Prairie reconstruction

DRS CAROLYN GRYGIEL, JACK NORLAND AND MARIO BIONDINI

Professor Emeritus and former Director of Natural Resources Management at North Dakota State University, **Dr Carolyn Grygiel** and her colleagues **Drs Jack Norland** and **Mario Biondini** are at the forefront of new methods for redressing the lost biodiversity of grasslands

Firstly, as Director of Natural Resources Management (NRM), how did you support the faculty and student body in their endeavours?

CG: While I was Director my main focus was working with the undergraduate and graduate students, inspiring them to take the 'long-term decision' and ask the 'next big question.' As is customary with interdisciplinary programmes, NRM was primarily dependent upon other departmental cohorts to provide our graduate students with research projects and stipends. While there was no NRM faculty per se, because interdisciplinary programmes do not traditionally have faculty, those assigned to NRM were always given the utmost encouragement and freedom to pursue their research and academic interests, all of which was returned to the NRM Program tenfold via their excellent independent efforts. I have complete faith in the continuing success of NRM under its new Director.

What prompted your current line of research and inspired your career progression?

CG: My line of research was initiated at the Niobrara Valley Preserve in Ainsworth, Nebraska with a research grant funded by The Nature Conservancy. It was here that my colleagues and I began studies on the fire/bison grazing interaction, which would later evolve into the 'patch-burn grazing application' that is being employed as a management practice today. However, I was also intrigued by the pocket gopher-driven patch disturbance process that appeared to be pushing vegetation changes at the landscape level. This new perspective led me to the concept of 'patch dynamics', which would eventually focus on the impacts of small-scale disturbances as a model for prairie reconstruction.

Is it feasible to 'rewild' these environments? Why must they be managed as prairie land?

Prairie reconstruction is feasible. Our research has shown that the installation of small-scale disturbances and proper seed mixtures can sustainably enhance the vegetative diversity in a standing grass matrix. Precision Prairie Reconstruction (PPR) is effectively applying a simulation of Nature's own approach, which is small-scale disturbances and forb patches. Managing prairie is important simply because there is so little of it remaining and what does remain has been referred to as 'functionally extinct.'

Through your longitudinal studies, what have been the most surprising findings?

Installation of the seeded small-scale disturbances provided an impetus for a landscape dynamic that overcame the impact of the presence of invasive species and allowed the seeded native forb species to propagate outside into the surrounding grass matrix. The disturbances were self-sustaining as distinct communities resisting invasion by non-native grass species that comprised the surrounding grass matrix. The combination of self-sustaining patches and movement of seeded forbs into the undisturbed matrix over time meant that the PPR method effectively increased native species richness and diversity.

Are herbicides or rototilling traditional management options? Can they be applied sustainably?

Herbicide application/drill seeding and rototilling/broadcast seeding are conventional methods that take an agronomic, ie. farming, approach to restoring a natural system. While both of these methods may prove initially effective, they are not generally sustainable in that the forb component diminishes within a few years. We contend that the success of the PPR approach hinges on the fact that installing the small-scale disturbances allowed us to plant forb communities, resulting in self-sustaining patches of forbs as opposed to the widespread distribution of individual forb plants which occurs with broadcast and drill seeding.

How will you further this research? To what extent do you work with policy makers to manage this natural resource?

JN: Currently there are several efforts to utilise the PPR method to increase diversity in sites that are dominated by native plants but lack diversity. Those species that are lacking tend to be scarce and expensive to collect, so by using the PPR method and planting those species in patches rather than scattering them around the site, a manager can get the most out of scarce and expensive seed.

Another line of future research will investigate the effect the PPR method has on the spatial pattern of prairie reconstructions and how it can be used to match the pattern seen in native prairies.

Restoring biodiversity using Nature's method

Researchers in the Natural Resources Management Interdisciplinary Program at **North Dakota State University** are using Nature's method for restoring species richness in the Northern Tallgrass Prairie

THE TALL, GENTLY waving grasses of prairie landscapes are not necessarily the first image that comes to mind when one thinks of species loss or conservation efforts. But the vast expanses of the Northern Great Plains are in fact biodiversity arenas in which native species often struggle for survival.

