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Cover: Buffelgrass infestation of a Sonoran Desert landscape in southern Arizona; Aaryn Olsson, Northern Arizona University

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Review and Assessment of Programs for Invasive Species Management in the Southwestern Region, 2012

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Policy stated in Forest Service Manual (FSM) 2093 requires the Forest Service to "Initiate, coordinate, and sustain actions to prevent, control, and eliminate priority infestations of invasive species in aquatic and terrestrial areas of the National Forest System using an integrated pest management approach, and collaborate with stakeholders to implement cooperative invasive species management activities in accordance with law and policy." Responsibility for managing invasive species in the Forest Service is primarily shared between staffs of the National Forest System (NFS) and the Forest Health Protection Program of State and Private Forestry (S&PF). The NFS directly manages national forests and grasslands whereas the Forest Health Protection (FHP) Program has the responsibility of providing technical expertise and financial assistance (primarily for suppression of insects and disease) for all national forest lands, including urban, state, private, and tribal lands, and forested lands managed by other Federal agencies.

To manage invasive species and the pesticides used to control them, coordinators for invasive species and pesticide use are appointed to serve in the regional office and forest supervisor's offices. In addition, coordinators and pesticide applicators may be appointed at the ranger district (RD) level. The Forest Service's Southwestern Region (Region 3) maintains a cadre of nearly 50 coordinators and pesticide applicators to serve the 11 national forests (NFs) and 4 national grasslands (NGs) associated with the Region which primarily encompasses Arizona and New Mexico. The Cibola NF in New Mexico administers all four NGs (Black Kettle, Kiowa, McClellan Creek, and Rita Blanca), although three of these NGs are located in Oklahoma and Texas.

Invasive species coordinators on national forests and grasslands in Region 3 include range conservationists, ecologists, wildlife biologists, botanists, and other NFS specialists. Regional coordination for invasive species management is provided by the Rangeland Management staff in the Regional office in Albuquerque, NM. Duties and activities for invasive species coordinators include:

1. Preventing the introduction and establishment of terrestrial and aquatic invasive species on NFS lands;
2. Coordinating with state and local agencies, tribes, and landowners in control and restoration efforts associated with invasive species management;
3. Collecting and reporting information related to invasive species infestations, impacts, and management activities occurring on NFS lands;
4. Implementing measures associated with invasive species management in forest plans and other resource management and project-level plans; and
5. Maintaining working relationships with state or local invasive species or noxious weed management committees, districts, or boards, and other organizations involved with invasive species.

In association with invasive species management on NFS lands, the Forest Service also provides funding for management of invasive plants on state and private land through State and Private Forestry's FHP Invasive Plants Program. A major goal of the program is to promote Forest Service partnership with non-Federal cooperators such as cooperative weed management areas (CWMAs) in projects that will complement invasive weed management on national forests or grasslands. Further information on invasive species programs of the Forest Service may be found

at http://www.fs.fed.us/foresthealth/management/fhm-invasives-plants.shtml and at http://www.fs.fed.us/invasivespecies/index.shtml.

As outlined in FSM 1920, forest plans generally mandate that principles of integrated pest management (IPM) be used for management of forest pests such as insects, diseases, animals, and invasive plants. The objective of the IPM process is to identify control strategies (physical, cultural, biological, and chemical) that are effective and ecologically and socially acceptable. Forest Service policy for using pesticides as part of the IPM process requires:

1. Basing actual and recommended uses of pesticides on analysis of effectiveness, specificity, environmental impacts, economic efficiency, and human exposure;
2. Reviewing and approving all proposals for the use and application of pesticides on NFS lands; and
3. Using pesticides in compliance with all Federal, state, and local laws and regulations.

Pesticide application on NFS lands may not be undertaken unless documentation for a project is in compliance with the National Environmental Policy Act (NEPA) (FSM 1950). For pesticides used by the Forest Service in its management activities, human health and ecological risk assessments (HERAs) are prepared. These risk assessments are used to evaluate the probability (i.e., risk) that a particular use of a pesticide might pose harm to humans or other species in the environment. For pesticide projects, the Forest Service incorporates relevant information from a HERA into project NEPA documents, i.e., environment assessments (EAs) or environmental impact statements (EISs), which are used to guide agency decision-making and also to disclose potential environmental effects to the public.

In support of pesticide use on NFS lands, S&PF's Forest Health Protection Program coordinates pesticide training and management within NFS lands. Region 3 personnel who initially need formal instruction in pesticides and weed management are encouraged to take the USDI Bureau of Land Management's "Integrated Pest Management and Pesticide Application Certification" course or a similar course. Only pesticide coordinators and applicators who are adequately trained and qualified in the proper use of pesticides may implement pesticide-use projects. Before a project involving pesticides can proceed, a pesticide-use proposal (PUP) (Form FS-2100-2) must be completed as part of the environmental analysis process to provide details regarding the purpose of using the pesticide, as well as the actual pesticide application. In Region 3, line officers at the forest or district level may approve a PUP only if a pesticide coordinator with a state license has been appointed for their office (FSM R3 Supplement 2151.04a). License holders must maintain their license on an annual basis by taking continuing education units (CEUs) for recertification which can be obtained from the Region's pesticide workshop, from annual conferences of statewide weed management associations in either New Mexico or Arizona, or through training courses as published on state agency Web sites. The Region has implemented a plan to standardize training and certification for pesticides which may be obtained from the Regional coordinator for invasive species and pesticide use at (505) 842-3280.

Regional invasive issue teams (RISITs) have been established by the Forest Service to coordinate management activities and research needs at the region, station, and area levels. RISITs consists of a multidisciplinary team of invasive species coordinators, pesticide coordinators, wildlife biologists, engineers, hydrologists, etc., who are responsible for implementing the national strategy for invasive species management within the region or area. At least once every 3 years,

the RISIT for Region 3 will be expected to assess and adjust Regional invasive species priorities for its respective ecosystems and to provide a report on accomplishments for invasive species management across respective units.

Invasive Species in Region 3

Region 3 has a substantial number of invasive species that require an effective response to minimize their presence and impacts. Table 1 lists major invasive species currently found on national forests and grasslands in the Region which includes both terrestrial and aquatic invasive species of plants, vertebrates, invertebrates, and pathogens. Individual forests and grasslands vary in the number of invasive species present due in part to their susceptibility to certain types of invasive species and the number of possible pathways for invasion such as highways, utility corridors, etc., that contribute to the spread of invasive species. The number of invasive species also reflects factors such as disturbance (fire, construction, grazing, etc.) that can increase their presence. In addition to the invasive plant species shown in table 1, there are a number of common weed species that can extensively infest NFS lands such as common mullein (*Verbascum thapsus*) on the Apache-Sitgreaves National Forests (NFs) and Russian thistle (*Salsola* spp.) on the Coconino and Kaibab NFs. These common weed species also require treatment when their infestations impact native plant communities.

Table 1. Major invasive species of national forests and grasslands in Region 3

National Forest	Major Invasive Species*	
Apache-Sitgreaves	amphibian	bullfrog (*Rana catesbeiana*)
	fish	brown trout (*Salmo trutta*) rainbow trout (*Oncorhynchus mykiss*)
	terrestrial plant	cheatgrass (*Bromus tectorum*) knapweeds (*Centaurea* spp.) Lehmann lovegrass (*Eragrostis lehmanniana*) **musk thistle** (*Carduus nutans*) **saltcedar** (*Tamarix* spp.)
	pathogen	white pine blister rust (*Cronartium ribicola*)
Carson	fish	brown trout rainbow trout
	terrestrial plant	bull thistle (*Cirsium vulgare*) **Canada thistle** (*Cirsium arvense*) **hoary cress** (*Cardaria draba*) **leafy spurge** (*Euphorbia esula*) musk thistle perennial pepperweed (*Lepidium latifolium*) **Russian knapweed** (*Acroptilon repens*) saltcedar **Scotch thistle** (*Onopordum acanthium*) **yellow toadflax** (*Linaria vulgaris*)
Cibola (includes Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs)**	mammal	feral swine (*Sus scrofa*)
	terrestrial plant	black locust (*Robinia pesudoacacia*) cholla (*Cylindropuntia* spp.) **eastern redcedar** (*Juniperus virginiana*) field bindweed (*Convolvulus* spp.) Johnsongrass (*Sorghum halepense*) jointed goatgrass (*Aegilops cylindrica*) mesquite (*Prosopis* spp.)

