

# **Southern Arizona Buffelgrass Strategic Plan**

**Prepared by:  
Buffelgrass Working Group**

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This document is the product of a collaborative effort among a multitude of people and organizations. In early 2006, a Buffelgrass Working Group was formed and joined with the Buffelgrass Core Team in 2007 to develop a coordinated strategy and guide for buffelgrass management, which culminated in this document. The Editor would like to take this opportunity to thank them for their extraordinary efforts and to acknowledge their contributions.

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## **EXECUTIVE SUMMARY**

### **Background**

In response to the escalating number of acres being infested in the region by non-native buffelgrass (*Pennisetum ciliare*), a group of federal and state agency representatives, county and city leaders, university researchers, and staff from non-profit organizations formed a coalition in late 2006 to improve buffelgrass management across jurisdictions. This coalition organized the Buffelgrass Summit in February 2007, then went on to form the Buffelgrass Core Team, with the goal of implementing recommendations made at the Summit and improving communication about each member's buffelgrass management efforts. Attendance at the Summit was designed to be inclusive to maximize opportunities for dialogue and collaboration.



The Buffelgrass Working Group – a more formalized group including representatives of jurisdictions, agencies and organizations who had contributed financially to regional buffelgrass research and control efforts through the Cooperative Ecosystem Study Unit (CESU) – began meeting in 2006 to explore alternatives to buffelgrass control. With this Strategic Plan, the Buffelgrass Working Group expanded its membership to encompass the functions and representatives from the Core Team in an effort to combine parallel efforts to accomplish more.

Successful buffelgrass management will require coordinated action taking place across property lines and jurisdictional boundaries. The newly combined Buffelgrass Working Group determined that success would demand a multi-year, integrated set of actions designed to maximize efficiency and effectiveness of treatment activities. In June 2007 members of the Buffelgrass Working Group began work on a 5-year strategy in order to proactively manage buffelgrass, obtain funding for future management, and to increase public and volunteer involvement. The actions identified in this document are a product of the Buffelgrass Working Group's work, and represent a starting point for on-the-ground implementation of a regional strategy. Encouraging adoption, obtaining funding and orchestrating implementation of the actions specified here by the entities responsible for their execution is a critical next step. Fortunately, citizens of southern and central Arizona have repeatedly demonstrated support for eradicating buffelgrass. It is our hope that this document provides the road map and inspiration to get us there.

### **Critical Findings**

In Southern Arizona, rapid spread of buffelgrass and conversion of fire-resistant desert to flammable grassland rivals urban growth and water as the region's most pressing environmental issue.

Buffelgrass has introduced a new wildfire risk into an ecosystem that is not fire adapted. It grows in dense stands, crowds out native plants, and negatively impacts native wildlife species



and their habitat. Buffelgrass is considered a particularly serious threat to the saguaro cactus, the iconic plant of the Sonoran Desert Ecoregion, and is extremely detrimental to desert tortoise and mule deer habitat.

Buffelgrass not only impacts native ecosystems and conservation efforts, it also poses a serious threat to life, property, tourism and the regional economy. Ecotourism is a cornerstone of the economy of southern Arizona and wildfire in the Sonoran Desert has the potential to disrupt recreational activities and degrade views. This scenic native desert area attracts millions of tourists every year who contribute billions of dollars to the regional economy; tourism accounts for nearly 40,000 tourism-related jobs, about 12 percent of total wages in Pima County. Areas most at-risk to buffelgrass invasion are also highly prized real estate where multi-million dollar homes are nestled among the saguaros and paloverde trees of the mountain foothills.



Despite broad agreement about the need for buffelgrass control and mitigation, a practical strategy needs to be clearly articulated in a policy-relevant form. Our vision, therefore, extends beyond the control of buffelgrass and restoration of native desert and includes a commitment to public involvement, coordinated government initiatives, and strategic planning to guide buffelgrass management in the future.

### **Recommendations and Actions**

Given the advanced stage of invasion and prevalence of buffelgrass populations throughout the region, a two-pronged approach is necessary. An aggressive and well-organized effort should be undertaken to contain the rate of spread along public right-of-ways and open spaces. In areas where eradication and restoration might no longer be possible, measures should be taken to secure life, property and valuable natural resources from wildfire.

Contributors to the Southern Arizona Buffelgrass Strategic Plan integrated scientific data, information about treatment and mitigation needs, and information about community resources to determine the steps needed to increase the rate and effectiveness of buffelgrass control across the region. The Plan should be regarded as a living document that will evolve as actions are undertaken and as new resources and strategies are identified and adapted. The Strategic Plan addresses buffelgrass management through a number of efforts, including developing and funding a regional coordination center; developing comprehensive legislation, codes, and ordinances; improving education, outreach and volunteer programs; prioritizing treatment strategies; identifying mapping and database management gaps; utilizing contingency planning and adaptive management; and exploring research needs



related to buffelgrass. It is the Buffelgrass Working Group's intention that the identified management goals and recommendations be addressed both locally and in collaboration with the Governor's Invasive Species Advisory Council and the State Invasive Species Management Plan (in preparation).

### **Key Strategies: A Foundation for Action**

Five key strategies provide the framework for successfully managing buffelgrass infestations within the region. These strategies evolved from discussions among experts, land managers and stakeholders actively working to control buffelgrass infestations. To accomplish strategic and efficient buffelgrass control the public and private sector must work together to:

1. Minimize spread in areas where buffelgrass has not yet become established.
2. Set and implement control priorities based on actual and potential impacts.
3. Restore treated areas in ways that increase resilience against future invasion.
4. Mitigate wildfire risks to life and property in areas where control is no longer feasible.
5. Motivate legislation aimed at sustaining the control effort.

