Determining the Invasive Potential of Golf Course Grasses in Restored Prairies

By Dr. John Stier, *Professor and Chair, Department of Horticulture, University of Wisconsin-Madison*

The article "New NR40 Rule Targets Invasive Species" in the November/December 2009 issue of *The Grass Roots* discussed the Wisconsin DNR's new rule regarding invasive species in Wisconsin and outlined some of the UW-Madison's research efforts in that area. One of the complaints I consistently hear in my travels is that grasses like Kentucky bluegrass are invasive in prairie restoration efforts. One thing to keep in mind is that we don't live in the same type of environment as existed 200 years ago. Almost all land area east of the Mississippi has been plowed or logged, then replanted with non-indigenous plants. Wildfires don't occur. Animal populations have changed. Wetlands have been drained, former prairie areas tiled. We now often actively manage "natural" areas. We do know that proper timing of burning and other management practices, coupled with other management practices (e.g., preventing over-grazing), influence the presence of non-native grasses in prairie ecosystems (Mitchell et al., 1996). In some cases the presence of non-native grasses in natural areas is due to their intentional planting at some point in the past (Tunnell et al., 2004; Garrison et al., 2009). Roads and trails promote the presence of turfgrasses in natural areas, perhaps as they spread from being planted along the roadsides (Tyser and Worley, 1992). In Wisconsin, botanists from UW-Madison reported an apparent and dramatic increase of either Kentucky or Canada bluegrass in 10

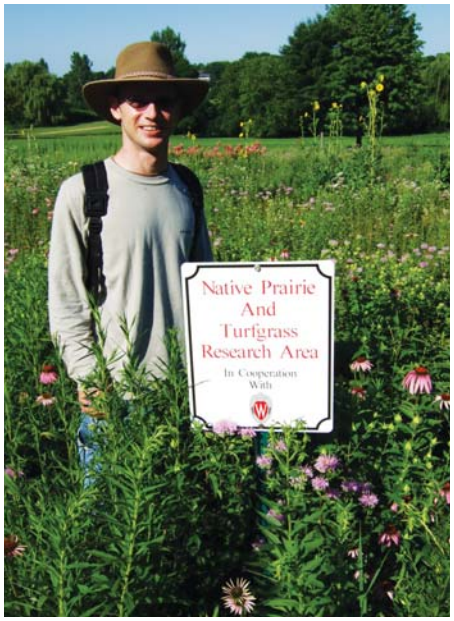

Fig. 1. Mark Garrison and prairie research site.

remnant prairie sites (Kraszewski and Waller, 2008). One important set of questions, though, has to do with determining how the non-native grasses arrive in natural areas, and how likely are they to thrive?

My graduate student Mark Garrison and I set out to determine the relative seed survival of turfgrass seeds compared to seeds of native grasses. We also wanted to know, if turfgrasses were able to establish in a prairie ecosystem, their likelihood for survival and spread.

How We Tested Seed Viability and Grass Colony Spread

One of the first things we did was locate prairies on golf courses in different parts of the state, with similar soil types and prairie ages, for us to conduct our work. We wanted prairies that had been established by people rather than prairie remnants because the history of most prairie remnants is not well known. We wanted the sites to be on golf courses because we would need full access to the site, and because we would need some on-site assistance (e.g., management records, use of golf carts, etc.). Scott Sann, superintendent of Greenwood Hills Country Club in Wausau, and Andrew Putzer, superintendent of Monroe Country Club in Monroe, both enthusiastically agreed to help us use prairies that had been planted on their golf courses (Fig. 1). The prairie areas at Monroe CC were planted in 1991 using a mixture of about 80% forbs and 20% prairie grasses. At Greenwood Hills CC, the prairie areas were planted in 1993 using a similar seed mixture. The soil type at both sites was a silt loam soil, with pH about 6.5 and sufficiently high phosphorus and potassium soil test results for turfgrasses.