National Forest	Major Invasive Species*	
		musk thistle Russian knapweed **saltcedar** **Scotch thistle** **Siberian elm** (*Ulmus pumila*)
	pathogen	white pine blister rust
Coconino	amphibian	bullfrog
	fish	**black bullhead catfish** (*Ameiurus melas*) **channel catfish** (*Ictalurus punctatus*) **flathead catfish** (*Pylodictis olivaris*) **green sunfish** (*Lepomis cyanellus*) **northern pike** (*Esox lucius*) **smallmouth bass** (*Micropterus dolomeiu*) **yellow bullhead catfish** (*Ameiurus natalis*)
	crustacean	**northern crayfish** (*Orconectes virilis*) **red swamp crayfish** (*Procambarus clarkia*)
	terrestrial plant	bull thistle **camelthorn** (*Alhagi pseudalhagi*) cheatgrass common teasel (*Dipsacus fullonum*) **Dalmatian toadflax** (*Linaria dalmatica*) **diffuse knapweed** (*Centaurea diffusa*) **giant reed** (*Arundo donax*) halogeton (*Halogeton glomeratus*) Himalayan blackberry (*Rubus discolor*) **hoary cress** **houndstongue** (*Cynoglossum officinale*) jointed goatgrass **leafy spurge** **Malta starthistle** (*Centaurea melintenis*) **Mediterranean sage** (*Salvia aethiopis*) **musk thistle** red brome (*Bromus rubens*) Russian knapweed **Russian olive** (*Elaeagnus angustifolia*) **saltcedar** **Scotch thistle** **Siberian elm** **spotted knapweed** (*Centaurea biebersteinii*) **tree-of-heaven** (*Ailanthus altissima*) wild oats (*Avena fatua*) **yellow starthistle** (*Centaurea solstitialis*)
	aquatic plant	Eurasian watermilfoil (*Myriophyllum spicatum*)

National Forest	Major Invasive Species*	
Coronado	amphibian	**bullfrog**
	fish	brown trout green sunfish mosquito fish (*Gambusia affinis*) rainbow trout
	crustacean	northern crayfish
	terrestrial plant	**buffelgrass** (*Pennisetum ciliare*) **fountain grass** (*Pennisetum setaceum*) **giant reed** **sweet resinbush** (*Euryops subcamosus*) **tree-of-heaven**
Gila	amphibian	bullfrog
	fish	brown trout rainbow trout
	terrestrial plant	**bull thistle** cheatgrass musk thistle **purple loosestrife** (*Lythrum salicaria*) Russian olive **saltcedar** Scotch thistle Siberian elm spotted knapweed tree-of-heaven **yellow starthistle**
	pathogen	chytrid fungus (*Batrachochytrium dendrobatidis*)
Kaibab	terrestrial plant	**bull thistle** **camelthorn** **cheatgrass** **Dalmatian toadflax** **diffuse knapweed** **Japanese brome** **jointed goatgrass** **leafy spurge** **Russian knapweed** **Russian olive** **saltcedar** **Scotch thistle**

National Forest	Major Invasive Species*	
Lincoln	mammal	feral swine
	terrestrial plant	Dalmatian toadflax **musk thistle** **Russian knapweed** yellow toadflax
	pathogen	white pine blister rust
Prescott	terrestrial plant	**Dalmatian toadflax** diffuse knapweed Malta starthistle **saltcedar** **sweet resinbush**
Santa Fe	fish	brown trout rainbow trout
	terrestrial plant	bull thistle Canada thistle musk thistle Scotch thistle
	pathogen	whirling disease (*Myxobolus cerebralis*) white pine blister rust
Tonto	amphibian	bullfrog
	fish	brown trout green sunfish mosquito fish rainbow trout
	crustacean	northern crayfish
	terrestrial plant	**buffelgrass** bull thistle **Canada thistle** **Diffuse knapweed** **fountain grass** **Malta starthistle** **musk thistle** red brome **saltcedar** Scotch thistle tree-of-heaven **yellow starthistle**

* Species shown in **bold** have priority for treatment by the forest.

** The Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs are administered by the Cibola NF.

As indicated in table 1, there are several significant pathogens that are affecting ecosystems in Region 3. White pine blister rust, a fungal pathogen, has impacted forests in the Region that have populations of Southwestern white pine (*Pinus strobiformis*). The pathogenic parasite *Myxobolus cerebralis* causes whirling disease in juvenile trout and is a major threat to national forests in Region 3 with cold water fisheries. As an etiologic agent, the chytrid fungus currently found in amphibians on the Gila NF and possibly other NFS lands in Region 3 can cause mortality and subsequent population declines. Apart from sanitation measures taken to stop the spread of these pathogens, selection and propagation of disease-resistant stock of affected species may be the only strategy in mitigating impacts once these invasive pathogens are present.

In addition to the aquatic pathogen *M. cerebralis*, major aquatic invasive species currently found in water systems of Region 3 include an aquatic plant and animal species such as fish, an amphibian (bullfrog), and several invertebrates (table 1). These particular species have the potential to alter aquatic communities through their presence. Although brown trout and rainbow trout are currently stocked for recreational fishing, these introduced fish species can negatively impact native fish species either through predation, competition, or hybridization with closely related species. Preventive measures such as eradication, educational outreach, signing, inspections, and equipment washing may be the most useful ways to help prevent spread of these species between waterways. Management of aquatic invasive species is generally the responsibility of fishery biologists in the NFS wildlife, fish, and rare plants program.

Terrestrial invasive plants shown in table 1 include annual, biennial, and perennial species of grasses, forbs, shrubs, and trees. Nearly all of these species are listed by states in Region 3 as noxious weeds which by statutory regulation require management by landowners; however, these species are typically quite difficult to control once established. Effective treatment of a number of these invasive plants may require more than one method of treatment or a series of separate treatments to control them. In some cases, re-treatment of infested sites may be necessary over a period of years to control seedlings arising from seed banks or prevent regrowth from residual plant propagules such as roots. Many of the deep rooted perennial species cannot be controlled by manual or mechanical methods and require chemical treatment for effective control. Region 3 has developed field guides for identification and management of many of the invasive plant species listed in table 1 which may be found at Region 3's Forest Health website: http://www.fs.usda.gov/main/r3/forest-grasslandhealth. Further information on these field guides is provided at the end of this report.

Figure 1 shows the increase in estimated invasive plant acreages that have occurred across most national forests and grasslands in Region 3 from the years of 2002 to 2012. The exceptions are the Carson and Prescott NFs which respectively show a slight decline or stability in estimated acreage of invasive plants over the 10-year period. The median increase across the other nine forests in Region 3 occurs with the Cibola NF which had an increase of 9.8×.[1] These increases for estimated infested acreage over the 10-year period probably reflect a combination of (1) an upward trend in infestations resulting from the spread of invasive plant species as well as from fire, (2) improved methods for survey and inventory, and (3) possible exclusion of certain noncontainable invasive species in the 2002 estimate. Exclusion of invasive grasses as part of the total infested acreage may account for the 500-fold increase shown in 2012 for the Tonto NF which has experienced successive waves of invasive grass species (red brome, lovegrasses, etc.)

[1] The median is the middle value at which 50 percent of variables are above the value and 50 percent are below.

over the last few decades (P. Fenner, Tonto NF, pers. comm., 2012). In general, these grasses are not treated on the Tonto NF due to their widespread expansion across the forest and the need to focus on the threat from other invasive plant species.

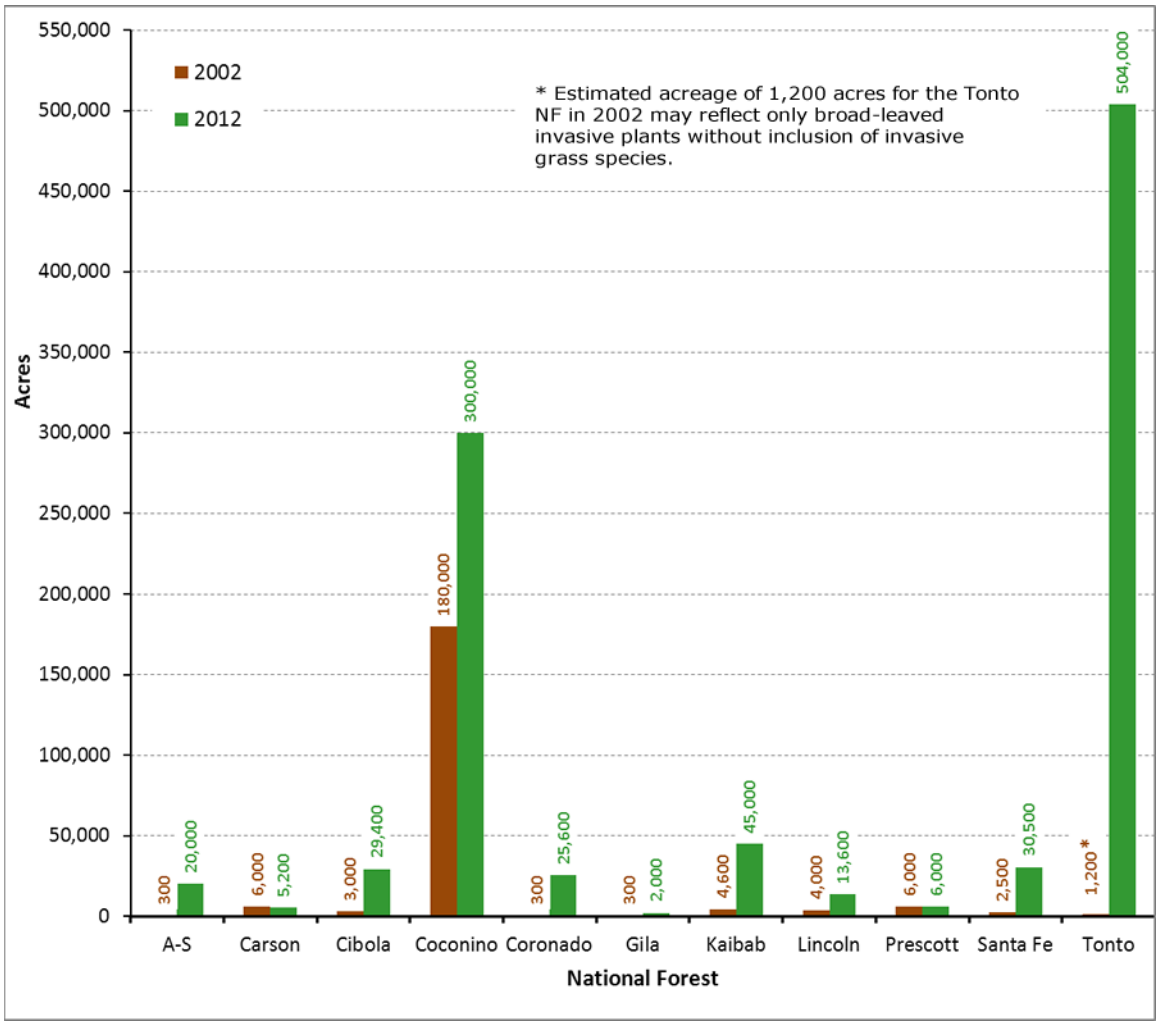

Figure 1. Estimated invasive plant acreages on national forests and grasslands in Region 3 over a 10-year period from 2002 to 2012

