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Department of
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Forest
Service

**Southwestern
Region**

FINAL Invasive Species Specialist Report

Forest Plan Revision
Final Environmental Impact Statement

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Specialist Report

Introduction

This report evaluates and discloses the potential environmental consequences from and on invasive species that may result with the adoption of a revised land management plan. It examines, in detail, four different alternatives for revising the 1987 Apache-Sitgreaves NFs (A-SNFs) land management plan (1987 forest plan).

Relevant Laws, Regulations, and Policy that Apply

The principal statutes governing or supporting the management of aquatic and terrestrial invasive species on the National Forest System include but are not limited to, the following statutes. Except where specifically stated, these statutes apply to the entire National Forest System.

Granger-Thye Act of 1950 (16 U.S.C. §§580h) - Authorizes the Secretary to use a portion of grazing fees for range improvement projects on National Forest System lands. Specific projects mentioned are artificial re-vegetation, including the collection or purchase of necessary seed and eradication of poisonous plants and noxious weeds, in order to protect or improve the future productivity of the range. Section 11 of the Act authorizes the use of funds for rangeland improvement projects outside of National Forest System lands under certain circumstances.

Sikes Act (Fish and Wildlife Conservation) of September 15, 1960 (16 U.S.C. 670g-670l, 670o, P.L. 86-797), as amended. Section 201 - Directs the Secretary of Agriculture to plan, develop, maintain, coordinate, and implement programs for the conservation and rehabilitation of wildlife, fish and game species, including specific habitat improvement or species management [including invasive species management] projects, on lands and waters under the Secretary's jurisdiction. The Act also provides for carrying out wildlife and fish conservation programs on Federal lands and waters including authority for cooperative State-Federal plans and authority to enter into agreements with States to collect fees to fund the programs identified in those plans.

Wilderness Act of 1964 (16 U.S.C. §§1131 et seq.) - Authorizes the Secretary to administer certain congressionally designated National Forest System lands as wilderness. Also directs the protection and preservation of these wilderness areas in their natural state, primarily affected by nature and not human actions. Integrated pest management actions [including aquatic and terrestrial invasive species] in Wilderness are authorized to meet provisions of the Act and consistent with Forest Service policy and guidance for wilderness management.

The National Historic Preservation Act of 1966 (16 U.S.C. §§470 et seq.) - Requires agency heads to assume responsibility for the preservation of historic properties owned or controlled by the agency and to develop a preservation program for the identification, evaluation, and nomination of historic properties to the National Register. Management activities to protect and preserve historic properties and cultural sites may include actions to prevent and control invasive species threatening or impacting those areas. The Act requires agency heads to evaluate the effects of an undertaking on property that is included or eligible for inclusion in the National Register and to afford the Advisory Council a reasonable opportunity to comment on the undertaking. Also defines undertaking to include permitting activities or Federal financial assistance under the jurisdiction of an agency.

National Environmental Policy Act of 1969 (16 U.S.C. 4321) - Requires agencies to analyze the physical, social, and economic effects associated with proposed plans and decisions, to consider alternatives to the action proposed, and to document the results of the analysis. The provisions of NEPA and the Council on Environmental Quality implementing regulations apply to invasive species management (FSM 1950; FSH 1909.15).

Federal Noxious Weed Act of 1974 (7 U.S.C. 2814) - Although the Plant Protection Act superseded and repealed most of the Federal Noxious Weed Act of 1974 (FNWA), it left intact section 15 of the act, "Management of undesirable plants on Federal lands" (7 U.S.C. 2814). Section 15 of the FNWA requires Federal land management agencies to develop and establish a management program for control of undesirable plants that are classified under State or Federal law as undesirable, noxious, harmful, injurious, or poisonous, on Federal lands under the agency's jurisdiction (7 U.S.C. 2814(a)). The Act also requires the Federal land management agencies to enter into cooperative agreements to coordinate the management of undesirable plant species on Federal lands where similar programs are being implemented on State and private lands in the same area (7 U.S.C. 2814(c)). The Secretaries of Agriculture and Interior must coordinate their respective control, research, and educational efforts relating to noxious weeds (7 U.S.C. 2814(f)). USDA's Departmental Regulation 9500-10 sets forth the Departmental policy relating to the management and coordination of noxious weeds activities among the agencies within USDA and other entities.

Clean Water Act of 1977 (33 U.S.C. 1251, 1254, 1323, 1324, 1329, 1342, 1344; 91 Stat. 1566) - This act amends the Federal Water Pollution Control Act of 1972. Section 313 is strengthened to stress Federal agency compliance with Federal, State and local substantive and procedural requirements related to the control and abatement of pollution to the same extent as required of nongovernmental entities. Invasive species management to improve watershed condition supports the Act's charge to maintain the ecological integrity of our nation's waters, including the physical, chemical and biological components.