The remarkable efforts and success of production agriculture in providing sustenance for the human population have significantly impacted the biodiversity of many native landscapes, including the once seemingly limitless area of the Northern Tallgrass Prairie (NTP). An ecosystem that spread across Manitoba, Minnesota, Iowa, and North and South Dakota in an estimated 38 million acres is now reduced to less than 300,000 acres of prairie fragments. These landscape shards are mostly found in small patches, separated from one another by agro-ecosystems that now dominate the plains.

Non-native grass species, which were originally introduced to provide forage for livestock, presently cover millions of acres that were once native prairie landscapes. These non-native species can quickly invade existing prairie sites and crowd out native species. The harsh actuality is that the NTP has been declared 'functionally extinct' as a self-sustaining ecosystem and the patterns of its natural landscapes practically forgotten. "Nevertheless," state Drs Carolyn Grygiel, Jack Norland, and Mario Biondini, "these scattered fragments of native landscape are strongholds of genetic diversity with yet untold benefits to humankind. The NTP is a unique ecosystem and, as such, provides crucial habitat for species found nowhere else".

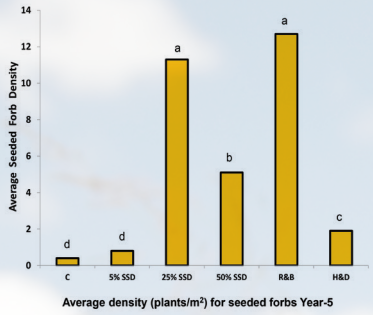
Grygiel, Norland and Biondini, of the Natural Resources Management Interdisciplinary Program at North Dakota State University, have designed a low-impact technique for restoring native biodiversity in grasslands. Dubbed Precision Prairie Reconstruction (PPR), it offers a method that establishes micro-communities of forbs in patterns resembling their natural growth as plant communities.

The word forb refers to a category of herbaceous plants distinct from grasses. Forbs are the prairie flowers, but many are considered weeds. These original inhabitants of the prairies are less aggressive than introduced grasses, but account for most of the diversity in native prairie sites.

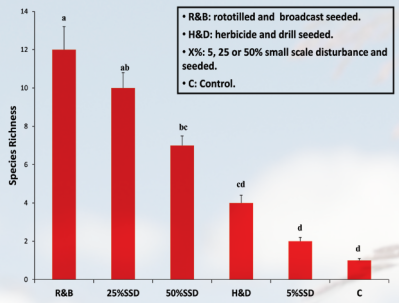
GRASSLAND RESTORATION

Attempting to restore prairies after they have ceased to serve as agricultural fields or pastures is not a new concept, and techniques traditionally used include mowing, inter-seeding, cultivating and prescribed burning. The problem is that species of perennial grasses such as smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) are highly invasive and persistent. A grass matrix which is dominated by a small number of introduced species such as these becomes a hostile environment for most native species, preventing them from re-establishing. The success of techniques such as prescribed burning or herbicide applications in ridding the ground of persistent grasses depends heavily on the existing presence of native species. In order for such methods to be effective, indigenous species should comprise at least 20 per cent of the species mix. Attempts at prairie restoration using traditional seeding methods to plant native forbs and grasses have repeatedly shown that the forb populations dwindle significantly over time, edged out by the grasses.

This has been an issue for conservation lands aiming to restore areas planted to introduced species. "Many conservation lands like those in the Conservation Reserve Programs (CRPs) comprise dense, few-culture acreages of mainly grass species," Grygiel, Norland and Biondini explain. "While this may be effective for reducing soil erosion and supporting some wildlife species, it does not provide the complex habitat necessary for supporting a variety of 'species interactions'." And species interactions are vital. Plant species diversity is critical



Average forb density (plants/m^2) for the seeded species in year five. Statistics were calculated for total seeded forb density. Treatments with different letters are different at $p<0.05$.



Year five mean species richness (± 95% CI) of seeded native forbs. Treatments without a common letter are statistically different ($p<0.01$).

PPR resulted in higher total species richness, native grass frequency, native forb richness, stability and density than the herbicide and drill-seeded method

because it represents the first step in the food chain and the variety of diet on offer has upward implications. The trio explain: "A restored NTP habitat is attractive to wildlife. For example, flowers attract pollinating insects which in turn attract birds which build nests. The eggs and young attract predatory small mammals which attract predatory large mammals, and so on. This represents a prairie dynamic vastly different from a culture grass matrix with just a few species."