Infested acreages shown in figure 1 for each forest combine both priority and nonpriority species of invasive plants with respect to treatment.[2] Certain invasive species such as cheatgrass or saltcedar that have spread out over entire landscapes may not have priority for treatment on a particular national forest due to cost and adequacy of treatment methods. Treatment of these species may only occur as a second priority when opportunities become available. Currently, there is no single strategy used in Region 3 to prioritize invasive plant species for treatment. Various strategies are used by Region 3 forests to prioritize invasive species including strategies

[2] The term "treatment" refers to any activity or action taken directly to eradicate, control, or otherwise manage the spread of an invasive species or weed.

that were originally outlined in the forest's NEPA document for herbicide use. Some forests use a prioritization system that categorizes invasive plants into three classes for treatment:

1. Class A – Those invasive weeds that are nonnative (exotic) to the state and are of limited distribution or are unrecorded in the state and pose a serious threat to agricultural croplands; rangelands; plants listed as endangered, threatened, or sensitive; and other natural and economic resources in the ecosystem. Class A plants receive highest priority. Management emphasis is on complete eradication.
2. Class B – Those invasive weeds that are nonnative (exotic) species that are of limited distribution or are unrecorded in a region of the state but are common in other regions of the state. Class B plants receive second highest priority. Management emphasis is to contain the spread, decrease population size, and eventually eliminate infestations when cost-effective technology is available.
3. Class C – Consists of any other invasive weeds (exotic or native). This classification receives the lowest priority. Management emphasis is to contain spread to present population size or decrease population.

Major invasive species potentially threatening national forests and grasslands in Region 3 in the near future are listed in table 2. Establishment of these species on NFS lands may best be controlled though prevention measures (e.g., contract requirements for sanitation methods involving transport of equipment) and by early detection and rapid response (EDRR) at the earliest stages of infestation or appearance. In a review of eradication projects in California, Rejmánek and Pitcairn (2002) found that eradication of exotic weed infestations smaller than 2.5 acres (one hectare) were generally successful but that projects attempting to eradicate infestations between 2.5 acres and 250 acres were successful only one-third of the time. Their review also found that infestations larger than 2,500 acres were almost never eradicated due to realistic limits on available resources to control them.

Table 2. Major invasive species potentially threatening national forests and grasslands in Region 3 in the near future

National Forest	Major Invasive Species Threats in the Near Future*	
Apache-Sitgreaves	terrestrial plant	buffelgrass camelthorn **Dalmatian toadflax** hoary cress **yellow starthistle**
Carson	terrestrial plant	black henbane (*Hyoscyamus niger*) field bindweed (*Convolvulus arvensis*) myrtle spurge (*Euphorbia myrsinites*) yellow starthistle
	aquatic algae	Didymo (rocksnot) (*Didymosphenia geminata*)
	pathogen	white pine blister rust

National Forest	Major Invasive Species Threats in the Near Future*	
Cibola (includes Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs)**	none known	
Coconino	reptile	spiny softshell turtle (*Apalone spinifera*) pond slider turtle (*Trachemys scripta*)
	fish	armored catfish (*Plecostomus* spp.) black crappie (*Pomoxis nigromaculatus*) bluegill (*Lepomis macrochirus*) brown trout common carp (*Cyprinis carpio*) fathead minnow (*Pimephales promelas*) golden shiner (*Notemigonus crysoleucas*) goldfish (*Carassius auratus*) largemouth bass (*Micropterus salmoides*) mosquito fish rainbow trout red shiner (*Cyprinella lutrensis*) walleye (*Sander vitreus*) white crappie (*Pomoxis annularis*) yellow perch (*Perca flavescens*)
	mollusc	Asian clam (*Corbicula fluminea*) Chinese mystery snail (*Bellamya chinensis*) decollate snail (*Rumina decollate*) ramshorn snail (*Planorbarius* spp.)
	terrestrial plant	Athel tamarisk hybrids (*Tamarix aphylla*) buffelgrass Canada thistle dyer's woad (*Isatis tinctoria*) oxeye daisy (*Leucanthemum vulgare*) purple loosestrife sulfur cinquefoil (*Potentilla recta*)
	pathogen	white pine blister rust
Coronado	mollusc	quagga mussel (*Dreissena bugensis*) zebra mussel (*D. polymorpha*)
	terrestrial plant	Malta starthistle Sahara mustard (*Brassica tournefortii*) saltcedar
Gila	terrestrial plant	African rue (*Peganum harmala*) hoary cress yellow toadflax
	pathogen	white pine blister rust
Kaibab	none known	

National Forest	Major Invasive Species Threats in the Near Future*	
Lincoln	fish	brown trout rainbow trout
	terrestrial plant	Canada thistle
Prescott	fish	brown trout rainbow trout
	terrestrial plant	buffelgrass **tree-of-heaven** yellow starthistle
Santa Fe	terrestrial plant	rush skeletonweed yellow starthistle
	aquatic algae	Didymo (rocksnot)
Tonto	mollusc	quagga mussel apple snail (*Pomacea* spp.)
	terrestrial plant	camelthorn globe chamomile (*Oncosiphon piluliferum*) **sweet resinbush**

* Species shown in **bold** have priority for treatment by the forest.

** The Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs are administered by the Cibola NF.

Invasive Species of Special Concern

Buffelgrass

Of the invasive species identified in table 1, buffelgrass (*Pennisetum ciliare*) is the single greatest threat to national forests in Arizona. Buffelgrass is an invasive bunchgrass species from Africa that was developed in the U.S. as a drought tolerant forage grass. Buffelgrass was originally planted in Texas and Mexico for forage; however, it now threatens the Sonoran Desert ecosystem through its expansion into southern Arizona and most of the State of Sonora in Mexico. Although buffelgrass seed may be spread over long distances by dispersing mechanisms such as vehicles and wind, individual patches of buffelgrass can double in 3.3 to 6.5 years due to an exponential growth rate (Olsson, 2010). The threat from buffelgrass comes from its ability to out compete native desert vegetation for water, nutrients, and sunlight and also by the formation of dense buffelgrass patches that allow fires to spread across the landscape on a cyclical basis. The Sonoran Desert evolved without fire, and most of the native plants in the desert such as the iconic saguaro cactus (*Carnegiea gigantea*) are fire intolerant. As a result, buffelgrass is effectively transforming large parts of the desert ecosystem into fire-prone tropical savanna.

Both the Coronado and Tonto NFs in Arizona have become infested by buffelgrass. In particular, the Coronado NF in southeast Arizona has more than 25,000 total acres of buffelgrass at varying levels of density along the foothills of the Santa Catalina Mountains that lie north of Tucson. The foothills contain the Pusch Ridge Wilderness (PRW) which encompasses almost the entire Sonoran Desert ecosystem on the forest. Buffelgrass is altering the wilderness character of the PRW as well as degrading native habitat for species of concern such as the Sonoran desert tortoise (*Gopherus agassizii*) and desert bighorn sheep (*Ovis canadensis nelsoni*) (S. Biedenbender, Coronado NF, pers. comm., 2012). Smaller stands of buffelgrass have been found on the Coronado's Nogales and Sierra Vista RDs along the Mexican border. The Tonto NF in central Arizona has buffelgrass infestations on four of its six ranger districts. Buffelgrass expansion into other national forests in Arizona may be limited only by the relative intolerance of buffelgrass to cold climes or higher elevations. However, global warming and the potential release of a winter-hardy buffelgrass cultivar (cv. "Frio") may further this expansion into northern regions or higher elevations.

The Coronado and Tonto NFs have engaged in a number of activities to control buffelgrass including (1) use of NFS personnel for grubbing or applying herbicide, (2) physical removal of buffelgrass by using local volunteers and Arizona Department of Corrections work crews, (3) coordinating with Arizona Department of Highways on highway projects, and (4) cosponsoring community volunteer events such as an annual Beat Back Buffelgrass Day. Given the widespread buffelgrass infestations across the Coronado NF, only the Sabino Canyon Recreation Area (approx. 1,388 acres) and possibly other relatively small portions of the forest found at lower elevations may realistically be kept free of buffelgrass through ground treatments alone (S. Biedenbender, Coronado NF, pers. comm., 2012). Aerial treatment with the most commonly used herbicide for buffelgrass control (i.e., glyphosate) would provide more comprehensive control

although nontarget species would be susceptible to this nonselective herbicide. An interagency spray project using glyphosate on 12 test plots near Tucson was undertaken in 2010 to test effects of variable herbicide rates on buffelgrass and native vegetation. Cooperators on the spray project included the Forest Service, Saguaro National Park, BLM, Pima County, University of Arizona, and City of Tucson. In addition, two separate studies have been funded by FHP's Pesticide Impact Assessment Program (FS-PIAP) to study the feasibility of using preemergent and postemergent herbicides in conjunction with glyphosate to control buffelgrass. No classical biocontrol agents are available for buffelgrass; however, a study project with Rocky Mountain Research Station was funded in 2012 through FHP's Biological Control Program to investigate the possible development of an herbicide from a phytotoxin associated with a fungal pathogen of buffelgrass.

