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# A Comparison of Moist-Soil Seed Sampling Techniques in the Nebraska Rainwater Basin

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A COMPARISON OF MOIST-SOIL SEED SAMPLING TECHNIQUES IN THE NEBRASKA  
RAINWATER BASIN

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AN UNDERGRADUATE THESIS

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## **Abstract**

Wetland managers sometimes estimate seed production of wetlands managed for migrating waterfowl habitat. Using estimation techniques, managers can determine if wetland plants produce enough seed to support the nutritional needs of migrating waterfowl. Usually, a one-time sampling method is used; this technique samples seeds once a year during peak seed production. However, this technique may underestimate seed production due to plants producing large quantities of seed before or after peak seed production or producing seed throughout the growing season. Season long sampling may be more representative of a wetland's seed production. We comparing one-time sampling with season-long sampling by setting up and sampling seeds from plots; one plot was sampling once every two weeks; the other plot was sampled once during peak seed production. Overall, we found that one-time sampling tends to underestimate seed production relative to season long sampling. If a wetland contains large quantities of early-seeding species, late-seeding species, or species with indetermination growth, the season long sampling technique may be more representative of a wetland's seed production. If the wetland is dominated by species that produce most of their seed during peak seed production, the one-time sampling method is efficient at capturing a wetland's seed production.

## **Introduction**

Migrating waterfowl rely on abundant moist soil seed production of wetlands for survival. Managers often maintain wetlands to produce enough seed to support the migrating waterfowl populations. Migrating waterfowl are important economically; they bring in \$6 million in direct tourist spending and \$10.2 million indirectly to Nebraska's economy (Poor 1997). During the 1980s-90s, waterfowl populations significantly declined due to the loss of wetland habitat (Nichols et al. 1995). Sedimentation, invasive species, and manual draining have contributed to the decline of wetlands in the central U.S. (Green and Galatowitsch 2001, Luo et al. 1997). Recently, governments have stabilized and increased waterfowl populations by protecting wetlands (Nichols et al. 1995). Maintenance of current wetlands is necessary to prevent waterfowl populations from declining again; this is why evaluating the effectiveness of wetland management is important.

The Rainwater Basin is a 6,150 mi<sup>2</sup> region of wetlands located in south central Nebraska; waterfowl use these wetlands as temporary habitat during their spring migration to prepare for reproduction (CEAP Conservation Insight 2008). The Rainwater Basin hosts 7 to 14 million spring migrating waterfowl annually (LaGrange 2004). Waterfowl eat seeds, roots, and tubers of wetland grasses and forbs. The seeds provide essential amino acids, vitamins, and mineral nutrients that cannot be obtained from other food sources (Martin and Uhler 1939, Delnicki and Reinecke 1986, Loesch and Kaminski 1989). Waterfowl rely on these seeds to maintain a healthy weight and increase their chance of successful reproduction (Conroy et al. 1989). Annual plants provide more seeds for waterfowl than biennials or perennials because annuals establish easily, grow quickly, and put most of their energy into seed production (Kolowski and Wiegert 1987); therefore, wetlands that provide food for migrating waterfowl often are managed to promote growth of annual plants (Frederickson and Taylor 1982).

Wetland managers use several methods to encourage annual plant growth. Controlled burning increases bare soil; this increases annual plant populations (de Szalay and Resh 1997). Disking, herbicides, and grazing can increase annual plant populations by reducing invasive plant populations (Paveglio and Kilbride 2000). In the Rainwater Basin, reed canarygrass (*Phalaris arundinacea* L.), an early-seeding invasive species, competes with native moist-soil species (Lavergne and Molofsky 2004, CEAP Conservation Insight 2008), so wetland managers use grazing to reduce the biomass of reed canarygrass (LaGrange, 2010). Proper use of management techniques should increase wetland seed production for waterfowl. When managers estimate seed production, they determine the effectiveness of management techniques (Laubhan and Frederickson 1992).

A common technique for estimating seed production involves collecting and weighing seeds from randomly selected points in a wetland. Extrapolating the data from those points to the entire wetland area gives an estimation of total seed production (Bowyer et al. 2005). Sampling is usually completed once a year during peak seed production. However, some plants produce their seeds before or after peak seed production, while other moist-soil plants continually produce seeds throughout the growing season. The one-time sampling technique may underestimate seed production in the Rainwater Basin; sampling

throughout the growing season is an alternative that may be more effective at capturing a wetland's total seed production. Unfortunately, due to budget and time constraints, sampling throughout the growing season is often not feasible (Bolstad 2008).

