The Spread of Invasive Weeds in Western Wildlands:

A STATE OF BIOLOGICAL EMERGENCY

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The purpose of this paper is to explain how hundreds of public land watersheds in the west are rapidly undergoing what is perhaps the greatest permanent land degradation in their recorded history. This paper only very brief touches on Integrated Weed Management, which can be so successful in controlling weeds and preventing the spread to uninfested lands, because other speakers will address these solutions in the remainder of this summit.

I would like to make some preliminary clarifications before explaining the details of why I call the spread of weeds on western lands a biological emergency. First, fine weed control work is underway by private, county, state and federal people and these people deserve a great deal of credit. Second, the term "permanently degraded" means with today's economics and technology and in the time frame of our children and their grandchildren. The terms permanently degraded and biological emergency are used only after considerable forethought and collaboration with many leading weed scientists, agency weed experts, and land managers.

The term "permanent" is used because, even though there are dozens of commendable restoration projects underway, the amount of wildland being restored is infinitesimal compared to the amount of land that needs to be reseeded. Furthermore, severe weed infestations near trees and shrubs and in riparian areas frequently become permanent because of restrictions on herbicides in those areas. Examples of severe and permanent land degradation are discussed because we need to learn from our experiences. There is absolutely no criticism intended. Finally, the terms exotic, alien, noxious, invasive,

and non-native plants will simply be referred to as weeds.

Our basic land management goal is to maintain or improve the health of the land. This goal really means striving to have a wide variety of healthy grasses, forbs, shrubs and sometimes trees. Unfortunately, when we look at the vast public lands in the west, the greatest negative impact to healthy communities and to the restoration of less than healthy communities is the rapid expansion of invasive weeds. The best way to rate the health of a plant community is by the percent of exotic species present (Fegler, 1998).

These weed invasions began a few centuries ago but primarily in the mid-1800's when weeds began arriving from other countries (new invaders continue to arrive here) without the natural enemies, such as insects and pathogens, that kept them in check in their country of origin.Consequently, these new plants are typically very aggressive and have the ability to dominate many wildland sites. For example, in its native habitat, purple loosestrife only comprises one to four percent of the native vegetation, but in North America densities of up to 80,000 stalks per acre have been recorded (Strefer, 1996). Thus, purple loosestrife out competes and forces out native plant species and reduces biodiversity (Nyvall, 1995).

Lets discuss four examples of what I consider permanent land degradation. These four represent hundreds of other extensive and permanent wildland degradation situations. The purpose of discussing these examples is to show that many more western federal wildlands will move into this category of permanent degradation - if we allow that to happen.

In 1993, Jackson county in southern Oregon, and Umatilla county in north east Oregon both reported explosions of yellow starthistle with over 100,000 acres in Jackson county and 200,000 acres in Umatilla county. Now, a little over four years later both counties report that the populations have doubled! Similarly, in the BLM Cottonwood Resource Area in western Idaho, it is estimated that thirty percent of the BLM land is already infested with yellow starthistle (Wilson, 1994).

In 1970, there was about thirty-two acres of leafy spurge in the Theodore Roosevelt National Park in North Dakota. The use of herbicides was not allowed and now leafy spurge dominates over 4,000 acres of the park (Andrascik, 1997). There are over one million acres of leafy spurge in North Dakota, 600,000 acres in Montana and extensive infestations continuing to spread in Wyoming, Idaho and Oregon.

There were only minor populations of spotted knapweed in Montana in 1920. Today, there are about five million acres with another 29 million acres of highly susceptible land in that state alone (Duncan, 1997). Spotted knapweed is also expanding rapidly in Idaho, Oregon and California.

From just a few plants in western Idaho in 1954, rush skeletonweed now infests over four million acres as it continues to "leapfrog" to the east, now out beyond Shoshone, Idaho, and to the west into the Hells Canyon National Recreation in Oregon and Idaho. Severe infestations are also spreading in California, Washington and other parts of Oregon.

