Shrub-Steppe Symposium, Part II
By Mike Marsh, Conservation Committee

In the last issue I reported on some papers presented at the Northwest Scientific Association's annual meeting in Ellensburg on March 26,2004 in a symposium organized by The Shrub-Steppe Working Group. That first install ment highlighted reports describing changes in much of the shrub-steppe grassland of Eastern Washington due to invasion of exotic weeds and to more frequent fires since Europeans occupied the land.

Recognition of the past losses of shrub-steppe land and of the fragmentation of remaining native lands has led to considerable interest in developing methods for assessment and restoration of these communities. In this Update, I summarize some of the work to accomplish these goals that was reported at the Northwest Scientific Association meeting. Great challenges must be overcome, for the land areas to be restored are extensive, water in the form of rainfall is scarce, restoration techniques are in their infancy, and the major impediment—cheatgrass (*Bromus tectorum*, an invasive grass with effects that were described in Conservation Update in the Summer 2004 issue of Douglasia)—is omnipresent. Nevertheless, some innovative approaches are being tried.

Mapping tools

It is of primary importance to know the detailed geography of shrub-steppe lands so that the total area, the area on different soil types, and the degree of fragmentation can be assessed. GIS methods and satellite imaging have been of great value recently in doing this work, and crop lands, shrub lands, and other areas such as urban habitat are readily distinguished by modern geographers. I used a map based on satellite imagery to locate study sites in shrub-steppe habitat in 1992. Among several hundred sites that the geographers identified as shrub-steppe, only one was misidentified. It turned out to be a goose- berry field—a rare crop in the Yakima Valley where I was working.

An important need for restoration work is improved methods for detection and mapping of steppe areas that are invaded by cheatgrass. For her report, Janelle Downs chose the title, "detecting alien invaders from space: tools to identify cheatgrass invasion in the shrub-steppe using satellite remote sensing imagery and GIS' Fortunately, perhaps, it was the tools rather than the invaders that were in outer space. She and colleagues Jerry Tagestad and Greg Petrie used satellite remote sensing imagery to identify areas of vegetation invaded by cheatgrass in order to plan for control efforts and for fire management.

Downs used words like "QuickBird," "LandSat' "leaf area index and "spectral band' which reinforced the connection to outer space in my mind. She and her colleagues combined satellite imagery with geographical data, such as soil type and elevation, in their mapping work. Cheatgrass dries early in the growing season, turn ing from green to red while native vegetation is still green, so comparison of "spectral signatures" in satellite images taken at different dates in the growing season offers promise in detecting patches of cheatgrass. Unfortunately, each type of satellite imagery has its advantages and disadvantages. LandSat images, with greater color resolution, return coarse-grained images which cannot resolve small patches. Quickbird makes much finer-grained images, resolving areas as small as one meter, but its images have fewer spectral bands, meaning that it is less capable of distinguishing differently colored vegetation.

Research in this area is ongoing, but the methods being developed by Downs and colleagues are already being used successfully to identify vegetation types on the Snake River Plain of southern Idaho.

A method called coincidence mapping, being developed by George Wooten and Dave Demyan, uses the degree of coincidence of mapped vegetation types using different sources, including ASTER, a satellite-mounted imaging instrument with 30 meter resolution, and orthophotos (aerial photographs). Analytical techniques such as patch analysis and pattern recognition are used to produce more accurate maps of vegetation types. The method is being used to classify both forest and steppe grassland habitats.

Biological control

Among the most interesting proposals for controlling cheatgrass was one described by Ann Kennedy, with the U.S. Agricultural Research Service in Pullman, Washing ton. She studies a group of deleterious rhizobacteria (DR), and was seeking one that would inhibit cheatgrass while not harming wheat crops or native vegetation.

Cheat grass and jointed goatgrass compete with winter wheat in Washington, and are difficult to control with herbicides because they germinate at the same time. By quickly developing a strong root system, they take moisture from the wheat seed.

Kennedy tried various DRs on cheatgrass. Soil bacteria of the genus Pseudomonas were found which stunt root growth in cheatgrass so that the plant is not as competitive. These rhizobacteria do not inhibit root growth in wheat. The bacteria colonize the root zone and plant residue, or litter, tolerate low soil moisture, and survive low temperatures. They do not survive the hot dry conditions of summer (which could be an advantage if you want to get rid of them). The bacteria apparently cause little or no inhibition of growth in cultivars of bluebunch wheatgrass (*Pseudo roegneria spicata*). Native fescue bunchgrasses, also, are apparently not affected by these bacteria. Kennedy said there has been little work to determine the effectiveness of DRs on native steppe, but she has found that plant litter is not detrimental to the activity of the soil bacteria.

While working with Kennedy on the potential to biologicals to manage crops and weeds, Robert Venable became interested in impacts of cheatgrass on rangeland. He found two different strains of Pseudomonas which inhibit root structure in cheatgrass. The negative effect of one bacterial strain, PSF D7, on *Agropyron dasystachyum*, another native bunchgrass, was almost as severe as on cheatgrass; but the most widespread and important native, bluebunch wheatgrass, showed a slight positive effect, and four other species also were not affected negatively.

