The *Phragmites australis* Invasion and the Use of Rock Salt as a Road De-icer

By
Corrine Higley
Jeff Marsh
Shannon Moore

ABSTRACT

Phragmites australis [Cav.] Trin. Ex Steudel is a salt tolerant invasive species that has spread across temperate regions in the U.S. via roadside drainage ditches that are de-iced in the winter with road salt. *P. australis* rhizomes were collected from a site in northern Lower Michigan. Optimal salinity for *P. australis* growth were determined by growing rhizomes at five salinity variants between 5ppm and 75ppm (parts per million of chloride will be referred to as ppm from here on). The results showed no significant relationship between salinity and growth. These results implied that *P. australis* had no salinity preference. This gives them an edge in invading areas that have had their species richness lowered due to increased salinity from road salting. It also means that the spread of *P. australis* can not be managed simply by changing road salting practices.

INTRODUCTION

Invasive plants are defined as "species or strains that rapidly increase their spatial distribution by expanding into native plant communities" (Richardson et al. 2000). Invasive plants are important because they are known to reduce plant and animal diversity and alter food webs (Zedler et al. 2004). They do this by creating monoculture stands and reducing the species richness of an area (Zedler et al. 2004).

Many wetland plants fit this definition (Richardson et al. 2000). In fact, many of the world's most invasive plant species are wetland invaders (Zedler et al. 2004). Wetlands comprise less than 6% of earths land mass, and yet 24% of the most invasive plants invade wetlands (Zedler et al. 2004). Wetlands are considered landscape "sinks" (Zedler et al. 2004). They accumulate materials that result from disturbances (excess water, nutrients, sediments, salts, heavy metals, other contaminants, and debris) (Zedler et al. 2004). This accumulation of materials makes them particularly vulnerable to invasion (Zedler et al. 2004).

The common reed, *Phragmites australis* [Cav.] Trin. Ex Steudel is a salt-tolerant invasive wetland plant that has invaded the Great Lakes area (Zedler et al. 2004). It is a tall perennial grass with cane-like stalks (Wilcox et al. 2003) that grows in both aquatic and terrestrial environments, and is most commonly found in coastal wetlands (Wilcox et al. 2003). It is considered to be the most common emergent macrophyte in the world (Asaeda et al. 2002). It can reproduce sexually through seeds, but its primary means of reproduction is asexually through rhizomes (Wilcox et al. 2003). Rhizomes are thick stem-like structures that spread underneath the soil. They form a mat of entangled structures that are capable of producing shoots. The thick, tangled mat of rhizomes inhibit other species from growing amongst them.

It is suggested that the voracious spread of *P. australis* is due to human alterations of landscapes; such as disturbances, pollution, and altered salinity (Saltonstall 2002). *P. australis* is drawing attention in temperate regions of the U.S. because its salt tolerance allows it to expand in drainage ditches along highways (and the wetlands that those ditches drain into) where salt is used as a road de-icer in the winter (Zedler et al. 2004). In Michigan, the reed has invaded freshwater coastal areas and marshes (Wilcox et al. 2003). It has created monoculture stands in roadside ditches(particularly along the Lake Huron and Erie corridors) (Wilcox et al. 2003). It is suggested that this is a result of increased soil salinity from the use of road de-icing salts (Saltonstall 2002).

The purpose of this study was to explore the relationship between the invasion of *P. australis* and road salt by growing rhizomes on a salinity gradient. We hypothesized that *P. australis* growth would be maximized at optimum salinity. We predicted that there would be a greater growth (expressed in a volume change) in rhizomes at optimum salinity, and less growth at less optimum salinity.

METHODS

FIELD METHODS

A monoculture stand of *P. australis* was located in a roadside ditch along a main road that is salted in the winter. *P. australis* rhizomes were dug up out of the ground with a spade. The stalks and flowers were removed and left at the site. The rhizomes were stored in a five-gallon bucket during transportation from the collection site to the research site. Soil was also dug from the site and stored in five-gallon buckets for transportation.

Soil core samples were collected from the site. Soil salinity was tested by adding a small amount of water to 3 grams of soil. The water and soil were shaken and mixed well. An IEC HN-SII centrifuge was used to settle the soil out of the water. The remaining water was tested for chloride concentration (6ppm), using standard method SM 4500-Cl (E) with an Auto Analyzer 2 at the University of Michigan Biological Station. That concentration was used as a basis for establishing a range of salinities.

