The Invasion of Our Rockies: Hype or Management Priority?

By Anna Sher, guest contributor

We've all heard how bad invasive plants are, how they crowd out wildflowers, waste our precious water, and poison our livestock. Scientists in Colorado and Montana made news in science not long ago for presenting evidence that invasive spotted knapweed was releasing toxins into the soil.[1] And yet, the cover of a recent issue of *Discover* magazine read, "Are invasive species really so bad?"[2] Closer to home was a feature article in *BioScience*, "Tiff over tamarisk: Can a nuisance be nice, too?"[3] The most inflammatory articles were a series published in the nineties, charging invasion scientists with "nativism" and even Nazism.[4] The thesis of these papers is that the recent "hype" over species invasions is misguided at best and, at worst, a symptom of xenophobia.

All of this press has been in the wake of the pronouncement by leading scientists, the USDA, the Rio Convention on Biological Diversity, and now even NASA, that invasive species are a national priority, second only to habitat destruction as the most serious threat to native species, which costs the U.S. as much as $300 billion dollars a year.[5,6,7] The early statistics were enough to prompt then-President Clinton to issue Executive Order 13112, creating the National Invasive Species Council.

And now we are seeing the (inevitable?) backlash. Invasive species are not the problem, the recent articles charge. They say that the public has been misled to engage in witch-hunts targeting nonnatives, with various incentives for doing so.

So, should we be concerned about invasions in the Rocky Mountain region or not? Should you panic at the sight of a Russian olive seedling in your yard, or should you enjoy that patch of purple loosestrife you found by the creek? As a plant ecologist who has specialized in invasion biology for over a decade, I will attempt to clarify this issue, with a challenge to the reader to consider.

My challenge is to consider the problem of invasions (particularly plant invasions) in a new light that casts the offending species as neither villain nor victim. I challenge us to shift our focus away from the species and toward the underlying issue: ecosystem disturbance. Therefore, I agree in part with those who are against blaming invasions for species extinctions; they point to the fact that many so-called invaders are actually poor competitors and therefore hardly at fault. My own research on invasive tamarisk trees supports this view: healthy native cottonwoods can easily over-top tamarisk.[8,9] Considering this and other research, the scientific community has been looking for causes other than competitive exclusion by tamarisk for the decline in cottonwood forests in the Western U.S., such as decreased over-bank flooding. However, to ignore the role of tamarisk completely would mean disregarding the terrible fires they promote that clearly kill native cottonwoods. Thus, I argue here that we must focus on the flood and the fire, i.e., the ecosystem disturbances, and what role the invader plays in responding to, promoting, or even preventing these disturbances. Understanding this can then guide effective management. With this approach we can better concentrate on solutions and goals, rather than finger-pointing and bickering over semantics.

Tamarisk flowers are a testament to their ornamental uses. Very few ornamentals become invasive, but some of our worst invasion problems were once ornamentals. Photo by Tim Carlson.

Terminology

Within the field, it is generally understood that the words weed, invasive, noxious, adventive, and exotic are related but not necessarily synonymous. The term "weed" simply reflects a judgment that a particular plant is undesirable in a given location. Thus, tamarisk trees may be weeds in Western watersheds of the U.S., at the same time as they are a benign feature of the landscape in Israel and Iran. Whether a lone ornamental tamarisk in a xeriscape qualifies as a weed will depend on the eye of the beholder. Sometimes a distinction is made between agricultural/horticultural weeds and "wildland weeds," the former requiring human disturbance and sometimes maintenance, whereas the latter is more synonymous with the term "invasive species," as used by ecologists.

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To be labeled "invasive," many would argue that a species has to be able to spread aggressively beyond its native range while actively displacing natives and changing ecosystem processes. By this definition, the dandelion in your lawn is not invasive, although it is considered a weed by most homeowners. Some weed biologists prefer the classifications "transformer species" and "landscape transformers," i.e., spreading beyond a native range makes a species invasive, but only some of these invasives alter ecosystems, or worse, ecosystem processes. The qualifier "noxious" is also used, primarily by managers, to identify the priority placed on the problem species; that dandelion may not be aggressive enough to earn the title "noxious weed," but the bindweed taking over your garden might, as does the leafy spurge dominating the pasture next door. As an ecologist I am primarily concerned with the latter, but I acknowledge the economic importance of invaders of human landscapes. In this essay I will be referring to species that are of the greatest concern because of the extent of their impact on native ecosystems, which may be referred to interchangeably as "invasives," "transformer species," "wildland weeds," and "noxious," even if these terms are not necessarily equivalent.