On White Bluffs, on the east bank of the Columbia River, Venable applied *Pseudomonas* to seeds of Sandberg's bluegrass (*Poa secunda*) and broadcast it in a cheatgrass area after a burn. The burn was in July 2002, seeding was in January 2003, and first year evaluations were in April, May, and June 2003. In early results, they found less cheatgrass, slightly less Sandberg's bluegrass, slightly more fescues and tall tumble mustard (*Sisymbrium altissimum*), and significantly more phlox with the treatment than in a control seeding without Pseudomonas.

Gary Piper, a Washington State University biocontrol advocate, spoke of efforts to manage Dalmatian toadflax (*Linaria genistifolia dalmatica*), a snapdragon. Used in gardens in Europe, it appeared in Washington in the 1920s in PS1 Oreille, Stevens, and Ferry Counties. Although it does not form monocultures, it degrades habitats and is a major problem in Conservation Reserve Program lands, preferring sandy loam soils on well-drained slopes. Individuals live three to five years, sending roots as deep as six feet. Lateral roots go as far as ten feet and send up satellite daughters. Seeds persist up to ten years in the soil. Among the biocontrols Piper found are two moths and two beetles. *Mecinus janthinus*, a beetle 2 to 3 mm long, has proved to provide the best control of toadflax. Piper described how these beetles do their work. Adults feed on apical foliage, inhibiting flower development, while larvae feed inside plant stems, depleting their stored reserves. They have been distributed in Eastern Washington and have diminished toadflax populations there.

An important component of healthy steppe vegetation is the soil crust of lichens and mosses covering bare ground between clumps of vegetation (see Conservation Update in the Summer 2004 issue of *Douglasia*). Some observers have noted an apparent adverse influence of the presence of soil crusts on cheatgrass establishment, and this led Roger Rosentreter and his colleagues to investigate the effects of seeding native perennial grasses into degraded sites. There was a concern that the disturbance of remaining soil crust by the seed drill would compromise recovery of the seeded sites. In typical rangeland drill work, at least 20% of the soil crust is disturbed.

Their early results are reported in the January 2004 issue of the Journal of Range Management. They found that seeded sites had increased soil crust and perennial grasses and reduced growth of annual grasses and forbs compared to unseeded sites. In the abstract to their article they conclude, "Our results indicate that seeding is necessary to facilitate recovery of biological soil crusts and hasten the development of the perennial component of the shrubland and therefore increase landscape structure. These findings suggest that seeding perennial grasses and resting the land from livestock grazing reduces the abundance of exotic annual grasses after fire and benefits native mosses."

Chemical control

Steve Link is working to determine the minimum concentration of herbicides that will shift the competitive balance away from cheatgrass. He described an experi ment in which steppe plots were burned, then subjected to treatment by one of two different herbicides at five concentrations (from 1 oz. per acre to 8 oz. per acre,) and a no-herbicide control. The two herbicides were glyphosate (as Roundup) and imazapic (Plateau). The latter is selective (targets only plants with certain biochemical characteristics not shared with other plants, such as the crop you plant), but glyphosate is not (it targets all plants, although some only succumb to higher concentrations). Link seeded Secar bluebunch wheatgrass (*Elymus wawawaiensis*) in a sampling of the plots to study the effect of this addition on the competitive balance among natives and introduced species.

Control plots (not sprayed) contained twenty-seven annuals and biannuals, of which eighteen were native; and twenty-two perennials, of which nineteen were native. In plots under treatment, eighteen of the annuals became more frequent, and five were less frequent. Eleven perennials became more frequent, and nine became less frequent after treatment. A species of stephanomeria, the mariposa lily (*Calocortus macrocarpus*), and a delphinium species became very common after the burn.

Plateau at 4 oz. per acre eliminated annual forb exotics, but even at 8 oz. there was 20% cheatgrass cover. Roundup reduced cheatgrass cover to 10% at 8 oz. per acre, but it had negative effects on perennials, while Plateau at 8 oz. did not seem to have negative effects. 100% of plots treated with Plateau had bluebunch wheatgrass plants after treatment, but there was a drop-off of the propor tion of plots with bluebunch wheatgrass plants using Roundup at 8 oz per acre.

Link learned to push the right buttons to secure re search funds. “Don’t say: ‘ecological restoration,” said the Forest Service guys. “Call it ‘fuel reduction.” This not only made good politics, it made good sense, considering the observed increase in frequency of wildfires where cheatgrass was present; so he designed one of his cheatgrass studies to correlate the percentage cover of cheatgrass with the percentage of plots that propagated a fire started by an automatic igniter. He found that plots with over 48% cheatgrass suffered an almost 100% risk of sustaining fire. Fire propagation risk fell to 75% with 32% cheatgrass cover, and to 45% at 12% cheatgrass cover.

Link feels that tumble mustard, not cheatgrass, is the plant we need to get rid of to allow perennials to flourish. Roundup affords less control of tall tumble mustard than Plateau. In sum, while Roundup offered better control of cheatgrass than Plateau, it had adverse effects on the very desirable bluebunch wheatgrass and other perennials, and it failed to control certain undesirable species.

I have had at least three occasions recently to refer individuals and groups seeking information on the management of invasives to the studies of shrub-steppe reported by participants in the Northwest Scientific Association meeting last March. This sort of work is at the leading edge of ecological studies today, and deserves support and recognition by funding sources, and by managers at all levels.