membranaceum* most often occurs at moderate to high elevations in the southern Canadian Rockies (Haeussler and Coates, 1986; Roberts et al., 2014). Both *S. canadensis* and *V. membranaceum* utilize mycorrhizal symbiosis to help attain essential nutrients (Visser et al., 1991; McCracken, 1999). Finally, *A. alnifolia* is a thicket- or clump-forming species that occurs in a wide variety of habitats, often reproducing vegetatively by sprouting from root crowns and rhizomes (Fryer, 1997; Chai et al., 2013). *A. alnifolia* is limited by moisture availability and will not tolerate prolonged periods of drought (Fryer, 1997). It is shade intolerant and generally grows in forest openings or under moderate levels of canopy cover (Fryer, 1997). In the southern Canadian Rockies, *A. alnifolia* is found from low to high elevations (Roberts et al., 2014), although it is less common at higher elevations where growth is often limited by temperature.

2.3. Presence–absence data

Presence–absence data were collected for *S. canadensis*, *V. membranaceum*, and *A. alnifolia* at 322 stratified field plots during the springs and summers of 2012 and 2013. Occupancy rates were calculated for 100-m elevation zones ranging from 1300 m to 2100 m. The frequency of available elevations in the study area was used to weight sampling effort across each 100-m elevation zone. Refer to Braid and Nielsen (2015) for further information on field methods.

2.4. Site selection and planting trial design

Experimental sites included 18 forest harvests with a minimum of three replicates in each of four 100-m elevation zones ranging from 1400 m to 1800 m. Only forest harvests with slopes of less than 10° were used for trials to minimize slope–aspect effects. Site selection was also limited to forest harvests that had been planted within the past five years to reduce competition effects between experimental seedlings and canopy species, including conifer seedlings. Site-specific details for planting trials are summarized in Table A.1.