Twelve overall management goals identified as necessary to implement these five key strategies are listed below. These management goals and associated action items are described in more detail in the BUFFELGRASS MANAGEMENT OBJECTIVES, STRATEGIES AND ACTIONS section (page 9-24) and in Tables 3 through 9 in the PROGRAM IMPLEMENTATION section (pages 27-36).

## **ORGANIZATION, LEADERSHIP AND PARTNERSHIPS**

Existing regional buffelgrass coalitions have merged into the Buffelgrass Working Group to more effectively implement this Strategic Plan. Additional stakeholders will be identified and invited to participate in implementation actions. Better coordination of buffelgrass management can be achieved by establishing a Buffelgrass Coordination Center, to be overseen by the Buffelgrass Working Group. The Coordination Center will serve as a clearinghouse for relevant information, a resource and learning center for volunteers, and fiduciary agent for obtaining and distributing funds.

***Management Goal #1*** – Maintain the Buffelgrass Working Group as an effective coordinating and advisory group for buffelgrass management and control in southern and central Arizona. (pages 9-10)

***Management Goal #2*** – Identify a non-profit organization that can house a centralized Buffelgrass Coordination Center to serve as the informational network, volunteer network, and fiduciary agent that will receive and distribute funds for high priority actions throughout the region. (page 11)

Since buffelgrass crosses jurisdictional boundaries, it is imperative that comprehensive partnerships be forged among land management agencies, public and private entities, corporations, and others in order to implement a coordinated regional effort. All community members have a role to play.

***Management Goal #3*** – Identify and provide information to partners to facilitate their implementation of buffelgrass management. (pages 11-12)

## **LEGISLATION, CODES AND ORDINANCES**

State-authorized programs must receive appropriated funds to be implemented to their fullest degree. Local codes and ordinances should be developed and/or revised to contribute to buffelgrass management within the region. It is also critical that buffelgrass management be addressed in site Covenants, Conditions & Restrictions (CC&Rs) and in other site management tools and regulations in order to provide broad authority to eradicate buffelgrass.

***Management Goal #4*** – Increase awareness within the ranks of the Arizona State Legislature and U.S. House and Senate to the buffelgrass crisis so that legislation will be brought forward to provide funding and support for buffelgrass management within Arizona. (pages 12-13)

***Management Goal #5*** – Assist local jurisdictions in amending or developing new codes, ordinances, zoning requirements and other requirements addressing the eradication and control of buffelgrass on all public and private lands within their jurisdictions, and coordinate efforts to reach regional consistency in the control and enforcement of buffelgrass requirements. (pages 13-14)

## **EDUCATION, OUTREACH AND VOLUNTEER PROGRAMS**

Education and outreach are cost-effective tools in preventing new buffelgrass infestations and reducing further spread. Existing tools should be used to their fullest capacity and new tools should be created to reach new audiences. Volunteers can expand the capacity of land managers and partners to implement strategic management goals. It is important volunteers and education and outreach are fully integrated to increase the capacity for partners to conduct buffelgrass management throughout the region.

***Management Goal #6*** – Expand public understanding of how buffelgrass impacts the natural resources, human communities, and economies of the Sonoran Desert Region. (pages 14-15)

***Management Goal #7*** – Increase awareness of the availability to use or join volunteer programs for buffelgrass eradication and education efforts in the Sonoran Desert Region. (page 15)

## **BUFFELGRASS TREATMENT STRATEGIES**

Buffelgrass infestations should be kept below ecologically and economically damaging levels and prevented from spreading into new areas. Coordinated treatment should be implemented across the region based on common priorities. Buffelgrass treatment programs should be continuously updated and re-evaluated based on new priorities, trends, research, and information.

***Management Goal #8*** – Public and private land owners and managers should protect life, property, and natural and cultural resources by preventing, controlling and reversing the spread of buffelgrass. (pages 15-16)

***Management Goal #9*** – Continuously document and evaluate the buffelgrass treatment programs in the region through research, analysis, and field monitoring to provide the most up-to-date and effective buffelgrass control treatments. (pages 16-17)

## **MAPPING, DATABASE MANAGEMENT AND INVENTORY**

Once buffelgrass infestation locations and sizes are known, treatment needs can be assessed, selected and prioritized based on designated criteria. Mapping and inventory data should be collected on an on-going basis and used to update and prioritize buffelgrass management year-to-year. A shared comprehensive database should be developed for use by all partners.

***Management Goal #10*** – Ensure that all jurisdictions and entities can easily access and share existing information to guide buffelgrass management decisions, improve treatment efforts, and provide a single, comprehensive method for inputting data for the benefit of all partners and public and private stakeholders. (pages 17-21)

## **CONTINGENCY PLANNING**

Some vulnerable areas have crossed a threshold where contingency planning is needed to protect human health and safety, and property from the wildfire potential of buffelgrass infestations.

***Management Goal #11*** – Develop a contingency plan to protect life, property, and high-resource-value areas if buffelgrass control is not attainable. (pages 21-22)

## **RESEARCH**

Regionally-specific buffelgrass research must be conducted in the next one-to-three years to support an aggressive control program that will help reduce ecological and economic risks associated with buffelgrass invasions in Arizona.

