



CHAPTER 11

Pasture Naturalization

Yousef A. Papadopoulos, John Duynisveld, Michel S. McElroy, Sherry A.E. Fillmore and Alan Fredeen

Pastures are important on many Canadian livestock farms because they are relatively low cost to manage and potentially high in feed value (Karnezos and Matches 1992). Pastures that are not renovated for extended periods are referred to as ‘permanent pastures’ (Kunelius and Campbell 1984; Papadopoulos et al. 1993). In the Atlantic region of Canada there are few native pastures, but about half of the permanent pastures consist mainly of ‘naturalized’ species adapted to local climate, soil and grazing management (Papadopoulos et al. 1993). These pastures had been seeded with domesticated cultivars but were gradually re-colonized by naturalized and native species from the soil seed bank. In northeastern North America, permanent pastures average 32 plant species per 1000 m² (¼ ac) (Tracy and Sanderson 2000).

The process of pasture naturalization, such as source of seeds and interspecies competition, is not well understood. We do know that the outcome of naturalization depends on soil, seeded species, and grazing and nutrient management. In this chapter we describe the naturalization of contrasting

pastures and discuss factors that influence the evolution of pasture types.

Pasture renovation

Single species or simple two-species mixtures have been generally recommended for sowing pastures in North America over the last 50 years. The view was that a high-yielding grass species, receiving nitrogen fertilizer or in association with a productive legume, would yield more than multi-species mixtures which would likely include some lower-yielding components (Clark 2001). There is now strong evidence, however, that complex pasture mixtures produce higher and more stable yields, resist invasive species better, and retain more soil nutrients than simple mixes (Sanderson et al. 2004). Recent experimental evidence indicates that there is often a direct positive relationship between the number of plant species (floristic richness) and biomass production (Tilman et al. 2001; van Ruijven and Berendse 2005). In some temperate pastures there is an optimal intermediate level of species diversity — hence a unimodal response of productivity to diversity (Waide et

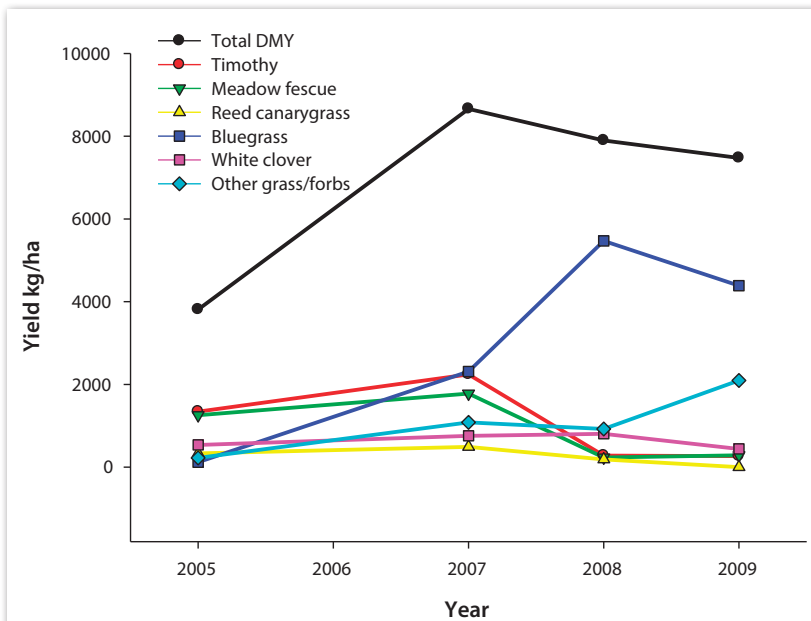


Figure 1. Change in yield of four grasses and white clover grown in a mixture in Nova Scotia. Plots were seeded in 2004 (Adapted from Papadopoulos et al. 2012) (for lb/ac multiply by 0.9).

al. 1999; Grace and Julita 1999). In these pastures, too few plant species cannot efficiently utilize all of the available resources, while seeding too many plant species can lead to competitive exclusion of the less resilient ones (Pärtel et al. 2007).

The success of pasture mixtures largely depends on the selection of compatible species components. Competition may cause a species to perform better, worse or equally compared to its performance in monoculture (McCloud and Mott 1953). Also, environmental factors during and after establishment will affect the relative growth rates of seedlings and mature plants in the stand, while the relative growth rates of the species will influence the ultimate botanical composition (Blaser et al. 1956). Species mixtures may take more than two years after seeding to stabilize (Fig. 1) and this is influenced by grazing height, time of harvest and the relative aggressiveness of the species in the mixture (Papadopoulos et al. 2012; Blaser et al. 1956). In our experiments, bluegrass began to dominate four years after seeding, replacing mainly timothy and meadow fescue.

For the two years after seeding, we found only minor yield differences among mixtures comprised of two, three or four productive grasses (Papadopoulos et al. 2012). However, significant differences among these mixtures emerged later according to species competitiveness, demonstrating that success of pasture mixtures greatly depends on the selection of genotypes that are compatible under the prevailing conditions. In our studies, Kentucky bluegrass (*Poa pratensis*) was less compatible with meadow fescue (*Festuca elatior*) than with timothy (*Phleum pratense*) in binary mixes.

In tertiary mixtures, bluegrass and timothy were better when combined with meadow fescue than with reed canarygrass (*Phalaris arundinacea*).

Naturalization of pastures

Compatible two-species mixtures, such as timothy and red clover, dominate for at least five years after planting in well-managed pastures where rotational grazing is practised, grass height is carefully controlled and ample nutrients are supplied (Fig. 2). However, premature naturalization of both simple and complex pasture mixtures was observed if incompatible grasses were selected (McElroy et al. 2012; Papadopoulos et al. 2012). For example, invasive grasses and forbs rapidly encroached into mixtures dominated by timothy and reed canarygrass but less encroachment occurred when mixtures contained Kentucky bluegrass. Our results showed that a quaternary mixture had less encroachment by unseeded species than tertiary and binary mixtures, indicating that the quaternary mixture was somewhat

less prone to naturalization (Table 1), although its yield was comparable to the simpler mixes (not shown). The greater success of diverse swards was probably related to compatibility of species: mixtures containing both bluegrass and timothy were associated with high yields, high grass content, and low invasion by weedy forbs and grasses compared to stands seeded with only one of those grasses. This study demonstrated the contrasting contribution of bluegrass and timothy in swards. Bluegrass contributes to sward productivity by successfully competing with other species during

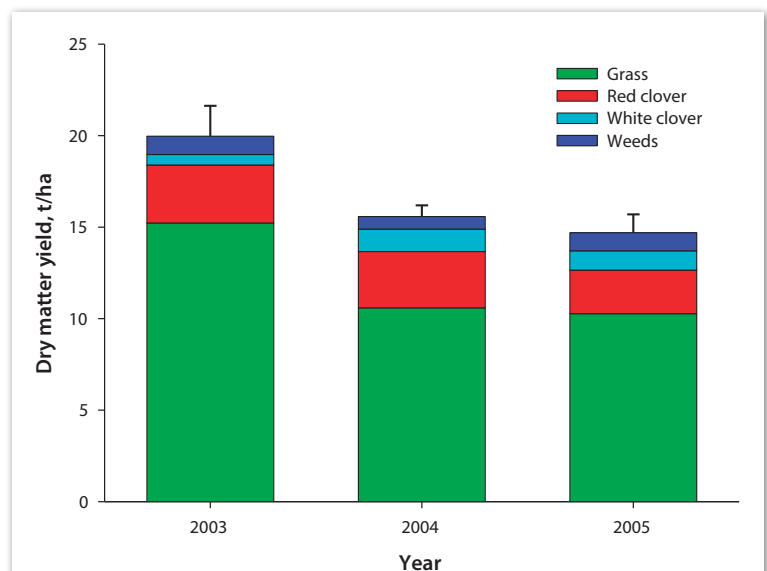


Figure 2. Average botanical composition and annual biomass distribution of pastures in the early stages of naturalization at the Nappan Research Farm, Nova Scotia, evaluated during the 2003, 2004 and 2005 grazing seasons. The field was seeded to timothy and red clover in 2000 (for T/ac multiply by 0.45).