In contrast with the more technical jargon above are the labels "exotic," meaning nonnative or introduced, and "adventive," meaning a naturalized exotic. Many use the term "exotic" interchangeably with "invasive"; however, not all invasive species are nonnative, and by no means are all exotics invasive. By some estimations, only one percent of introduced species become invasive, and many argue that this is usually only after repeated introductions. On the other hand, even native species can act invasively when natural checks are removed, usually by human activities. Many animal examples come to mind, including Canada geese that fail to migrate due to artificial food sources and, therefore, destroy plant communities along waterways,[10] and deer whose numbers explode in the absence of natural predators, directly threatening native wildflowers.[11] Although one rarely, if ever, hears the word "invasive" applied to such cases, the impacts and management approaches are the same. Thus, it is not the species itself that is either "bad" or "good" by virtue of being exotic or native, but it is its impact that will earn a population of organisms a label of "invasive."

The lobby against the attention paid to invasions appears to miss the point that it is the plant's behavior and its broad ramifications, not its identity, that make it a candidate for control. Many invasive species are or were ornamental plants: those that were brought to this country for their beauty, and presumed to be benign. Some seem to fear that invasion biologists intend to demonize exotics, when in fact we agree that most *are* benign, requiring a helping human hand to start the invasion ball rolling, usually through alteration of historic disturbance regime.[12]

Natives are usually adapted to a particular type, intensity, timing, or frequency of disturbance, and therefore will be displaced by changes to any of these aspects, making a niche for better-adapted (sometimes nonnative) species to come in.[13] If these new species

Tamarisk draws down water tables, making conditions difficult for natives. Photo by Tim Carlson.

An example of a severe Russian olive invasion. Photo by Tim Carlson.

are able to maintain dominance even after the initial ecosystem change (perhaps by perpetuating a change in disturbance regime), they will be considered invasive. Why some species require disturbance to become invasive and others do not is still a mystery. Even if the invasion didn't require disturbance, the invasion may promote or prevent disturbance. This linkage between invasion and disturbance is the crux of my argument in favor of invasion biology as a scientific and management priority and will be discussed in more detail below with two examples from the Rocky Mountain region.

Invasion in the Rocky Mountain Region (RMR)

The states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming have, in total, identified approximately 162 different species as noxious in state weed lists. Fortunately, alpine and subalpine regions have few, if any, invaders. Generally speaking, those habitats that are most intensely used or otherwise impacted by human activity tend to be the ones that are most seriously invaded.[14] For the RMR, these would be primarily the grasslands of the foothills and plains and also the river corridors. Indeed, the degree to which we use these for development, grazing, agriculture, recreation, and other purposes tends to be correlated with the level of infestation.

This bulldozer is equipped with a HydroAx to mow down woody invaders. Removing invasives at this site in Florence, Colorado, will not be enough. Active revegetation is likely needed. Photo by Anna Sher.

For our grasslands, responsible herders know that "overgrazing" is not simply a conservationist's political term; rotating cattle or sheep is critical for sustainability of a pasture and the health of the herd. It is easy to identify the numerous areas of the RMR where this has not been done: depression of native grasses has led to invasive cheatgrass (and other species) invasions.[15] Cheatgrass is arguably the most pervasive invader of the West (reported as invasive in five of the eight RMR states), and is credited with displacing native grasses and degrading rangelands through aggressive competition for water.[16] Indeed, it was likely ranchers who named *Bromus tectorum* "cheat": although *B. tectorum* and related exotic grasses provide green shoots for grazing early in the season before the native perennial grasses have begun growing, the cattlemen were cheated by late season when the cattle become endangered by the awns on the seeds that painfully stick in their gums and nostrils.[17]

Once cheatgrass has a foothold in a grassland, it can promote wildfires that further displace natives and other desirable fodder.[18,19] Cheatgrass does this by finishing its life cycle early in the season (June), becoming dry tinder for wildfires when they would be most detrimental for native perennial grasses that do not mature until late August and September. Native grasses are adapted to fire, but not when they are still setting seed. That is, while an initial anthropogenic disturbance (e.g., overgrazing) may give the initial advantage to the invasive species, the species itself is able to maintain dominance as the new climax species through competition for resources and by further changing the fire disturbance regime.[20] While fire is historically important for maintaining the diversity of our rangeland plant communities, cheatgrass changes the role of fire by altering its timing.