***Management Goal #12***– Obtain scientific data on the effects and efficacy of buffelgrass control on the biophysical ecosystem (Sonoran Desert) as well as on local social structures and perceptions, to inform the development of future management goals and priorities. (pages 22-23)

## **Conclusion**

We must act now to strategically and efficiently control buffelgrass in order to prevent frequent wildfires, prevent loss of existing desert, and avoid potentially damaging economic impacts. The Southern Arizona Buffelgrass Strategic Plan provides a regional vision to guide buffelgrass control and management for the next five years in a spirit of collaborative engagement, informed analysis, and coordinated practical action. Adequate and sustained funding is essential to implement many of these strategies.

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## STRATEGIC PLAN OVERVIEW

### BACKGROUND AND CRITICAL NEED

Across southern Arizona, buffelgrass (*Pennisetum ciliare*), a non-native invasive grass, threatens to irrevocably alter the native Sonoran Desert vegetation that is essential to the region's ecological integrity and identity, and threatens public safety and regional tourist industry.

Buffelgrass is one of many African grasses that have been introduced to improve cattle forage in tropical and subtropical regions of the world, including the southern U.S. Buffelgrass is native to Africa, Arabia, Canary Islands, Madagascar, Indonesia, northern India, and Pakistan. It grows in areas with warm, frost-free winters and a summer rainy season with 6 to 24 inches of rainfall a year. Buffelgrass is cultivated and has become invasive in Australia, North and South America, and many islands in the Pacific Ocean (including Hawaii), Indian Ocean and the Caribbean Sea. Buffelgrass invasion has become a global issue.



Like other invasive plant species, buffelgrass grows rapidly and has a high reproductive rate – at maturity each plant produces thousands of seeds annually. In the Sonoran Desert, buffelgrass tends to colonize roadsides and disturbed areas, but can move into surrounding deserts where it grows in dense stands and crowds out native plants. Competition for water can weaken and kill desert plants including larger trees and cacti, while dense roots and ground shading prevent germination of native seeds. Buffelgrass alone can kill or exclude most native plants by these processes, but buffelgrass-fueled wildfires hasten the process.



Buffelgrass has introduced a new wildfire risk into the Sonoran Desert, an ecosystem that is not fire adapted. It fuels unprecedented and devastating wildfires that are considered a particularly serious threat to most native desert plants, including the saguaro cactus, the iconic plant of the Sonoran Desert Ecoregion. Desert wildfires exacerbate the buffelgrass invasion because buffelgrass is able to quickly respond to fires, filling in the newly disturbed areas with seedlings.

### *Increased Wildfire Risk*

Since the late 1950s almost 3 million acres of desert have been converted to buffelgrass pasture in the Mexican state of Sonora, south of Arizona. In Sonora, buffelgrass has expanded from these pastures into surrounding urban and natural

areas, and is now fueling wildfires most of the year including almost daily fires along some roadsides. Given our similarities in climate and vegetation with Sonora, southern Arizona municipalities will be challenged by more frequent and intensive buffelgrass



wildfires, with impacts to life and property, air quality, visibility, and public health.

Protection from buffelgrass wildfires will require increased funding for fire departments, training firefighters in grass-fire suppression, higher fire insurance costs, rising suppression costs for homeowners, development of fire breaks, aggressive public education, and development of fire ordinances aimed at reducing wildfires in populated areas.

### *Threats to Natural Areas and Ecosystems*

Buffelgrass is an equal opportunity invader that respects no boundaries. It has already formed dense stands in parts of Saguaro National Park, the Coronado National Forest, Sabino Canyon, and other natural open spaces. It is hard to imagine Saguaro National Park without saguaros and Picacho Peak State Park without wildflowers. Scientists are greatly concerned about the potential for significant ecological impact to these and other ecological resources.



The native plants most likely to be impacted by buffelgrass infestation and associated wildfires include saguaros, barrel cactus, palo verde trees, ironwood trees, native grasses and wildflowers. Additionally, wildlife habitat and forage will be compromised for animals that depend on native plants, such as the desert tortoise and mule deer. Saguaro girdling by pack rats has been observed in desert areas where native vegetation has been replaced by buffelgrass. Mule deer habitat alteration by buffelgrass has been identified as a critical management issue by the Western Association of Fish and Wildlife Agencies, Mule Deer Working Group. Habitat alteration by buffelgrass is also a conservation concern for the cactus ferruginous pygmy-owl.



### *Economic Impacts*

Ecotourism is a cornerstone of the economy of southern Arizona. The tourism and hospitality industry and its associate tax base will suffer greatly if the buffelgrass invasion continues undeterred. As this fire-prone grass colonizes rocky hill slopes, it will primarily impact native plant communities that define southern Arizona's

character. Wildfires in the Sonoran Desert have the potential to disrupt recreational activities, degrade views, and impact native plant communities that define southern Arizona's character. When the saguaro loses its habitat, Arizona loses its signature plant.

Sonoran Desert attractions (Arizona-Sonora Desert Museum and other parks and protected areas) attract tourists from around the world and are frequently visited by local residents. According to the Metropolitan Tucson Convention and Visitors Bureau (based on studies conducted by the University of Arizona) 3.5 million visitors pump \$2 billion a year into Tucson's economy, including \$20 million in tax revenues for Tucson and Pima County. Tourism accounts for nearly 40,000 jobs and about 12 percent of total wages in Pima County.