Cheatgrass

Cheatgrass (*Bromus tectorum*) is of particular concern on the Kaibab NF in Arizona due to the introduction of a wildfire regime in cheatgrass-dominated plant communities. In the past, the North Kaibab RD on the northern rim of the Grand Canyon has experienced devastating wildfires within the sagebrush-bunchgrass and pinyon-juniper communities that cover the district. An extensive spraying program with Plateau® herbicide (imazapic a.i.) is used on the district to control large stands of cheatgrass which must be sprayed annually to prevent wildfire outbreaks and the destruction of native plant communities.

Feral Swine

Feral swine (*Sus scrofa*) in Region 3 principally occur on the Lincoln NF and on the Black Kettle, Kiowa, and Rita Blanca NGs; however, they are known to be present on other NFS lands in the Region. Feral swine are comprised of free roaming European wild boars, former domestic pigs, and hybrids. Rooting in the ground by feral swine for food can create large areas of disturbance that potentially causes establishment of invasive plants, soil erosion, water quality degradation, and property damage. Unless properly controlled by hunting or through animal damage control efforts by USDA Animal and Plant Health Inspection Service (APHIS), NFS lands can serve as a reservoir for feral swine that allows them to move in and out of Federal land onto adjacent private property or state lands and, thereby, cause damage to crops, rangeland, or other resources.

Saltcedar

One of the most widely dispersed invasive species in Region 3 is saltcedar (*Tamarix* spp.) which commonly occurs as either a shrub or tree in thick stands along waterways. Saltcedar can affect riparian systems by altering stream flow (via evapotranspiration processes) and the ecology (e.g., soil salinity and microbial activity). However, some detrimental effects attributed to the species such as excessive evapotranspiration may be overestimated (Glenn and Nagler, 2005). In New Mexico, saltcedar is listed as a Class C noxious weed species, which allows saltcedar management to be determined locally according to infestation levels and feasibility of control. In contrast, Arizona does not include saltcedar on its prohibited, regulated, or restricted plant lists.

In 2001, the northern tamarisk beetle (*Diorhabda carinulata*; syn., *Diorhabda elongata deserticola*) from central Asia was released in Colorado, Nevada, and Utah as a host specific biological control agent for saltcedar. Adult tamarisk beetles and larvae both consume the foliage of saltcedar which can damage or kill the plant over a period of several years, thereby reducing

saltcedar competition with native riparian flora. Since its release, *D. carinulata* has migrated into northern parts of Arizona and New Mexico from the original release sites. Other species of *Diorhabda* from different ecoregions in Eurasia were also released in California and Texas in the early 2000s.

Although USDA APHIS no longer issues permits for transport of *Diorhabda* beetle species across state boundaries, beetle migration is expected to continue naturally and possibly by human intervention within individual states. Therefore, it may no longer be necessary in the future to treat saltcedar on some NFS lands in the Southwest. However, areas with defoliated saltcedar may become infested by other invasive plant species or weeds that would need to be controlled. In addition, the advancing migration of tamarisk beetle species threatens nesting habitat used by the federally listed southwestern willow flycatcher (*Empidonax traillii extimus*) which nests in saltcedar dominated plant communities that have replaced native willow species (*Salix* spp.). To identify potential *Diorhabda* impacts on the flycatcher, a collaborative study between Region 3's FHP Program, U.S. Geological Survey, and Northern Arizona University (NAU) has been funded by FHP's Biological Control Program to collect baseline data on plant diversity, avifauna, herpetofauna, and microclimate in watersheds of the Verde and Tonto Rivers in Arizona prior to *Diorhabda* establishment.

Sweet Resinbush

Sweet resinbush (*Euryops subcarnosus* ssp. *vulgaris*) is a medium-sized shrub (2 to 3 feet tall) with bright yellow flowers and prolific seed production. The shrub was brought into southern Arizona from Africa during the 1930s to aid in erosion control. Livestock and wildlife do not utilize the plant for forage, and it has subsequently been found to form monocultures that can eliminate native plants and, thereby, exacerbate erosion. The potential threat from sweet resinbush's ability to out compete native plant communities has caused local land managers to attempt eradication or containment of the species while its infestation sites are relatively small. However, this is not easily achieved due to rough terrain and the inconspicuous appearance of the shrub during the nonflowering part of the year. A limited number of herbicides have been found to control sweet resinbush, but these herbicides (hexazinone, tebuthiuron, and metsulfuron methyl) can also impact nontarget vegetation. Prescribed burning provides only partial control of this invasive shrub. A classical biocontrol agent may need to be investigated to assure long-term control if current eradication and containment efforts do not adequately control this invasive shrub.

The largest infestation of sweet resinbush occurs on state land on Frye Mesa which is located 15 miles southwest of the town of Safford, Arizona. Containment of the estimated 5,000-acre infestation on Frye Mesa is currently enforced at the base of the mesa and along the boundary of the Coronado NF at the upper end of the mesa. However, long-term containment of the site may not be possible since escaped individuals are increasingly showing up in nearby valley bottomland. Sweet resinbush infestations also exist elsewhere on the Coronado (1,030 acres), Tonto (27 acres), and Prescott (140 acres) NFs. The three forests have been heavily committed to controlling the invasive shrub on NFS lands through prescribed burning, herbicide application, and sponsoring hand-pulling events with local organizations. Although eradication and containment of sweet resinbush have been used on NFS sites, some sites are proving difficult to control and may be impossible to eradicate or contain completely.

Program Operations

Regional Personnel for Invasive Species and Pesticide Use

Under FSM 2904.07 and FSM 2150.4, line officers in the Forest Service have the responsibility to appoint staff as needed to coordinate invasive species management and pesticide use in accordance with statutory regulations, policy, and other national and regional requirements. Management of aquatic invasive species primarily resides with wildlife biologists rather than personnel designated as invasive species coordinators who are generally focused on invasive plant management. The Region's FHP Program is responsible for survey and monitoring of invasive forest pathogens and insects.

Of the approximately 50 persons involved with invasive species and pesticide use in Region 3, nearly all of them at the forest or district level are collateral duty and can only perform work in these particular positions in conjunction with their other duties. For example, the invasive species/pesticide-use coordinator for the Prescott NF is able to spend only 20 percent of her time on the two programs which can even be less in some years due to other work priorities (K. Spleiss, Prescott NF, pers. comm., 2012). The Coconino and Tonto NFs are the only forests that have full-time coordinators for invasive species and pesticide use. About 40 coordinators and applicators involved with pesticide use carry a state pesticide license which is required for developing pesticide-use proposals and application of restricted-use pesticides. Although funding for travel has been an issue in some cases, licensed personnel in Region 3 have generally been able to maintain their license on an annual basis by obtaining CEUs from the region's pesticide workshop, statewide vegetation management conferences, or training courses as published on state agency Web sites.

The level of staffing in Region 3 for invasive species and pesticide-use coordinators has gradually built up during the last decade; however, full staffing on a number of forests has not been achieved due to personnel transfers, retirements, lagging reappointments of coordinators, etc. In addition, training for invasive species management and pesticide use must be done with most new appointments for these positions. This has led to gaps in active invasive species management that can potentially increase infestation levels.

Treatment Targets and Funding Needed for Invasive Plant Management

Under Forest Service policy for managing terrestrial and aquatic invasive species, treatment activities for invasive species on NFS lands are assessed in accordance with NFS program business rules and national standards that have been established for invasive species (see http://fsweb.wo.fs.fed.us/invasivespecies/data/index.shtml). With these business rules and standards, the Forest Service has established protocols necessary for entering and managing site-specific treatment records. The number of acres treated for an invasive species is recorded for each completed site-specific treatment activity on a spatial basis. Records for inventory, treatment, and associated spatial information regarding invasive species are maintained in the Forest Service's database of record, i.e., the FACTS database (**F**orest **AC**tivity **T**racking **S**ystem). The total treated acreage for a particular national forest is summarized for activities undertaken by both NFS personnel and any contracts/agreements awarded during the current fiscal year (FY) when funds have been obligated. On some forests, the overall treated acreage reported in FACTS may reflect treatment conducted on NFS lands by outside organizations such as treatment of

rights-of-way by state or county highway departments. A memorandum of understanding (MOU) between the Forest Service, Federal Highway Administration, and Arizona Department of Transportation was implemented in 2003 to allow use of herbicide in rights-of-way on NFS lands in Arizona.