Table 1. Proportion (%) of annual yield of three sward components as affected by mixture complexity and grass component; sward was seeded in 2004, (data are averaged for 2007–2009) (Adapted from Papadopoulos et al. 2012).

	Seeded Grass Mixture	White Clover	Forbs/Other Grasses
Mixture complexity			
Binary	58.0	15.5	26.5
Tertiary	65.9	11.6	22.5
Quaternary	74.6	8.4	17.1
Seeded Species			
Timothy	65.1	13.4	21.2
Meadow fescue	62.3	14.2	23.5
Reed Canarygrass	60.6	12.1	27.3
Kentucky Bluegrass	68.5	11.0	20.4

repens), meadow foxtail (*Alopecurus pratensis*), bentgrass, redtop (*Agrostis alba*), smooth brome (*Bromus inermis*), reed canarygrass, perennial ryegrass (*Lolium perenne*), orchardgrass (*Dactylis glomerata*) and numerous weeds and forbs. Generally, these pastures produced well and the production was well distributed over the growing season, although there was significant year-to-year variation (Fig. 4). While the dominant species varied throughout the evaluation period and over years, on average, 18% of pasture biomass was from

the early part of the growing season while timothy yield is consistent despite the presence of other competitive species and variation in environmental conditions among years (Papadopoulos et al. 2012).

The dominance of seeded grasses can be prolonged, and naturalization with grassy species delayed, by applying suitable doses of N, P and other fertilizers. For example, in a long-term experiment in Nova Scotia, timothy contributed 45% of the total yield 65 years after seeding in monoculture when supplied annually with 150 kg N/ha (135 lb N/ac), but timothy contributed only 20% of the total yield when receiving no fertilizer (Fig. 3; Papadopoulos et al. 1991).

The encroachment of the sward by the weedy bentgrass (*Agrostis spp.*) was reduced by half with the addition of manure, with bentgrass making up less than 10% of the sward yield in the high fertility treatment compared to 38% of the yield in the unfertilized treatment. But, more commonly, naturalized pastures in Eastern Canada contain many forage species including bluegrasses, bentgrass, meadow fescue and creeping red fescue (*Festuca rubra*).

Despite the importance of naturalized pastures on eastern Canadian farms, the composition and nutritional quality of the swards over the grazing season is not well known. In a recent study of a 25-year-old naturalized pasture in Nova Scotia, we identified over 12 common pasture grasses including creeping red fescue, timothy, bluegrass, white clover, couch grass (*Agropyron*

meadow fescue and 16% was from various bluegrass species, whereas only 5% of the biomass came from timothy and 4% from white clover. It is worth observing that of the three fields depicted in Figure 4, field 'A' stands out in terms of evenness of species and seasonal distribution of biomass production (bluegrass in early season, fescues in mid season, naturalized species in late season), as opposed to fields 'B' and 'C', where biomass production is largely a function of bluegrass productivity. This can be largely attributed to the history of site 'A', which has been dedicated to beef grazing for decades, as opposed to the dual-use grazing/hay production in the remaining sites, and this is a testament to the