SAMPLE PREPARATION

All shoots were removed and each rhizome was rinsed thoroughly. The volume of each rhizome was measured using volumetric displacement. Each rhizome was then planted in a single quart-size plastic gardening pot (a total of 20 individually planted rhizomes) in the soil that came from the collection site. Each quart-sized pot was submersed into a 3-gallon bucket and 1.56L of well water was added (5ppm). A total of five treatments (four replicates each) were administered to the collection of rhizomes.

The set of rhizomes in each treatment was treated with different concentrations of road salt. The control had no additional road salt added. The salinity of the control is assumed to be 6ppm, the same salinity as the soil that the rhizomes were planted in. The treatments administered had salinity levels of 15ppm, 25ppm, 40ppm, and 75ppm.

Each five-gallon bucket was placed in a hole in the ground approximately 6 inches deep so the water in the buckets would stay cool. The plants were left in a sunny location for nine days. After nine days the volume of each rhizome was measured again, and changes in rhizome volume was calculated.

DATA ANALYSIS

Statistical analysis was done using SPSS version 15.0. A Levine's test for equality of variance was performed to meet the statistical assumptions. A one-way ANOVA was performed to test for differences in volume change among treatment groups. Chi-square tests were performed to test for differences in the number of shoots per group, the number of plants with shoots per group, and the total height of shoots per group. Alpha was set at .05 for all tests.

RESULTS

There was no significant difference in volume change between treatment groups (One-way ANOVA $p=0.267$).

There was no significant difference between treatment groups and the number of plants with shoots (Chi-square $p=0.910$). (Figure 1)

There was no significant difference between treatment groups and the total number of shoots per group (Chi-square $p=0.635$). (Figure 2)

There was a significant difference between treatment groups and the total height of shoot growth (Chi-square $p=0.000$). (Figure 3)

DISCUSSION

Our results did not support our hypothesis that *P. australis* growth would be maximized at optimum salinity. This suggests that *P. australis* does not have an optimum salinity preference for growth. According to our data, our prediction that greater growth would occur in rhizomes at optimum salinity, and less growth would occur at less optimum salinity was incorrect. There was no correlation between shoot height, volumetric change, or frequency of shoot growth displayed between treatment groups.

Since there is shown to be no significant correlation between salinity and *P. australis* growth the interpreted range in which *P. australis* can grow is widened. It can grow in both salt rich environments, as well as salt poor environments. This demonstrates no fitness advantage for *P. australis* in either condition.

Since our prediction that *P. australis* would have an increased growth in higher salinity was incorrect, we can assume that *P. australis* has a higher overall fitness potential than we previously believed. *P. australis* is a better overall competitor with a larger fundamental niche since it is not limited to salt rich environments. This increased niche area may allow *P. australis* to spread into disturbed areas with potentially lower salt concentrations; such as marshes, fens, and swamps that have been impacted by human or other disturbances (unrelated to increased salinity). Due to this increased fitness potential and potentially greater range, *P. australis* has an increased possibility of out-competing native wetland plant species.

Road de-icing practices in Michigan that use salt may still be contributing to the spread of *P. australis*. Salting disturbs the natural wetland (also roadside) habitat and decreases the fitness potential of native plant species (Zedler et al. 2004). This decrease in fitness potential and species richness is then exploited by the highly competitive *P. australis* invasive species (Zedler et al. 2004). *P. australis* has a higher range of salinity variability than native plant species; this increases the likelihood of it out-competing the native species. Potentially resulting in increased monoculture stands of *P. australis* throughout the state of Michigan.

It was hoped that with the understanding of salt tolerance in *P. australis* a management practice could be derived. It was believed that changing Michigan's road salting practices may potentially lead to decreasing the rapid spread of *P. australis*. Since *P. australis* shows little to no salt preference for growth, management through decreasing winter salting may not be a viable option. Other sources of management should be studied.

Contrary to previously studied research our results showed no relationship between salt concentration and growth of *P. australis*, several factors should be taken into account. Due to the limited time at the University of Michigan Biological Station we were not able to allow a growth period of greater than 9 days. Full maturity of *P. australis* can take several months throughout a growing period (Saltonstall 2002). The variance in our results from previous research could also be due to differences in rhizome size, or their readiness to grow shoots at the time they were planted. There was also a rain event six days into growing, that altered the amount of water in the buckets by 2 liters. The rain event brought the water level above the soil and most likely reduced the amount of chloride concentration. The heightened water level and reduced chloride concentration mid-way through the treatment could have affected the growth of the *P. australis* rhizomes. Too much water may have stunted shoot growth by waterlogging the rhizomes. The above considerations have all been taken into account when considering the validity of our results.