Our first experiment was aimed at determining seed survival in prairie ecosystems. Most seed survival experiments place seeds in jars, bury them in the ground, then exhume the jars at different times to determine the number of seeds which survive. We felt it was important to place the seeds in a more natural state, though, as in nature seeds are subject to attack by fungi and other microbes plus toxins and other secretions from plant roots. In order to allow seeds to be influenced by these environmental factors, yet prevent them from being carried away or consumed by insects and ensure we could find them at later dates, we placed 100 seeds of a given grass species into nylon mesh bags, along with soil from each site, and buried them in the prairies at a 2 inch depth. Road construction flags, about 4 inches tall, were placed along with a small metal plate above each bag to help us locate them in the future. Bags were exhumed at 6, 12, and 22 months after planting. Seed viability was determined by the Wisconsin Crop Improvement lab. A combination of seed germination tests and tetrazolium staining on ungerminated seeds were used to distinguish viable, dormant, and dead seeds. We compared several non-native turfgrass species such as Kentucky bluegrass (*Poa pratensis* cv. Touchdown) and creeping bentgrass (*Agrostis stolonifera* cv. Penneagle) to three native tallgrass prairie species, switchgrass (*Panicum virgatum*), big bluestem (*Andropogon gerardii*), and Virginia wildrye (*Elymus virginicus*).

For our second experiment, we grew colonies of turfgrasses, from seed, in plastic tubes (1.5 inch diameter by 6 inches length) in a greenhouse during summer of 2006. The soil type was a 2:1 mixture of autoclaved (pasteurized) silt loam soil and Scotts Metro-Mix. The grasses were fertilized and watered to prevent stress; bentgrasses were kept clipped to a height of 2 inches while the other grasses were maintained at 3 inch height. Grasses included 'Touchdown' Kentucky bluegrass, 'Providence' creeping bengrass, 'Legendary' velvet bentgrass (*A. canina*), 'SR5210' creeping red fescue (*Festuca rubra* var. *rubra*), 'SR5100' Chewings fescue (*F. rubra* var. *commutata*), and 'SR4500' perennial ryegrass (*Lolium perenne*). Other turfgrasses were also tested , but not reported here

Fig. 2. Kentucky bluegrass colony in prairie after being chewed to ground level by unknown animal.

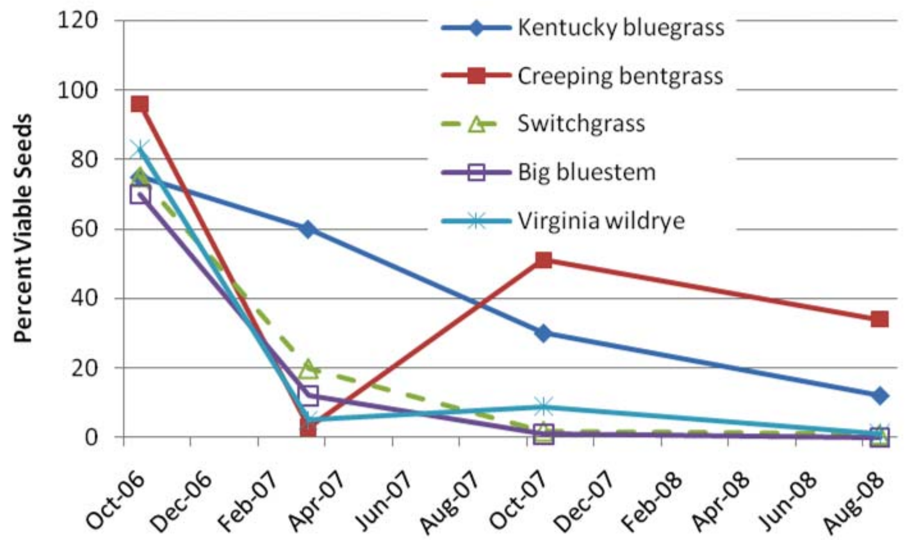

Fig. 3. Survival of non-native grass seed (Kentucky bluegrass, creeping bentgrass) and native grass seed when buried in prairie ecosystems in Wausau and Monroe, WI. Standard errors for comparing between species were reported in Garrison and Stier, 2010.

for spatial reasons or because they are less relevant for Wisconsin golf courses. Those data are available in Garrison and Stier (2010).

In early September, we moved the grass colonies outside to the O.J. Noer Turfgrass Research and Educational Facility to let the plants acclimate to climatic fluctuations, including less water, to prepare them for planting into prairies. In early October, we placed colonies of each turfgrass species about 6 feet apart into prairie sites on the golf courses. Within 48 hours we found all the grasses at Monroe had been chewed to ground level (Fig. 2), so we placed metal screens (4 inch diameter by 6 inch height) used for downspouts over each colony at both locations to reduce the effects of herbivores on turfgrass survival. The screens were removed during the late spring as prairie vegetation began growing and replaced late each summer as prairie vegetation began to senesce (die). We visited the sites about once each month for two years and measured the lateral spread of the grass colonies.