Table 3 shows forest targets for treated acreage relative to estimated treated acreage needed to control invasive plants adequately on individual forests in Region 3. In a number of cases, treatment targets to control invasive plants on a forest mostly reflect available funding levels rather than needed treated acreage. As allowed by Forest Service business rules, the targets may also reflect only partial or preparatory treatments (e.g., mowing performed before herbicide application) rather than actual control or eradication of individual weed populations. Only 3 of the 11 forests in the Region are currently treating invasive plants at an estimated rate that can adequately control the forest's total infested acreage. Of the forests not meeting the annual treatment rate needed for control, the Carson NF may be able to increase its current annual treatment rate to meet the annual treatment rate once the combined supplemental environmental impact statement (SEIS) for the Carson and Santa Fe NFs is completed in FY13 which will allow herbicide use on these two forests. The seven national forests with the greatest shortfalls for treated acreage needed annually (i.e., Cibola, Coconino, Coronado, Kaibab, Lincoln, Santa Fe, and Tonto NFs) have extensive infestations of invasive plants throughout the forest or associated national grassland. Treatment rates on these forests are inadequate due in part to the extensive nature of these invasive plant infestations. Although the Lincoln NF has a relatively large amount of infested acreage, the forest is able to treat invasive plants at a relatively large scale (5,505 acres in FY11). The Lincoln NF's use of a contracted service allows herbicide application at a greater rate on the forest than can be done by part-time applicators. The cost of $25 per acre for herbicide treatment is also the second lowest average treatment cost in the Region (see table 4).

Table 3. Forest treatment targets and estimated treated acreage needed for invasive plant control

National Forest	Estimated Total Infested Acreage	Treated Acreage Target in FY11	Acreage Actually Treated in FY11	Percent of Treatment Target Done in FY11	Treated Acres Planned in FY12	Estimated Treated Acreage Needed Annually*	Shortfall of Treated Acreage Needed Annually
Apache-Sitgreaves	20,000	700	991	142	700	700	
Carson	5,200	350	403	115	350	750	400
Cibola	29,400	1,000	850	85	500	3,000	2,500
Coconino	300,000	2,200	2,309	105	2,250	4,000	1,750
Coronado	25,600	960	960	100	600	6,400	5,800
Gila	2,000	400	400	100	400	400	
Kaibab	45,000	2,000	2,600	130	2,000	5,000	3,000
Lincoln	13,600	5,500	5,505	100	2,000	5,500	3,500
Prescott	6.000	750	751	100	750	750	
Santa Fe	30,500	350	298	85	350	3,000	2,650
Tonto	504,000	641	718	112	250	3,000	2,750
Region Totals	**981,300**	**14,851**	**15,785**		**10,150**	**32,500**	**22,350**

* Based on estimates by invasive species coordinators for acreage needed to be treated annually on their respective forest.

Table 4 details treatment costs and FY12 budget allocations for invasive species management by each forest. In addition to labor costs for treatment of invasive plants, budget line items (BLIs) used for program operations must also cover purchases of herbicides and equipment (sprayers, utility terrain vehicles (UTVs), trailers, portable data recorders, etc.) as well as costs for equipment maintenance. Treatment costs for individual forests in Region 3 as shown in table 4 reflect factors such as local contracting costs, remoteness of treatment sites, etc. Invasive species funding for Region 3 is principally obtained through the integrated National Forest Resource Restoration (NFRR) allocation for vegetation management. The NFRR BLI was combined from the former BLIs of NFVW, NFTM, and NFWF (respectively, Vegetation and Watershed Management, Forest Products, and Wildlife/Fisheries Habitat Management). The new NFRR BLI is intended to provide line officers with greater flexibility to allocate funding according to priority work that will restore and maintain watersheds and forests on a broad landscape scale. However, each forest is responsible for the actual allocation of money used in treatment of invasive species; and specific funding for invasive species projects must be weighed against other program priorities funded under NFRR. Although all forests received at least partial funding for salaries of personnel for invasive plant management in FY12, no funding was available for treatment on the Coronado and Tonto NFs beyond salaries for personnel. To fund costs for needed annual treatment of acreage in Region 3, overall funding in the Region would have to increase approximately fourfold from $1,107,500 (cost for treatment of planned acreage in FY12) to $4,029,250. However, some of the acreage requiring treatment and resulting treatment cost could possibly be reduced for certain forests through greater refinements in prioritizing invasive plant species for treatment.

Table 4. Treatment costs and funding allocations for invasive plant management

National Forest	Treated Acres Planned in FY12	Estimated Treated Acreage Needed Annually	Average Treatment Cost per Acre	Cost for Planned Treated Acres	Cost to Treat Acreage Needed Annually*	Funding for Salaries and/or Treatment in FY12**	NFRR BLI Allocation in FY12***
Apache-Sitgreaves	700	700	$70	$49,000	$49,000	$41,000	$3,807,525
Carson	350	750	$125	$43,750	$93,750	$48,185	$2,386,844
Cibola	500	3,000	$20	$10,000	$60,000	**$46,484**	$1,721,245
Coconino	2,250	4,000	$111	$249,750	$444,000	$244,000	$3,078,748
Coronado	600	6,400	$200	$120,000	$1,280,000	**$0**	$2,017,465
Gila	400	400	$100	$40,000	$40,000	$62,000	$2,490,416
Kaibab	2,000	5,000	$100	$200,000	$500,000	$200,000	$1,947,920
Lincoln	2,000	5,500	$25	$50,000	$137,500	**$40,000**	$2,469,091
Prescott	750	750	$300	$225,000	$225,000	$48,900	$1,865,617
Santa Fe	350	3,000	$200	$70,000	$600,000	$70,000	$2,978,359
Tonto	250	3,000	$200	$50,000	$600,000	**$0**	$2,308,834
Region Totals	**10,150**	**32,500**		**$1,107,500**	**$4,029,250**		**$27,072,064**

* Total costs based on acres planned for treatment plus shortfall of treated acres.

** Funding received for salaries and/or treatment for invasive plant management through various budget line items (BLIs) including NFRR. Figures in **bold** do not include salaries and indicate funding for treatment only.

*** Under the NFRR BLI, funding for the invasive species program is integrated with other programs.

In addition to funding invasive species projects from NFRR, other BLIs and sources of funding may be used for treatment of invasive species as seen in table 5. Under FSM 2903, funding for invasive species management can be integrated broadly across NFS programs as part of accomplishing the purpose and needs of a particular project or program objective. BAER (burned area emergency response) funding for fire restoration projects involving invasive plants has been made available when substantial fires have occurred. Some forests in the Region have obtained grant money to supplement invasive species treatment as shown in the table. There is an expectation on certain forests that shortfalls in funding for invasive plant treatment should be made up from alternative funding sources other than program funding. Treatment for buffelgrass and other invasive plants on the Coronado NF in FY12 was accomplished entirely through grants rather than program funding under NFRR or other BLIs. However, grants and similar funding sources in general have declined or become nonexistent in the last few years due to budgetary shortfalls.

Table 5. Alternative budget line items (BLIs) and supplemental funding used for invasive species management in Region 3

National Forest	Alternative BLIs and Supplemental Funding*
Apache-Sitgreaves	BAER funding
Carson	Partnership and volunteer labor, NFRW for YCC treatments, severity dollars for fire personnel who need work assignments between fires.
Cibola (includes Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs)**	NFIM, NFXN (Sikes Act), NFRG, WFHF
Coconino	NFN3 and WFW3 pending availability in fire rehabilitation projects NFWF for wildlife habitat improvement CFRR05 for survey, inventory, and treatment in the 4FRI project area Grants: Resource Advisory Committee (RAC), State & Private Forestry, National Fish and Wildlife Foundation, Walton Foundation CONT is contributed work from partner agencies (ADOT, AZG&F, AZ State Parks, APHIS, Coconino County, municipal, National Park Service, NRCD, Yavapai County)
Coronado	AZ State Forestry Agreement (agreement ends September 2012) Pima County Secure Rural Schools grant (funds will be exhausted in FY12) Santa Cruz County Secure Rural Schools grant (funds will be exhausted in FY12) Graham County Secure Rural Schools grant
Gila	None
Kaibab	BAER treatments Arizona Game and Fish Agreement Arizona Department of Transportation
Lincoln	WFW3
Prescott	None
Santa Fe	CFLN

National Forest	Alternative BLIs and Supplemental Funding*
Tonto	Grants: Eastern AZ RAC grant, Southern AZ RAC grant CONT (contributed), CWCD (cooperative) NFMG, CMXN (ADOT Hwy. projects), PSCP, WFHF

* Treatment funding received through BLIs other than NFRR: CFLN (Cooperative Forest Landscape), CFRR (Collaborative Forest Landscape Restoration Matching), CMXN (Constrained Non-Fed External Reimburse), NFIM (Inventory/Monitoring), NFN3 (Rehab and Restoration), NFXN (Non-Federal External Reimbursement), PSCP (Payments to States, County Projects), WFHF (Hazardous Fuel Reduction), WFW3 (Wildlands Rehab and Restoration).

** The Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs are administered by the Cibola NF.

Surveying and Monitoring for Invasive Species

Forests are required to collect, maintain, and report information related to invasive species infestations, impacts, and management activities (including inventories, surveys, assessments, treatments, and treatment efficacy) in compliance with national invasive species program protocols, criteria, rules, and requirements (FSM 2904.07). Surveying is the process of systematically searching a geographic area for invasive species to determine their presence whereas inventory is typically conducted to quantify the extent and nature of infestations identified during survey activities. Treatment activities involving invasive species infestations are monitored for effectiveness, and a target of 50 percent of acres treated is set by Forest Service business rules for monitoring of treatment effectiveness. In addition, management activities (e.g., construction) on NFS lands are required to be monitored for establishment or potential spread of invasive species. Data from survey, inventory, and monitoring activities is recorded through the use of a software application (Invasive Species Mobile v. 2.5) that has been developed by the Forest Service's Natural Resource Information System (NRIS) for use with portable data recorders (PDRs), PCs, or tablets. The GPS-driven application integrates tabular and spatial field data on invasive species which can then be downloaded into the FACTS database.

