REVEGETATION EFFORTS ON A DEGRADED LAKE SUPERIOR CLIFF EDGE

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Figure 1. Shovel Point.

Abstract

Cliff edge communities can be fragile, having thin soils and being exposed to temperature, wind and moisture extremes. Many cliff edges are popular recreational areas and become damaged through use. Restoring or halting damage on such sites is challenging for resource managers because of on-going pressure from visitors and insufficient knowledge about suitable native plant restoration materials and techniques. Shovel Point at Minnesota's Tettegouche State Park is our study site. It is a popular recreational destination with severe degradation. We harvested *Danthonia spicata* and *Potentilla tridentata* seeds from populations adjacent to Shovel Point to test propagation and re-establishment techniques. We compared the germination rates of seeds that were freshly harvested, cold stratified (4°C), or treated with Giberrellic acid (GA_3), comparing three sets of 50 seeds for each treatment. We tested the effects of three randomly assigned soil types on the growth of 180 seedlings of each species in a greenhouse, and measured the growth and survival of 450 greenhouse-grown plants of each species on Shovel Point. At Shovel Point plants were randomly assigned to $0.25m^2$ plots with six different soil treatments, and growth and survival data were taken over one year. Cold stratification and GA_3 treatment both gave high (> 96%) germination rates for *D. spicata*, while the highest *P. tridentata* germination rates were in cold stratified seeds (> 67%). Greatest growth in the greenhouse for both species was with Sunshine # 5, a commercial soil mix. Survival at Shovel Point after one year for all treatments was 96.7% for *D. spicata* and 79.1% for *P. tridentata*. Both species had high growth and survival rates in plots treated with hydrogel. *Danthonia spicata* and *P. tridentata* can successfully be propagated in a greenhouse and transplanted to assist in the restoration of severely trampled areas such as Shovel Point.

Introduction

Cliff edge habitats often have thin, easily damaged soils, host different plant communities than the surrounding areas, and are popular recreational areas. Many of these areas are degraded and require restoration efforts (Parikesit, Larson and Matthes-Sears 1995). Ideally, restoration efforts will encourage the growth of local, native plants so that native plant communities, with their locally adapted genotypes, will suffer as little disruption as possible (Moore 2000). We tested revegetation techniques for two native species (*Danthonia spicata* and *Potentilla tridentata*) at Shovel Point, in Minnesota's Tettegouche State Park, with the goal of learning whether these species can successfully be used in cliff edge restoration.

Figure 2. Climbers at the Shovel point cliff edge

Methods

Study Site:

- ❖ An actively used eroding slope at Shovel Point, Tettegouche State Park, Minnesota, (On Lake Superior's North Shore)
- ❖ Offers spectacular views and good rock climbing opportunities
- ❖ Damaged by 50,000 hikers and 3,000 climbers per year

Experimental Design:

- ❖ Three replicate plots of each treatment
- ❖ Six different soil treatments (Table 1)
- ❖ Plots are 0.5m x 0.5m
- ❖ Plots each contain 25 *D. spicata* or *P. tridentata*
- ❖ Two sets of unplanted control plots:
  1) No treatment
  2) Soil dug to 10 cm depth

In June 2000 we established three blocks of six $0.25m^2$ treatment plots for each species. We dug these plots to 10 cm and filled them with plants and a soil amendment with potential to ameliorate site conditions (Table 1). We placed 25 plants in each plot for a total of 450 plants of each species. Two additional plots in each block were established, but not planted. One was tilled and one was left untilled to test for unassisted revegetation.

To assess survival we counted all live plants at one and two years after planting. To assess plant growth we counted live stems at ground level: *P. tridentata* stems with fully expanded leaves and *D. spicata* stems longer than 2 cm. We counted stems in all plots at 2 years, but only in one of the blocks at 1 year.

Table 1. Soil Amendments

• **Hydrogel**
• **Sterile soil**
• **Sterile soil plus local soil**
• **Fertilizer**
• **Woodchips**
• **None**

Figure 3. ***D. spicata*** (left) and ***P. tridentata*** (right).