These examples may seem like a lesson in history. However, we have just begun to see the scope of the massive degradation that will occur in the future - if we allow that to happen. Like human populations, weeds typically increase exponentially beginning slowly, then doubling and redoubling (Kummerow, 1992).

To gain a better understanding of the term degraded, let us examine the impacts from invasive weeds to native plant communities, watershed health, wildlife, and to people. First the impacts to native plant

communities which I will describe as ability to manage for desirable vegetation, permanent change in plant communities and some plant community dynamics.

Land management agency vegetative goals for properly functioning watersheds, wildlife habitat, recreation values, livestock grazing, and rare plant protection call for a wide variety of healthy native plants. Native plants form the basic biological matrix of all communities, and the growth forms of plants are an important component of community structure (Krebs, 1994). Weeds often completely alter structure when near monocultures of one invasive plant are formed. Plant communities, such as those dominated by leafy spurge or Russian knapweed, do not have the matrix of vertical and horizontal structure or the variety of species commonly found in healthy plant communities. Weeds displace native plants, blocking the land manager's ability to meet land health goals. Aggressive foreign plants spread quickly into natural areas, monopolize resources, and push out native flora and fauna - including endangered species (Cheater, 1992).

Speculation by local land managers that dyers woad could eventually exist on most of the Cache National Forest in Utah, including the Mt. Naomi Wilderness Area, is supported by the fact that the weed was observed on fifty-five of sixty possible land cover types (Dewey, 1991). The Wilderness Act of 1964 and policy mandates that wilderness be managed to ensure that natural conditions are preserved and ecosystems and ecological processes function naturally. Invasive weeds violate that law and policy (Asher and Harmon, 1995).

Well managed land is the best defense against the spread of weeds and weeds prefer disturbed areas such as roadsides, overgrazed areas, campgrounds, trails, and wildlife bed-grounds. However, recent literature, many observations and our pictures make it clear that weeds also commonly invade relatively undisturbed communities. Several exotic noxious perennial weeds, including spotted, diffuse and Russian knapweeds, leafy spurge, and yellow starthistle are moving into excellent condition stands of native vegetation (Harris, 1991). Tyser and Key (1988) reported that spotted knapweed invaded and reproduced in rough fescue communities in Glacier National Park. Forcella and Harvey (1983) documented Eurasian weeds dominating relatively undisturbed grasslands in Montana. Several exotic weeds will invade undisturbed climax communities and can become significant components of a community (Bedunah, 1992).

The simplest effect of some invasions is the displacement of native plant species, by simple crowding, by competition for resources, or by other mechanisms. Many invasive plants form broad-leaved rosettes or in some other way shade out neighbors (Huenneke, 1996).

The impact of purple loosestrife on native vegetation has been disastrous, with more than 50 percent of the biomass of some wetland communities displaced. Monospecific blocks of this weed have maintained themselves for at least twenty years (Thompson, 1987).

When wildland weed infestations become severe and widespread, especially in rugged and rocky terrain, restoration often becomes either impractical or impossible with todays technology and economics. We usually recognize an invasion only after it has entered an explosive phase. Unfortunately, by this stage, it is difficult or impossibly expensive to control the increase of the invader (Huenneke, 1996). When a weed infestation, like other disturbances, goes beyond a certain threshold, it becomes impossible to restore a site to the before infestation condition because of changes in structure and function in the plant community. An example is the Nature Conservancy's Altamount Prairie in South Dakota which is so badly infested with leafy spurge that it is no longer regarded as being worth managing as native prairie and cannot be sold as cropland (Randall, 1996).

Rare plant habitat can deteriorate. Released from their natural enemies in Eurasia, weeds can be more

competitive for moisture, sunlight and space especially at the germination phase.

Native plants with cultural significance, such as camas and bitterroot, are declining in number across the western landscape. This decrease is of great concern to many tribes, as traditional gathering areas have experienced a decline in productivity due to anthropogenic influences of the past century and the proliferation of invasive plant species - especially spotted knapweed and sulfur cinquefoil (Bonnicksen, 1998).