Table 6 shows acreages or miles of invasive plants that were surveyed and monitored by individual forests during FY11. Relative to total infested acreages found on Region 3 forests, the current level of surveying may not adequately assess the spread of invasive plant infestations on a given forest. Although most forests exceeded the 50 percent target for monitoring of treatments done in FY11, this target is not always achievable during the fiscal year due to interruptions from fire season activities, budget shortfalls, and other considerations. Increases in infested acreage as a result of fires can require increased surveying and monitoring that could prove problematic in budget restricted years. In addition, FS personnel may not be able to survey and inspect sites to ensure that contractors are following best management practices (BMPs) for invasive plants.

Table 6. Forest activities for surveying and monitoring in FY11

National Forest	Estimated Total Infested Acreage	Acres or Miles Surveyed in FY11	Percent of Infested Acres Surveyed	Number of FY11 Monitoring Events	Acres Monitored in FY11	Percent of Treated Acres Monitored
Apache-Sitgreaves	20,000	0	0		1,000	100
Carson	5,200	50	1	12	140	35
Cibola	29,400	250	1	numerous	850	100

National Forest	Estimated Total Infested Acreage	Acres or Miles Surveyed in FY11	Percent of Infested Acres Surveyed	Number of FY11 Monitoring Events	Acres Monitored in FY11	Percent of Treated Acres Monitored
Coconino	300,000	24,000	8	numerous	8,574	371
Coronado	25,600	900	4	18	1,460	100
Gila	2,000	30 miles				
Kaibab	45,000	2,600	6	numerous	2,600	100
Lincoln	13,600	0	0	all trmts	5,505	100
Prescott	6.000	100	2	2	141	0
Santa Fe	30,500	1,500	5	20	150	50
Tonto	504,000	45	< 1	52	718	100
Region Totals	**981,300**	**29,445 acres and 30 miles**			**21,138**	

Cooperative Management for Invasive Species

The Forest Service's "National Strategy and Implementation Plan for Invasive Species Management" emphasizes partnerships and collaboration as part of the overall strategy for weed management within NFS lands.[3] The plan states that Forest Service collaboration should extend to other Federal agencies, state and local governments, tribal interests, nongovernmental organizations, the private sector, and international stakeholders. Direction in FSM 2904 also requires line officers to foster collaborative efforts such as cooperative weed management areas (CWMAs), cooperative invasive species management zones, and similar collaborative partnerships. CWMAs (or similar entities) are local organizations consisting of land managers, landowners, and other interested parties whose purpose is to facilitate cooperation in managing common weed problems across jurisdictional boundaries within the defined area of the CWMA. Cooperative projects for invasive species may include education, prevention, early detection and rapid response, control and containment, restoration and rehabilitation, and inventory and monitoring activities. To facilitate cooperative projects, agreements may be made between CWMAs and the Forest Service to manage invasive plants. This includes cooperative agreements, participating agreements, challenge cost-share agreements, and memoranda of understanding. A participating agreement based on the Wyden Amendment may be used by the Forest Service for cooperatively performed work on private or public land that benefits natural or cultural resources on NFS lands within the watershed. Regional guidance for working with CWMAs and other cooperators has been developed and is available from the Regional coordinator for invasive species and pesticides by calling (505) 842-3280.

State and Private Forestry's Forest Health Protection Program for Region 3 provides funding to both Arizona and New Mexico for assistance with local management of invasive plants on state and private lands. Funding for the invasive plant program is made through a consolidated grant to the State Forester's office which is responsible for administering the program. In FY11, S&PF

[3] The "Forest Service's National Strategy and Implementation Plan for Invasive Species Management" will be replaced in 2013 by the "National Strategic Framework for Invasive Species Management."

provided $418,000 for invasive plant management in the two states; however, only $182,000 was available in FY12. Funding through S&PF's grant program has been used to treat buffelgrass, starthistles, thistles, saltcedar, knapweeds, toadflaxes, and other invasive weeds within the two states. Applicants for treatment projects involving invasive plants are generally CWMAs or resource conservation districts (RCDs), but other organizations can qualify if they are able to treat invasive plants on a cooperative basis. Priority for funding is given to applicants with projects that propose to treat invasive plants (normally species on the state's noxious weed list) that threaten forests and woodlands within the state. Broad-scale projects for management of invasive species on state and private lands may be funded through S&PF's "Competitive Resource Allocation Program" which focuses on projects at a landscape level. For further information on S&PF grant programs for invasive species, contact the state forester offices located in Phoenix, Arizona, ((602) 771-1400) and Santa Fe, New Mexico, ((505) 476-3325).

Table 7 lists cooperative management activities between individual national forests and local CWMAs or other cooperators on invasive weed projects in Region 3. CWMAs and projects highlighted in **bold** indicate forest coordination on invasive plant projects that have been funded by S&PF's FHP grant programs.

Table 7. Forest activities for cooperative management of invasive plants

National Forest	Cooperators and Weed Management Activities*
Apache-Sitgreaves	**Little Colorado River Weed Management Area (LCRWMA) – saltcedar control.** Cooperation with LCRWMA unrelated to S&PF funding includes participation in CWMA's public education efforts.
Cibola (includes Black Kettle, Kiowa, McClellan Creek, and Rita BlancaNGs)**	**Canadian River Riparian Restoration Project– saltcedar control.**
Coconino	**San Francisco Peaks Weed Management Area (SFPWMA) – invasive plant control in Wildland-Urban Interface (WUI), and along roads, creeks, and rights-of-way.** Projects with SFPWMA unrelated to S&PF funding include: (1) maintenance and harvest of local biocontrol insectaries, (2) surveying and monitoring of weed treatment and revegetation projects on city and State lands upstream of Coconino NF, and (3) training to provide annual CEUs for licensed pesticide applicators in wildland settings. Participation in Southwest Vegetation Management Association to (1) coordinate weed management in wildland settings and ROWs and (2) provide pesticide training and CEUs for licensed applicators in wildland settings. **Verde Watershed Restoration Coalition – invasive plant control along the Verde River.** Yavapai Weed Management Area – coordination for workshops on mapping and monitoring.
Coronado	Participation and coordination with Southeast Arizona CWMA, Southern Arizona Buffelgrass Coordination Center (SABCC), Buffelgrass Working Group, and Tucson Mountain-Sonoran Desert Weedwackers.
Gila	**Southwest New Mexico Cooperative Weed Management Area – invasive plant control.** Participation at meetings held by Sierra County CWMA, Southwest New Mexico CWMA, and New Mexico Department of Transportation.

National Forest	Cooperators and Weed Management Activities*
Kaibab	**San Francisco Peaks Weed Management Area – classical biocontrol of invasive plants.**
Lincoln	Coordination with local soil and water conservation district for invasive plant treatments on private lands. Participation in CWMAs of both Lincoln and Otero Counties.
Prescott	Participation in meetings of West Yavapai Weed Management Area.
Santa Fe	Northern New Mexico CWMA – weed inventory and planned treatment of private lands near Coyote, NM.
Tonto	Participation and coordination with Arizona Department of Transportation, Las Sendas community of the city of Mesa, Phoenix Weedwackers, Tohono O'odham Nation, Tonto NRCD, Tonto Weed Management Area, towns of Star Valley and Superior, Volunteers for Outdoor Arizona, and the WAKEUP! coalition (AZ State Land Department, Maricopa County Parks, Desert Foothills Land Trust, city of Scottsdale, and towns of Cave Creek and Carefree). Participation in Southwest Vegetation Management Association to (1) network weed management in wildland settings and ROWs and (2) provide pesticide training and CEUs for licensed applicators in wildland settings.

* CWMA projects shown in **bold** were funded through S&PF grants.

** The Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs are administered by the Cibola NF.

NEPA Status in Region 3

Nine of the 11 national forests in Region 3 currently have existing environmental reviews and decisions that enable pesticide use on NFS lands. A combined supplemental environmental impact statement (SEIS) for the Carson and Santa Fe NFs is currently in development with completion expected in FY13. Until herbicide use is authorized through a decision based on environmental analysis, invasive species management on these two forests is restricted to physical methods of control (hand pulling, mowing, etc.) or cultural techniques (e.g., sanitary procedures). These types of non-herbicide methods typically allow only a very limited approach for treatment and should not be expected to provide adequate control of certain invasive plants such as deep rooted perennial species. If a determination is reached by the Coronado NF to treat buffelgrass on a landscape basis with aircraft, an EIS will need to be developed to apply herbicide aerially to buffelgrass in accordance with Forest Service Handbook (FSH) 1909.15 – Chapter 20. EISs would also have to be developed for other national forests to allow aerial treatment for infestations that normally cannot be controlled by ground methods alone.

