Garry oak ecosystems recovery team

Annotated Bibliography on the Ecology and Management of Invasive Species:

Dovefoot Geranium (*Geranium molle*)

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Peer-Reviewed Journal Articles

Pakeman, R. J., J. P. Attwood, and J. Engelen. 1998. Sources of plants colonizing experimentally disturbed patches in an acidic grassland in eastern England. Journal of Ecology 86 (6): 1032-1041.

Abstract: 1. The sources of propagules for regeneration in an acidic grassland were identified from analysis of differences in colonization between plots subject to surface (0-5 cm) soil disturbance and plots where surface soil had been replaced by 'seedfree' soil from deeper soil horizons (30-35 cm), and between plots with and without the removal of rabbit pellets. 2. After 1 year, 10 species had a significantly higher cover on plots where the seed bank had been left intact. These included *Agrostis capillaris* (the dominant species prior to disturbance), *Myosotis arvensis* and *Veronica arvensis*. 3. Five species, including *Sagina apetala*, *Senecio jacobaea* and *Veronica arvensis*, showed significantly higher cover on plots where rabbit pellets were left in situ. 4. From calculations it appeared that rabbit-dispersed seeds accounted for 15% of the developing higher plant cover, other means of dispersal from outside the plot accounted for 40%, and regeneration from the seed bank accounted for 45%. 5. Similar calculations suggested that three higher plant species, *Geranium molle*, *Myosotis arvensis* and *Senecio jacobaea*, appeared to depend most on non-rabbit dispersed seed for colonization of bare ground. 6. High concentrations of *Urtica dioica* in pellets contrasted with its poor establishment in the experiment. However, the other common species in the pellets, *Sagina apetala*, *Senecio jacobaea* and *Veronica arvensis*, all established in greater numbers on the plots where the pellets were not removed. 7. Seed bank content correlated well with the pattern of regeneration for *Agrostis capillaris*, *Holcus lanatus*, *Myosotis arvensis* and *Veronica arvensis*. However, removal of the seed bank did not have a significant effect on the regeneration of either of the most common species in the seed bank, *Rumex acetosella* and *Sagina apetala*. 8. No species appeared to be reliant on only one mechanism for regeneration from seed in disturbed areas in this community.

Pakeman, R. J., J. Engelen, and J. P. Attwood. 1999. Rabbit endozoochory and seedbank build-up in an acidic grassland. Plant Ecology 145 (1): 83-90.

Abstract: The sources of seed for seedbank build-up in an acidic grassland were identified from analysis of differences in seedbank build-up over one year between plots where the input of rabbit pellets to 'seed-free' soil had either been left or removed. In parallel, the flux of seed arriving in rabbit pellets was monitored. Pellet seed content and total seed input were highest in late summer/early autumn and again in the spring. The seed content of the pellets was dominated by a small number of species: *Sagina apetala*, *Senecio jacobaea*, *Urtica dioica* and *Veronica arvensis*. Smaller seeded species were more likely to be present as germinable seed in the pellets. Seedbank build-up as a result of wind, splash or adhesive dispersal totalled 547 seeds/m^2. The additional effect of allowing seed input in pellets was 267 seeds/m^2, though this increase was not significant. The total increase in seedbank over one year was equivalent to 15-20% of the seedbank present in undisturbed soil. Eight species showed a significant build-up of seed in the seedbank over one year as a result of all means of dispersal, but only *Myosotis discolor* showed a significantly higher soil germinable seed content in the plots where pellets had been allowed to remain in situ. The build-up of seed in the seedbank is contrasted with the build-up of vegetation on disturbed areas within the same system.

Roberts, H. A. and J. E. Boddrell. 1985. Seed survival and seasonal emergence in some species of *Geranium*, *Ranunculus* and *Rumex* (abstract). Annals of Applied Biology 107 (2): 231-238.