The objective of this study is to determine if sampling once a year is effective at capturing most of the yearly seed production in the Nebraska Rainwater Basin. Specific objectives were to: (1) estimate seed production using standard one-time sampling protocols; (2) estimate seed production by sampling once every two weeks throughout the growing season; and (3) examine the similarities and differences between treatments and determine if an adjustment factor should be included in the seed production estimation.

### **Study Location**

We conducted the study at three sites in the eastern part of the Rainwater Basin. The first site is Kirkpatrick Basin South Wildlife Management Area. This site is four miles northeast of Henderson, Nebraska; 305 acres are shallow wetlands. The second site is Harms Waterfowl Protection Area. It is 3 miles southeast of Clay Center, Nebraska; about 33 acres are wetlands. The third site is Smartweed Marsh Wildlife Management Area. It is 3 miles southwest of Edgar, Nebraska and contains 74 acres of wetlands. These areas all have a history of grazing. We chose these sites because they include both moist soil and reed canarygrass ecosystems; also, information on common seed producing species and time of peak seed production was available for these sites as a result of previous research.

### **Materials and Methods**

The fieldwork took place from April to October of 2010 and 2011. Each year, in April and May, we randomly selected points for plot locations. Points were evaluated based on the vegetation at each location. We classified these points into two habitat types: moist soil (MS) and reed canarygrass (RCG). Moist soil points consisted of at least 75% wetland species that did not include reed canarygrass, while reed canarygrass points included at least 75% reed canarygrass. We chose six moist soil points and six reed canarygrass points that met the evaluation criteria. At each plot location, two 1m<sup>2</sup> plots were marked. We placed the plots a few meters apart and made sure each plot had similar vegetation by field

observation. Fiberglass posts were used to mark the plots' corners; this ensured consistency throughout the sampling period. Since cattle grazed during part of the growing season, fence panels and posts were erected around each plot to prevent cattle from disturbing vegetation within the plots.

One plot from each plot pair was sampled once every two weeks for a total of nine or ten times; this period occurred from mid-June to mid-October. The other plot at each pair was sampled once during peak seed production in mid-September. To sample a plot, we collected the seeds of dominant seed-producing grasses and forbs (Table 1) rooted within the plot. We put the seeds in envelopes and kept the different species separate.

After the seeds were collected, we put them in a dryer at 35°C for 48 hours to dry out the plant material; this allowed the seeds to separate from the plant material more easily. Inflorescences were manually processed, and seeds were separated from other plant material using sieves. Next, we used a machine to blow out remaining plant material. After processing, seeds were placed back in the dryer for 24 more hours to ensure that seeds were dried to a constant weight. Finally, seeds were weighed with a scale accurate to thousandths of grams; we used this data to calculate seed weight in  $\text{g}/\text{m}^2$ . In 2012, we compared the seed weight of the one-time sampling to the seed weight of the season long sampling technique by using the paired two tail t-test for means.

## **Results**

We examined eleven dominant seed producing species (Table 1) and found that the total mean seed weight of the season long sampling was significantly greater than that of one time sampling when averaged over 70 plots across all variables. The overall mean seed production found using one-time sampling for all species at all locations was  $3.65 \text{ g}/\text{m}^2$ , which was significantly lower than the  $8.97 \text{ g}/\text{m}^2$  seed production found using season long ( $p \text{ value} < 0.001$ ); this means that there was a more seed produced in the season long sampling overall.

When we examined the data by species, the differences between one-time and season long sampling varied by species (Table 2). We removed one pair of plots from the data because one of the one-time plots was located on a dense line of seeds from the wetland's seedbank; this was a major outlier.

Marshpepper knotweed ( $p = 0.007$ ), water knotweed ( $p$  value  $<0.001$ ), and reed canarygrass ( $p$  value  $<0.001$ ) produced five times more seed on average with the season long sampling method than with the one-time sampling (Table 2). We found no difference in mean seed weight when we compared the two treatments of the remaining eight species (Table 2). Overall, the majority of the species were similar among treatments, while three of the eleven species showed differences between treatments.