Seed Survival

Seed viability of all species was roughly similar at the beginning, ranging from about 75 to 95% viability (Fig. 3). Viability for all species declined over time. Seeds of the native grasses had very poor survival rates, becoming effectively zero between 12 and 22 months. Creeping bentgrass had about 35% seed survival after 22 months (low survival at 6 months appeared to be an anomaly), while just over 10% of Kentucky bluegrass seed remained viable at 22 months.

The poor survival of native grass species relative to the turfgrasses provide evidence that turfgrasses may generate in restored prairie sites if their seed had fallen or been planted into the soil within the previous two to three years. The data suggest that prairie restoration success could likely be ensured if an area containing turfgrasses was prevented from seeding for a couple of years. Timely application of systemic herbicides such as glyphosate that can kill stolons and rhizomes would appear to be helpful to ensure turfgrasses don't revegetate from those types of organs.

Grass Colony Spread

Grass colonies at Monroe all showed a bimodal (2 peak) growth and decline phases, with up to 400% spread in spring of the first year followed by a decline to at or below the initial colony size later that summer (Fig. 4). Colonies experienced a smaller scale regrowth the following spring, but usually declined to at or near zero by the second autumn. Some species like perennial ryegrass failed completely.

In Wausau, similar declines occurred for Kentucky bluegrass, creeping bentgrass, and perennial ryegrass (Fig. 5). Surprisingly, the colony size of velvet bentgrass increased, while fine fescue colony sizes stayed roughly the same over the two year period.

The loss of colony size for most grasses appeared to be due to a combination of herbivory and summer stress. We never saw which animals were eating the turfgrasses, though turkey and rabbits were abundant. Summer stresses, including drought and heat, would