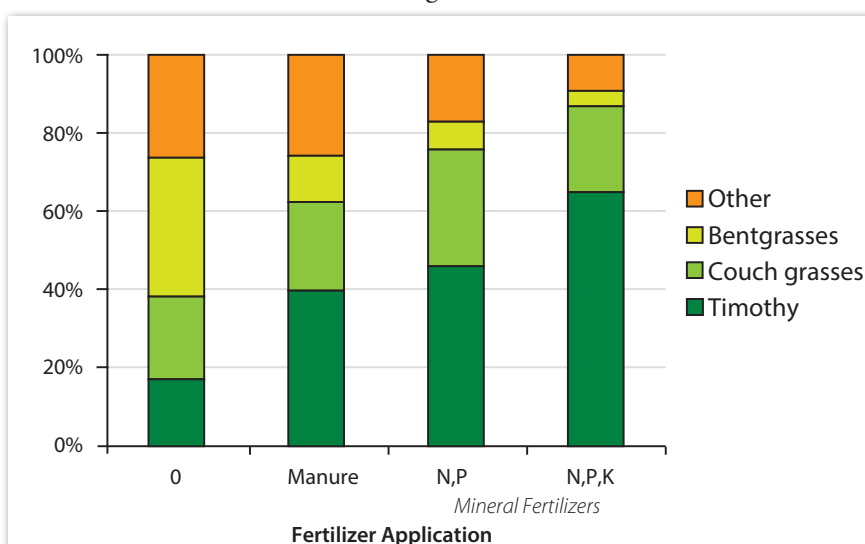


Figure 3. Percent seeded timothy and volunteer bentgrasses and couch grass (based on dry matter yield) in a sward after 65 years of yearly applications of beef cattle manure and mineral fertilizer at 150, 25, and 170 kg/ha of N, P₂O₅ and K₂O, respectively (135, 22 and 150 kg/ha). The study was conducted in Nova Scotia, Canada (based on Papadopoulos et al. 1991).