A similar role of disturbance can be seen with invasion of our Western watersheds by invasive tamarisk (aka saltcedar, *Tamarix spp*.). Throughout the RMR, riparian forests, or *bosque*, have been transformed from narrow cottonwood-willow bands hugging the riverbanks to wide swaths of this shrubby invader from Eurasia. This species has been charged with wasting water, elevating soil salinity, decreasing biodiversity, and altering river hydrology.[21] Within the RMR, it is found on the state weed lists of Colorado, Nevada, and New Mexico, but tamarisk can be found in every state of the region. Although controversy around this species is still raging, it seems clear that alteration of flooding disturbance plays a critical role, both as a cause and an effect of tamarisk invasion.[22,23,24,25] It has been necessary to dam and channelize our rivers to reduce flooding threats to farmlands, residences, and rangelands. However, without periodic spring floods, the native cottonwood cannot regenerate from seed, leaving adult stands with no future generation to replace them.[26] Mild floods later in the season are ideal for tamarisk establishment, however, and with no competition from native trees they can easily gain dominance.[27]

In this way, tamarisk is an invader that responds well to anthropogenic changes in the disturbance regime (flooding), but it is also a promoter of ecosystem disturbance change itself. It was widely planted in some areas as a stream-bank stabilizer, and it fills this role well, narrowing the stream channel and in some cases actually increasing the off-season flooding that does nothing to promote native species. As mentioned earlier, tamarisk also played an important role in promoting the hot fires in the Southwest in 1998,

which also killed native trees while stimulating vigorous tamarisk regrowth. Thus, like cheatgrass, a change in disturbance caused by humans (i.e., reduced and ill-timed flooding), has promoted invasion that in turn helps sustain a change in the historic disturbance regimes (i.e., in flooding and fire).

Weed Control Triage

And so the question remains: Are cheatgrass and tamarisk "bad" species that must be eliminated? If the source of the problem is mismanaged disturbance, is eradication still the objective? Is eradication even a possibility? I (and other experts) would argue that even though eradication is not realistic, we must pay particular attention to these and other specific Western invaders because of the key role they play in ecosystem dynamics. This does not make them bad; it makes them important players in dictating land management practices. But how do we identify these key species? This is far from an exact science, but generally the range or spread of a species attracts attention.

Several states compile a list of noxious weeds, prioritizing by category according to the current threat and our ability to contain it (see Appendix A). Acknowledged, therefore, is the fact that we have reached a triage situation in which there are inevitable lost causes. For Colorado (as well as New Mexico and Nevada), such lost causes are labeled "List C" (in Montana, "Category 3"), and includes such annoyances as field bindweed (*Convovulus arvensis*) and puncture vine (*Tribulus terrestris*). On the other end of the spectrum, "List A" (or "Category 1") includes species that are still rare in the state and may actually be prevented from gaining a significant foothold. These are the highest priority "Wanted," and in Colorado include those species that have wrought havoc in nearby states, including yellow starthistle (*Centaurea solstitialis*) and the beautiful purple loosestrife (*Lythrum salicaria*). The majority of the species, then, fall in the "List B"—species that are already widespread, but that cause enough trouble to warrant state plans for at least local control. Both cheatgrass and tamarisk fall into this category, meaning that it is most likely not possible to exterminate either from the state, much less the RMR.

Although these lists and their management plans tend to focus attention on the species themselves, they are useful if we consider them as a starting rather than ending point. These lists are valuable in drawing the attention of scientists and lawmakers on those issues important to land managers. They help point the way to identifying the ecosystem dynamics that underlie some of our most persistent problems, including wildfires, drought, flood and groundwater issues, and diminished biodiversity. In some cases, studying the invasives will lead us to solutions.

