

CATEGORY A - HIGH	
Invasive Weeds	Best Option for Control
African Rue	Hand pulling, grubbing, tilling, and prescribed burn are not recommended because the roots are too deep and will promote spread. Grazing is not an option because of the bad smell and taste, livestock will not eat. Treatment should occur when the plant is healthy and robust in the late summer (September-October) when using foliar spray. Using imazapyr alone or in combination with other herbicides provides the best control.
Blue Mustard	Changing crop rotation for heavily infested fields is effective. Tilling before plants produce flowers will reduce amount of seed in seed bank. Herbicide most effective when applied before stems elongate.
Bull thistle	Use integrated treatments. Cut-off seed heads and pull up roots repeatedly. Tillage, mowing and pulling at proper time will be effective. No burning. Livestock will graze young thistle. Biocontrol suitable for remote locations where other methods are not practical. Use biocontrol for large populations. Chemical treatment is effective
Canada thistle	Repeated mechanical control should focus on destroying seed heads and root systems. Tillage provides limited control. Do not burn. Goats and sheep can be used to graze young thistle. Best controlled by a selective post-emergent broadleaf herbicide.
Common Mediterranean Grass	Growth inhibited by shade. Plant dense shrubs. Hand removal is impractical. Plowing, disking or scraping reduces biomass initially then further encourages growth. Can be grazed, although disturbance will encourage growth. Herbicide use can be effective. ##
Dalmatian toadflax	Mechanical removal should focus on root systems. Hand-pulling and digging can be effective for small populations. Mowing, chopping, and cutting are not recommended. Burning is not recommended. Do not graze, it can be toxic to livestock. Long-term biocontrol effectiveness is unknown. Chemical treatment can be effective with re-seeding efforts if native grasses are not present.
Fountain Grass	Small populations can be hand pulled if roots are extracted. Hand pulling should occur every 1-2 months. Mow or till if infestations are accessible. Prescribed burn is not recommended. Fountain grass is not palatable to livestock, except when very young. Best method is to apply herbicide (glyphosate) spot treatments to actively growing plants annually for good control.
Leafy spurge	Hand-pulling and grubbing are not effective. Tillage should be combined with re-seeding effort. Long-term grazing with sheep and goats can be effective to control (>5 years). Biocontrol most effective when used with chemical control and grazing. Herbicide treatments are effective when done repeatedly.
Musk thistle	Use integrated treatments. Cut-off seed heads and pull up roots repeatedly. Tillage, mowing and pulling at proper time will be effective. No burning. Livestock will graze young thistle. Biocontrol suitable for remote locations where other methods are not practical. Use biocontrol for large populations. Chemical treatment is effective
Perennial pepperweed	Hand-pulling, hoeing, or grubbing are effective for seedlings. Do not mow or till unless used in combination with herbicide. Do not burn. Use grazing with other tools. Goats, sheep, and cattle should graze new foliage growth. Herbicides are effective especially when using with other integrated approaches.
Ravenna Grass	Seed heads can be cut, bagged and incinerated. Remove whole plant by their root and place in a high and dry area. Spray glyphosate on foliage for control of larger populations.
Sahara mustard	Hand pull, particularly seed heads, bag, and incinerate.
Scotch thistle	Use integrated treatments. Cut-off seed heads and pull up roots repeatedly. Tillage, mowing and pulling at proper time will be effective. No burning. Livestock will graze young thistle. Biocontrol suitable for remote locations where other methods are not practical. Use biocontrol for large populations. Chemical treatment is effective.