### *Practical Considerations*

In spite of extensive outreach, media coverage, the heroic efforts of volunteers, and growing public-agency engagement, buffelgrass control activities have not kept pace with the exponential spread of buffelgrass in the Southwest. Buffelgrass populations and associated control costs could double each year as this infestation spreads. Time is of the essence in facing this threat. Without collaborative and decisive regional action, we face frequent wildfires, loss of our existing natural desert, and damaging economic impacts.

Managing buffelgrass is complex. It can become established in a variety of natural and developed settings, and control in rugged, remote areas can be challenging. It is found on public reserves, state and local lands, and private property, but there is no single group that has jurisdiction to monitor and eradicate buffelgrass across these diverse areas.



Mechanical eradication (i.e., pulling) is effective, but labor-intensive.

Chemical eradication using

herbicides such as Round-up (glyphosate) is also effective, but these must be applied during the active growing season, which is generally in the summer when temperatures are typically over 100° F, and when assembling hardy, trained spray crews is difficult. With any control method, re-treatment is necessary as plants re-sprout from roots or the seed bank left in the soil. Adjacent untreated areas can also re-infest areas that have been treated for buffelgrass, requiring a coordinated regional control effort.

Due to these challenges, extraordinary efforts must be made to control buffelgrass or we will lose the battle in Southern Arizona. Land management agencies and private landowners need to establish clear priorities for control and adopt the most effective methods. These organizations must also be prepared to respond to public controversies that may arise over some control methods such as the use of herbicides and prescribed burns. Teams of trained herbicide applicators who can work safely in the heat of summer must be well organized and well coordinated. And – most importantly – significant financial resources must be applied to the problem.



Is the extraordinary effort needed to control buffelgrass worth it? Scientists, land managers, and volunteer grass pullers have observed the dramatic impacts of their efforts and believe that it *is* worth it. The cost of not taking action may be nothing less than the loss of the Sonoran Desert as we know it.

### *Strategic Plan Background*

Successful buffelgrass management will require coordinating action across property lines and jurisdictional boundaries. A group of federal and state agencies, county and city leaders, university researchers, and non-profit organizations formed a coalition in late 2006 to help improve buffelgrass management across jurisdictions. This coalition organized the Buffelgrass Summit of February 2007, which was attended by more than 120 stakeholders concerned about the buffelgrass crisis.



A sub-group of the coalition formed the Buffelgrass Working Group to develop a plan for future management and funding. This group broadened the coalition's initial geographic scope to encompass much of the Santa Cruz River watershed and surrounding areas, and developed this Southern Arizona Buffelgrass Strategic Plan with financial support provided by the Arizona State Parks Board.

## **PURPOSE, VISION, AND SCOPE**

The purpose of this Southern Arizona Buffelgrass Strategic Plan is to promote and facilitate buffelgrass management action across a broad geographic area. The Strategic Plan will assist and guide partners by helping to 1) identify and resolve regional needs for research, policy, financial resources and personnel resources; 2) provide a framework and guidelines for buffelgrass management; 3) facilitate and coordinate day-

to-day buffelgrass management activities; and 4) act as a catalyst for discussion, action, resource commitment, and further development of on-going partnerships.

This Strategic Plan recognizes that buffelgrass threatens the long-term viability of the Sonoran Desert ecosystem, local residents' health and safety, and the regional economy. Independent control actions may work, but effective mitigation requires the support and cooperation of the public, private, and business sectors to prioritize, comprehensively plan, and quickly execute control and eradication efforts.

The various federal, state, county, city, and private entities who manage or serve lands in southern Arizona are autonomous. This Strategic Plan is a non-binding compilation of ideas and guidelines developed by the Buffelgrass Working Group to provide a framework for partners to cooperatively plan, fund, and implement monitoring and control activities, in order to solve the looming buffelgrass challenge.

Working cooperatively will enable partners to pool resources to achieve common goals, provide better information, and improve access to funding. By working together on buffelgrass management issues, partners will be able to:



- Identify vectors that contribute to the spread of buffelgrass;
- Identify control methods and research data gaps;
- Develop data collection and management systems to help coordinate and prioritize treatments, and to inventory and monitor buffelgrass;
- Enable the transfer of compatible data to regional and national databases;
- Better coordinate training, education, and public awareness campaigns; and
- Help coordinate mapping and eradication efforts regionally.