When the problem (including the weed problem itself) appears to have started with a changed disturbance regime, the solution may best incorporate a return to historic disturbance conditions. Controlled burns are an example of attempts to reinstate disturbance, and there is promising evidence that it may control cheatgrass.[28] However, most changes to historic disturbance regimes were done to protect lives or property of human populations, and therefore are unlikely to be reversed.

This means that we must use the scientific and management tools available to us to do the best that we can. Understanding which aspects of the disturbance regime are important for our land management goals will be critical. In the landscape we are attempting to manage, is disturbance important because it suppresses dominant species to allow for greater total diversity? Does it stimulate nutrient cycling, break seed dormancy of desirable species, or make other resources such as light more available? Most of these outcomes can be promoted in multiple ways and do not depend on an exact replication of historic disturbance. In the case of tamarisk, we have seen some success in simulations of the effects of large historic floods without their detrimental effects; bulldozers rip up trees and calculated flows are gently released from dams during native seed dispersal.[29] The resulting *bosque* from a project that did this has prevented reinvasion of the site by tamarisk, even ten years later.[30] This is an excellent example of the principle that if the underlying disease (altered ecosystem process) is treated, the symptoms (weeds) are likely to subside.

Conclusion: Looking to the Future

Just as we are losing the distinguishing characters of our urban centers, invasive weeds are the strip malls of nature, transforming once unique communities into carbon copies found throughout similar climate and moisture zones. And yet, the weeds themselves may or may not be responsible for the initial damage, and so simply removing them is unlikely to solve the problem. Restoration of functioning ecosystems should be the ultimate goal, which is likely to require a consideration of the disturbance regimes to which the native community is adapted. This, in turn, will require study and management of the weeds that prevent, promote, and/or alter disturbance. It is our responsibility as stewards of the environment to find these mechanisms and thus (we hope) solutions to the underlying problems.

As inciting as the titles are of the articles that appear to proclaim that the invasive species problem is overstated, their content is generally less provoking. That thousands of species, both exotic and native, have had direct and indirect negative effects on ecosystems and economies is indisputable. Even in the *Discover* magazine article ("Are invasive species so bad?"), the author acknowledges

Tamarisk will grow where native species may not; in this case they are unlikely to have displaced native plants. Photo by Tim Carlson.

Invasions are often associated with human activity, like tamarisk at this picnic site in Moab, Utah. Photo by Tim Carlson.

the scourge that the Australian brown tree snake, bird diseases in Hawaii, and the fire-promoting melaleuca tree in Australia have been. His main point, as it turns out, is that invasive species are generally less competitive than we have given them credit for. On this point I agree; we have allowed invasions to start primarily by displacing natives through disturbance regime changes. However, arguments such as his ignore the fact that once a new species has a foothold, the species itself is often a problem. This is why creating state weed lists is still an important strategy, but we must also consider the species lists as indicators of larger problems that may need to be addressed. Effective weed control will necessarily be an ecosystem approach.

As a final note, I also agree with those authors[31,32] who argue that the way that we as scientists present our issues to the public is a sensitive matter, and that overstating our causes with loaded language can backfire in many ways, including triggering references to xenophobia. By keeping our focus, both internally and in our public discourse, on the impacts of invasions rather than the species itself, we are more likely to arrive at solutions to ecosystem problems, rather than stalling in rhetoric.

Endnotes

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Appendix A:
COLORADO DEPARTMENT OF AGRICULTURE
Plant Industry Division

8 CCR 1203-19 RULES PERTAINING TO THE ADMINISTRATION AND ENFORCEMENT OF THE COLORADO NOXIOUS WEED ACT

Part 3 List A Noxious Weed Species

3.1. List A of the Colorado noxious weed list comprises the following noxious weed species:

African rue (*Peganum harmala*)
Camelthorn (*Alhagi pseudalhagi*)
Common crupina (*Crupina vulgaris*)
Cypress spurge (*Euphorbia cyparissias*)
Dyer's woad *(Isatis tinctoria*)
Giant salvinia (*Salvinia molesta)*
Hydrilla (*Hydrilla verticillata*)
Meadow knapweed (*Centaurea pratensis*)
Mediterranean sage (*Salvia aethiopis*)
Medusahead (*Taeniatherum caput-medusae*)
Myrtle spurge *(Euphorbia myrsinites*)
Purple loosestrife (*Lythrum salicaria*)
Rush skeletonweed (*Chondrilla juncea*)
Sericea lespedeza (*Lespedeza cuneata*)
Squarrose knapweed (*Centaurea virgata*)
Tansy ragwort (*Senecio jacobaea*)
Yellow starthistle (*Centaurea solstitialis*)

3.2. All populations of List A species in Colorado are designated by the commissioner for eradication.

3.3. It is a violation of these rules to allow any plant of any population of any List A species to produce seed or develop other reproductive propagules.