GOPHERS: LANDSCAPE ENGINEERS

Despite the importance of biodiversity, there are certain fauna that get no sympathy: gophers (*Geomys bursarius*). Their landscape activities are important components of natural disturbances in grasslands, but as the team points out: "Gophers are generally considered vermin and are not an endangered species".

Grygiel, Norland and Biondini have authored several papers in the past couple of years detailing their research into alternative methods for restoring prairies. Their PPR research tested the effects of systematically simulating and positioning small-scale 'gopher mound disturbances' – patches of earth about 8 m^2 – into old fields, now dominated by smooth brome and Kentucky bluegrass. The technique is to 'install' these patches at regular intervals and then plant them with communities of native forb species. This was compared with two conventional restoration techniques: applying herbicide to existing grasses and then drill seeding (using a machine which simultaneously opens a slit in the soil and plants seed), and rototilling which overturns the soil and uproots the existing grasses, followed by broadcast seeding (scattering the seeds in the newly tilled soil). Both methods involve a well-spaced distribution of no more than a few seeds in any one place and herein lies the problem for restoration.

PPR IN PRACTICE

PPR resulted in higher total species richness, native grass frequency, native forb richness, stability and density than the herbicide and drill-seeded method. There were no statistical differences with the rototilled and broadcast method; however, PPR was substantially more cost-effective than the conventional methods, entailed a lower level of disturbance to the land and required less maintenance.

The creation of these patch communities resulted in a stable meta-community of native forbs, with a diversity of flowers comparable to a prairie habitat. "PPR was designed to be a one-time installation and self-sustaining process that would transform a 'landscape trap' into a dynamic natural prairie process," the researchers state. "The advantage of using PPR to increase diversity is that the standing grass matrix does not need to be completely disturbed." This is important because it means PPR can be used to boost biodiversity by enhancing the native forb component in an existing stand of seeded native grasses or degraded grassland, but without disturbing them unduly.

They also studied the effects of adding amendments such as carbon and phosphorus to the soil to see whether this would aid forb establishment and subsequent persistence. This companion study concluded that phosphorus supplements could potentially be useful for enhancing these PPR-planted forb communities. Carbon additions such as granulated sugar, however, found less favour with the researchers: "C additions, while enhancing native grass biomass, do not appear to be useful in reducing the biomass of non-native grasses and were found to be detrimental to forb density".

The PPR concept suffers no such doubts. Norland is currently advising on several grassland reconstruction projects around the Midwest and Northern Plains, from investigatory research to implementations, in which the proven results of PPR are used to better direct restoration efforts. With biodiversity such a current and pressing issue for natural habitats worldwide, findings such as these are likely to be key determinants.

INTELLIGENCE

ALTERNATIVE PROCESSES FOR RESTORING PRAIRIE LANDSCAPES

OBJECTIVES

- To determine if simulated small-scale disturbances seeded with native plant species can be an effective means for increasing plant species richness and diversity on reconstructed prairie sites that have become dominated by a few non-native or naturalised species
- To develop an advisory for the cost-effective, practical application of these precision prairie reconstruction methodologies to conservation lands experiencing declining vegetative species diversity

KEY COLLABORATORS

Brian Winter, Director of Science and Stewardship and his staff, Bluestem Prairie Scientific and Natural Area, Glyndon, Minnesota, USA

Jim Johansen and his staff, Prairie Restoration, Inc, Bluestem Farm, Hawley, Minnesota, USA

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CAROLYN GRYGIEL PHD, MBA, CPRM, MPM is Professor Emeritus and former Director of Natural Resources Management (NRM) at North Dakota State University. Her most recent research interests focus on engaging the simulation of natural processes in reconstructing tallgrass prairie. She is currently working on a book about prairie ecology for the general reader.

JACK NORLAND, PHD is Assistant Professor of Natural Resources Management at North Dakota State University. His research interests are restoration ecology and grassland ecology. Current research efforts focus on reducing invasive species in restorations and investigating factors that produce desired restoration outcomes used to develop decision analyses and cost comparisons.

MARIO BIONDINI, PHD, is Professor Emeritus at North Dakota State University. Areas of studies include C flows and N cycling in grasslands, grazing ecology, system analysis and ecosystem modelling, statistical ecology, spatial pattern analysis, scaling issues in ecology, landscape ecology and plant community ecology (www.ndsu.edu/pubweb/~biondini/vita/mebvita.htm).

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