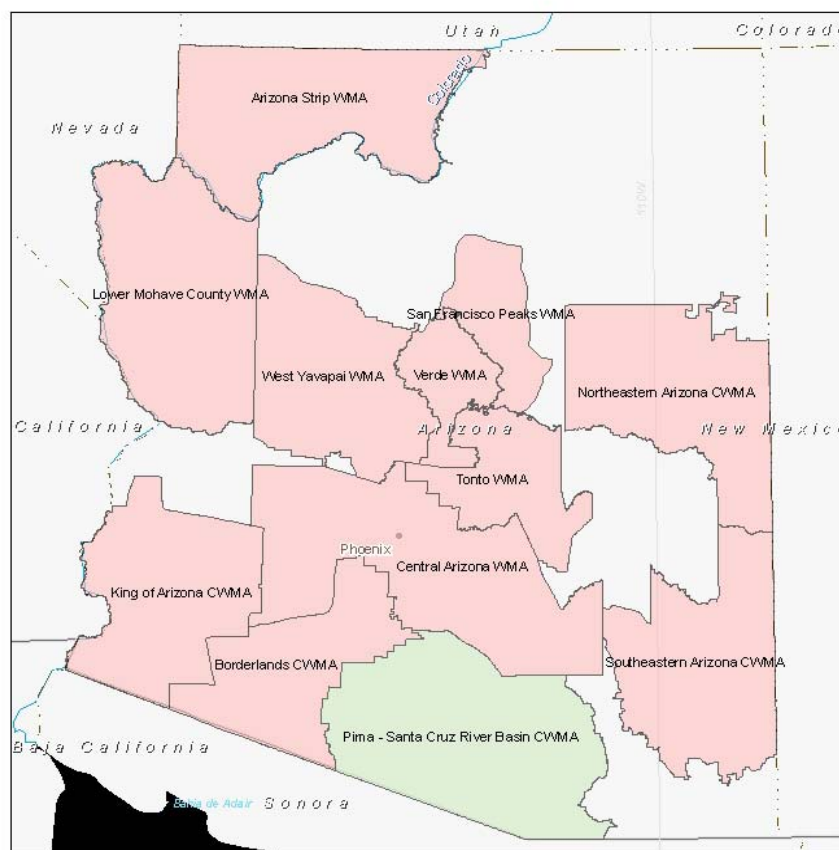
The Buffelgrass Working Group will meet a minimum of six times a year, with additional meetings as necessary, to assess opportunities for regional action, evaluate interim progress, and revise goals and guidelines as necessary. An accompanying Memorandum of Understanding (MOU) provides a framework to support cooperative action among partners (Appendix 2).

While the geographic focus of the Plan is generally the political boundaries of partners, there is a need for widespread cooperation to control existing buffelgrass populations and prevent further spread. The Plan describes efforts to coordinate within jurisdictions and other entities within Pima County and bordering counties, maintain a close working relationship with the Arizona Invasive Species Advisory Council, and gain assistance from other entities, as appropriate.

## **GEOGRAPHIC BOUNDARIES**

The efforts of the Buffelgrass Working Group are focused on southern and central Arizona, within the boundaries of the Pima-Santa Cruz River Basin Cooperative Weed Management Area (Figure 1). This Weed Management Area was established in 2004 and includes the eastern three-quarters of Pima County, a small southeastern portion of Maricopa County, southern portions of Pinal County and most of Santa Cruz County. This area may be modified as new partners and management needs are identified.

### **Arizona Cooperative Weed Management Areas**



**Figure 1.** Cooperative Weed Management Areas in southern Arizona. The proposed geographic boundaries for the Southern Arizona Buffelgrass Strategic Plan are shown in green.

## **RELATIONSHIP TO EXISTING MANAGEMENT EFFORTS**

The focus of this Strategic Plan is buffelgrass control within the political boundaries of partners, but there is a need for widespread cooperation to control buffelgrass populations and prevent further spread. Multiple initiatives address invasive species in the state and region (Appendix 11). These initiatives have multiple foci, including buffelgrass. While this Strategic Plan is primarily intended to address buffelgrass, the

effectiveness of buffelgrass management could increase if conducted with management of other invasive species by other regional initiatives.

Some of these initiatives include the Pima-Santa Cruz Basin Cooperative Invasive Species Management Area (CISMA), established to coordinate invasive species management activities and increase public awareness about invasive species in Pima and Santa Cruz Counties. More regionally, the Sonoran Desert Invasive Species Council consists of the King of Arizona and Borderlands Cooperative Weed Management Areas (CWMAs), and was established in 2002 to address 11 invasive plant species of interest, one of those being buffelgrass.

At the state level, the Arizona Invasive Species Advisory Council was established in 2005 to develop a consensus vision for a coordinated, multi-stakeholder approach to invasive species issues in Arizona, and to make recommendations on invasive species management for the State. The Council is jointly chaired by the Arizona Game and Fish Department and the Arizona Department of Agriculture.

## **PARALLEL STRATEGIES AND ADAPTIVE MANAGEMENT**

As with most environmental problems, simultaneously planning buffelgrass control actions and contingency actions is needed. Buffelgrass control will be guided by adaptive management, where monitoring will determine the efficacy of control actions, and inform changes in actions. Alternatively, control actions may not succeed in stemming buffelgrass spread no matter how aggressive the effort and contingency planning may be needed if buffelgrass becomes the dominant biomass over large areas of southern Arizona.

Contingencies may include prioritizing buffelgrass control to a limited number of parks and viewscapes critical to conservation and economic (tourism) objectives, and preventing potentially catastrophic wildfires with large fire breaks built and maintained



through valuable open spaces, such as natural resource parks, if they become heavily infested with buffelgrass. To sustain the current level of visitation, the tourism industry may need to supplement ecotourism with attractions not solely reliant on the ecological backdrop. The housing industry may have to consider the impact of buffelgrass infestations on property values

and fire insurance. More important is the need to anticipate increasing fire risks in what used to be a fire-resistant landscape. Local fire departments will be increasingly deployed to fight buffelgrass wildfires. There is every reason to think that the frequency, spatial extent, and intensity of buffelgrass wildfires will increase dramatically in the next 5 to 10 years. In areas particularly susceptible to buffelgrass invasion, neighborhoods may need to increase the number of fire hydrants and will bear the costs of increased fees from local fire departments.

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## **BUFFELGRASS MANAGEMENT OBJECTIVES, STRATEGIES, AND ACTIONS**

### *Prologue*

This section defines broad goals and objectives for buffelgrass management over the next 5 years. As this plan is implemented, technical and management guidelines will be evaluated and updated based upon criteria set forth by the Buffelgrass Working Group. This section provides the tools, methods, and analysis processes that decision makers can use to make buffelgrass implementation and financial management decisions.