Some plants produce chemicals that reduce the germination of native plants. This affect on other plants is called allelopathy and studies indicate that Russian knapweed is allelopathic (Roche, 1989). Also, the leaf litter of salt cedar increases soil salinity so that large areas are unfit for native vegetation and the wildlife that depend on that vegetation.

A typical sequence of events is as follows: Native plant communities become infested with cheatgrass (an invasive annual grass with some forage value), which is then commonly invaded by medusahead (another invasive grass with almost no forage value), which is then frequently invaded by yellow starthistle or knapweed, which is then invaded by sulfur cinquefoil. With each step of the "downward spiral", one annual weed is replaced by another deeper rooted annual plant which is replaced by more tenacious extensively rooted perennial weeds which results in reduced site productivity and restoration becomes more difficult if not impractical.

Knapweeds, for example, are the best regional symptom of desertification, the loss of the productive potential of the land (Roche, 1988). One of the five indicators for evaluating the susceptibility for desertification is exotics as a percent of total cover (Mouat, et. al., 1993). The severe level of deterioration in four desertification classes is described in part as follows: "Undesirable forbs and shrubs have replaced desirable grasses or have spread to such an extent that they dominate the flora" (Dregne, 1977). Also the roots of some noxious weeds, yellow starthistle, leafy spurge, and rush skeletonweed for example, grow deeper into the soil profile than many native plants (Larson, 1997). This ability to tap water and nutrients otherwise unavailable to some native plants allows the exotics to out compete natives. This creates less bio-diversity and production resulting in desertification.

These last two examples, the downward spiral in plant composition and desertification overlap somewhat with what I will discuss next, impacts to watershed health. Besides the changes in plant communities, there are other impacts including reduced water flows, and increased run-off and erosion.

Salt cedar, a deep rooted shrub or small tree, uses an excessive amount of water. A mature salt cedar consumes as much as 800 liters of water per day -- 10 to 20 times the amount used by native species it tends to replace (Cooperrider, 1995). Salt cedar commonly draws water levels down so completely that small springs and streams cease to flow. This has a dramatic effect on native vegetation, livestock and wildlife water and perhaps rare plants. As salt cedar displaces native vegetation, the value of the original habitat for animals is markedly diminished. Fibrous rooted native plants hold soil in place thus reducing erosion, and they promote infiltration and safe release of water and provide resilience against fire and drought. Many invasive weeds, in contrast, have primarily a tap root that does not have those beneficial characteristics. Runoff and sediment yield were fifty-six percent and 192 percent higher, respectively, for spotted knapweed than for bunch grass vegetation types (Lacey, 1989). This increased runoff, early in the season results in higher mountain stream temperatures in the summer, and the increased sedimentation degrades water quality and fish habitat.

Americans place a great deal of importance on the ability of public lands to provide quality wildlife habitat. Unfortunately, the proliferation of weeds is causing an ever increasing degradation of this habitat. Four vegetative characteristics commonly used to evaluate wildlife habitat quality include: 1.)

surface plant diversity, 2.) structural plant diversity, 3.) amount of "edge", and 4.) the degree of interspersion. As weed infestations become severe, diversity declines and wildlife habitat quality degenerates (Olson, 1995).

Numerous studies demonstrate reduced numbers and/or diversity in birds, reptiles, small mammals, and insects in stands of non-native plant species. (Huenneke, 1996) For example, kangaroo rat and ground squirrel populations were severely reduced or totally eliminated on sites infested with Russian knapweed in a study in Wyoming (Johnson, 1994). Studies in Montana show that spotted knapweed invasions reduced available winter forage for elk between fifty and ninety percent (Duncan, 1997).