CATEGORY A - HIGH	
Invasive Weeds	Best Option for Control
Spotted knapweed	Hand pulling can be effective for small populations-repeated pulling is necessary. Do not till. Mow young plants. Do not burn. Sheep and goat can graze during spring. Control burning is effective, but hard to keep ignited through a dense monoculture. Biocontrol is highly effective when using other control methods. Herbicide treatment with follow-up treatments are effective.
Squarrose knapweed	Hand pulling can be effective for small populations-repeated pulling is necessary. Do not till. Mow young plants. Do not burn. Sheep and goat grazing can be grazed during spring. Biocontrol is highly effective when using other control methods. Herbicide treatment with follow-up treatments will be effective.
Sulphur Cinquefoil	Best method is prevention. If infestation is small, shovels and tillers can be used to reach below the root crown to destroy plant. Till before the plant goes to seed. Mowing is not suggested. Plant with native seed and plants to reduce population. Chemical control is most effective. ###
Tall whitetop	Hand digging and grubbing may be feasible for small populations. Mowing is not recommended unless combined with herbicide applications. Tilling is effective if done repeatedly. Do not burn. Not recommended for livestock grazing. Bio-control agents are not available. Herbicides will provide effective control but need to be cautious about herbicide selection when spraying near crops.
Tamarisk, saltcedar	Hand removal methods are effective for sprouts/young plants. Mechanical clearing requires repeated applications. A grubbing tool mounted on a tractor will works well to pull root ball out. Mulching and excavating can be used for individual trees. Prescribed fire is not recommended for long term management but can be used to burn brush pile or dead saltcedar. Biological control not approved. Herbicide control can be effective: aircraft, helicopter, tractor, truck, ATV, backpack, etc.
Tree of Heaven	Hand-pull very young seedlings. Grub saplings or young trees if you can remove the root system. Not palatable for grazing. Tree will come back after a controlled burn. Basal spray or girdling with herbicide application with follow-up foliar spot spraying for new seedlings, sprouts and root suckers is a good option. Re-vegetating with native species should occur.
Uruguayan pampas grass	Pulling or hand grubbing seedlings is effective. A pulaski, pickaxe, or shovel can be used to remove clumps. Can use chainsaw or weed whacker to remove the crown, to expose the base of the plant making it easier to remove the root system. It can be controlled with glyphosate in the fall. Top foliage can be removed or burned and the re-growth treated with glyphosate.#
Yellow nutsedge	Controlling the tubers of this plant is important. Remove plants before they have 5-6 leaves by hand or hand hoe. Make sure to remove entire plant. Till only small areas before plants have 6 leaves. Can till and then dry tubers (do not provide irrigation). Can cover an area with polypropylene polymer fabric to suppress nutsedge growth. Few herbicides are effective. Use repeated applications of glyphosate to young and mature plants to kill tubers. Apply chlorsulfuron to nutsedge prior to the fifth-leaf stage. Dichlobenil will reduce number of plants, but needs repeated treatments.*
Yellow starthistle	Reproduces solely by seed so mechanical control should focus on that-hand removal for small populations, tillage can be effective. Mowing can be effective over a 3-year period. Burning can be effective from January to May. Goat and sheep grazing can be effective. Limited experience with biocontrol in AZ. Herbicide spraying is effective.

