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Strong Recruitment from Sparse Plug Plantings of Native California Bunchgrasses

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Introduction

Grassland restoration efforts in California include plug planting or direct seeding of native perennial grasses. These plantings are usually installed at densities intended to achieve full cover of mature plants from the planted individuals, not relying on recruitment of their progeny. Recruitment of future generations would both be reassuring for the long-term success of projects and an indication that lower density plantings might be sufficient, but restoration monitoring rarely looks for recruitment in later years (see Morgan 1999).

The extent of recruitment of new individuals into restoration plantings of native perennial bunchgrasses is poorly known for several reasons. First, most restoration projects simply monitor planted individuals for 1–3 years after planting (Kettenring and Adams 2011) and might miss new recruits. Second, most restoration plantings of grasses are installed at relatively high densities, which if successful could both render new recruits more difficult to recognize and also be less likely to establish them in stands with high cover. Third, restoration practitioners in California grasslands are aware that it is not uncommon for initial perennial grass planting to be cryptically successful; that is, potentially high densities of planted individuals establish at very small sizes in the first year or two and only become evident in subsequent years (Vaughn and Young, forthcoming). The identification of new recruits may be more difficult under these conditions.

Nonetheless, there are some indications that additional recruitment from the progeny of planted native grasses in restoration settings occurs. For example, Rayburn and Laca (2013) reviewed the success of strip-seeding and seed islands in restoration projects where target species are planted over only a fraction of the landscape in separated strips or in small patches, with the intention that future recruitment would fill in the unplanted areas. However, there appears to be a lack of such studies in the highly invaded grasslands of California, where Mediterranean annuals appear to prevent the recruitment of native species (Stromberg et al. 2007). However, even in California grasslands there are indications of such recruitment. We have found native California grasses recruiting beyond the boundaries of seeded plots in our restoration experiments (Porensky et al. 2012, Young et al., forthcoming, Kurt Vaughn, pers. comm.; see also Dyer 2003). Restoration practitioners and native seed producers also have seen recruitment of several native California grass species between drilled seeded rows, especially after several years (John Anderson, Andrew Fulks, Emily Allen, Kurt Vaughn, Chris Rose, pers. comm.).

We report here results from a study site that provided a test of how very low planting densities of native California bunchgrasses can spread and recruit over a long interval (11 years). A small number of purple needlegrass (*Stipa pulchra*) plugs at this site led to the recruitment of many hundreds of additional individuals.

Methods

The study site is an experimental valley oak woodland restoration site in research fields of the University California, Davis. The site was planted with several hundred valley oak (*Quercus lobata*) acorns and seedlings in the winter of 1999 as part of a separate restoration experiment (Young and Evans 2005, Holmes et al. 2008, 2011). The

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Figure 1. One of multiple stands of volunteer *Stipa pulchra* bunchgrasses that recruited from a handful of plugs planted very sparsely 8 years previously at the restored oak woodland site in Davis, California. This patch contains over 20 reproductive individuals. Note the bare ground between bunchgrasses. Planted valley oaks are in the background. *Photo: Truman Young*

Sparse Plug Plantings *continued*

original experiment was divided into 54 plots of 9 oaks each, planted at 2-m spacing, with 5 m between rows of subplots. In March 2003, following successful establishment of valley oaks, we planted in each subplot 2 plugs each of *Stipa pulchra* and blue wildrye *(Elymus glaucus)* at 2-m spacing in the interstices of the 9 oaks, for a total of 108 plugs of each species. One-third of the subplots were subject to controlled burns in June 2003 and another third in May 2004 (Holmes et al. 2008, 2011), after which there remained alive 48 *S. pulchra* and 63 *E. glaucus* individuals in May 2006 (Veblen et al. 2007). There was yearly mowing in the rows between the subplots, but no other management interventions.

In July 2014, we surveyed the entire study area, counting all individuals of *S. pulchra* and *E. glaucus*, which tended to occur in dense patches (Fig. 1). When these patches overlapped with known planting locations, we were not able to determine the fates of original plantings, but we could confirm the loss of original plantings from sites with no surviving individuals. Several stands of *S. pulchra* were so dense that distinguishing individual tussocks was difficult, so our counts may be underestimates.

Results

By the time of the 2014 survey, 15 of the 54 original subplots had been destroyed by new research projects. The remaining 39 subplots had been planted with a total of 78 *S. pulchra* and 78 *E. glaucus* plugs in 2003, of which 34 and 48 (respectively) were still alive in May 2006. We did not do a broader survey on 2006, and so we do not know whether some volunteers were already present at that time. By 2014, most of the original plugs were no longer present, but there had been recruitment of new individuals of these two native perennial grasses. We found at least 39 individuals of *E. glaucus*, of which not more than 12 were original plantings. More strikingly, we counted at least 1,153 individuals of *S. pulchra* within the study area, of which the vast majority were clearly not planted. This represented at least a 30-fold increase in the needlegrass population over a period of 11 years.

Sparse Plug Plantings *continued*

Several stands of *S. pulchra* were sufficiently dense that virtually no other vegetation was present (see Fig. 1). Although there was usually virtually no understory vegetation (including grasses) under the densest oak overstories, there was otherwise no striking pattern of *S. pulchra* with respect to canopy and intercanopy locations.

Discussion

Practicing restorationists have also reported native grass recruitment from planted individuals in California restoration sites, as well as cases where no such recruitment was seen (Rayburn and Laca 2013 and pers. comm.). However, all of these reports are from restoration plantings (or seed-increase fields) at fairly high density. Our data uniquely show that large-scale recruitment past the planted generation can occur even at very low effective planting densities of 2-m spacing, in contrast to typical plug spacings of 20–40 cm (Anderson 2001, Huddleston and Young 2004)

This observation begs the question: Why do natural (remnant) populations of California native grasses not similarly increase dramatically when left alone? One possibility is that the moderate disturbance at our study site (partial mowing) may have provided opportunities for needlegrass recruits. We have also seen needlegrass recruitment past the planted generation in seeded restoration research plots nearby (Porensky et al. 2012 Young et al., forthcoming). Similarly, rangeland researchers have found a diversity of responses of native grasses to different management actions. In particular, disturbance (grazing, clipping, fire, mechanical soil disturbance) is sometimes associated with increases in *Stipa pulchra*, and sometimes not (reviewed in George et al. 2013).

In any case, this case provides a hopeful example of how even very low densities of planted native grasses may serve as nuclei for more substantial recruitment. Experiments currently under way by Rayburn and Laca will formally test this possibility in a restoration-style setting.

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