Several forests in Region 3 have relatively old decision documents dating from the 1990s (e.g., EAs for the Lincoln and Gila NFs) or early 2000s (e.g., EA for the Coronado NF) that do not include new herbicide active ingredients (e.g., aminopyralid or aminocyclopyrachlor). These new types of herbicides can be more cost effective and potentially have better safety profiles with fewer environmental impacts. A review should be made of existing environmental analysis and decision documents to determine whether newly available herbicides have the same or similar impacts compared to analyses and effects evaluated in these older documents. If addition of these herbicides is consistent with the existing environmental analysis, a supplemental information report (SIR) may be used to add the new herbicides in lieu of a supplemental or a full revision of the NEPA document and new decision. Older environmental analysis documents for herbicide use may also need to be updated to allow use of biocontrol agents and to revamp control methods or

strategies that have proven inadequate including replacement of relatively small scale treatment with herbicides on the forest with larger scale treatments.

Pesticides Used for Invasive Species in Region 3

Herbicide active ingredients used on national forests and grasslands in Region 3 are shown in table 8. Most of the herbicides are selective for broad-leaved plants, although some herbicides (e.g., Plateau®) may control grasses in addition to broad-leaved species. Glyphosate, a nonselective herbicide, is used on most forests. The herbicides may be applied singly during treatment or in combination with other herbicide active ingredients. With the exception of picloram (e.g., Tordon®), nearly all herbicides used to control invasive plants are general-use pesticides.[4] Although general-use pesticides do not normally require licensing, Region 3 employees must obtain a pesticide license from his or her respective state licensing agency if their job entails (1) applying restricted-use pesticides, or (2) serving as a pesticide coordinator for their forest or district with the responsibility of developing pesticide-use proposals (PUPs). Treatment records for application of these herbicides during individual projects are maintained in the Forest Service's FACTS database. The records include information on the applicator, types of herbicide used, treatment sites, rate of application, and other pertinent records.

Pesticide application for invasive plant treatment is normally done with backpack sprayers or from sprayer tanks on ATVs, UTVs, or spray trailers. Coverage is generally limited to spot spraying in local areas, although personnel on the North Kaibab RD spray approximately 2,000 acres of invasive plants (mainly cheatgrass) each year by using a UTV sprayer. Nearly all pesticide applicators in Region 3 are collateral duty and can apply herbicides only on a part-time basis. This limits the amount of acreage that can be effectively treated each year with herbicides or other treatments. The use of a contracting service (as employed by the Lincoln NF) or another type of dedicated application service may be necessary to achieve a scale of herbicide application that meets the necessary treated acreage for the forest on an annual basis.

Table 8. Herbicides used in Region 3 for management of invasive plants and weeds

National Forest	Herbicide Active Ingredients	
Apache-Sitgreaves	dicamba	triclopyr
Cibola (includes Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs)*	2,4-D dicamba	glyphosate
Coconino	aminopyralid chlorsulfuron 2,4-D dicamba fluroxypyr glyphosate imazapic imazapyr	isoxaben metsulfuron methyl pendimethalin picloram** sethoxydim sulfometuron methyl tebuthiuron triclopyr

[4] Restricted-use pesticides such as picloram require state licensing since EPA or individual states have determined that these pesticides can adversely affect human health or the environment to an unreasonable degree. Therefore, use of these pesticides is restricted to a certified applicator or else requires the direct supervision of a certified applicator.

National Forest	Herbicide Active Ingredients	
Coronado	glyphosate tebuthiuron	triclopyr
Gila	aminopyralid imazapyr	triclopyr
Kaibab	aminopyralid chlorsulfuron	imazapic metsulfuron methyl
Lincoln	glyphosate dicamba	picloram** sulfometuron-methyl
Prescott	clopyralid glyphosate imazapyr	picloram** triclopyr
Tonto***	aminopyralid 2,4-D glyphosate	imazapyr metsulfuron methyl triclopyr

* The Black Kettle, Kiowa, McClellan Creek, and Rita Blanca NGs are administered by the Cibola NF.

** Restricted-use herbicide

*** Areas treated with herbicide on the Tonto NF prior to completion of the Tonto's EA in FY12 were done under a categorical exclusion (CE) as allowed by NEPA or under NEPA specific for treatment of invasive plants along Federal and State highways in Arizona.

In addition to the herbicides shown in table 8, two piscicides (rotenone and antimycin A) are used on several forests in Region 3 to control invasive aquatic species. These piscicides are restricted-use pesticides and are primarily used to remove invasive species such as rainbow trout for replacement with T&E fish species such as Gila trout (*Oncorhynchus gilae*). Treatment projects using piscicides to restore native fish in waters on NFS lands are conducted by licensed state game and fish biologists in cooperation with the Forest Service.

Classical Biocontrol Agents Used in Region 3

The Coconino, Kaibab, and Prescott NFs are actively engaged in the use of classical biocontrol agents for control of certain invasive plant species in conjunction with herbicide applications (see table 9). The biocontrol agents are used mainly to control knapweeds, yellow starthistle, Dalmatian toadflax, and leafy spurge. As part of the IPM process, biocontrol agents may be used when target species are spread too widely over a landscape for effective treatment with herbicide applications, or when unacceptable damage to nontarget species may occur.

In FY11, approximately 755 acres of infested plants on NFS lands in Region 3 were treated with biocontrol agents (515 acres treated on the Coconino NF and 240 acres on the Prescott NF). For recording treatment activities involving classical biocontrol agents, a one-time credit of 5 acres is assumed for release of an agent at a site on a single day. Sources for biocontrol agents include collections obtained from USDA APHIS, private companies, and locally developed insectaries. A permit must be obtained from APHIS before biological control agents can be transported across state boundaries. Further information on biocontrol projects in Region 3 may be obtained from Laura Moser at (928) 527-4323.

Table 9. Biocontrol agents used in Region 3 for invasive plants

National Forest	Biocontrol Species	Type	Targeted Weeds
Coconino	*Apthona lacertosa*	flea beetle	leafy spurge
	Apthona nigriscutis	flea beetle	leafy spurge
	Bangasternus fausti	weevil	diffuse and spotted knapweeds
	Bangasternus orientalis	weevil	yellow starthistle
	Calophasia lunula	moth	Dalmatian toadflax
	Cyphocleonus achates	weevil	diffuse and spotted knapweeds
	Eustenopus villosus	weevil	yellow starthistle
	Larinus curtus	weevil	yellow starthistle
	Larinus minutus	weevil	diffuse and spotted knapweeds
	Larinus obtusus	weevil	knapweeds and yellow starthistle
	Mecinus janthinus	weevil	Dalmatian toadflax
	Urophora spp.	gall fly	diffuse and spotted knapweeds
Kaibab	*Larinusminutus*	weevil	diffuse and spotted knapweeds
	Mecinusjanthinus	weevil	Dalmatian toadflax
	Urophora affinis	gall fly	diffuse knapweed
Prescott	*Mecinus janthinus*	weevil	Dalmatian toadflax

Conclusions

As with other Forest Service Regions, national forests and grasslands in Region 3 have experienced a substantial increase in invasive species numbers and infested areas during recent years. Continued expansion of invasive plant populations on NFS lands can be expected to have a major impact on forest resources and management goals for landscape restoration. The increase of NFS lands infested by invasive plants on the majority of Region 3 forests over the last decade indicates that efforts applied toward invasive plant control need to be improved across the Region.

As indicated in table 4, full funding for invasive plant treatment is a major problem on most forests. Funding levels for invasive plant treatment (apart from salaries) as provided for forests under the NFRR BLI range from (1) full funding under NFRR, (2) partial funding with NFRR and other BLIs, and (3) no funding under NFRR (Coronado and Tonto NFs). To a limited extent, alternative sources of funding apart from NFRR may be used to supplement NFRR funding. As allowed under FSM 2903, BLIs other than NFRR may be used to fund invasive species management as part of a particular project or program objective. Grants used extensively by some forests in the Region potentially could be an additional funding source on other forests when such grants are available. With inadequate funding, treatment activities on forests are generally restricted to (1) early detection and rapid response for new invasive plant populations, (2) eradication of relatively small weed patches, or (3) containment of existing infestations at perimeter boundaries. These types of responses are insufficient for substantial reduction of invasive plant populations on forests with widespread infestations and may even allow gradual expansion of invasive plants.

With a workforce of nearly 50 coordinators and applicators, Region 3 has relatively good coverage of invasive species and pesticide use across forests in the Region. However, efforts by the current workforce to achieve forest management goals for invasive plant control may be problematic in a number of cases. Due to the part-time status of nearly all of the workforce staff and limited funding available on some forests, invasive plant management on some forests may be restricted to the most basic activities. In addition, the lack of timely replacement of coordinators and applicators on individual forests as a result of lagging reappointments, personnel transfers, retirements, etc., has led to gaps in active management of invasive species.

Large-scale treatment on the order of 3,000 to 6,000 acres per year is needed to manage invasive plants on forests with extensive infestations. Approaches to accomplishing large-scale treatment on NFS lands such as using full-time pesticide applicators, local contractor services (as used on the Lincoln NF), GSA contracting services, or a Regional strike team for pesticide application should be evaluated. Aerial applications of herbicide may be necessary on some forests to treat areas that are too large to be covered adequately by ground methods or else are inaccessible. Highway departments should be encouraged to treat invasive plants in rights-of-way within NFS lands to the fullest extent possible. Biological control agents may be used to supplement other control methods (herbicide, mowing, etc.) for invasive plants when conditions for biocontrol are adequate. To accomplish large-scale treatment of invasive plants with herbicides or biocontrol agents, existing environmental analysis documents and their decisions will need to be reviewed and updated as necessary, including any appropriate NEPA compliance for ground and/or aerial treatments.