The Plant Protection Act of 2000 (7 U.S.C. 7701 et seq) as amended by the Noxious Weed Control and Eradication Act of 2004 (P.L. 108-412) - Among other provisions, the Plant Protection Act authorizes the Secretary of Agriculture to prohibit or restrict the importation, entry, exportation, or movement in interstate commerce of any plant, plant product, biological control organism, noxious weed, article, or means of conveyance, if the Secretary determines that the prohibition or restriction is necessary to prevent the introduction into the United States or the dissemination of a plant pest or noxious weed within the United States. The Act defines the term "Noxious Weed".

Wyden Amendment (P.L. 109-54, Section 434) - Authorizes the Forest Service to enter into cooperative agreements to benefit resources within watersheds on National Forest System lands. Agreements may be with willing Federal, Tribal, State, and local governments, private and non-government entities, and landowners to conduct activities on public or private lands. Under this authority, the Forest Service may enter into agreements to support or conduct invasive species management activities on aquatic and terrestrial areas owned by local and State governments, Tribes, other Federal agencies, and private individuals or organizations, to benefit and protect the National Forest System and other resources within a watershed at risk from invasive species.

Consolidated Appropriations Resolution, 2003. Section 323 of the Act, codified at 16 U.S.C. 2104 - Provides authority to the Forest Service to enter into stewardship contracts with public or private entities or persons to perform services to achieve land management goals for the National Forest System lands that meet local and rural community needs. Stewardship agreements may be entered into for other land management goals such as the following: removal of vegetation or other activities to promote healthy forest stands, reduction of fire hazards; watershed restoration and maintenance; restoration and

maintenance of wildlife and fish habitat; prevention and control of invasive species; and reestablishing native plant species.

Executive Order 13112 - Directs federal agencies whose actions may affect the status of invasive species to (1) prevent the introduction of invasive species, and (2) detect and respond rapidly to and control populations of such species in a cost effective and environmentally sound manner, as appropriations allow.

Forest Service Manual 2900 - Invasive Species Management, which sets forth National Forest System policy, responsibilities, and direction for the prevention, detection, control, and restoration of effects from aquatic and terrestrial invasive species (including vertebrates, invertebrates, plants, and pathogens).

Methodology and Analysis Process

Acres of management areas were used to compare alternatives. For the action alternatives - General Forest, Community-Forest Intermix, High Use Developed Recreation Area, Energy Corridor, and Wild-Horse Territory management areas may be the most susceptible to invasive infestation because they allow new road building. Wildlife Quiet Areas, Natural Landscape, Recommended RNAs, RNAs, Primitive Area, recommended wilderness, and wilderness management areas do not allow new road building. Alternative A - assumes only wilderness and primitive area do not allow new road building.

Assumptions

In the analysis for this resource, the following assumptions have been made:

- The 2008 *Environmental Assessment for the A-SNFs Integrated Forest-Wide Noxious or Invasive Weed Management Program* (Forest Service 2008ab) analyzed and approved the use of manual, biological, and chemical control agents (herbicides) for the treatment of noxious or invasive species. Is implemented and provides protections for federally listed species.
- The *Highway Right-Of-Way Mitigation for All Threatened, Endangered and Sensitive Species That Occur on The Apache-Sitgreaves National Forests for ADOT's Management of Noxious Weeds and Hazardous Vegetation on Public Roads on National Forest Systems Lands in Arizona* (Forest Service 2005) is implemented and provides protections for federally listed species.
- Compliance with terms and conditions that implement the reasonable and prudent measures described in applicable Biological Opinions provide protection for federally listed species.
- Compliance with FSM 2081.03.2 - All hay and straw used for animal feed or bedding, applied for erosion control, soil stabilization and land rehabilitation, or utilized for other purposes on National Forest System land by Forest Service personnel or their contractors shall be certified as being noxious weed free or noxious weed seed free by an authorized State Department of Agriculture official or State designated official in those states which have a legislatively established weed free hay or straw certification program. Each individual hay or straw bale must be marked in an official manner as prescribed by the respective State's hay or straw weed free certification program requirements (Forest Service 2009).

Revision Topics Addressed in this Analysis

Revision Topic 1: Maintenance and Improvement of Ecosystem Health

Invasive Species: Invasive species have been identified by the Chief of the USDA Forest Service as one of the four significant threats to our Nation's forest and rangeland ecosystems (Forest Service 2004). Invasive plants, such as mullein (*Verbascum thapsus* L.), saltcedar (*Tamarix* spp. L.), yellow starthistle (*Centaurea solstitialis* L.), and numerous (White 2008, 2011, 2013b) others currently infest at least 30,000 acres across the A-SNFs. Invasive animals, such as American bullfrogs (*Lithobates catesbeianus*) and virile crayfish (*Orconectes virilis*), prey on, out-compete, and degrade aquatic habitats that many native species depend on. The broad goals of the Forests Service's (2001, 2004) national strategy are to reduce, minimize, or eliminate the potential for introduction, establishment, spread, and impact of invasive species across all landscapes and ownerships. There is a need for the A-SNFs to provide future direction to control, treat, and eradicate non-native plant and animal invasive species.

- Indicator - Amount of A-SNFs that allows new road building.
- Indicator - Amount of annual silvicultural treatments
- Indicator - Amount of annual prescribed burn treatments

Summary of Alternatives

A summary of alternatives, including the key differences among alternatives, is outlined in the Draft Environmental Impact Statement.

Description of Affected Environment (Existing Condition)

As defined in Executive Order 13112 of February 3, 1999, an "invasive species" means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. While the typical definition of a "weed" is any undesired, uncultivated plant that grows out of place and competes with other plants for water, nutrients, and space.

Invasive plants are species that grow and spread rapidly, replacing desired plants. Invasive plants generally pose one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host for serious insects or disease and are new to or uncommon to the United States or parts thereof. These plants compete with crops, poison or injure livestock, wildlife and people, reduce forage for wildlife and livestock, change natural fire regimes, and reduce recreation enjoyment because of thorns, allergies or unsightliness. They also have a significant environmental advantage over native plant species because they are free of natural enemies. Invasive plants pose an increasing threat to native ecosystems. This is why prevention and direct control methods must be used to stress or remove invasive plants from native plant communities.

Non-native plants and animals that do or have the potential to cause ecological or economic harm are classified as invasive species (appendix A). Invasive species can be terrestrial or aquatic. On the A-SNFs, numerous invasive species pose risks to native species and ecosystem function and to the production of forest goods and services.

Invasive Plants

According to White (2013a), the A-SNFs provides habitat for nearly 2,450 vascular plants; of those, roughly 236 plants or 10 percent are non-native to the United States or the Forests; of these, 81 plants or

34 percent are classified as invasive species (appendix A table 1), These 81 invasive plant species are currently found on at least 30,000 acres of the forests. For example: musk thistle (*Carduus nutans* L.), mullein, and Siberian elm (*Ulmus pumila* L.) have spread along roadways; bull thistle (*Cirsium vulgare* (Savi) Ten.) and oxeye daisy (*Leucanthemum vulgare* Lam.) have become established in numerous meadows and wetlands; cheatgrass (*Bromus tectorum* L.) and red brome (*B. rubens* L.) are well established in the grasslands and woodlands; and saltcedar has become common along many streams.

According to Fairweather et al. (2006), most forest insects and pathogens in the Southwest are naturally occurring components of ecosystems and play an important role in dynamic ecological processes. However, one invasive fungus pest species has become established on the A-SNFs; white pine blister rust (*Cronartium ribicola* (J. C. Fisch. ex Rabenh.)). White pine blister rust is one of the most damaging tree infections in North America. This non-native fungus is expected to have a major negative impact on southwestern white pine (*Pinus strobiformis* Engelm.) on the A-SNFs (Fairweather et al. 2006). Trees of all sizes can be affected, although smaller trees are killed more rapidly than larger trees.

Invasive Animals

The most vulnerable A-SNFs species are those tied to aquatic systems, including riparian habitats. Non-native fish species, along with the American bullfrog and virile crayfish (appendix A table 2), impact all native fish, amphibian, reptile, macroinvertebrate, and plant species in those systems. American bullfrog and virile crayfish have contributed to the listing of seven native fish species and the Chiricahua leopard frog (*Lithobates chiricahuensis*) (Marshall et al. 2006; Robinson et al. 2006). They also contributed to the recent classification of the northern Mexican gartersnake (*Thamnophis eques megalops*) as a candidate for listing under the ESA, and are largely responsible for the decline in narrow-headed gartersnake (*T. rufipunctatus*) populations (Dolan and Mannan 2009).

An additional threat to the Chiricahua leopard frog, and other amphibians, is an introduced fungal skin disease, chytridiomycosis fungus (*Batrachochytrium dendrobatidis*), which is killing frogs and toads world-wide (Boyle et al. 2004). According to Boyle et al. (2004), chytridiomycosis fungus was first reported in Panama and Australia in wild frog populations undergoing rapid declines, and subsequently identified in Africa, South America, Central America, North America, Europe and New Zealand (Berger et al. 1998, 1999, Lips 1999, Bradley et al. 2002), the infection has been found in both wild and captive populations.

Two avian species are considered to be invasive and causing problems for several bird species. Competition for nest sites, nest parasitism, brood parasitism, and predation are problems associated with brown-headed cowbirds (*Molothrus ater*) and European starlings *(Sturnus vulgaris*) (Forest Service 2008; Dolan and Mannan 2009). According to Arcese and Smith (1999), brow- headed cowbirds are the most common North American brood parasite and can parasitize a wide range of hosts at high intensities, and can be locally abundant. Linz et al. (2007), suggest that European starlings may spread infectious diseases that sicken humans and livestock, costing nearly $800 million in health treatment costs, and conclude that European starlings conceivably have contributed to the decline of native cavity-nesting birds by usurping their nesting sites.

One invasive insect species has become established on the A-SNFs (Fairweather et al. 2006); spruce aphid (*Elatobium abietinum*). Observed damage caused by the spruce aphid to Engelmann spruce (*Picea engelmannii* Parry ex Engelm.) and blue spruce (*P. pungens* Engelm.) is greater in the southwest than in other parts of the U.S. Fairweather et al. (2006), consider the damage caused by this insect may be due to variations in its behavior. Research in the Southwest found that spruce aphid populations increase in the fall, have a sexual life cycle, and a greater cold-hardiness, all factors that may be contributing to the insect's success.

Feral horses have become established in several locations within the forests. Herds (small groups) of these animals can be found along the western forest boundary on the Apache portion (within the Black River drainage on Alpine and Springerville RDs, areas west of Big Lake on the Springerville RD, and upper Eagle Creek on the Clifton RD), and along the southern forest boundary on the Sitgreaves portion (along and north of FR 300 on the Black Mesa and Lakeside RDs). A feral horse is defined as a free-roaming horse having escaped from domestication. Feral horses are escaped domestic horses, or their descendants (branded or unbranded), that strayed, escaped, or were deliberately released onto National Forest System lands and continue to survive and reproduce on the forests in the wild. Feral horses are animals that do not meet the definition of a wild free-roaming horse and are considered unauthorized livestock**.** These unauthorized animals are negatively impacting ecological conditions as well as management opportunities were they occur. Feral horses have few predators.

Feral cattle have become established on the Sandrock allotment on the Clifton RD and the southern portion of the Raspberry allotment on the Alpine RD. These unauthorized animals are negatively impacting ecological conditions as well as management opportunities were they occur. Feral cattle have few predators.

Another species of concern to the Forests is the feral hog. Feral hogs are an invasive species native to Eurasia (Calkins et al. 2009). Although not currently found on the Forests, the feral hog has been reported in Grant County, New Mexico (NMDGF 2012); which is adjacent to the Clifton RD. According to the New Mexico Department of Game and Fish (2012), the reason for concern is that feral hog alter and damage habitat and directly compete for resources important to native wildlife. Feral hogs are also aggressive predators that prey on native wildlife species. In addition, there is a wide variety of diseases that feral hogs may carry that are transmissible to humans, such as several bacterial (*Brucellosis, Leptospirosis, and Salmonellosis*), viral (Influenza and Hepatitis E), and parasitic (*Cryptosporidium, Giardia, and Trichinella*) diseases. Feral hogs can reproduce rapidly and are highly adaptable to most environments, and within the Southwest, feral hogs have few predators.

Management of invasive species is needed across all vegetation types on the A-SNFs. There is an array of tools (chemical, biological, mechanical, and cultural) to help managers control or eradicate these species. To address terrestrial invasive plants, forest managers have implemented an integrated forest-wide noxious or invasive weed management program. An environmental analysis conducted in 2008 allows herbicide treatment of noxious and invasive weeds (Forest Service 2008ab). Even though complete eradication of invasive species is not always possible, aggressive treatment of existing populations, along with prevention of new infestations or populations is important to protect native ecosystem diversity.

Over the years several attempts have been made to gather feral horses with limited success.

Although there is current management emphasis to manage invasive species, the 1987 forest plan does not provide direction related to the issue of invasive species.

Environmental Consequences

All the action alternatives include desired conditions, objectives, standards, and guidelines to contain, control, or eradicate terrestrial and aquatic invasive species. These plan decisions are the same across all action alternatives. Alternative A does not specifically address invasive species and would therefore result in a greater potential for new and existing infestations to adversely affect native species populations.

The following sections evaluate the risk of infestation and spread of invasive species by alternative using invasive plant species, brown-headed cowbird, and chytrid as indicators.

Road Building

Roads can serve as a key indicator for the potential risk of invasive plant species spread. Vehicles driven through populations of invasive plants often pick up seeds in the radiator grill, under carriage, tire treads, etc. and transport these seeds to previously uninfested areas (Trunkle and Fay 1991). Chytridiomycosis fungus which survives in wet or muddy environments could be carried inadvertently in mud clinging to radiator grill, under carriage, tire treads, wheel-wells, etc. and transported to previously uninfested areas. According to (Petit no date), almost everything humans do in manipulating the environment is beneficial to brown-headed cowbirds. Removing or cutting into the forest for roads, or timber harvesting for example, can improve the habitat for brown-headed cowbirds by creating grassy foraging areas, open perch sites for surveying hosts, and more access to host species in edge or open forest habitats. Table 1 displays the amount of the forests where new road building would be allowed. It is based on management area direction.

Table 1. Percent of the A-SNFs where new road building would be allowed by alternative

	Alternatives			
	alternative A	alternative B	alternative C	alternative D
Percent	72	63	80	56

The table above indicates the potential risk of new road development, thus the potential additive risk of invasive plant species, chytridiomycosis fungus, and brown-headed cowbird spread. Alternative C would produce the most risk, followed by Alternatives A, B, and then Alternative D with the least risk. Alternative A also allows cross-country motorized travel throughout the forests and there is greater potential for invasive plant species, chytridiomycosis fungus, brown-headed cowbird spread compared to the action alternatives that restrict motorized vehicle travel to only designated roads, trails, and areas.

Mechanical and Wildland Fire Treatments

Areas where ground disturbing activities take place can serve as an indicator for the potential risk of invasive plant species and chytridiomycosis fungus spread and establishment. Logging equipment driven through populations of invasive plants can also pick up seeds and/or chytridiomycosis fungus infected mud and transport them to previously uninfested areas (Trunkle and Fay 1991). Areas of disturbed and exposed soil are ideal locations for the establishment of invasive plants. Logging debris and slash disposal also produces disturbed sites with little or no native ground cover that could provide locations for the establishment of new infestations of invasive plants. Roadside water collection locations are also ideal locations for the establishment of chytridiomycosis. Again, according to (Petit, no date), timber harvesting can improve the habitat for brown-headed cowbirds by creating grassy foraging areas, open perch sites for surveying hosts, and more access to host species in edge or open forest habitats.

According to McGlone and Egan (2009), prescribed fire, both with and without tree removal, is being applied to forest and woodlands to mitigate the risk of wildfire, such as those that have occurred on the A-SNFs. Wildland fire use (allowing naturally caused fire to burn for resource benefit) is also becoming a more widespread management practice. Regardless of whether the fire is prescribed or wild, increases in invasive plant occurrences have been documented in the post-fire understory community in forest and woodlands on the A-SNFs. Increasingly, invasive plant species are spreading into burned forests

regardless of fire type (McGlone and Egan 2009). Table 2 displays the amount of acres to be harvested and burned annually based on proposed treatment objectives.

Table 2. A-SNFs' proposed average annual acres of mechanical and fire treatment objectives by alternative

Treatment Type	Alternatives			
	alternative A	alternative B	alternative C	alternative D
Mechanical	11,932	19,091	23,747	14,858
Fire	5,134	18,610	9,771	32,839

The table above indicates the potential risk of timber harvest (and associated ground disturbance), thus the potential additive risk of invasive plant species, chytridiomycosis fungus, and brown-headed cowbird spread. Alternative C would produce the greatest risk, followed by Alternatives B, D, and then Alternative A with the least risk. Alternative C also allows for the greatest number of acres for planting (2,066 acres), which is an additional risk of invasive plant species spread.

Table 2 indicates the potential risk of prescribed burning activities; this can also serve as an indicator for the potential risk of invasive plant species establishment and spread. Areas of disturbed and exposed soil produced by fire are ideal locations for the establishment of invasive plants. Alternative D would produce the greatest risk, followed by Alternatives C, B, and then Alternative A with the least risk.

Combining the risks of both timber harvest and prescribed fire, Alternative D would produce the greatest risk, followed by Alternatives C, B, and then Alternative A with the least risk.

In addition, all alternatives would have potential effects from mitigating damage caused by uncharacteristic wildfire. Many areas within burns require some form of treatment to minimize flooding and soil loss. Primarily these treatments consist of mulching (covering the ground with some form of straw) and seeding. Both the introduction of straw and seed pose risk for the spread and establishment of invasive weeds. All alternatives would require the use of certified weed seed free straw and seeds and, as a result, present the same potential level of risk.

Other Activities

Livestock grazing

Livestock grazing takes place on 96 grazing allotments covering approximately 1.7 million acres of the A-SNFs. According to the US Fish and Wildlife Service (2003) chytridiomycosis could conceivably be spread by cattle carrying mud on their hooves and moving among frog habitats. The disease could also be spread by ranch hands working at an infected tank or aquatic site and spreading the fungus to another site by mud or water clinging to wheel-wells, tires, or on shovels, boots, or other equipment.

Livestock enhance feeding opportunities for brown-headed cowbirds by reducing grass height and increasing food availability in the form of invertebrates, body parasites, insects, and seeds (Goguen and Mathews 2001). Widespread livestock grazing, agriculture, irrigation, and human development have probably all facilitated the range expansion of brown-headed cowbirds (Rothstein 1994, 2004). All alternatives would provide for the continuation of livestock grazing on the A-SNFs and focus on balancing livestock grazing with available forage. As a result, all alternatives present the same potential level of risk for chytridiomycosis and brown-headed cowbird spread.

Grazing could contribute to risk on invasive plant infestation and spread. Grazing animals can trample and remove native plants, clearing vegetation consequently favoring an increase in invasive plants.

Trampling destroys soil crust and prepares weed seedbeds through hoof action by establishing openings and uncovering soil; and transporting and dispersing seeds from one area to another (Parks et al. 2005). All alternatives would provide for the continuation of livestock grazing on the A-SNFs and focus on balancing livestock grazing with available forage. As a result, all alternatives present the same potential level of risk for invasive plant species establishment and spread.

Maintenance of exterior forest boundary fences and interior allotment boundary fences are important factors in the management and control of feral horses and unauthorized cattle.

Burn Area Emergency Rehab (BAER)

Since the early 2000s, the A-SNFs has experienced numerous large wildfires. As a consequence, many areas within the burns have required some form of treatment to minimize flooding and soil loss. Primarily these treatments consist of mulching (covering the ground with some form of straw) and seeding. Since the beginning of 2002, the forests have mulched and seed roughly 160,000 acres (C. Nelson, A-SNFs Watershed and Air Program Manager, professional communication). Both the introduction of straw and seed pose risk for the spread and establishment of invasive weeds. The forests require the use of certified weed seed free straw and seeds; however, there is no guarantee. All alternatives would provide for the continuation of mitigating damage caused by fire; as a result, all alternatives present the same potential level of risk.

Recreation

Aquatic based recreation has the potential to spread chytridiomycosis in much the same way as other vehicular use, as well as fishing, boating, and walking and playing in streams and ponds. All alternatives would provide for the continuation of recreation on the A-SNFs and as a result, all alternatives present the same potential level of risk for chytridiomycosis spread.

Alternative A allows motorized cross-country travel throughout the forests and there would be greater potential for invasive plant species and chytridiomycosis, to spread because of vehicular use and the potential for ground disturbance. The action alternatives restrict motorized vehicle travel to only designated roads, trails, and areas and would limit opportunities to spread invasive species.

Climate Change

There may be environmental consequences as a result of climate change. The forests may be more vulnerable to invasive species (Deal et al. 2010; Runyon et al. 2012), including insects, plants, fungi (Swetnam et al. 1999; GAO 2007; Lenart 2007; Deal et al. 2010; Williams et al. 2010; Vose et al. 2012; among others), and vertebrates. Ecosystem change may arise from large-scale severe fires that lead to colonization of invasive species (Joyce et al. 2006). Disturbance may reset and rejuvenate some ecosystems in some cases, and cause enduring change in others. For example, climate change may favor the spread of invasive, non-native grasses (e.g., cheatgrass, red brome, Lehmann lovegrass (*Eragrostis lehmanniana* Nees)) into arid lands where the native vegetation is too sparse to carry a fire (Cable 1971; Cox and Ruyle 1986; Ruyle et al. 1988; Anable et al. 1992; Schussman et al. 2006). When these areas burn, they typically convert to non-native monocultures and the native vegetation is lost (Ryan et al. 2008). The need to treat invasive species may likely become more critical to maintaining desired conditions for healthy plant and animal communities under a changing climate. The state of knowledge needed to address climate change at the A-SNFs scale is still evolving. All alternatives would direct managers to contain, control, and eradicate invasive species and would use adaptive management to adjust to changing conditions.

Relationship of Short-Term Uses and Long-Term Productivity

Invasive infestation may have impacts on forest long-term productivity. However, the action alternatives are designed to contain, control, or eradicate invasive species.

Invasive species can degrade forest health increasing susceptibility to disease. Disease can lead to higher mortality (dead trees) increasing fuel loads and a higher risk of fire or increasing the number of hazard trees in recreation areas. Some invasive plants (e.g., cheatgrass, red brome) grow faster and mature before native plants, forming highly flammable ground cover that burns completely. Invasive plants (e.g., purple loosestrife (*Lythrum salicaria* L.); poison hemlock (*Conium maculatum* L.) may replace native plants in riparian areas leading to soil erosion. Invasive aquatic animals (e.g., virile crayfish, American bullfrogs) may disrupt the ecological balance of the aquatic ecosystem (Illman 2006). Invasive species may also cause damage to a suite of forest ecosystem goods and services, resulting in economic impacts (e.g., timber values, scenery, wildlife habitat) (Holmes 2009).

Overall, the action alternatives contain direction to contain, control, or eradicate invasive species. These alternatives also provide objectives to treat 500 to 3,500 acres and at least 2 stream miles annually to contain, control, or eradicate invasive species. The action alternatives, based on a more aggressive strategy for treating invasive species, would reduce the risk of infestation and spread more than Alternative A.

Cumulative Environmental Consequences

Invasive plant control is everyone's concern because they can occur across all land ownerships. Since there is expected to be continued growth in urban areas in and around the A-SNFs, it is reasonably foreseeable that the growth and expansion of invasive species on surrounding lands will continue and could threaten to extend onto National Forest System lands. Management focuses on containment, control, and eradication of invasive species under all alternatives, in combination with similar efforts of other agencies and land owner groups (Arizona Game and Fish Department, Arizona Department of Transportation, and the cooperative weed management area), would have a positive effect toward controlling infestation and spread from and onto surrounding lands.

Cooperation with the Arizona Game and Fish Department in the management of invasive wildlife species such as American bullfrogs, virile crayfish, and birds is important because they are the agency responsible for the management of wildlife.

Cooperation with adjacent land owners and the Arizona Department of Agriculture in the management and removal of feral horses is essential in controlling and preventing these undesirable animals from causing ecological harm to forest resources.

Adaptive Management

As research regarding invasive species prevention, treatment, and eradication techniques, forest management strategies will be adjusted.

Other Planning Efforts

The following agencies include efforts to manage invasive species:

Arizona Game and Fish Department's *Strategic Plan for the Years 2007-2012 Wildlife 2012* and *Arizona's Comprehensive Wildlife Conservation Strategy: 2005-2015*

Aquatic Invasive Species Interdiction Act (HB2157) of 2009. This legislation created a mechanism for the State of Arizona to statutorily address invasive species in the aquatic environment, administered through the Arizona Game and Fish Department

Little Colorado River Plateau Resource Conservation & Development Eastern Arizona Weed Management Area organization and program

Arizona State Forestry Division *Arizona Forest Resource Strategy*

Coconino, Coronado, Gila, Kaibab, and Tonto National Forests

Governor's Forest Health Council *Statewide Strategy for Restoring Arizona's Forests*

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Appendix A - Non-Native Noxious and Invasive Plant, Fungal Pathogen, and Terrestrial and Aquatic Animal Species on the A-SNFs

Appendix A table 1. A-SNFs' non-native noxious and invasive plant and fungal pathogen species