### *Management Strategies*

In addition to controlling buffelgrass, management goals described here address preserving and establishing native species to replace eradicated buffelgrass, protecting natural ecological communities from infestations, and preserving economic well-being. Based on guidance provided in this document, partners are encouraged to:

- Minimize the spread of buffelgrass in areas where it is not yet established;
- Set priorities for control, confinement and elimination of established buffelgrass populations based on their actual and potential impacts, and implement these control and elimination efforts;
- Promptly restore or rehabilitate areas treated for buffelgrass to establish desirable native species and reduce the potential for new buffelgrass invasions;
- In areas where buffelgrass control is no longer feasible, mitigate risks to life and property resulting from buffelgrass infestations; and
- Implement legislation on the local, state, and federal levels to eradicate and control *Pennisetum* species (buffelgrass and fountain grass) and other invasive species, as appropriate.

## **ORGANIZATION, LEADERSHIP AND PARTNERSHIPS**

The broad geographic scope of this plan requires close coordination of management actions originating as individual efforts, regional initiatives, partnerships among stakeholders, and other cooperative efforts. It is critical to identify the primary leadership and coordination roles and groups necessary to facilitate buffelgrass management activities.

### *Regional Buffelgrass Coalitions*

#### Buffelgrass Core Team

A group of federal and state agency representatives, county and city leaders, university researchers, and staff from nonprofit organizations formed a coalition in late 2006 to improve buffelgrass management across jurisdictions. This coalition organized the Buffelgrass Summit in February 2007, then went on to form the Buffelgrass Core Team, with the goal of implementing recommendations made at the summit and improving communication about each member's buffelgrass management efforts. Currently Core

Team members include city, county and federal land managers, and representatives from fire departments, transportation agencies, conservation agencies, scientific institutions, nonprofit organizations and others.

#### Buffelgrass Working Group

The Buffelgrass Working Group is a more formalized group including representatives of jurisdictions, agencies and organizations who have contributed financially to regional buffelgrass control efforts through the Cooperative Ecosystem Study Unit (CESU). With completion of the Strategic Plan, membership in the Working Group encompasses the functions and representatives of the Core Team (Appendix 1) and will meet a minimum of six times a year with the goals of assessing opportunities for regional action, evaluating interim progress, and revising goals and guidelines as necessary relative to the Plan. An accompanying Memorandum of Understanding (MOU) provides a framework to support cooperative action among partners (Appendix 2). Among the partner members of the Working Group are leadership skills and technical expertise that is tapped to build and strengthen cooperative invasive species management efforts.

Partners in the Buffelgrass Working Group seek to increase effective coordinated treatment and efficient use of funds by focusing on key buffelgrass management issues, including:

- Reducing institutional, jurisdictional, and political barriers that impede effective regional buffelgrass control,
- Strengthening strategic and tactical elements of an effective program at the local, and regional levels, and
- Focusing attention and resources on high priority buffelgrass management needs.

Additionally, the Working Group addresses invasive species issues more broadly to:

- Combine regional efforts for grappling with a range of invasive species issues including buffelgrass, and
- Integrate the objectives of multi-jurisdictional buffelgrass management strategies into an overall invasive plant management strategy for the Sonoran Desert.

#### Management Goal 1: Buffelgrass Working Group

Maintain the Buffelgrass Working Group as an effective coordinating and advisory group for buffelgrass management and control in southern and central Arizona.

#### Implementation/ Action Items

1. Jurisdictions, agencies, and other key stakeholders identify one or more partner representatives to serve on the Buffelgrass Working Group.
2. Nominate and elect co-chairs to lead the working meetings of the Buffelgrass Working Group between January 2008 and January 2009.
3. Refine the boundaries of management areas, identify stakeholders, and create annual operational plans to coordinate all buffelgrass treatments within the geographic area.
4. Identify key stakeholders to participate in the prioritization process for high value areas and host a management area forum to prioritize treatment areas.

*Buffelgrass Coordination Center*

Controlling current buffelgrass infestations will require multiple treatments of the same patches over many consecutive years. It is essential that a centralized coordination center be created to maintain consistent long-term commitment to buffelgrass issues, to increase buffelgrass control proficiency and to eliminate duplicative efforts. Once formed, the centralized Buffelgrass Coordination Center can serve in many capacities including as a clearinghouse of information (mapping, inventory, treatments, and research), a resource and learning center for volunteers, and a fiduciary agent for the receipt and expenditure of funds (public, corporate, private and grant management).

High priority areas scheduled for treatment will be determined by the Buffelgrass Working Group, who will oversee and advise the Coordination Center staff. It is imperative that the Buffelgrass Working Group and the Coordination Center work closely with the Arizona Invasive Species Council to ensure that buffelgrass remains a high priority within the state and that pertinent information is collected, retained, and used appropriately to further buffelgrass control efforts.

Management Goal 2: Create Buffelgrass Coordination Center

Identify a non-profit organization that can house a centralized Buffelgrass Coordination Center to serve as the informational network, volunteer network, and fiduciary agent that will receive and distribute funds for high priority actions throughout the region.

Implementation/ Action Items

1. Identify an existing centralized 501(c)3 non-profit that can serve as a fiduciary agent to receive and expend dollars for long-term, prioritized buffelgrass management within the geographic area.
2. Identify, develop and broker funds and personnel to implement buffelgrass management within the geographic area.
3. Identify a mechanism for funding a Coordination Center Director/ Development Officer position (1.0 FTE), a Weed Specialist/ Restoration Ecologist (1.0 FTE), and a GIS Informatics Technician (1.0 FTE) that will support regional buffelgrass management efforts through garnering financial support (cooperative agreements, donations, grant management, etc.), facilitating buffelgrass information exchange, and gaining public support for buffelgrass management efforts.
4. Develop a process whereby prioritized buffelgrass projects receive funds and treatment summaries are submitted to inform long-term management decisions.

*Public and Private Partnerships*

The corporate sector in southern and central Arizona has a vested interest in mitigation and adaptation to buffelgrass invasion due to the negative economic impacts that could result. Developers, title companies, property management groups, homeowners associations, realtors, and others who own or manage large land parcels, or are

otherwise associated with land, need to have on-going long-term buffelgrass management programs to address infested properties, whether vacant or in some stage of development. Additionally, ecotourism is a cornerstone of the regional economy and wildfires in the desert are becoming more common during the fall and winter 'tourist season.' The visual scars of firebreaks, frequent wildfires, and the replacement of iconic cacti with buffelgrass stands can trigger a domino effect of economic decline in the region. Public utilities typically control rights-of-way that can become infested with buffelgrass; therefore corporate partners and utilities are key players in a coordinated regional effort.

**Management Goal 3: Creating Public and Private Partnerships**

Identify and provide information to partners to facilitate their implementation of buffelgrass management.

**Implementation/ Action Items**

1. Educate regional and local leaders, agencies, utilities and other organizations regarding the buffelgrass impacts to the Sonoran Desert environment, economy, and community health and safety.
2. Identify benefits to partners for providing contributions of direct funding, in-kind match, volunteers, tax incentives, etc.
3. Educate land managers, developers, private land owners and the public about buffelgrass treatment and control programs, the associated wildfire risks, threats to life, property and the natural desert, and their associated responsibilities. Make these contacts through Southern Arizona Home Builder's Association (SAHBA), the development community (engineers, architects, landscape architects, surveyors, landscape contractors, and construction managers, among others), title companies, real estate agencies, property management companies and various residential and commercial associations.

**LEGISLATION, CODES AND ORDINANCES**

State legislation is needed to mandate and define standards and requirements applicable to buffelgrass control at the local and regional level. Such legislation can allow local standards to be more stringent in some cases, or can establish standards for local governments that apply at or above certain thresholds. Ultimately, any program authorized at the state level must receive appropriated funds in order to be implemented to the fullest degree.

Local county, city, and town codes, policies, and ordinances should be developed and/or revised to enable buffelgrass control on all properties within their jurisdictions. An effective and comprehensive approach to local buffelgrass control which can elicit support and participation of the broader community is critical to landscape scale control. Consistency and compatibility between jurisdictional code, policy, and ordinance requirements is necessary in the development of such a comprehensive approach. A regional, comprehensive approach of this nature re-enforces the message that all jurisdictions are committed to buffelgrass eradication. Additionally, local jurisdictions

should incorporate buffelgrass control into all scales of land development from regional-scale planning to project-specific approvals. While each jurisdiction maintains its own authority to regulate development, the following types of development approvals represent the various scales at which buffelgrass control stipulations can be applied to both commercial and residential properties:

- General Plans/ Comprehensive Plans
- Zonings and Rezoning
- Codes and ordinances governing environment, flood control, transportation, and nuisance control matters
- Certificates of Occupancy
- Covenants, Conditions, & Restrictions (CC&Rs)

Regardless of the vehicle(s) a local government may use to implement buffelgrass control on public and private properties under its jurisdiction, enforcement of required control actions is essential to maintain public support and effect successful buffelgrass eradication. Buffelgrass control implemented through the authorities of local government is especially important for lands located within identified high-priority buffelgrass control areas and for development projects near or adjacent to public preserves.

#### Management Goal 4: Buffelgrass Legislation

Increase awareness within the ranks of the Arizona State Legislature and U.S. House and Senate to the buffelgrass crisis so that legislation will be brought forward to provide funding and support for buffelgrass management within Arizona.

#### Implementation/ Action Items

1. Identify a group of Arizona State Legislators and U.S. Congress members who will 'champion' the buffelgrass crisis. Provide them with all necessary information to develop, introduce and pass legislation addressing buffelgrass in Arizona.
2. Develop legislation which enforces requirements that public and private property owners implement buffelgrass management programs on their landholdings.
3. Coordinate and host site visits for policy makers, law makers, and staff members to areas with buffelgrass problems to increase their awareness buffelgrass issues.
4. Develop and present periodic updates to policy makers, legislative liaisons and other interested parties regarding the buffelgrass problem.

#### Management Goal 5: Buffelgrass Codes and Ordinances

Assist local jurisdictions in amending or developing new codes, ordinances, zoning requirements and other requirements addressing the eradication and control of buffelgrass on all public and private lands within their jurisdictions, and coordinate efforts to reach regional consistency in the control and enforcement of buffelgrass requirements.

Implementation/ Action Items

1. Create and facilitate an inter-jurisdictional subcommittee comprised of local government staff members to identify local needs and develop appropriate scale-dependent buffelgrass control standards.
2. Obtain support from decision makers to create, implement and enforce codes, ordinances, zoning requirements and other actions that address buffelgrass control.

**EDUCATION, OUTREACH, AND VOLUNTEER PROGRAMS**

Education about the impacts of buffelgrass on critical regional ecosystems is an important facet of long-term buffelgrass control efforts.

