Annotated Bibliography on the Ecology and Management of Invasive Species:

Annual Bluegrass (*Poa annua*)

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Peer-Reviewed Journal Articles

Gange, A. C., D. E. Lindsay, and L. S. Ellis. 1999. Can arbuscular mycorrhizal fungi be used to control the undesirable grass *Poa annua* on golf courses? Journal of Applied Ecology 36: 909-919.

Abstract: 1. *Poa annua* (annual meadow-grass or annual bluegrass) is the most problematic weed of temperate zone golf putting greens. In the UK there are no chemicals approved for its control, although several herbicides and plant growth regulators are available in the USA. Reducing *P. annua* levels in ®ne turf would greatly reduce the heavy reliance on pesticides and water that currently exists. 2. This paper reports on an observational and a manipulative study in golf putting greens, aimed at determining whether arbuscular mycorrhizal (AM) fungi have any potential for the reduction of this weed in ®ne turf. 3. All 18 greens on three golf courses were sampled, and in two courses a negative relation between AM fungi and *P. annua* abundance was found, upholding previous results. In greens where AM fungi were relatively common (as measured by root colonization), *P. annua* was rare, and vice versa. Furthermore, when the fungi were common, abundance of the desirable turfgrass *Agrostis stolonifera* was greater. 4. Two explanations are suggested for these relations, a competitive one, in which AM fungi alter the balance of competition between the two grasses, and an antagonistic one, in which the fungi may directly reduce the growth of *P. annua*. 5. In a manipulative experiment, where mycorrhizal inoculum was added to a golf green, the colonization level of *A. stolonifera* roots was enhanced, as was the abundance of this grass. Furthermore, there was a suggestion that adding inoculum could decrease the abundance of *P. annua*. 6. AM fungi have the potential to be a much more environmentally sound method of *P. annua* control in sports turf than the currently used chemicals.

Gough, R. E. and R. Carlstrom. 1999. Wheat gluten meal inhibits germination and growth of broadleaf and grassy weeds (abstract). Hortscience 34 (2): 269-270.

Abstract: The herbicidal activity of wheat gluten meal (WGM) was evaluated on 17 species of monocotyledons and dicotyledons. Treatments included WGM at 0, 1, 2, 3, 4, 6, and 9 gcntdotdm-2. Germination, shoot and root lengths, and root numbers were recorded. Treatments reduced germination and root extension in nearly all species. Leafy spurge (*Euphorbia esula* L.), redroot pigweed (*Amaranthus retroflexus* L.), shepherd's purse (*Capsella bursa-pastoris* (L.) *Medik*.), henbit (*Lamium amplexicaule* L.), quackgrass (*Agropyron repens* (L.) Beauv.), annual bluegrass (*Poa annua* L.), Canada thistle (*Cirsium arvense* (L.) Scop.), orchardgrass (*Dactylis glomerata* L.), purslane (*Portulaca oleracea* L.), annual ryegrass (*Lolium multiflorum* Lam.), and snap bean (*Phaseolus vulgaris* L.) were particularly sensitive. Germination of curly dock (*Rumex crispus* L.) and common lambsquarters (*Chenopodium album* L.) was suppressed at the higher rates. Germination of black medic (*Medicago lupulina* L.), spotted knapweed (*Centaurea maculosa* Lam.), mustard (*Brassica* sp.), and corn (*Zea mays* L.) were not substantially affected at any rate. Shoot growth of all species was inhibited at rates >2 gcntdotdm-2, and at the highest rates no shoots developed. In nine species, shoot extension was stimulated at 1 gcntdotdm-2 WGM. The herbicidal activity of WGM was not due to a "mulching" effect, since growth characteristics were also altered in bean seeds barely covered by the treatments.

Keeley, J. E., M. Baer-Keeley, and C. J. Fotheringham. 2005. Alien plant dynamics following fire in Mediterranean-climate California shrublands. Ecological Applications 15 (6): 2109-2125.

Abstract: Over 75 species of alien plants were recorded during the first five years after fire in southern California shrublands, most of which were European annuals. Both cover and

richness of aliens varied between years and plant association. Alien cover was lowest in the first postfire year in all plant associations and remained low during succession in chaparral but increased in sage scrub. Alien cover and richness were significantly correlated with year (time since disturbance) and with precipitation in both coastal and interior sage scrub associations. Hypothesized factors determining alien dominance were tested with structural equation modeling. Models that included nitrogen deposition and distance from the coast were not significant, but with those variables removed we obtained a significant model that gave an $R^2 = 0.60$ for the response variable of fifth year alien dominance. Factors directly affecting alien dominance were (1) woody canopy closure and (2) alien seed banks. Significant indirect effects were (3) fire intensity, (4) fire history, (5) prefire stand structure, (6) aridity, and (7) community type. According to this model the most critical factor influencing aliens is the rapid return of the shrub and subshrub canopy. Thus, in these communities a single functional type (woody plants) appears to the most critical element controlling alien invasion and persistence. Fire history is an important indirect factor because it affects both prefire stand structure and postfire alien seed banks. Despite being fire-prone ecosystems, these shrublands are not adapted to fire per se, but rather to a particular fire regime. Alterations in the fire regime produce a very different selective environment, and high fire frequency changes the selective regime to favor aliens. This study does not support the widely held belief that prescription burning is a viable management practice for controlling alien species on semiarid landscapes.