Abstract: Seeds of 14 species were collected, usually in each of 2 or 3 yr, and mixed with the top 7.5 cm of sterilised soil confined in cylinders sunk in the ground outdoors and cultivated three times yearly. Seedling emergence was recorded for at least 3 and usually 5 yr. Most seedlings of *Ranunculus bulbosus* and *Rumex acetosa* appeared during the autumn of sowing, while the main emergence of *Geranium pretense, Ranunculus acris*, *Rumex conglomeratus* and *R. maritimus* was in the following spring. Emergence of *G. pyrenaicum* and *G. robertianum* took place throughout much of the year after sowing. Seeds of all these species were relatively short-lived in cultivated soil, and few seedlings appeared after the second year. Seed survival was greater in *G. dissectum*. *G. molle*, *Rumex acetosella, Ranunculus sceleratus* and especially *R. repens*, of which emergence in the fifth year after sowing amounted to 4% of the seeds sown. Emergence from the persistent seed bank was mainly from May to September for *G. dissectum* and *G. molle* and during autumn for *Ranunculus flammula* and *R. sceleratus*, while seedlings of *Ranunculus repens* and *Rumex acetosella* appeared sporadically over most of the year.

Yeo, P. F. 1984. Fruit-discharge-type in *Geranium* (Geraniaceae): its use in classification and its evolutionary implications (abstract). Botanical Journal of the Linnean Society 89 (1): 1-36.

Abstract: Three main types of seed-discharge in Geranium are made the basis of its division into subgenera: *Geranium* subgenus *Geranium*, with a ballistic expulsion of the seed from the mericarp, termed 'seed-ejection'; *Geranium* subgenus *Robertium*, with forcible discharge of the mericarp with the seed in it, separately from the awn, termed 'carpel-projection', and *Geranium* subgenus *Erodioideae*, with the seed-containing mericarp being thrown off with the attached awn, which becomes helically coiled, called the 'Erodium-type'. Variants of the seed-ejecting type permit the division of *Geranium* subgenus *Geranium* into three sections. Other criteria are used to divide *Geranium* subgenus *Robertium* into eight sections and *Geranium* subgenus *Erodioideae* into two. Species are fully enumerated except for *Geranium* section *Geranium*, which comprises the bulk of the genus, and for which some tentative subgroups are given in an Appendix. Diversity of fruit-type in *Geranium* is greatest in the Mediterranean Region. Characters of the fruit in other genera of *Geraniaceae* are surveyed. Geographical distributions, chromosome numbers, pollen morphology and phytochemistry are reviewed. It is suggested that Erodium-type fruit discharge, shared with the four remaining genera of the family, is primitive, and that carpel-projection and seed-ejection arose from it separately, the latter probably more than once. The very large, mainly perennial, *Geranium* subgenus *Geranium* is contrasted with *Geranium* subgenus *Robertium*, half of which is hapaxanthic, and which occupies marginal habitats and shows greater morphological and chromosomal variation despite its being only one tenth the size. *Geranium* subgenus *Erodioideae* is smaller still and probably relictual.

Other Published Sources

Dunwiddie, P. W. 2005. Management and Restoration of Grasslands on Yellow Island, San Juan Islands, Washington, USA. The Nature Conservancy. 217 Pine St., Suite 1100, Seattle, WA 98101.

Abstract: A native grassland dominated by Roemer's fescue (*Festuca idahoensis* var. *roemeri*), great camas (*Camassia leichtlinii*), and a diversity of other forbs has been the focus of a variety of experiments on restoration techniques, as well as studies tracking ecological changes since 1981. Investigations in existing grasslands have primarily focused on responses of native and non-native species to prescribed burns. Following each of 3 burns, responses of different species are complex, varying in direction, magnitude, and duration. A second series of studies has focused on developing effective means for controlling and removing invading trees and shrubs, and on limiting non-native grasses and forbs. Methods have included a variety of manual, mechanical, and chemical techniques. We have also tested several approaches for

restoring native grassland species in areas where they had been excluded by competing woody plant growth. Even when abundant native seed sources exist in close proximity, non-native species usually establish more quickly following removal of trees and shrubs, and continue to dominate for many years. Out-planting of propagated plants has proven most effective in rapidly re-establishing native species. Greatest success has been achieved in establishing a dense fescue matrix that excludes invasive species.

