CHAIRS' SUMMARY PAPER: Forages for Land Reclamation and Rehabilitation

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The theme papers for Session 16 were "Genecological Considerations in Grassland Restoration Using Wild-collected Seed Sources" by Susan E. Meyer, and "Nitrogen Deposition, Grassland Conversion and Rehabilitation" by Edith Allen et al. The two papers spanned a range of disciplines, from genetics to biogenochemistry, but had a common concern with restoring and maintaining plant species diversity in native communities. Although the topics of the posters in this Session were diverse, many also focused directly or indirectly on species diversity.

Meyer began her theme paper by pointing out that if the intent of revegetation is restoration, i.e. returning the land to pre-disturbance native plant cover and composition, then attention needs to be paid to the genetic variation within and among the wild plant populations used as seed sources. The genetic composition of the source population is important in ensuring that restored ecosystems have diversity, resilience and the capacity for continued evolution. Allen emphasized the latter points in responses to questions from the audience, pointing out that the goal of restoration is to put back a dynamic, sustainable system resembling a natural ecosystem and not to try to create some static, idealized pre-disturbance vegetation.

Native plant species are often characterized by large within- and among-population genetic variation. Whereas the traditional plant breeder might aim to select lines with desirable traits from such large pools of genetic variation, the restoration ecologist tries to maintain the genetic diversity, not to limit it. Meyer illustrated this point using her studies of *Pentstemon* and *Linum* species that show large variation in seed germination in response to chilling. Several populations of Lewis Flax remain dormant unless particular chilling requirements are met. In contrast, cultivar APPAR germinates under a wide range of chilling conditions. Although this may be desirable for easy establishment, it means that this population has no dormancy, and might be unable to carry over in the soil seed bank. Variation in dormancy among individuals in native populations ensures that some portion of the population survives into the future. During the discussion, Meyer explained that some species are in-breeding, and in fact resist selection.

Meyer is convinced that the best strategy to ensure genetic diversity in restored populations is to develop regional ecotypes with large genetic variability for use as seed sources in restoration and revegetation. This would be cheaper than trying to use large numbers of distinct local populations. The likelihood of local plants out-competing introduced non-local ones is small - local populating might be able to transfer genes to the generalized introduced population, thus increasing genetic diversity.

Another practical concern expressed by Meyer is the possible negative effects of seed collections on native plant populations. The high market value of some native seed has led to over-harvesting of seed. This is particularly significant in those species showing mast seed production - extremely high seed yields in some years that saturates seed predators allowing part of the population to survive. Human harvest of mast seed production means that these species may not be able to escape from seed predators, leading to reduced population sizes in future.

The use of native species in revegetation and restoration provides opportunities for selection of species that are pre-adapted for growth on disturbed sites. In addition to their adaptation to stressful conditions, these early successional species populations may ameliorate site conditions, and facilitate establishment of species typical of more advanced successional communities. Responding to a question, Meyer pointed out that this facilitation model can not be applied universally. The limits to plant growth caused by environmental stresses, eg. Salinity, acidity and surface instability also were topics of several poster papers in the session.

The second theme paper, by Edith Allen and co-workers described how atmospheric nitrogen deposition is changing the composition and functioning of natural ecosystems. Nitrogen deposition in southern California is great enough (30+ kg/ha yr) to eutrophy soils, and lead to shifts in plant species composition away from native shrubs and nutritious forbs to coarse grasses and weedy species. Soils in these eutrophied systems are rich in mineral nitrogen. Allen's work and other published literature have shown that increased fertility can decrease species diversity.

Allen elaborated on the mechanisms underlying the shifts in competitive balance among plant species in response to N enrichment. The high levels of NO3- and NH4+ in affected soils are correlated with changes in the richness and functioning of mycorrhizae. With additions of N the fungi/bacteria ratio decreases from values typical of forest and shrubland to levels that resemble annual grassland. The role of below ground processes and root functioning also was the topic of several posters. The root system is the primary locus for the effects of stresses that are typical of many disturbed sites requiring revegetation. Allen was somewhat optimistic about the prognosis for rehabilitation of eutrophied systems, assuming excess n deposition could be stopped.

At present the problem of high atmospheric N deposition is confined to particular regions such as Western Europe and Southern California, although trends toward greater anthropogenic releases of nitrogen could expand to other parts of the world. For example, one audience member commented that atmospheric N deposition in Ontario, Canada has increased significantly in recent years. Concern over N enrichment was not universal; during the discussion some participants pointed out that at present there are still many areas where revegetation is limited by shortages of nitrogen.

The poster papers all related in some way to the rehabilitation of land, and the use of plant cover to maintain proper ecosystem structure and functioning. Many of the posters, directly or indirectly documented the importance of restoring or maintaining plant diversity. Several general sub-themes could be recognized:

- Strategies for overcoming environmental limitations, eg. salinity, acidity and surface instability. Forage species add organic matter, and reduce erosion, leaching and acidification.

- Responses of plant species to defoliation or grazing and the use of grazing to direct succession, and maintain diversity by reducing dominance.

- The use of non-crop species for improving crop yield or quality through intercropping, rotations, or maintaining legumes in the crop stand. Adding species does not necessarily cause competition with the crop species.

- The value of plant diversity as a source of novel new crops or for their benefits for wildlife or soil conservation.

These sub-themes were not restricted to any country or region, but seem to be getting world-wide attention. Although a few of the poster papers were regional in scope, in general the research described at the Congress appeared to be global in scope and interest.