Part 4 List B Noxious Weed Species

4.1. List B of the Colorado noxious weed list comprises the following noxious weed species:

Absinth wormwood (*Artemisia absinthium*)
Black henbane (*Hyoscyamus niger*)
Bouncingbet (*Saponaria officinalis*)
Bull thistle (*Cirsium vulgare*)
Canada thistle (*Cirsium arvense*)
Chinese clematis (*Clematis orientalis*)
Common tansy (*Tanacetum vulgare*)
Common teasel (*Dipsacus fullonum*)
Corn chamomile (*Anthemis arvensis*)
Cutleaf teasel (*Dipsacus laciniatus*)
Dalmatian toadflax, broad-leaved (*Linaria dalmatica*)
Dalmatian toadflax, narrow-leaved (*Linaria genistifolia*)
Dame's rocket (*Hesperis matronalis*)
Diffuse knapweed (*Centaurea diffusa*)
Eurasian watermilfoil (*Myriophyllum spicatum*)
Hoary cress (*Cardaria draba*)
Houndstongue (*Cynoglossum officinale*)
Leafy spurge (*Euphorbia esula*)
Mayweed chamomile (*Anthemis cotula*)
Moth mullein (*Verbascum blattaria*)
Musk thistle (*Carduus nutans*)
Orange hawkweed (*Hieracium aurantiacum*)
Oxeye daisy (*Chrysanthemum leucanthemum*)
Perennial pepperweed (*Lepidium latifolium*)
Plumeless thistle (*Carduus acanthoides*)
Quackgrass (*Elytrigia repens*)
Redstem filaree (*Erodium cicutarium*)
Russian knapweed (*Acroptilon repens*)
Russian-olive (*Elaeagnus angustifolia*)
Salt cedar (*Tamarix chinensis, T.parviflora, and T. ramosissima*)
Scentless chamomile (*Matricaria perforata*)
Scotch thistle (*Onopordum acanthium*)
Scotch thistle (*Onopordum tauricum*)
Spotted knapweed (*Centaurea maculosa*)
Spurred anoda (*Anoda cristata*)
Sulfur cinquefoil (*Potentilla recta*)
Venice mallow (*Hibiscus trionum*)
Wild caraway (*Carum carvi*)
Yellow nutsedge (*Cyperus esculentus*)
Yellow toadflax (*Linaria vulgaris*)

4.2. List B noxious weed species are species for which the commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to stop the continued spread of these species. Until such time as these plans are developed and implemented by rule, all persons are recommended to manage List B species but are not required to do so by these rules (although other state or local jurisdictions may require such action).

Part 5 List C Noxious Weed Species

5.1. List C of the Colorado noxious weed list comprises the following noxious weed species:

Chicory (*Cichorium intybus*)
Common burdock (*Arctium minus*)
Common mullein (*Verbascum thapsus*)
Common St. Johnswort (*Hypericum perforatum*)
Downy brome (*Bromus tectorum*)
Field bindweed (*Convolvulus arvensis*)
Halogeton (*Halogeton glomeratus*)
Johnsongrass (*Sorghum halepense*)
Jointed goatgrass (*Aegilops cylindrica*)
Perennial sowthistle (*Sonchus* arvensis)
Poison hemlock (*Conium maculatum*)
Puncturevine (*Tribulus terrestris*)
Velvetleaf (*Abutilon theophrasti*)
Wild proso millet (*Panicum miliaceum*)

5.2. List C noxious weed species are species for which the commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional educational, research, and biological control resources to jurisdictions that choose to require management of List C species.

Hot fires promoted by tamarisk invasion kill natives but promote regrowth of tamarisk. Photo by Tim Carlson.