When each site was examined, we found that the total mean seed weight of season-long treatment was significantly greater than one-time treatment for all three sites ( $p < 0.001$  top = 0.02, Figure 1). The magnitudes of these differences varied from 1.6-3.7 times more seed with season long sampling. Kirkpatrick had the largest difference with 3.7 times more seed in season long treatment than the one-time sampling treatment. Marshpepper knotweed, water knotweed, reed canarygrass, and floating pondweed are the most abundant species at these sites. When the top four species' one-time means are summed, the result is  $1.35 \text{ g/m}^2$ , or 37.3% of the total mean seed weight; when these species' season-long means are summed, the result is  $6.94 \text{ g/m}^2$  or 77.4% of the total mean seed weight. Three of the four species showed differences between the treatments; the presence of these species is largely driving the differences in the sampling treatments on the site level.

When the other variables were examined, the patterns were similar. Moist soil plots and reed canarygrass plots yields similar results; they all showed a significant difference in seed production when the treatments were compared. We also got similar results when we examined the years individually. For example; water knotweed produced more seed with the season-long sampling technique than the one-time method for both years; while Pennsylvania smartweed produced similar seed production between the two treatments for both years. Overall, the patterns across years and habitat type were similar.

## Discussion

Many species had similar seed production estimates with both one-time sampling and season long sampling, suggesting that these species produce most of their seed during a short period that coincides with peak seed production. Swamp smartweed, Pennsylvania smartweed, curlytop knotweed, floating pondweed, annual ragweed, arrowhead, barnyard grass, and northern water plantain did not show a

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**Comment:** A discussion section should at least partially address how your results fit into a larger context. Yours focus almost exclusively on explaining your results. Some explanation isn't a bad thing, but you need more context.

You do very little to put this in context right now, but it's more because of how you're presenting the information than because you're not thinking about it. Instead of focusing on the species, shift the attention to the explanations- For example, you could rewrite your first sentence to say something like "Many species had similar seed production estimates with both one-time sampling and season long sampling, suggesting that these species produce most of their seed during a short period that coincides with peak seed production" You really don't need to address species specific explanations much at all unless there's something unusual going on or you want to provide a specific example.

**Focus on the common themes, not on the species!**

difference in mean seed weight; this may have occurred because they produced most of their seed during the one-time sampling period. In this study, the majority of the dominant seed producing species produced most of their seed during peak seed production.

Three species had different seed production estimates when one-time sampling was compared with season long sampling. Marshpepper knotweed's difference may have been caused by the species' indeterminate seeding pattern throughout the growing season. Reed canarygrass and water knotweed may have showed differences because both plants are early seeding species; thus they produce their seeds before peak seed production. Overall, species that differed in seed production estimates tended to produce lots of their seed before or after peak seed production, or they continually produced seed throughout the growing season.

There are several reasons why seed production may have been higher with season long sampling. One possible reason is that some species produce lots of seed before or after peak seed production; other species have ongoing seed production throughout the growing season. We also may have gotten differences due to harvesting seeds constantly. When we picked the seeds, the plants could have produced more seeds as a response to its seed loss. However, these seeds were usually small in size and number. There was also an ongoing production of seeds from both harvested and unharvested plants. Overall, excess seed production due to harvesting was probably not an issue.

Even though there were differences among the hydrology and the species at the three sites, the sites still showed the same pattern of producing more seed during the season long sampling than the one-time sampling. Marshpepper knotweed was very abundant at all three sites; it was also the most abundant species of the eleven that were examined (Table 2). The Harms site might have produced more seed in the season long sampling because there was an abundance of marshpepper knotweed, water knotweed, and reed canarygrass. Kirkpatrick produced more seed in the season long technique because it had a lot of reed canarygrass and marshpepper knotweed. Smartweed produced more seed using the season long technique because it contained a large quantity of marshpepper knotweed and floating pondweed. These sites also differences in hydrology; for example Kirkpatrick was dry, while Smartweed had a lot of deep

water. Even though there were differences in hydrology and species, the sites still showed the same pattern of differences among treatments. Basically, if a site contains an abundance of early-seeding species or species with ongoing seed production throughout the growing season, the site will produce more seed using the season long technique than using the one-time sampling method.