Wildlife habitat in riparian areas is especially vulnerable to devastation by weeds because of the extra moisture and transport into riparian areas by people, animals, and water. For example perennial pepperweed, leafy spurge, Russian knapweed and salt cedar easily form monocultures along riparian areas and adjacent uplands. Purple loosestrife forms solid stands, crowding out food plants needed by ducks and geese, and reducing suitable nesting sites. Muskrats and long-billed marsh wrens leave infested areas (Thompson, 1987).

Tamarisk (also known as salt cedar) has been able to out compete willow and other riparian plants in many locations, greatly diminishing the quantity and quality of riparian habitat for migrant songbirds and vegetation dependent birds, like the endangered Yuma clapper rail at the Salton Sea and elsewhere (Dudley, 1995). Similarly, tamarisk dominated riparian areas have depauperate faunas, even in the native range of tamarisk (Lovich, 1996). And, a study by DeLoach (1991) in the Lower Colorado Valley showed that for the entire year, salt cedar had only fifty-nine percent of the mean density of birds as the cottonwood-willow, screwbean and western honey mesquite communities. During the winter, saltcedar had only thirty-nine percentof the density of birds as other vegetative communities.

One study showed that when chukar partridge were given free access to all the medusahead caryopses (seed) they would eat, along with other dietary requirements, they suffered dramatic losses in body weight (Savage, 1969).

Finally, weeds impact people and the way we use wildlands. Weeds affect us financially along with the opportunities for public land recreation.

Annual economic impacts of leafy spurge infestations on grazing and wildlands in Montana, North Dakota, South Dakota, and Wyoming are approximately $129,000,000 (Leitch, 1994). The reduction in wildlife-associated recreation expenditures due to current leafy spurge infestations on wildlands in North Dakota is estimated to be $2,900,000 (Wallace 1992).

In Montana knapweed infestations result in an estimated direct annual impact of $14,000,000 with total secondary impacts of about $42,000,000 per year which could support over 500 jobs in the states economy (Hirsch and Leitch, 1997). And, an economic study in Grant county, Oregon, showed the annual economic impact, just from losses in livestock grazing, was $247,000. It was estimated that those losses would climb to over $3,000,000 without increased weed management (Test, 1993).

In 1988, a 1,300 acre ranch in Klammath County, Oregon was abandoned due to leafy spurge. The ranch was then purchased at an auction for about ten percent of what it would have sold for otherwise (Humphrey, 1988). And, in 1991 a 3,200 acre ranch in Ward County, North Dakota, sold at sixty percent below market value due to leafy spurge (Weiser, 1995).

Numerous studies and repeated landowner experiences show that weeds commonly reduce livestock

carrying capacity from thirty-five percent to ninety percent (Hilken, 1980; Bucher, 1993; Harris, 1988).

Without repeated investments of $100 per acre, Scotch broom partially blocks reforestation efforts and reduces growth rates of surviving trees on some timber harvest units in western Oregon (Fairchild, 1997). Similarly, rush skeletonweed is retarding forest regeneration, especially after fires, on the Boise National Forest (Ririe and Stearns, 1997).

Weeds commonly invade the most productive sites such as riparian areas, benches along streams and rivers and other sites with deep, fertile soils.

Leafy spurge causes severe eye irritation and possibly blindness in humans and it is poisonous to cattle. Infections in the eyes, mouth, and throat commonly occur in cattle and sheep feeding where medusahead is present (Bovey, 1961; Hilken, 1980). Thistles cause pain to humans trying to walk through them and yellow starthistle is poisonous to horses (Callihan, 1989).

Weeds cause abandonment of wildland recreation sites and trails. Hunters and bird dogs are reluctant to use land infested with thistles and weeds diminish the enjoyment of recreationists along trails and near campgrounds. For example, float boaters encountering the spines of thistles and the stickery knapweeds, frequently have a difficult time finding a suitable campsite to place their tents and sleeping bags. Similarly, fishing along stream banks is often impossible because of the pain inflicted by thistles.

California is spending approximately $1,500,000 a year to control hydrilla and Wyoming spends similar amounts to reduce the spread of leafy spurge. After infestations have been allowed to become severe on wildlands, the cost of weed control commonly exceeds the market value of the land. Nevertheless, it is usually critical to control the weeds on severely infested lands to reduce the weed seed that will eventually infest other lands.