CATEGORY B - MEDIUM	
Invasive Weeds	Best Option for Control
Camelthorn	Do not till, mow or burn. Can pull small populations. Grazing may be effective for young growth. Chemical is the most effective treatment over multiple years.
Diffuse knapweed	Hand pulling can be effective for small populations-repeated pulling is necessary. Do not till. Mow young plants. Do not burn. Sheep and goat grazing can be grazed during spring. Biocontrol is highly effective when using other control methods. Herbicide treatment with follow-up treatments will be effective.
Halogeton	Can be controlled by mechanical tillage but should be followed up by re-seeding. Can be controlled using repeated herbicide treatments. ***
Johnsongrass	Can remove individual plants by hand if you can remove all the roots. Herbicide is the most effective method.##
Russian knapweed	Hand-pulling or hoeing can be effective for small populations if repeated over multiple years. Tillage should not be used w/out herbicide application. Burning should not occur, except for debris disposal. Cattle, sheep, and goats can graze during early growth. Toxic to horses. Biocontrol agents can be effective. Best controlled with selective, post-emergent herbicide.
Russian Olive	Hand removal of small trees (shovel, hoe) Can mow sapling stems <1 inch diameter. Repeated tillage is effective in agricultural situations and should be coordinated with reseeding. Excavator can be used to remove trees. Burning is a suppression technique can modestly control saplings and reduce top growth of more mature trees. Mature goats will graze on seedlings and young trees. No biocontrols available. Herbicide treatment is effective especially when used with other methods.
Siberian Elm	Basal spray or cut-surface treatment initially and follow-up with foliar spot spray to control new seedlings, sprouts and root suckers. Can use heavy machinery to grub trees (uproot from ground). Plant dense native shrubs and trees to prevent re-growth.
CATEGORY C - LOW	
Invasive Weeds	Best Option for Control
Bald Brome	Hand removal effective if before seed heads are produced; remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds develop to reduce plant size but may cause plant to increase in number of stems produced. Burning can be used with other control methods. Can use grazing but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated, the area should be seeded or planted with native species to out-compete recolonizing brome.
California Burclover	Hand pulling plants may control small populations if roots are removed. Maintain or plant native vegetation for competition. Glyphosate may be effective.
Cheat grass	Hand-pulling or hoeing will work for small infestations. Disking or tilling repeatedly may be effective if seed is buried at least 4-6 inches. Mowing every 2-3 weeks may be effective. Burning is effective when used with other methods. Grazing is effective during 6-8 weeks early in the season. No biocontrols available. Herbicides are effective, however may affect native species.
Field bindweed	Deep tillage of root system and hand removal of top growth can be effective if done repeatedly. Hoeing is partially effective when treated every 2-3 weeks. Herbicides are effective.*
Field Brome	Hand removal effective if before seed heads are produced-remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds are developed can reduce plant size but may cause plant to increase in number of stems produced. Burning can be used with other control methods. Can use grazing but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing brome.
Horehound	Hand pull before seeding small populations. Plants do not persist in areas of clean cultivation. Plants can be mowed to the ground as they begin to grow in spring, will need to be repeated. Deep plow ag fields with crop rotation to improve control. Sheep will graze if other feed is scarce but may open up new areas for infestation. Control burn with follow-up treatments for germinating plants. Herbicides will work with follow-up treatments.!!!

CATEGORY C - LOW

Invasive Weeds	Best Option for Control
Jointed goatgrass	Hand pulling effective for small populations. Deep tillage can be effective. Mowing can be effective during late winter. Control burn can be effective in agricultural setting but limited for range or non-crop lands. Grazing can be effective in combination with glyphosate spraying. No biocontrol. Effective control with non-selective herbicide.
Kochia	Small infestations can be hand-pulled to remove whole root. Mowing reduces seed production but should be done repeatedly. Deep tillage may prevent seed germination. Can be grazed in small amounts but toxic in large amounts. Will re-grow after grazing. Competitive native vegetation, such as perennial grass plantings, can inhibit establishment. Chemical treatment will work, however there are chemical resistant populations. ¹
Puncturevine	Best controlled by hand-removal or hoeing to cut plant off taproot. Mulch can be used around ornamentals to prevent this species. Biocontrol may be effective. Herbicides are an effective control.*
Red brome	Hand removal effective if before seed heads are produced; remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds develop to reduce plant size but may cause plant to increase number of stems produced. Burning can be used with other control methods. Can use grazing but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing red brome.
Rescuegrass	Hand removal effective if before seed heads are produced; remove roots. May require several return visits. Mow in winter or early spring before seeds develop to reduce plant size but could cause increase number of stems produced. Burning can be used with other control methods. Can use grazing but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing weeds.
Ripgut Brome	Small populations can be hand pulled if roots are extracted. Hand pulling will need to occur repeatedly. Mowing or cutting should occur regularly. Deep tillage can be effective. Herbicide application can be successful.@@
Russian thistle	Mowing or hand-pulling young plants can prevent seed production but must be repeated. Do not burn. Planting competitive native species can prevent establishment. Can use preemergent and post emergent herbicides. Repeated use of a single herbicide should be avoided due to herbicide resistance.*
Smooth brome	Can hand pull small populations. Spray herbicide in fall after a killing freeze for best results. Can use control burn in a field during the dormant period and followed by cattle grazing of re-growth. @
Spreading Wallflower	2,4-D provides good control.

