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Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL

RESEARCH ARTICLE

Growing *Zostera marina* (eelgrass) from Seeds in Land-Based Culture Systems for Use in Restoration Projects

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Abstract

The use of aquaculture systems to grow the seagrass *Zostera marina* (eelgrass) from seeds for restoration projects was evaluated through laboratory and mesocosm studies. Along the mid-Atlantic coast of North America *Z. marina* seeds are shed from late spring through early summer, but seeds typically do not begin to germinate until the late fall. Fall is the optimal season to plant both seeds and shoots in this region. We conducted studies to determine if *Z. marina* seeds can be induced to germinate in the summer and seedlings grown in mesocosms to a size sufficiently large enough for out-planting in the fall. Seeds in soil-less culture germinated in the summer when held at 14°C, with percent germination increasing with lower salinities. Cold storage (4°C) of seeds prior to planting in sediments enhanced germination and seedling survival. Growth rates of seedlings were significantly higher in nutrient enriched estuarine sediments. Results from preliminary studies were used in designing a large-scale culture project in which 15,000 shoots were grown and out-planted into the Potomac River estuary in the Chesapeake Bay and compared with an equal number of transplanted shoots. These studies demonstrate that growing *Z. marina* from seeds is an alternative approach to harvesting plants from donor beds when vegetative shoots are required for restoration projects.

Key words: culture, eelgrass, restoration, seed germination, seedling growth, *Zostera marina*.

Introduction

Zostera marina (eelgrass) has been the focus of most of the submerged aquatic vegetation (SAV) restoration activities along temperate coasts of North America (Fonseca et al. 1998), Europe (Christensen et al. 2004; van Katwijk et al. 2009), and the northwest Pacific (Park & Lee 2007; Hizon-Fradejas et al. 2009). This is also true for the Chesapeake Bay on the mid-Atlantic coast of North America where this species has historically dominated in the higher salinity areas, but has declined during the last century as a result of disease and poor water quality (Kemp et al. 1983; Orth & Moore 1983*a*). *Zostera marina* restoration methods have traditionally involved transplantation from natural donor beds to restoration sites using either cores or bare-root shoots (Fonseca et al. 1982; Davis & Short 1997; Orth et al. 1999; Moore & Short 2006; Park & Lee 2007). Another recent approach has been to use seeds for *Z. marina* restoration (Orth et al. 2003, 2008, 2009; Pickerell et al. 2005). Tissue culture has also been used to propagate some species of SAV for restoration (Koch & Durako 1989; Ailstock et al. 1991; Bird et al. 1994); however, tissue culture methods are only beginning to be developed for *Z. marina* (Tigani et al. 2007).

Transplanting shoots and dispersing seeds both have advantages and disadvantages. Transplanted shoots have high short-term survival rates (usually greater than 70%; Davis & Short 1997; Orth et al. 1999) relative to seed germination rates (<10–40%; Orth et al. 1994, 2003, 2009), but harvesting and planting shoots have higher costs, even if mechanized harvesters are used (Fishman et al. 2004) and may have a greater impact on the donor bed (Orth et al. 2008). Flowering shoots are relatively easy to collect by mechanized harvesters, but most restoration methods using seeds require separation of seeds from flowers and storage of seeds until conditions are optimal for planting (Orth & Marion 2007; Busch et al. 2010). Maintaining genetic diversity is usually one of the goals of seagrass restoration (Fonseca et al. 1998; Williams & Orth 1998; Rhode & Duffy 2004). Transplanting adult plants can lead to low genetic diversity as shoots are tend to be harvested from small areas (Williams 2001). Restored eelgrass beds using seeds should be more genetically diverse. Williams (2001) reported a positive relationship between genetic diversity and seed production, and flowering shoots are often harvested on a larger scale (Orth & Marion 2007; Busch et al. 2010).

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doi: 10.1111/j.1526-100X.2010.00693.x