### **Conclusion**

A wetlands' dominant seed producing species will largely determine the effectiveness of the one-time sampling method. If a wetland contains large quantities of species that produce seed before or after peak seed production, the one-time sampling method will probably underestimate the wetland's seed production. On the other hand, one time sampling may estimate seed production well in a wetland dominated by species that produce most of their seed during peak seed production. To effectively estimate seed production, wetland managers should observe and monitor their wetlands' dominant seed producing species. If the wetland is largely dominated by marshpepper knotweed, reed canarygrass, or water knotweed, the one-time sampling method should be applied; then, multiply the resulting estimation by 5. If the wetland is dominated by ragweed, barnyard grass, curlytop knotweed, arrowhead, northern water plantain, Pennsylvania smartweed, and swamp smartweed, the one-time sampling method will be effective at capturing that wetland's seed production.

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Table 1: Dominant seed-producing wetland species

Common Name	Scientific Name
Annual ragweed	<i>Ambrosia artemisiifolia</i>
Arrowhead	<i>Sagittaria spp.</i>

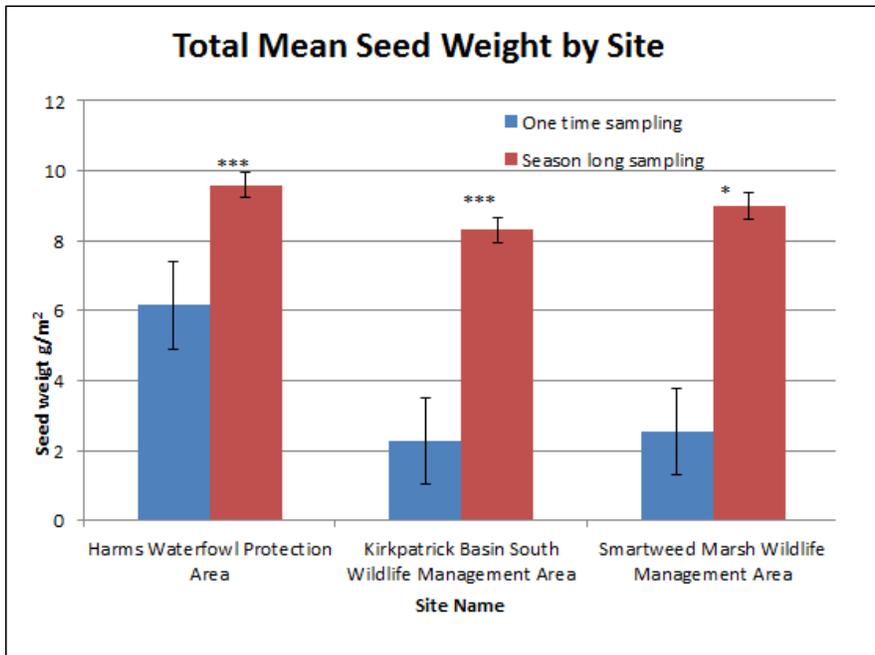
Barnyard grass	<i>Echinochloa crus-galli</i>
Curlytop knotweed	<i>Polygonum lapathifolium</i>
Floating pondweed	<i>Potamogeteon natans</i>
Marshpepper knotweed	<i>Polygonum hydropiper</i>
Northern water plantain	<i>Alisma triviale</i>
Pennsylvania smartweed	<i>Polygonum pensylvanicum</i> or <i>P. bicorne</i>
Reed canarygrass	<i>Phalaris arundinacea</i>
Swamp smartweed	<i>Polygonum hydropiperoides</i>
Water knotweed	<i>Polygonum amphibium</i>

Table 2: Mean Total Seed Weight Differences by Species

Species Name	One Time g/m <sup>2</sup>	Season Long g/m <sup>2</sup>
Annual ragweed	0.003	0.42
Arrowhead	0.56	0.18
Barnyard grass	0.07	0.006
Curlytop knotweed	0.02	0.002
Floating pondweed	0.02	1.43
Marshpepper knotweed	1.10	2.25**
Northern water plantain	0.64	0.52
Pennsylvania smartweed	0.78	0.60
Reed canarygrass	0.001	1.86***
Swamp smartweed	0.22	0.30
Water knotweed	0.23	1.40***

\*0.05>p value>0.01    \*\*0.01>p value>0.001    \*\*\*p value<0.001

Figure 1: Average Total Seed Weight by Site (2010 and 2011):



\*0.05 > p value > 0.01    \*\*0.01 > p value > 0.001    \*\*\*p value < 0.001