Germination characteristics of wetland sedges from Prudhoe Bay, Alaska

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Introduction:
With continuing development in the oilfields on the North Slope of Alaska, it is becoming increasingly important to develop successful rehabilitation practices for disturbed sites (e.g. Figure 1). Rehabilitation of disturbed lands in the Arctic is challenged by low temperatures, nutrient availability, and low soil moisture. Land rehabilitation methods include fertilizing adjacent tundra to encourage seed production, sowing of native-grass cultivars and indigenous seeds, and transplanting tundra plugs and soil (Figure 2).

Arctic vegetation is dominated by wetland plant communities. Two of the most common wetland species, Carex aquatilis (Figure 3) and Eriophorum angustifolium (Figure 4), were studied to determine germination characteristics when used in rehabilitation programs. These sedges are known to colonize disturbed sites (e.g. Phillips, 1994; Ebersole, 1965; Jorgenson and Joyce, 1994, Kidd et al., 2006) and, once established, spread via rhizomatous growth (Leck and Schütz, 2005). There are few studies that have provided quantitative results, but, seeds of these species have been used by rehabilitation ecologists for a number of years. To address the need for successful rehabilitation methods, this study investigated seed germination under different environmental conditions.

Methods:
Carex aquatilis and Eriophorum angustifolium seeds were harvested in 2008 within the Prudhoe Bay oilfield (Figure 5) from 30 individual sites per species (Figure 6). Seeds were harvested three times, at two week intervals, corresponding with maximum seed maturity. Date ranges and morphological characteristics of seed maturity were determined from preliminary investigations conducted during the previous year. Within one week of harvest, filled and empty seeds were mechanically separated (Figure 7) and filled seeds were randomly chosen for testing.

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Analysis of variance was used to test for significance differences for percent germination among different harvest locations (30 sites), different harvest dates (3 dates), constant (25°C) versus alternating (25/10°C, 8-9 hours, respectively) temperatures, seed storage methods (fresh, after-ripened, wet-cold stratified, and after-ripened plus cold-wet stratification), and light conditions (total light or total dark).

Results and Discussion:
Significantly more seeds of both sedge species germinated with increased light, fluctuating temperatures (Figure 10), and following cold-wet stratification. These results are in agreement with previous studies (e.g. Baskin and Baskin, 2001; Leck and Schütz, 2005) that indicated physiological dormancy controls. However, the percent germination of Carex seeds was considerably higher than Eriophorum seeds. Carex displayed a maximum germination of 75.2% under conditions of 6 month after-ripening at 4°C, and incubation at 25/10°C (Figure 11). Eriophorum displayed a maximum germination of 10.7% after sixty days of cold-wet stratification at 4°C and incubation at 25/10°C (Figure 11).

Germination of both species varied considerably by harvest location. After-ripened Carex seeds grown under standard light quality ranged from 32.5 to 87.9% germination and fresh Eriophorum seeds ranged between 0.6 and 7.6% germination. These results suggest that in order to avoid using low viability seeds for rehabilitation, these sedge seeds should be collected from multiple sources, bulked together and tested for viability prior to application. Carex germination percentage by collection date did not differ significantly, while collection date was associated with significant differences for Eriophorum (Figure 12), showing that Carex displayed a wider range of harvest dates for achieving maximum germination. In summary, these results suggest that sedge seeds from Carex should be more useful than Eriophorum and may be beneficial for arctic rehabilitation programs.

Conclusion:
Germination trials conducted over a range of environmental variables indicate that germination of Carex aquatilis and Eriophorum angustifolium seeds from the Alaskan arctic are subject to physiological dormancy controls. Germination success of both species varied significantly by harvest location, seed storage method, temperature regime, and light condition. Eriophorum germination was also significantly different by harvest date. Overall, germination of Carex seeds was much higher than Eriophorum seeds. These germination results suggest that Carex seeds, collected locally, could be successfully applied in arctic land rehabilitation programs. It is important to note, however, that germination under laboratory conditions would not necessarily mimic environmental conditions in the field. To better understand how Carex seed could be used in rehabilitation programs, future studies should quantify seedling establishment and survival under field conditions with differing substrata and moisture regimes, as well as measuring seedling growth rate over time. Determining whether stand seed quantity and viability differ over time would help land managers and rehabilitation ecologists to set appropriate seed harvest goals and produce a better result.

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Literature cited: