Overview of Vol.6, No.1 – Invasive Species of Grasslands

Assessing The Impacts And Control Of Invasive Species In Grasslands

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The grasslands of North America were once expansive, wind swept landscapes home to an array of grasses and wildflowers and an abundance of grazing herds of elk and bison. With the westward movement of human settlement, these grass-filled ranges quickly became host to grazing cattle and sheep. Many grasslands, though productive in wet years, were farmed through years of frequent drought on a thin layer of yielding soil. Soil blew away with every pass of the plow and the grasses that once held this thin crust of workable earth intact were removed or severely degraded. In the Dust Bowl years of the 1930’s, concern for the grasslands arose and government programs were established to aid destitute farmers and restore the degraded rangelands. Many farms were abandoned and left to revegetate naturally. Other lands have remained privately owned and are primarily used for large cattle operations. However, much of the grasslands have now been placed under the guidance of the Bureau of Land Management (BLM).

The BLM, and other federal and non-profit agencies, have attempted to restore portions of the grasslands of North America. These grasslands have not only lost the great diversity of species they were once host to, but have been overtaken by a multitude of non-indigenous, highly aggressive species. In this volume of Restoration & Reclamation Review, the impacts and control of four invasive species are described in detail. These invasive species include *Cenchrus ciliaris* (buffel grass), *Carpobrotus edulis* (hottentot fig), *Centaurea maculosa* (spotted knapweed), and *Bromus tectorum* (cheatgrass). These invasive species are particularly interesting because of their significant impacts on grassland integrity and ecosystem processes.

Grassland deterioration is primarily due to the effects of poor grazing management, increases in the frequency and intensity of wild fires, and the presence and proliferation of invasive species. The presence and proliferation of invasive species is perhaps the greatest threat to grassland integrity since they drastically alter the inherent balance of this ecosystem. Many invasive species, including *B. tectorum* and *C. ciliaris*, increase the available fuel sources for wild fires. Other alterations of ecosystem health may include increased soil erosion, loss of soil fertility, reductions in wildlife and livestock forage, increased surface water runoff, unstable watersheds and degraded water quality, and an overall reduction in biodiversity. Neu describes *C. maculosa*’s ability to reduce populations of *Pseudoroegneria spicata* thereby reducing elk foraging use by 98%. Of utmost concern is the threat to the rich diversity of flora present in grasslands. Invasive species effectively out-compete most indigenous species because of their favorable life history traits, their pre-adaptation to the climatic and disturbance regimes of grasslands, and their ability to achieve widespread dispersal.

Invasive species have the ability to grow more vigorously than indigenous species and tend to be more prolific seed producers. In grasslands, many invasive species can also spread rhizomatically or clonally, as is the case with *C. edulis* and *C. ciliaris*. Invasive species often
produce more seed than they would in their native environments. Neu notes this to be particularly true of *C. maculosa*, which is capable of producing 5,000 to 40,000 seeds per square meter. Not only is seed production a competitive advantage over native species, many invasive species also exhibit other protective defenses.

Au found that *C. edulis* creates significant alterations in resource availability for native species. Alterations in resources include changes in space, nutrients, and soil moisture availability. Neu describes how *C. maculosa* contains an allelopathic compound, cnin, which can reduce germination in various native plants, such as *Agrpyron cristatum*, *Pseudoroegeria spicata*, and *Festuca altaica*. Other invasive species find their competitive advantage in scavenging available soil moisture from an environment prone to drought. Kaczmarski found this to be true of *B. tectorum*, which can grow roots nearly twice as fast as native species and in soil temperatures as low as 37°F (3°C). This enables *B. tectorum* to reach a soil depth where over-winter root development may occur. With roots up to three feet long by spring, this invasive species effectively out-competes other native species often leading to their peril. Life history strategies are not the only advantage invasive species have over indigenous species.

Encompassing the Great Plains, the Great Basin, the American Southwest, and portions of coastal communities, grasslands are characterized by dry winds with periods of severe drought in the summer and cool, often bitter conditions in the winter. These climatic extremes require a tolerance of the native plant species of the grasslands. Many invasive species arrived to North America with a pre-adapted tolerance for these climatic extremes. Neu describes *C. maculosa*’s ability to germinate over an extensive range of environmental conditions that include precipitation differences of up to 70 inches (178 cm). Other invasive species survive harsh conditions by completing their growth and seed production early in the growing season then going dormant during the drier, more drought prone late summer months, as is the case with *B. tectorum*.

Many invasive species also arrived pre-adapted to the disturbance regimes of the grasslands. This is particularly true of the historical presence of wild fire and its ability to renew these dry landscapes. Tix found *C. ciliaris* to be fire-adapted and an even greater fuel source than other native species since its leaves dry out earlier in the growing season and provide a greater surface area on which fire can generate. This is also the case with *B. tectorum*, which Kaczmarski says has increased the frequency of fire in the Great Basin grasslands from every 60 to 100 years in the past to every 3 to 5 years today. This increase in fire frequency is a concern not only for public and animal safety, but also for the successful reestablishment of native species that are not adapted to this narrowed return interval of disturbance. Increased fire frequency also aids the proliferation of most invasive species, providing a medium for quick establishment, increased solar penetration, and greater accessibility to available soil moisture and nutrients.