Invasive plants continue to threaten the biodiversity of wetlands ecosystems throughout Michigan and the United States. The management of invasive species may not be as simple as altering current human actions. The *P. australis* species is just one of the many invasive species threatening the ecosystem of native plants across America. With the increased threat of invasive species on native plant habitats comes an increased threat to the wildlife that depend on resources from those native plants. This study hoped to increase the understanding of invasive species, specifically *P. australis* in relation to salinity, and to possibly aid in the management of invasive plants in American wetlands.

Works Cited

Asaeda, Takashe, and Le Hung Nam. "Effects of Rhizome Age on the Decomposition Rate of Pragmatism Australis Rhizomes." Hydrobiologia 485 (2002): 205-208.

Byoung-Hwa, Lee, and Miklas Scholz. "What is the Role of Phragmites Australis in Experimental Constructed Wetland Filters Treating Urban Runoff?" Ecological Engineering 146 (2007): 87-95.

"Dry (Rock Salt)Mining." Salt Institute. 3 June 2007 <http://qqq.saltinstitute.org/mich-1.html>.

L.A. Meyerson, K. Saltonstall, L. Windham, E. Kiviat and S. Findlay. A comparison of Pragmatism australis in freshwater and brackish marsh environments in North America. Wetlands Ecology and Management 8:89-103; 2000

Wilcox, Kerrie L., Scott A. Petrie, Laurie A. Maynard, and Shawn W. Meyer. "Historical Distribution and Abundance of Phragmites Australis At Long Point, Lake Erie, Ontario." Journal of Great Lakes Research 29 (2003): 664-680.

Vasquez, Edward A., Edward P. Glenn, J. Jed Brown, Glenn R. Guntenspergen, and Stephen G. Nelson. "Salt Tolerance Underlies the Cryptic Invasion of North American Salt Marshes by an Introduced Haplotype of the Common Reed Phragmites Australis (Poaceae)."Marine Ecology Progress Series 298 (2005): 1-8.

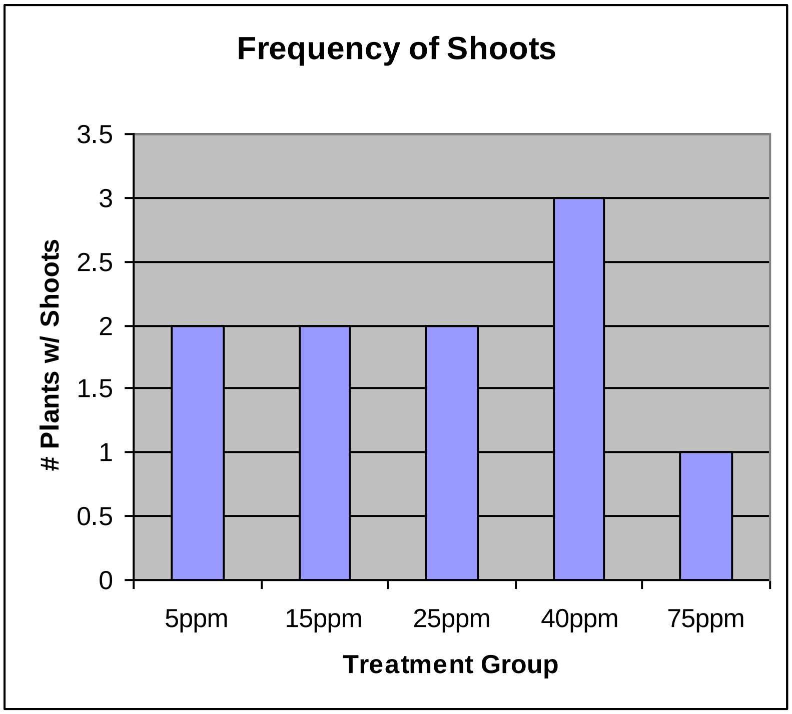
Richardson, D.M., Pysek, P., Rejmanek, M. Barbour, M.G., Panetta, F.D., and West, C.J. 2000. “Naturalization and invasion of alien plants: concepts and definitions.” Diversity Distributions 6: 93-107.

Rolletscheck, Hardy, and Thomas Hartzendorf. "Effects of Salinity and Convective Rhizome Ventilation on Amino Acid and Carbohydrate Patterns of Phragmites Australis Populations in the Neusiedler See Region of Austria and Hungary." New Phytol 146 (2000): 95-105. Sun, Hungbing, Allison Brown, Jorge Coppen, and Paul Steblein. "Response of Phragmites to Environmental Parameters Associated with Treatments." Wetlands Ecology Management 15 (2007): 63-79.

Schabath, Gene. "Ecologists Battle Invasive Marsh Weed." Detroit News 5 Nov. 2001.Accessed online 3 June 2007 at <http://www.lre.usace.army.mil/_kd/Items/actions.cfm?action=Show&item_id=2261&destination=ShowItem>.