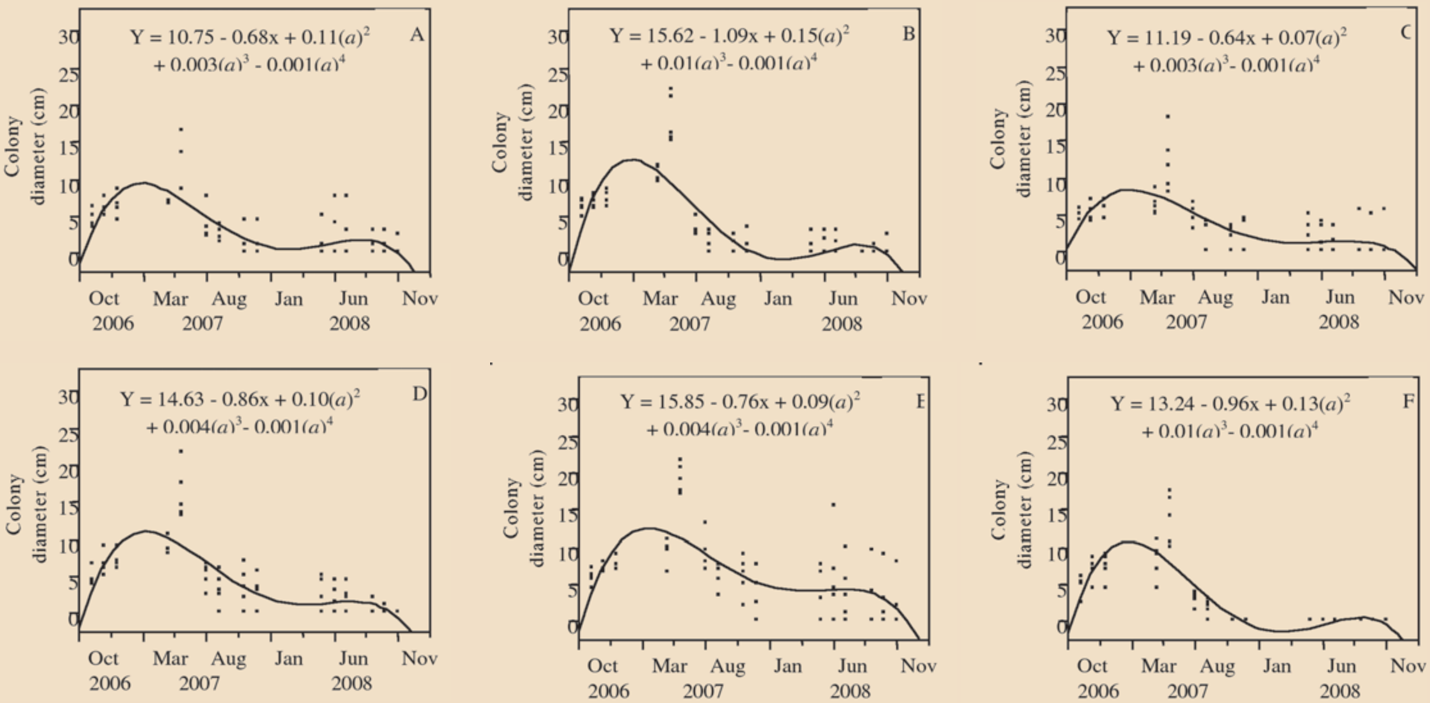

Fig. 4. Turfgrass colony diameter changes after placement in 15-yr old prairie, Monroe Country Club, Monroe, WI. A='Touchdown' Kentucky bluegrass, B = 'Providence' creeping bentgrass, C = 'Legendary' velvet bentgrass, D = 'SR5210' creeping red fescue, E = 'SR5100' Chewings fescue, and F = 'SR4500' perennial ryegrass. For all regression equations, a = x-13.4; convert months into numbers with Oct. 2005 being zero (e.g., Aug. 2007 would be 10).