In summary, in many ways weeds are simply taking away our ability to manage for healthy and productive plant communities.

Again, far too many public land watersheds are rapidly undergoing what is perhaps the greatest permanent land degradation in their recorded history. That is because so many lands are in the process of becoming infested. This weed spread continues and science tells us that on average weeds spread about fourteen percent per year which is an exponential doubling every five years (USDI, 1985). In relation to the ecological equilibrium of native plant communities, the introduction of exotic plants can throw this balance off, possibly forever (Bedunah, 1992). In the absence of predators, immune systems or other biological control mechanisms adapted to counteract these species, populations of some exotics have exploded (Monnig, 1992).

Invasive weeds are a major issue in the Interior Columbia Basin Ecosystem Management Project Draft Environmental Impact Statements. Many scientists worked on those documents that cover portions of seven states. Quoting from one EIS: "Weeds are spreading rapidly, and in some cases exponentially, in every cluster and sixty-six percent of the BLM/FS lands are susceptible to knapweeds and yellow starthistle" (USDA/USDI, 1997).

Now let us review more examples of explosive wildland weed spread.

In one research area in Colorado, dalmation toadflax recently increased 1,200 percent over a six year period (Beck, 1998). Similarly, field inventory data in the South Fork drainage in northwest Wyoming showed that dalmation toadflax increased from four acres in 1985 to 2,000 acres in 1997 (Christy,

1998). This data supports the field observations by BLM employees in Prineville, Oregon, who for many years have taken a management trip during the first week in June every year through wilderness study areas along the Lower John Day River. In 1996, they returned from the trip reporting that the dalmation toadflax populations had doubled in size from 1995. Following their 1997 trip, they reported that the toadflax had doubled in size again!

Six invasive weeds have invaded extensive areas of undisturbed Sonoran desert vegetation. Theinvasions appear to be irreversible and other exotic species show signs of becoming increasingly invasive (Burgess, 1991). For, example bufflegrass is a non-native grass that is aggressively invading the Sonoran desert. Where bufflegrass is dense enough, it can carry fire into Sonoran desert vegetation that has no natural adaptation to fire. Within the next several decades, buffelgrass might displace many common plants native to this desert (Rutman, 1997).

Near the Lower Salmon River on BLM land in Idaho, a 1983 "range trend record" picture and accompanying vegetative data show a complete absence of yellow starthistle. A picture from that same transect in 1993 shows almost total domination by yellow starthistle.

Field inventory data in the Renner watershed on BLM land near Worland, Wyoming, shows that hoary cress increased from fourteen acres in 1990 to 2,000 acres in 1995 (Christy, 1998). Similarly, in the Keating Valley of eastern Oregon, hoary cress was confined to the farmland fifteen years ago. Today hoary cress extensively dominates BLM lands (that are critical deer winter range) surrounding that valley.

Sixteen years ago yellow starthistle infested about 1,000,000 acres of land in California. Today, population estimates range up to 20,000,000 acres (O'Connel, 1998).

If all this isn't bad enough, lets discuss examples of weed spread following fire. Please keep in mind: we are *not* saying fire is bad. Fire is often very beneficial to plant communities, but fire can also result in massive increases in bad actor weeds - if we allow that to happen. And, we need to recognize that, as cheatgrass invades an area, the frequency of fire is likely to increase. For example, cheatgrass invasion has increased the frequency of fires from once every sixty to 110 years to once every three to five years on millions of acres of rangeland in the Great Basin (Whisenant, 1990). There are great opportunities to control bad actor weeds with prompt post fire weed detection followed by timely control before the weeds set seed. Here are some examples of post-fire-weed increase.