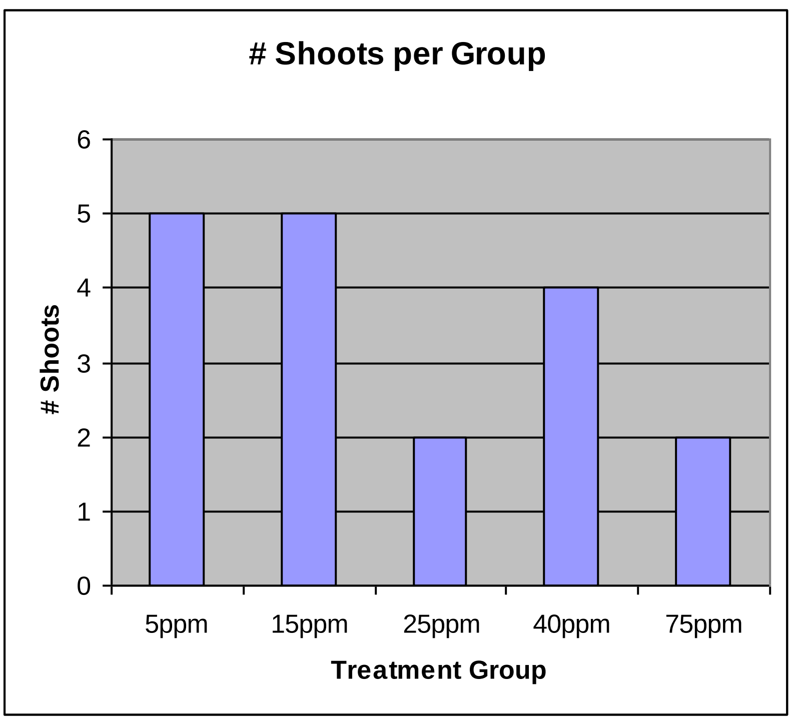
Vasquez, Edward A., Edward P. Glenn, Glenn R. Guntenspergen, J. Jed Brown, and Stephen G. Nelson. "Salt Tolerance and Osmotic Adjustment of Spartina Alterniflora (Poaceae) and the invasive M Haplotype of Phragmites Australis (Poaceae) Along a Salinity Gradient." American Journal of Botany 93 (2006): 1784-1790.

Figure 1



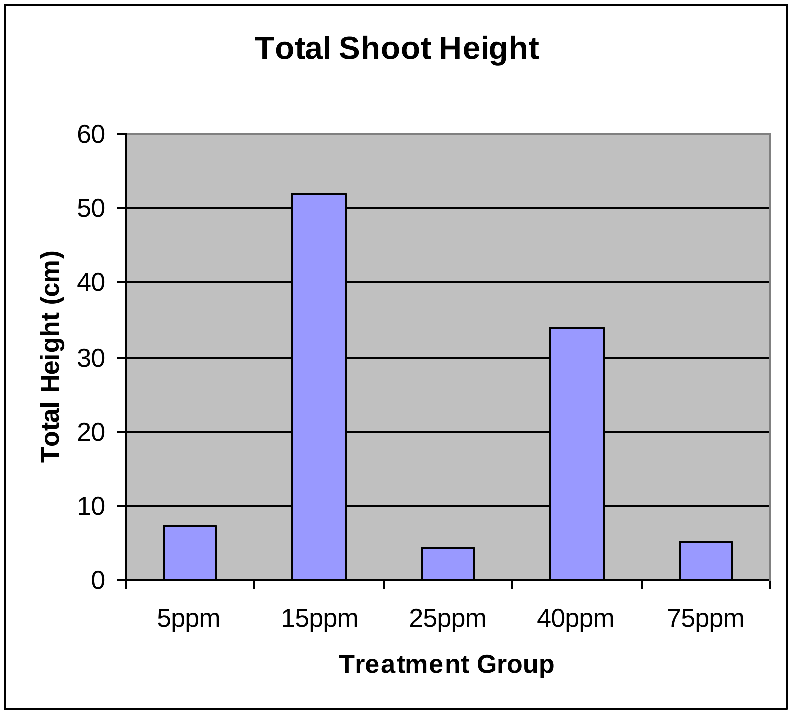
Frequency of plants with shoots per treatment group
Chi-square test (p-value 0.910)

Figure 2



Total number of shoots per treatment group
Chi-square test (p-value .635)

Figure 3



Total growth of shoots in centimeters per treatment group
Chi-square test (p-value 0.000)