NOTES ON TABLES

Weed management strategies for above-mentioned weeds extracted from USDA Forest Southwestern Region Field Guides for Managing Species

(<http://www.fs.usda.gov/detail/r3/forest-grasslandhealth/invasivespecies/?cid=stelprdb5228481>)

- * Statewide Integrated Pest Management Program at the University of California at Davis (<http://ucipm.ucdavis.edu/PMG/PESTNOTES/pn74139.html>)
- *** USDA NRCS Plant Guide (<http://plants.usda.gov/java/>)
- **** BugwoodWiki- High Plains Integrated Pest Management (<http://wiki.bugwood.org/HPIPM>)
- # Produced by the USDA Forest Service, Forest Health Staff, Newtown Square, PA. Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive_plants
- ## Lake Mead Exotic Plant Management Plan
- ### University of Nevada, Cooperative Extension Fact sheet
- ! DiTomaso, J.M., G.B. Kyser et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of Calif
- @ http://www.ks.nrcs.usda.gov/news/coneds12/brome_grass.html and [Restoring Native Grassland Species](http://www.ks.nrcs.usda.gov/news/coneds12/brome_grass.html)
- !!! <http://sdrsnet.snr.arizona.edu/data/sdrs/www/docs/marrvulg.pdf>
- @@ Montana Utah Wyoming Cooperative Extension Weed Management Handbook

Herbicide Rankings based on Human Toxicity

Herbicides proposed under Alternative 2 ranked based on adverse human health impacts from harmful doses. Herbicides are listed from least toxic to most toxic based on oral ingestion. However, toxicity based on oral or ingest exposure and dermal exposures are also included. LD₅₀ corresponds to the dose at which 50% of tested animals died and are reported by the USEPA as part of the pesticide registration process. The order can be used to prioritize herbicide selection, with a preference for herbicides with lower toxicity rates based on exposure method.

Herbicide	Application Rates (lbs a.i./acre)	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀	Inhalation LD ₅₀ (mg/L)	Adverse Human Health Effects
Chlorsulfuron	0.047 – 0.062	5,545	>2,000	5.9	Little to no effect on fertility, reproduction, or offspring development. Does not cause genetic damage, cancer, or birth defects.
Aminopyralid	0.03 – 0.11	>5,000	>5,000	>5.79	Causes eye irritation. Potential effects on development and reproduction at high doses. No evidence of carcinogenicity or mutagenicity.
Imazapic	0.0313 – 0.1875	>5,000	>5,000	>2.38	Can cause moderate skin and eye irritation. Not a known carcinogen or mutagen.
Imazapyr	0.45 – 1.5	>5,000	>2,000	>1.3	Can cause moderate skin and eye irritation. Not a known carcinogen or mutagen.
Isoxaben	0.66 – 1.33	>5,000	>2,000	>2.68	Can cause eye irritation and corneal damage. The additive, crystalline silica, is a listed carcinogen. can cause birth defects and adverse effects on reproduction. Classified as a possible human carcinogen and mutagen.
Metsulfuron methyl	0.0125 – 0.15	>5,000	>5,000	>5.3	Mild to moderate skin and eye irritant. Not classed as a carcinogen or mutagen. Not known to impact or inhibit reproduction or development.
Prodiamine	0.75 – 1.5	>5,000	>2,000	>1.81	Does show increased toxicity during pregnancy for fetus and mother. Adverse impacts on liver and thyroid. Classified as a possible human carcinogen.
Thifensulfuron methyl	0.0023 – 0.028	>5,000	>2,000	>5.03	Mild eye irritant. Not carcinogenic or mutagenic. Has little to no effect on reproduction, development, or fertility.
Glyphosate	0.5 – 4	4,320	>2,000	1.6 - 5.63	Possible alteration of intestinal microbial community. Some evidence of endocrine disruption. Linked to increased risk of Non-Hodgkin's Lymphoma for workers.
Clopyralid	0.35 – 1	4,300	>5,000	>3.0	Can cause severe eye damage. Does not cause cancer or genetic mutations. Some evidence of reproductive or developmental effects at higher doses.