Frost, W. E., J. W. Bartolome, and J. M. Connor. 1997. Understory-canopy relationships in oak woodlands and savannas. In Proceedings of a Symposium on Oak Woodlands: Ecology, management, and urban interface issues. Gen. Tech. Rep. PSW-GTR-160. Pillsbury, N. H., J. Verner, and W. D. Tietje (eds.). U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. Albany, CA. pp. 183-190.

Abstract: STUDY OBJECTIVE: to summarize available information about the relationships between oak overstory and understory plants for major California rangeland types. Although *Quercus garryana* is mentioned as a component of the montane hardwood forests, one of the five major hardwood rangeland habitat types in California, there is no specific mention of the species in the literature review. RESULTS: Deciduous oak canopies in areas with less than 50cm annual precipitation generally have either no effect or enhance understory productivity compared to adjacent grassland. Dense canopies in areas with more than 50cm annual precipitation generally suppress understory productivity. Forage management implications are summarized for different woodland types around the State (Table 1 - live oaks vs. deciduous oaks - not species specific).

Odion, D. C., J. Alexander, and M. Swezy. 1999. Use of short rotation burning to combat non-natives and their seed banks in California north coastal prairie. In Proceedings of the symposium: fire management: emerging policies and new paradigms. Sugihara, N. G., M. E. Morales, and T. J. Morales (eds.). Association for Fire Ecology. San Diego, CA. pp. 46-57.

Abstract: We have been conducting and monitoring the effects of prescribed burns aimed at thwarting invasion by exotic pest plants on public land flanking Mt. Tamalpais in Marin Co., California for five years. This area is just north of the Golden Gate in central California. French broom (*Genista monspessulana*) and yellow starthistle (*Centaurea solstitialis)* are the most pernicious invaders here; both are capable of completely displacing grassland vegetation. Previous research in our grassland site suggested that stands of French broom reach a threshold at some age after which they will be extremely difficult to eliminate because of the accumulation of huge seed populations that become distributed relatively deeply in the soil. However, seed bank sampling after our most recent burn documented that seed populations in areas where old stands had occurred have plummeted since the initial inventory. Seed mortality caused directly by the 1998 fire was not detectable. Without natural seed predators, we assume predation on seed stored in the soil also contributed little if any to the decrease. Annual data on seedling emergence only explained a tiny fraction of the decrease. Apparently undetected germination was important. Age-related seed mortality may have also occurred. The percent of seed that germinated in samples from old infestations was lower than from young, possibly indicated an age-related reduction in viability, and/or a more impervious seed coat among remaining seed. Continuing to prevent input of new seed following initiation of a burning program will be crucial to maintaining the depletion trend. This prevention can be accomplished by additional burning before seedlings reach reproductive age. Fortunately, at our sites repeat burning has increased the cover of native plants and appears to have minor negative ecological consequences (coyote brush mortality, increased cover of annual grasses). We also present data documenting how burning three consecutive years has virtually eliminated yellow starthistle at another site. This annual species does not maintain a persistent soil seed bank. Annual grasses have filled the void left by its disappearance. There has not been a detectable increase in native cover where starthistle burning has occurred.

Pilorge, E. and C. Mircovich. 1999. Weed Control Strategies Using GMO Herbicide Tolerant Oilseed Rape. 10th International Rapeseed Congress. Canberra, Australia.

Abstract: The use of GMO herbicide-resistant oilseed rape varieties must be considered as a complete change in weeds control techniques in oilseed rape, since, at present time, weeds control is obtained mainly through pre-sowing and pre-emergence herbicides. The results of this study give some answers concerning the way to optimize the use of herbicide-resistant oilseed rape systems regarding efficacy and weeds control strategies. It clearly appears that the control of some weeds species remains difficult, even with the broad spectrum herbicides which are involved in these systems. Weather interactions may be important on the efficiency of the weeds control strategies (number and dates of herbicides applications) using non persistent herbicides, as far as it may be more or less favorable to continuous emergence of weeds during autumn. At last, the possibility to spray or not according to the actual situation of the field would induce needs of decision criteria for farmers.

Online Resources

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