Standard procedures for prioritizing invasive plants within the Region should be reviewed. Policy in FSM 2093 requires the Forest Service to “Develop and utilize site-based and species-based risk assessments to prioritize the management of invasive species infestations in aquatic and terrestrial

areas of the National Forest System." Since the overall infested acreages shown in figure 1 represent a combination of priority acreage requiring treatment coupled with nonpriority acreage, a key issue for invasive plant treatment on individual forests is whether forestwide treatment efforts can adequately control priority and nonpriority invasive plants. Strategies for prioritizing invasive species in Region 3 need to be reviewed to assure that (1) the overall increase of invasive plant infestations across the Region from 2002 to 2012 does not reflect inadequate treatment of priority species, and (2) continued spread of nonpriority species does not cause unacceptable adverse effects on ecosystem function and health.

The current level of efforts for survey and inventory of invasive plants across individual forests in Region 3 is probably inadequate. Annual targets specifically related to invasive species infestations as set by Region 3 forests may not provide adequate assessments for conducting detection, inventory, and monitoring of priority invasive plants. In particular, efforts to inventory and survey susceptible NFS lands may not allow effective implementation of the EDRR process such that invasive plant infestations can be detected in early stages and eradicated before the plants can spread.

As evidenced in table 7, forests in Region 3 have made significant efforts in collaborative management of invasive plants with CWMAs, adjacent landowners, and other stakeholders such as DOTs. In particular, grants funded by S&PF allow the Forest Service to partner with CWMAs and other stakeholders in invasive plant projects that can benefit national forests and grasslands. Additional collaboration may be made by employing CWMAs in projects involving the Wyden Amendment or similar instruments. Collaborative grants such as S&PF's "Competitive Resource Allocation" grant that are designed for landscape-level projects on state and private lands may be particularly useful for invasive species management in areas adjacent to NFS lands.

Buffelgrass is an ecosystem-transforming grass species that is currently impacting the Coronado and Tonto NFs. An inability to manage buffelgrass on the Coronado NF will potentially have far-reaching consequences for the Pusch Ridge Wilderness and other parts of the forest covered by the Sonoran Desert. On the Tonto NF, buffelgrass expansion could lead to large ecosystem-changing wildfires in northern reaches of the Sonoran Desert as well as increase the fire hazard for wildland-urban interface (WUI) areas within the forest. A structured, decision-making process should be used to develop a comprehensive strategy for adaptive management of buffelgrass on these forests. Preparation should also be made toward a decision as to whether aerial herbicide application on the Coronado NF is feasible and can be used as a tool for buffelgrass management.

The ongoing expansion of *Diorhabda* beetles into Arizona and New Mexico may facilitate control of saltcedar on some NFS lands; however, the final extent and impact of beetle migration throughout the two states will not be known for some time. Region 3 forests should evaluate the need for saltcedar control projects that eventually may be superseded by biocontrol from *Diorhabda* beetles. Early detection and rapid response will be necessary in areas with defoliated saltcedar to prevent establishment of new invasive plant species or aggressive weeds. Forests should also prepare for restoration of nesting habitat of the southwestern willow flycatcher that potentially will be disrupted by saltcedar depletion on NFS lands.

Recommendations

1. Replacement of coordinators and applicators for invasive species and pesticide use on forests should be expedited to prevent lapses in invasive species management and coordination including the development of PUPs. Sufficient staff time should be given to coordinators and applicators with collateral duties to allow adequate management of invasive species.
2. Forests in Region 3 with relatively small or stable acreages of invasive plants (i.e., Carson, Gila, and Prescott NFs) should attempt to maintain their current low level of infestations through aggressive treatment of new or existing infestations, minimization of disturbance, implementation of sanitary measures for seed and other plant propagules, and other management practices as necessary for controlling invasive plants.
3. Forests with relatively large infestations of invasive plants and low treatment rates (Apache-Sitgreaves, Cibola, Coconino, Coronado, Kaibab, Santa Fe, and Tonto NFs) should adopt strategies for large-scale treatment (3,000 to 6,000 acres) of priority invasive plants on an annual basis as permitted by funding, personnel, etc. Large-scale herbicide application currently practiced on the Lincoln NF through its contractor service should be expanded to 5,500 acres per year.
4. Forests should attempt to provide greater funding priority under the NFRR BLI for treatment of priority invasive plants whenever possible, and funding processes on all Region 3 forests should be reviewed for better integration of BLIs with invasive species projects. In particular, BAER funding for invasive plant management after fires should be improved.
5. Forest management projects should attempt to incorporate survey and control of invasive species as a component whenever possible. In particular, forest plans should require projects to anticipate an increase of invasive species infestations due to disturbance or other factors and incorporate treatment costs as part of overall project costs.
6. Forests should review their process for prioritization of invasive species and develop annual targets for necessary treatment of individual species. Information on treatment targets and funding needed annually should be shared with the Regional coordinator for invasive species and pesticide use.
7. Forests should review their process for survey and inventory of priority invasive plants and develop strategies that provide adequate assessments for conducting detection, inventory, and monitoring of priority invasive plants.
8. NEPA processes allowing treatment of invasive plants should be expedited across the Region. The SEIS for the Carson and Santa Fe NFs should be completed no later than the beginning of FY13 to allow implementation of herbicide use during the summer of 2013. Relatively old EAs and EISs on some forests in the Region should be reviewed and updated as necessary to allow use of biocontrol agents and new chemistry herbicides such as aminopyralid and aminocyclopyrachlor.
9. The Coronado NF should use a risk assessment process to determine whether aerial spray projects with an herbicide will be necessary to forestall unacceptable impacts to the forest. An aerial EIS should be undertaken if determined to be warranted by the risk assessment.

References

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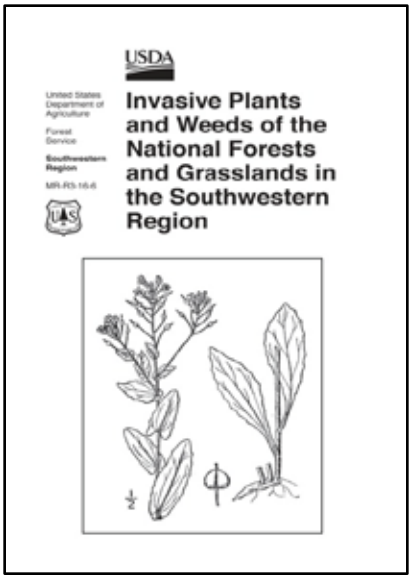
Field Guides for Identification and Management of Invasive Plants in Region 3

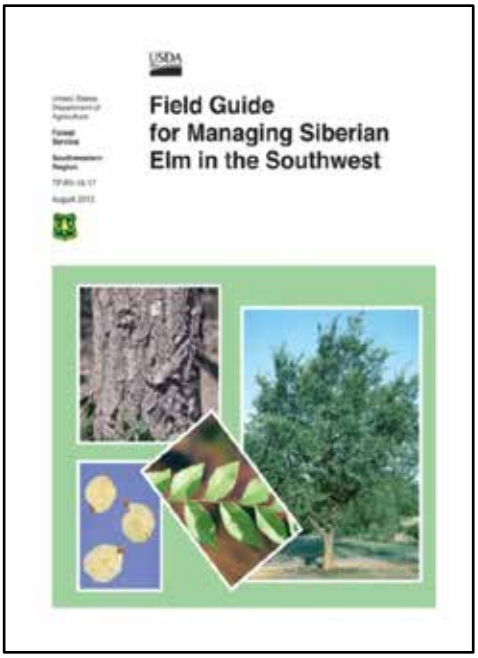


Field Guide for Identifying Invasive Plants and Weeds

An Internet version of the "Invasive Plants and Weeds of the National Forests and Grasslands in the Southwestern Region" will be available in 2013 on our Forest Health Web site: http://www.fs.usda.gov/main/r3/forest-grasslandhealth. The guide provides descriptions and pictures of invasive plants and weeds common to forests and grasslands in Region 3. The Internet version contains all of the information found in the printed guide, and sections of the guide will be available for users to print individually. For more information, contact the regional coordinator for invasive species and pesticide use at (505) 842-3280.

Field Guides for Managing Invasive Plants

The U.S. Forest Service has developed a series of field guides to provide information on management of invasive plant species in forests, woodlands, rangelands, and deserts associated with the Southwest. The field guides contain practical approaches to invasive plant management by employing principles of integrated weed management (IWM). Individual guides will be added to our Forest Health Web site (http://www.fs.usda.gov/main/r3/forest-grasslandhealth) as they become available. For more information, contact the regional coordinator for invasive species and pesticide use at (505) 842-3280.



Contacts for Invasive Species and Pesticide Use in Region 3

Regional Office

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National Forests

Apache-Sitgreaves	Genevieve Masters	(928) 333-6302
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Cibola	Rick Newmon	(505) 759-6380
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Coronado	Sharon Biedenbender	(520) 559-2762
Gila	Teresa Smergut	(575) 539-2481
Kaibab	Dustin Burger	(928) 643-8136
Lincoln	Mark Cadwallader	(575) 682-5303
Prescott	Kelli Spleiss	(928) 567-1126
Santa Fe	Jon Williams	(505) 438-5430
Tonto	Patti Fenner	(602) 225-5386

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CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife — if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practies for the disposal of surplus pesticides and pesticide containers.