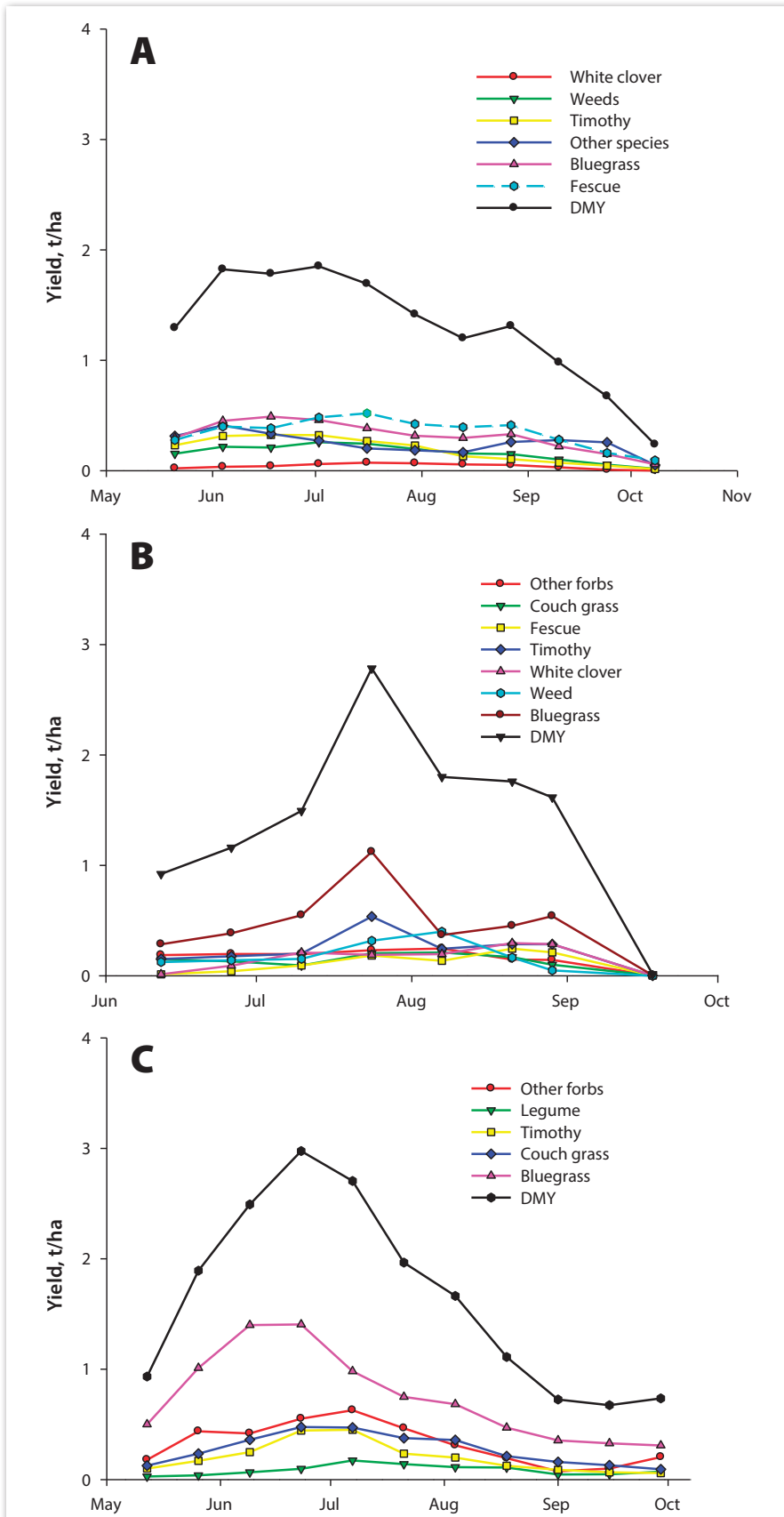


Figure 4. Seasonal production by dominant species in three naturalized permanent pastures renovated with timothy, white clover and red clover between 1965 and 1975. Fields A and B were located in Nappan Research Farm, NS, and evaluated 1995–1999 and 1996–1997, respectively. Field C was located in Nova Scotia Agricultural College and evaluated 2004–2005 (For T/ac multiply by 0.45).

role that long-term grazing management can have on a pasture as it naturalizes.

Conclusion

Pastures are unlike other agrosystems in that they are perennial, diverse and dynamic, changing in species composition as they move toward a ‘natural’ state. Influencing this process to favour an equilibrium point with high forage production requires an understanding of the conditions that allow adapted species to thrive. The examples discussed in this chapter reflect how the direction of this change in sward assemblage is influenced by three key management factors: 1) **Sward Complexity** — a sward comprised of several adapted species makes efficient use of available resources throughout the growing season, slows encroachment by invasive species, and is more likely to perform well under a wide range of environmental conditions; 2) **Fertility** — adapted forage cultivars are selected to respond to high resource availability whereas naturalized species may have adapted to survive in sub-optimal environments; and 3) **Grazing Management** — proper grazing management with ample rest or stubble will favour adapted cultivars, especially those with regrowth potential, over naturalized and weedy species that often tolerate intensive grazing. Creating a forage stand that will remain productive for many years depends on selecting a compatible and well-adapted mix and managing these species to make best use of their attributes.

References available online at www.farmwest.com

- Yousef A. Papadopoulos** Agriculture and Agri-Food Canada, Faculty of Agriculture, Dalhousie University, HALEY INSTITUTE, Truro, NS, Canada | yousef.papadopoulos@agr.gc.ca
- John Duynisveld** Nappan Research Farm, Nappan, NS, Canada
- Michel S. McElroy** Faculty of Agriculture, Dalhousie University, HALEY INSTITUTE, Truro, NS, Canada
- S.A.E. Fillmore** Agriculture & Agri-Food Canada, Kentville, NS, Canada
- Alan Fredeen** Faculty of Agriculture, Dalhousie University, HALEY INSTITUTE, Truro, NS, Canada