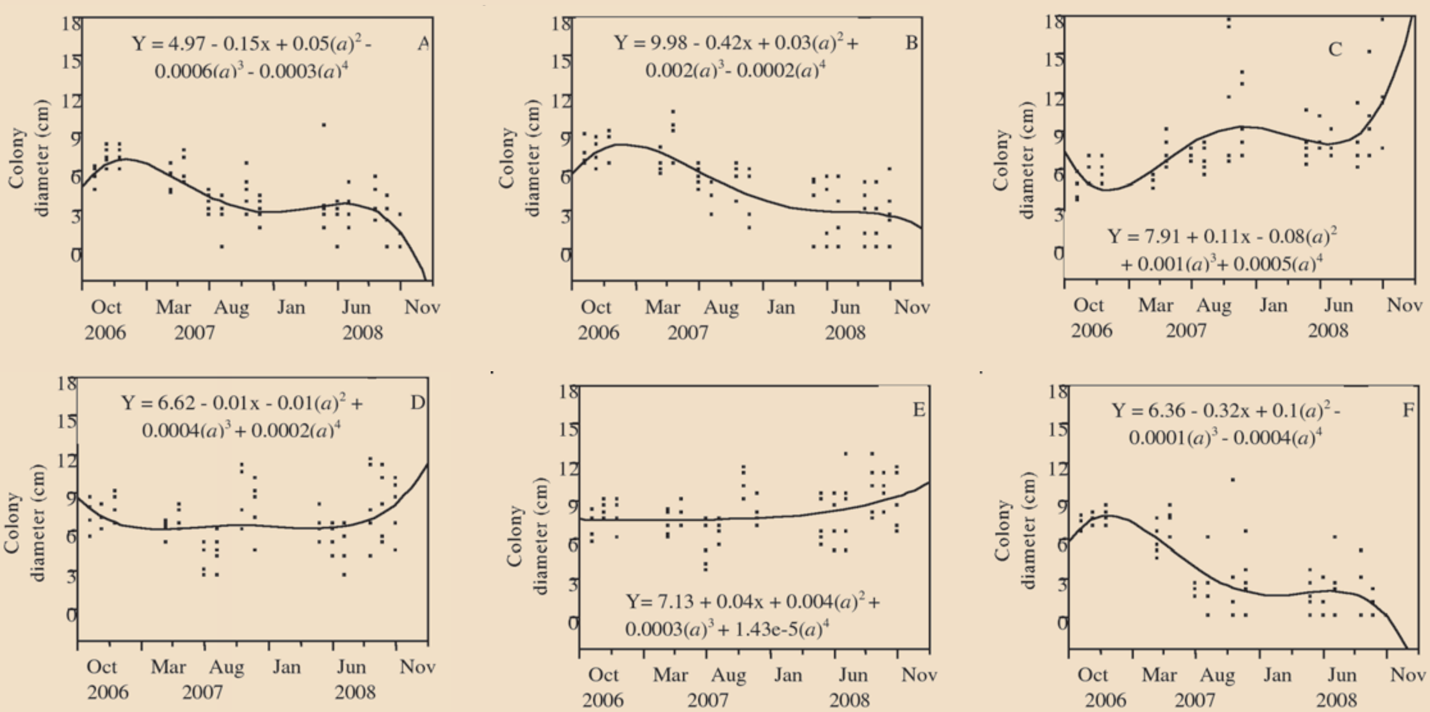

Fig. 4. Turfgrass colony diameter changes after placement in 15-yr old prairie, Monroe Country Club, Monroe, WI. A='Touchdown' Kentucky bluegrass, B = 'Providence' creeping bentgrass, C = 'Legendary' velvet bentgrass, D = 'SR5210' creeping red fescue, E = 'SR5100' Chewings fescue, and F = 'SR4500' perennial ryegrass. For all regression equations, a = x-13.4; convert months into numbers with Oct. 2005 being zero (e.g., Aug. 2007 would be 10).

have suppressed turfgrasses. Shading by prairie plants during the summer was likely a major factor in the poor growth of the turfgrasses. At Wausau, the survival of velvet bentgrass and the fine fescues may have been due to their superior drought and shade tolerances. It is also important to note that both red fescue and velvet bentgrass are deemed by some ecologists and taxonomists as native to the U.S. or at least to North America.

The Meaning of Our Work

The superior seed survival of the turfgrasses relative to the native grasses indicates that turfgrasses may be better able to establish in untended prairie plantings. However, herbivores seemed to preferentially eat the turfgrasses as compared to the prairie plantings. In addition, the turfgrasses were susceptible to environmental stresses, some of which were caused by the prairie plants themselves, culminating in poor survival for non-native turfgrasses. Thus, unless turfgrass seed was routinely introduced into a prairie restoration site, it appears unlikely that turfgrasses would dominate. Since we do occasionally find bluegrasses in Wisconsin prairie sites, however, future work should determine if those plants are indeed Kentucky bluegrass or other species of bluegrass (e.g., Canada bluegrass), some of which are native to the U.S. Additional work is also needed to further examine influences that facilitate the survival or spread of turfgrasses into prairie sites or other natural areas. In the short term, our project provided useful information to ensure grasses such as perennial ryegrass and creeping bentgrass were not placed on the Wisconsin DNR invasive species list. Other grasses like Kentucky bluegrass and tall fescue are still being considered for listing. Outside of Wisconsin, virtually all of the cool-season turfgrasses have been placed on one or more invasive species lists, so the education and research have to continue if we are to make accurate listings.

Acknowledgements

We express sincere thanks for Andrew Putzer and Scott Sann for their assistance and allowing us to use their prairie sites for our project. We are also grateful to Heidi Larsen at Wisconsin Crop Improvement Association for her seed viability testing and to L.L. Olds Seed Co. for donating seed. Funding for the project was supplied by a University of Wisconsin-College of Agricultural and Life Sciences and Federal Hatch grant (WIS01092).

Literature Cited

Garrison, M.A., J.C. Stier, J.N. Rogers, and A.R. Kowalewski. 2009. Cool-season turfgrass survival on two former golf courses in Michigan. Invasive Plant Sci. Manage. 2:396-403.

Garrison, M.A., and J.C. Stier. 2010. Cool-season turfgrass colony and seed survival in a restored prairie. Crop Sci. 50:345-356.

Mitchell, R.B., R.A. Masters, S.S. Waller, K.J. Moore, L.J. Young. 1996. Tallgrass prairie vegetation response to spring burning dates, fertilizer, and atrazine. J. Range Manage. 49:131-136.

Kraszewski, S.E., and D.M. Waller. 2008. Fifty-five year changes in species composition on dry prairie remnants in south-central Wisconsin. J. Torrey Bot. Soc. 135:236-244.

Tunnell, S.J., D.M. Engle, and E.E. Jorgensen. 2004. Old-field grassland successional dynamics following cessation of chronic disturbance. J. Veg. Sci. 15:431-436.

Tyser, R.W., and C.A. Worley. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). Conserv. Biol. 6:253-262.