Herbicide	Application Rates (lbs a.i./acre)	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀	Inhalation LD ₅₀ (mg/L)	Adverse Human Health Effects
Dichlobenil	4 -6	4,250	>2,000	>3.3	Impacts to liver and kidneys with acute exposure. Classified as a possible human carcinogen. Potential endocrine disruptor.
Picloram*	0.125 – 1	4,012	>2,000	>8.11	Acute poisoning can lead to nervous system damage, weakness, and diarrhea. Chronic exposure can cause liver damage. Mild to moderate skin and eye irritant. Chronic exposure can lead to developmental effects. Not a known carcinogen or mutagen.
Fluroxypyr	0.12 – 0.5	2,405	>2,000	>6.2	Can cause damage to the liver at high doses. Potential effects if swimming in or drinking contaminated water. Not likely to be carcinogenic or mutagenic.
Metribuzin	0.17 - 3	2,300	>5,000	0.72	Sub-chronic exposure linked to abnormal liver function and adverse impacts to reproduction. Known endocrine disruptor. Not a known carcinogen or mutagen.
Fluazifop –p-butyl	0.1 – 0.375	>2,000	>2,110	1.7-5.2	Slight eye irritation, moderate skin irritation, and adverse effects to the liver with prolonged exposure. Increased risk to the public from long-term consumption of contaminated vegetation. Not likely to be carcinogenic or mutagenic.
Indaziflam	0.046 – 0.091	>2,000	>2,000	>2.3	Can cause degenerative neuropathology and damage to kidneys, liver, and thyroid with chronic exposure. No evidence of carcinogenicity or genotoxicity.
Atrazine	1-4	1869	>2,000	5.8	Causes endocrine disruption. Most impacts affect pregnant women and children. Known effects include preterm delivery, fetal growth retardation, delayed onset of puberty, and mammary tumors. Not likely to be carcinogenic or mutagenic. Potential endocrine disruptor.
Pendimethalin	1.485 – 1.98	>1050	>2,000	320	Possible human carcinogen affecting the thyroid. Mild skin and eye irritant. Some adverse effects on liver function. Has not been shown to cause birth defects or affect reproduction.
Triclopyr	0.5 - 8	630	>2000	>4.8	Mildly toxic to developing embryos. High doses can cause adverse birth defects and maternal toxicity. Not classified as a human carcinogen. Can cause mutations but with no adverse effects.

Herbicide	Application Rates (lbs a.i./acre)	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀	Inhalation LD ₅₀ (mg/L)	Adverse Human Health Effects
2,4-D	0.23 - 9	579 - 1646	>2,000	0.78 – 5.4	Neurological, cardiac, hepatic, and renal toxicity with high doses. Chronic high doses could increase risk of cataracts and retinal degeneration. Some correlation with non-Hodgkin's lymphoma and cervical cancer. Currently classed as not a human carcinogen. Potential endocrine disrupter.
Paraquat	0.07 - 1	283	>2,000	0.001	Toxic if ingested or dermally adsorbed. Known to adversely impact the liver, kidneys, and lungs. Can cause moderate to severe eye irritation and moderate skin irritation. Reclassed as non-carcinogenic but found to be weakly mutagenic.