Non-native Noxious and Invasive Plant[1, 2] and Fungal Pathogen Species	
common name	**scientific name**
Plants	
Russian knapweed	*Acroptilon repens* (L.) DC
jointed goatgrass	*Aegilops cylindrica* Host
tree of heaven	*Ailanthus altissima* (Mill.) Swingle
camelthorn	*Alhagi maurorum* Medik.
common burdock	*Arctium minus* Bernh.
kochia	*Bassia scoparia* (L.) A.J. Scott
rescuegrass	*Bromus catharticus* Vahl
ripgut brome	*Bromus diandrus* Roth
Japanese brome	*Bromus japonicus* Thunb.
red brome	*Bromus rubens* L.
cheatgrass	*Bromus tectorum* L.
lens-podded hoarycress	*Cardaria chalepensis* (L.) Hand.-Maz.
whitetop	*Cardaria draba* (L.) Desv.
hairy whitetop	*Cardaria pubescens* (C.A. Mey.) Jarmolenko
spiny plumeless thistle	*Carduus acanthoides* L.
musk thistle	*Carduus nutans* L.
southern sandbur	*Cenchrus echinatus* L.
coastal sandbur	*Cenchrus spinifex* Cav.
red starthistle	*Centaurea calcitrapa* L.
diffuse knapweed	*Centaurea diffusa* Lam.
Iberian knapweed	*Centaurea iberica* Trev. ex Spreng.
yellow starthistle	*Centaurea solstitialis* L.
spotted knapweed	*Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek
sulphur knapweed	*Centaurea sulphurea* Willd.
squarrose knapweed	*Centaurea virgata* Lam.
curveseed butterwort	*Ceratocephala testiculata* (Crantz) Roth
rush skeletonweed	*Chondrilla juncea* L.
blue mustard	*Chorispora tenella* (Pall.) DC.
chicory	*Cichorium intybus* L.
Canada thistle	*Cirsium arvense* (L.) Scop.
bull thistle	*Cirsium vulgare* (Savi) Ten.
poison hemlock	*Conium maculatum* L.
field bindweed	*Convolvulus arvensis* L.
hounds tongue	*Cynoglossum officinale* L.
perennial wallrocket	*Diplotaxis tenuifolia* (L.) DC.
quackgrass	*Elymus repens* (L.) Gould
Russian olive	*Elaeagnus angustifolia* L.
weeping lovegrass	*Eragrostis curvula* (Schrad.) Nees
Lehmann lovegrass	*Eragrostis lehmanniana* Nees
redstem filaree	*Erodium cicutarium* (L.) L'Hér. ex Aiton
leafy spurge	*Euphorbia esula* L.
halogeton	*Halogeton glomeratus* (M. Bieb.) C.A. Mey.
Texas blueweed	*Helianthus ciliaris* DC
black henbane	*Hyoscyamus niger* L.
tall morning-glory	*Ipomoea purpurea* (L.) Roth
Dyer's woad	*Isatis tinctoria* L.
broadleaved pepperweed	*Lepidium latifolium* L.
oxeye daisy	*Leucanthemum vulgare* Lam.

Appendix A table 1. Continued

Non-native Noxious and Invasive Plant[1, 2] and Fungal Pathogen Species	
common name	**scientific name[2]**
Dalmatian toadflax	*Linaria dalmatica* (L.) P. Mill.
yellow toadflax	*Linaria vulgaris* Mill.
purple loosestrife	*Lythrum salicaria* L.
horehound	*Marrubium vulgare* L.
black medick	*Medicago lupulina* L.
burclover	*Medicago polymorpha* L.
alfalfa	*Medicago sativa* L.
white sweetclover	*Melilotus albus* (L.) Lam.
yellow sweetclover	*Melilotus officinalis* (L.) Lam.
Eurasian watermilfoil	*Myriophyllum spicatum* L.
Scotch thistle	*Onopordum acanthium* L.
African rue	*Peganum harmala* L.
little hogweed	*Portulaca oleracea* L.
Himalayan blackberry	*Rubus armeniacus* Focke
Russian thistle	*Salsola* spp. L.
Mediterranean sage	*Salvia aethiopis* L.
tall fescue	*Schedonorus phoenix* (Scop.) Holub
tansy ragweed	*Senecio jacobaea* L.
wild mustard	*Sinapis arvensis* L.
Carolina horsenettle	*Solanum carolinense* L.
spiny sowthistle	*Sonchus asper* (L.) Hill
perennial sowthistle	*Sonchus arvensis* L.
Johnsongrass	*Sorghum halepense* (L.) Pers.
saltcedar	*Tamarix* spp. L.
yellow salsify	*Tragopogon dubius* Scop.
puncturevine	*Tribulus terrestris* L.
red clover	*Trifolium pratense* L.
white clover	*Trifolium repens* L.
Siberian elm	*Ulmus pumila* L.
wooly mullein	*Verbascum thapsus* L.
lilac chastetree	*Vitex agnus-castus* L.
spiny cocklebur	*Xanthium spinosum* L.
rough cocklebur	*Xanthium strumarium* L.
Fungal Pathogens	
amphibian chytrid fungus, chytridiomycosis, or Bd	*Batrachochytrium dendrobatidis*
white pine blister rust	*Cronartium ribicola* J.C. Fisch

[1] White 2008, 2011, and 2013b

[2] All scientific plant names are those used by the USDA, NRCS. 2012. The PLANTS Database (http://plants.usda.gov, 28 March 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA

Appendix A table 2. A-SNFs' non-native invasive terrestrial and aquatic animal species

Non-native Invasive Terrestrial and Aquatic Animal Species	
common name	**scientific name**
Mammals	
cattle (feral)	*Bos primigenius*
hog (feral)	*Sus scrofa*
horse (feral)	*Equus ferus caballus*
Birds	
brown-headed cowbird	*Molothrus ater*
European starling	*Sturnus vulgaris* (Linnaeus)
Invertebrates	
spruce aphid	*Elatobium abietinum* (Walker)
virile crayfish	*Orconectes virilis* (Hagen, 1870)
Amphibians	
American bullfrog	*Lithobates catesbeianus*