Near Tintic Junction and Perry, Utah, pictures of fire line contrasts between burned and unburned areas make it obvious that when squarrose knapweed or dyer's woad is a minor component of a plant community those weed populations commonly explode after fire. When Pat Fosse, with BLM in the Fillmore (Utah) Field Office, studied nine major weed infestations in her area of responsibility, she found that all of those weed infestations are in areas that have burned recently.

In the Sellway Bitteroot Wilderness in Idaho and Montana, spotted knapweed frequently becomes the dominate plant after fires. In 1993, the Forest Service District Ranger explained how he wished he could employ crews to promptly return to burned areas to search out and destroy new spotted knapweed infestations for a few years to give the native vegetation a chance to become well established. The cost of that weed control would be a pittance in comparison to the amount of money wisely spent controlling the fires (Dailey, 1993).

Dalmation toadflax exploded recently after wildfires in parts of Yellowstone National Park. Similarly, a few musk thistle plants were noticed in 1995 in a woodcutting area on BLM land near Montrose,

Colorado. Following a wildfire in 1996, musk thistle populations now form near mono-cultures over large areas.

Where there were only a few plants of hoary cress in 1996 before the Broken Back fire on BLM land near Worland, Wyoming, there is now a major population of this noxious weed (Christy, 1998).

Accelerated by wildfire, yellow starthistle now infests about twenty-five percent of the Forest Service Ishi wilderness in northern California.

In the BLM Sand Butte and adjoining Wilderness Study Areas in Idaho, considerable weed surveillance had been underway for many years. Until a huge wildfire burned over the area in 1992, rush skeletonweed was not known to exist there. In 1995, a few rush skeletonweed plants were found and controlled. In 1996 the entire area burned again. A preliminary detection survey in 1997 outlined a 60,000 acre area that now has serious rush skeletonweed infestations scattered within.

One indication of how these bad actor weeds are so competitive is shown in a series of pictures we have of squarrose knapweed, diffuse knapweed and rush skeletonweed quickly sprouting and setting seed within five to eight weeks after fires. Thus, these weeds promptly produced their second crop of seeds while all other plants were awaiting another season to arrive.

The Departments of Agriculture in eleven western states estimate that there are about 70,000,000 acres of invasive weeds on private, state and federal wildlands. Essentially, this means there are 70,000,000 acres of weed seed being produced every year, much of which is being carried to other wildlands by wind, water, wildlife, livestock, people and equipment. Consequently, just as predictably as lightning strikes ever year, anywhere, all the public lands are under attack from these weed seeds.

The magnitude of this problem can leave us feeling overwhelmed. But, if we had just discussed wildlife management ,or range management, everywhere - all at once - like we just discussed weeds, we would also feel overwhelmed. However, in local watersheds (someone is responsible for every piece of land), cooperative weed management can be a reasonable and successful endeavor - especially if we remember that about ninety percent of the 350,000,000 acres of western public lands are not significantly infested - yet. Cooperation is the key, and that is why cooperative weed management areas are so urgently needed. A county, state and federal effort produced the "Guidelines for Coordinated Management of Noxious Weeds in the Greater Yellowstone Area" (USDA/USDI, 1992) which can help people initiate and implement cooperative weed management areas.

How urgent is it to control weeds, especially the thousands of new or small infestations currently growing out of control in relatively uninfested areas? Let us consider the priority in relation to fire. Nature often helps put out fires, nature does not help put out weeds. Fires are often very beneficial, weeds are not beneficial. If and when there are negative impacts from fire, they are usually short-term, whereas impacts from weeds are long term and often permanent. Therefore, the thousands of small/new infestations that are currently growing out of control on relatively uninfested land, truly constitute a state of biological emergency!

In conclusion, we must keep relatively uninfested land from becoming seriously infested. Future generations of Americans deserve to inherit healthy productive wildlands, not vast landscapes infested with spiney, poisonous weeds that are unfit for people or wildlife. We must be wise enough and committed enough - right now - to increase our cooperative weed efforts at all organizational levels and to fully implement enough cooperative weed management areas so that the history of weed spread does not repeat itself over and over again across these public lands we value so highly.

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