Most invasive species quickly take advantage of disturbed soils, such as those in burn areas or on land that is prone to intensive grazing. Invasive species also target areas in the site preparation stages of restoration. Invasive species’ ability to target disturbed soils is compounded by their capability to achieve widespread dispersal of their seeds. Dispersal may occur by wind, water, in animal scat, attached to animal hair and human clothing, and in crop seed and hay. Tix states that *C. ciliaris* is particularly successful at widespread dispersal due to its unique seed coat. The barbed bristles on the seed coat of *C. ciliaris* easily attach to human clothing and animal hair. Because of their ability to achieve widespread dispersal, and their subsequent damaging impacts
on grasslands, control of these invasive species is a priority among land managers and restoration ecologists.

Potential methods of controlling invasive species include chemical control, biological control, competitive exclusion, manual removal, reseeding, soil nutrient alteration, and cultivation. Other methods mentioned in these articles include mowing, hand-pulling, grazing, greenstripping, and prescribed burning, but most of these are not recommended optimal control methods and can often counteract their intended purpose. Tix states that chemical control of *C. ciliaris* is perhaps the most effective technique, in comparison to biological control and competitive exclusion. He recommends a combination of glyphosate, a broad-spectrum herbicide, and ammonium sulfate. Kaczmarski also recommends chemical means for the control of *B. tectorum*. She lists a number of potentially viable herbicides that can be used in the spring, and preferably after a burn.

In comparison to the control of *B. tectorum* and *C. ciliaris*, Au recommends the manual removal of *C. edulis*. Since *C. edulis* grows in dense mats, Au states that it can be easily “rolled up.” However, the drawback to this technique is that it is difficult to dispose of the large amounts of accumulated biomass.

Neu describes various chemical and biological control techniques, as well as cultivation and competitive exclusion, for the removal of *C. maculosa*. She states that chemical control is perhaps the most widely used method currently in practice. However, she also provides a variety of biological control options, including the use of seedhead-feeding insects and root-mining insects. Neu proposes that an integrated management approach is the most viable solution to controlling invasive species in grasslands. An integrated approach is a formulation of various control techniques that are site specific and appropriate to the specific goals of the project. By combining a series of techniques, as Neu suggests, it may be possible to successfully eradicate invasive species from degraded grasslands.

One of the greatest barriers to successful restoration of North American grasslands is the cultural component that pervades the presence, control, and eradication of invasive species. Many invasive species have been grown as horticultural commodities. Au states that *C. edulis* has been a popular ornamental in Californian coastal communities. This invasive species has also been used by the California Department of Transportation as a stabilizing roadside ground cover. Other invasive species have been used as forage crops for grazing cattle and sheep.

The agricultural use of invasive species is a particularly “wicked problem” in that many cultural misunderstandings and economic issues constrain the control and elimination of these species. Tix states that *C. ciliaris* is a favorite among ranchers and farmers since it provides nutritional forage for livestock and quickly recovers from intensive grazing. Kaczmarski discusses the impact of the ranching industry at length. She states that an enormous barrier to land managers working to control invasive species is that many ranchers feel that *B. tectorum* is a great benefit to their livestock operations. Kaczmarski suggests that for restoration to even be an option, the cultural components must be addressed and further elucidated. An invaluable tool to use when addressing the cultural complications associated with the use of invasive species is community education. Since the ranching industry has an enormous amount of political influence, the use of invasive species in grasslands may pose as an indefinite problem to the restoration of these
For the restoration of grasslands to be successful, a few necessary goals must be reached. The first goal is to reduce the infestations of invasive species, including *Cenchrus ciliaris* (buffel grass), *Carpobrotus edulis* (hottentot fig), *Centaurea maculosa* (spotted knapweed), and *Bromus tectorum* (cheatgrass). Reducing invasive species may be achieved through various integrated management and control programs that stem from any of the control methods described in this section. Reducing invasive species is also closely tied to the cultural component of their usage. Without community education and/or governmental regulation, the use of invasive species in the horticultural and agricultural industries will continue. Secondly, it is important to reverse the destructive frequency and intensity of wild fires currently occurring on many grasslands. Lastly, the ultimate goal is to return grassland landscapes to within close approximation of their presettlement conditions while monitoring and minimizing the reoccurrence of invasive species within the restored ecosystem. All of the papers in this section provide a basis for understanding and controlling invasive species of grassland ecosystems. By understanding the impacts and control of invasive species, there is potential to successfully restore degraded landscapes of the North American grasslands.