MacDougall, A. S. and R. Turkington. 2007. Does the type of disturbance matter when restoring disturbance-dependent grasslands? Restoration Ecology 15 (2): 263-272.

Abstract: The reintroduction of burning is usually viewed as critical for grassland restoration; but its ecological necessity is often untested. On the one hand, fire may be irreplaceable because it suppresses dominant competitors, eliminates litter, and modifies resource availability. On the other hand, its impacts could be mimicked by other disturbances such as mowing or weeding that suppress dominants but without the risks sometimes associated with burning. Using a 5-year field experiment in a degraded oak savanna, we tested the impacts of fire, cutting and raking, and weeding on two factors critical for restoration: controlling dominant invasive grasses and increasing subordinate native flora. We manipulated the season of treatment application and used sites with different soil depths because both factors influence fire behavior. We found no significant difference among the treatments-all were similarly effective at suppressing exotics and increasing native plant growth. This occurred because light is the primary limiting resource for many native species and each treatment increased its availability. The effectiveness of disturbance for restoration depended more on the timing of application and site factors than on the type of treatment used. Summer disturbances occurred near their reproductive peak of the exotics, so their mortality approached 100%. Positive responses by native species were significantly greater on shallow soils because these areas had higher native diversity prior to treatment. Although likely not applicable to all disturbance-dependent ecosystems, these results emphasize the importance of testing the effectiveness of alternative restoration treatments prior to their application.

Roberts, H. A. 1986. Persistence of seeds of some grass species in cultivated soil. Grass and Forage Science 41: 273-276.

Abstract: Freshly collected ripe caryopses of twenty-five indigenous grasses were mixed with the top 7-5 cm of sterilized soil confined in cylinders sunk in the ground and cultivated three times yearly. There was a flush of seedlings of most species shortly after sowing, but species differed in the persistence of viable seeds. About one third, including *Bromus sterilis, B. hordeaceus, Lolium perenne ssp. perenne, Arrhenatherum elatius a.nd Alopecurus pratensis,* produced few seedlings after the initial flush. Others such as *Deschampsia cespitosa, Holcus lanatus* and *Poa trivialis,* recognized as forming persistent seed banks in grassland soils, produced appreciable numbers of seedlings in the second year after sowing. Most persistent

were species that occur as arable weeds *{Avena fatua, Poa annua)* or in wetlands *{Glyceria plicata, G. maxima, Alopecurus geniculatus).* Emergence from the seed bank generally followed soil disturbance but some species *{Aira praecox, Avena fatua, A. sterilis* ssp. *ludoviciana, Danthonia decumbens)* exhibited consistent seasonal patterns which may be associated with cyclic changes in germination requirements of the buried seeds.

Other Published Sources

Alaska Natural Heritage Program. 2005. Non-native plant species of Alaska: Annual bluegrass (*Poa annua* L.). Alaska Natural Heritage Program.

Abstract: The Non-Native Plant Species of Alaska is a series of fact sheets about invasive flora in Alaska. They discuss the plant identification, ecological impacts, invasive potential, distribution and abundance, and management of each species.

Christians, N. 2006. Control options: What's next for *Poa annua* control? Grounds Maintenance March 2006: 28-31.

Abstract: Annual bluegrass (*Poa annua*) is a problematic weed in golf courses all over the world. It produces profuse amounts of seed throughout the winter, even when mowed to heights as low as of 0.1 inches. It is very difficult to control, largely because it is so genetically variable. It has been found that the various biotypes react differently to stresses and herbicides. Testing of numerous chemical materials found many to be promising control agents in the early phases of testing, but failed under more extensive testing. This is due to the fact that some varieties were controllable by these materials while others were tolerant. New chemicals that have not yet been tested extensively will likely provide the same result. It is the author's opinion that it is very unlikely that there will ever be a single herbicide that can control the *Poa annua* problem. However, modern biotechnology has developed Roundup Ready (meaning tolerant to the non-selective herbicide Roundup, or glyphosate) Creeping Bentgrass, a common turf-grass that is often out-competed by *Poa annua*. RRCB was not yet available on the market as of 2006.

Youngner, V. B. and F. J. Nudge. 1968. Chemical control of annual bluegrass as related to vertical mowing. California Turfgrass Culture 18: 17-18.

Abstract: Chemical control of *Poa annua* has not been effectively achieved due to conflict between turf culture and weed control practices. *Poa annua* seeds germinate from the start of cool fall weather right through to spring, peaking in mid to late fall. Studies have shown that vertical mowing or aerating turf during this period will lead to an increase in *Poa annua*. As these practices are necessary for turf culture, they could be paired with chemical control to reduce the bluegrass population. An experiment was conducted to evaluate the effectiveness of control of various combinations of vertical mowing and the immediate application of bensulide. There were a total of eight treatments from no vertical mowing and no bensulide application to 3 vertical mowings and 3 applications of bensulide. It was confirmed that vertical mowing with no application of bensulide lead to the greatest population of *Poa annua*, while this was lowered if the mowing was immediately followed by chemical treatment. However reduction in *Poa annua* was always greater when chemical treatment was not preceded by vertical mowing, with a second application causing the greatest reduction. As vertical mowing still increased the populations of *Poa annua*, even when followed by bensulide application, this practice should be avoided.

Online Resources

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