Results

- ❖ Survival rates for *D. spicata* were very high in all treatments at year 1. In year 2 Survival was highest in plots treated with woodchips (Fig. 4).
- ❖ Survival rates for *P. tridentata* were high at 1 and 2 years, and best in Sterile soil (Fig. 5).
- ❖ After 1 year *D. spicata* growth was poorest with fertilizer or woodchips. *P. tridentata* growth appears best with sterile + forest soil (Table 3) (Fig. 6).
- ❖ The three tilled, but unplanted plots recruited a total of 9 *D. spicata* seedlings after **1 yr**. After **2 yrs** there were a total of 4 *D. spicata* plants. The three untilled plots had no recruitment.
- ❖ At **1 year** *D. spicata* plants in the hydrogel and no amendment treatments had significantly more leaves than those in the woodchip and fertilizer treatments ($P \leq 0.004$) but did not differ significantly from the other treatments ($P \geq 0.05$). At **2 yrs** the *D. spicata* in hydrogel treatments had significantly more leaves than those in the sterile soil and fertilizer treatments ($P \leq 0.007$), but did not differ significantly from the other treatments ($P \geq 0.05$).
- ❖ At **1 yr** *P. tridentata* plants in the Sterile + local soil had significantly more leaves than those in any other treatment ($P \leq 0.02$). At **2 yrs** the *P. tridentata* plants in plots with no soil amendment had significantly fewer leaves than those in any other treatment ($P \leq 0.05$).
- ❖ At **2 yrs** many *D. spicata* plots had recruited new species (Fig. 8)

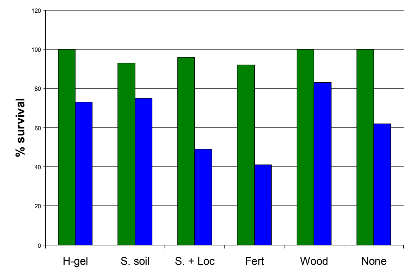

Figure 4. Percent survival at one (green bars) and two (blue bars) years in *D. spicata*.

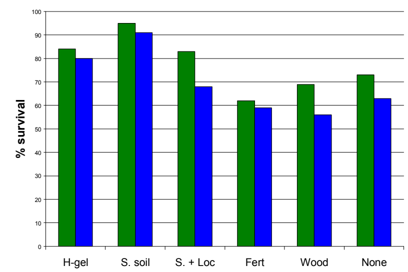

Figure 5. Percent survival at one (green bars) and two (blue bars) years in *P. tridentata*.

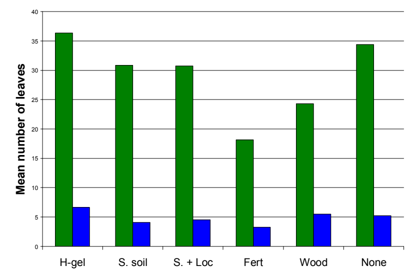

Figure 6. Mean number of leaves at one (green bars) and two (blue bars) years in *D. spicata*.

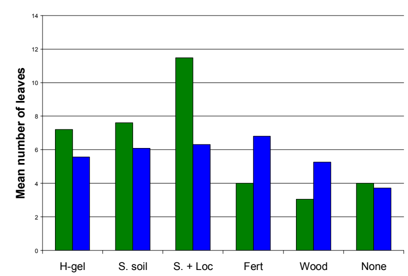

Figure 7. Mean number of leaves at one (green bars) and two (blue bars) years in *P. tridentata*.

Figure 8. *Picea glauca* seedling in *D. spicata* plot (above left), and cliff edge with 0.25 m^2 plots after one year (above right).

Discussion

- ❖ 1 yr Plant survival rates were surprisingly high given the harsh site and the lack of measurable rainfall during the first 5 weeks after planting.
- ❖ Revegetation will not occur without transplantation.
- ❖ *D. spicata and P. tridentata* are good choices for planting in similar settings. *D. spicata's* good early survival and aggressive growth make it a good choice for controlling erosion and rebuilding soil.
- ❖ The relative variability in performance of *D. spicata* and *P. tridentata* in years 1 and 2 (Figs 4 – 8) suggests differing responses to each season's weather. Planting multiple species may provide better restoration success.
- ❖ Hydrogel treatment is worth considering in future plantings. The gel crystals are relatively easy to apply and provide general "planting insurance"
- ❖ Fertilizer treatment does not benefit *D. spicata*
- ❖ First year Sterile + local soil treatment results suggest that *P. tridentata* may be benefiting from mycorrhizal fungi.

Literature Cited

Moore, Peter D. 2000. Seeds of Doubt. Nature 407:683-685.

Parikesit, Pampang., Larson, Douglas W. and Matthes-Sears, Uta. 1995. Impacts of Trails of Cliff-edge Forest Structure. Canadian Journal of Botany 73:943-953.

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