Education and outreach are very cost-effective tools in helping prevent new buffelgrass infestations and helping reduce spread. With improved marketing techniques and additional education products aimed at diverse stakeholders, the public's recognition of the threat of buffelgrass would greatly improve.

Volunteers can map and remove buffelgrass infestations, and present education and outreach programs to interested groups, thus expanding the capacity of land managers and partners to implement strategic management goals. Groups needing education include land managers, policy makers, local residents, homeowner associations, public land users, agricultural groups, conservationists, landscapers, researchers, local fire department personnel (permanent and seasonal), civic groups and school groups, among others. A campaign to build volunteer capacity will target many of the same audiences, with a special emphasis on local community members in the areas of major buffelgrass infestations.

**Accomplishments:**

Education and outreach activities following the Buffelgrass Summit (February 2007) included:

- Development of the "Wanted Buffelgrass Dead and Gone" brochure and flyer;
- Recruitment of 30 new volunteers for buffelgrass management activities (managed by Pima County – NRPR);
- Development and facilitation of a 3-part Buffelgrass Action Leadership Training (covering Pulling, Education and Outreach, and Mapping); and the
- Development and facilitation of four buffelgrass eradication training courses for landscaping companies.

Buffelgrass education and outreach materials are available in Appendix 8.

Management Goal 6: Buffelgrass Education and Outreach

Expand public understanding of how buffelgrass impacts the natural resources, human communities, and economies of the Sonoran Desert Region.

Implementation/ Action Items

1. Develop a regional media program by coordinating preparation and presentation of television spots, ad campaigns, and public service announcements.
2. Create effective informational materials in partnership with existing educational groups, about the nature, characteristics, and impacts of buffelgrass on the

environment, economy, and quality of life, including potential impacts to threatened and endangered species, water quality, and wildfire.

3. Distribute informational materials across the community and the region, including providing briefing packages and presentations for national, state, and local officials; the development community; K-12 students; and other key communities.
4. Obtain funding for a dedicated webmaster (at least 0.5 FTE) for the development and maintenance of a buffelgrass website that promotes information dissemination to stakeholders.
5. For partners who have data important for a central repository, provide database management training on data access and collection, metadata specifications, and uploading procedures for a mapping database link located on the buffelgrass website.

#### Management Goal 7: Buffelgrass Volunteer Awareness

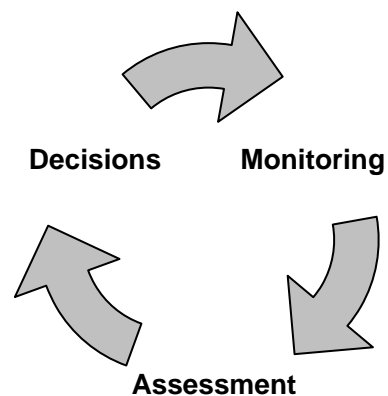
Increase awareness of the availability to use or join volunteer programs for buffelgrass eradication and education efforts in the Sonoran Desert Region.

#### Implementation/ Action Items

1. Continue to use and promote established curricula for training buffelgrass eradication and education volunteers.
2. Provide information via the buffelgrass website to established and potential volunteers about existing opportunities for their involvement and encourage individuals to participate regularly.
3. Host annual volunteer gatherings to acknowledge and celebrate the work that volunteers contribute to the buffelgrass management efforts. All partners will participate in the gatherings by providing information back to the volunteers regarding successful management as a result of volunteer efforts.

### **BUFFELGRASS TREATMENT STRATEGIES**

Strategically managing buffelgrass requires adaptive management (the repetitive process of optimal decision-making in the face of uncertainty, with the aim of reducing uncertainty over time via monitoring). In the context of buffelgrass management, adaptive management can be viewed as a repeated process of decisions, monitoring, and assessment. Multiple year treatments of infestations are essential for achieving results and decisions must be made regarding each treatment. Monitoring the results of various treatments provides information on the success of particular actions. Assessing treatment and monitoring information becomes the foundation for adaptive management – the refinement of subsequent operations to make them more effective. All three components are necessary for effective long-term management, habitat protection, optimal use of time, and effective use of limited resources. When



**Figure 2.** A typical adaptive management cycle for invasive species management.

implemented collectively, these components provide data to justify future management priorities, strategies and actions.

### *Treatment*

Once buffelgrass initially infests an area, it should be kept below ecologically and economically damaging levels and prevented from spreading to new areas. If an infestation expands, controlling around its edges prevents further spread, while long-term control efforts should focus on the remainder of the infestation. Buffelgrass control strategies need to utilize both integrated pest management principles and “best management practices.” Entities working to control buffelgrass should utilize known effective controls (manual and chemical) and investigate new potentially effective chemical, biological and cultural controls (Appendix 5).

### Management Goal 8: Buffelgrass Treatment

Public and private land owners and managers should protect life, property, and natural and cultural resources by preventing, controlling and reversing the spread of buffelgrass.

### Implementation/ Action Items

1. Those who have responsibility to treat buffelgrass should institute a minimum three-year treatment and management program, including identifying and obtaining the associated funding for each high priority buffelgrass infestation area.
2. Treat new buffelgrass patches in identified high priority-high risk buffelgrass infestation areas.
3. Treat high priority large buffelgrass populations starting along the patch perimeter and treat the infestation inward to reduce seed spread from the outer perimeter into adjacent non-infested areas.
4. Treat buffelgrass populations along roadways in high priority areas where they are the vector of buffelgrass spread.
5. Create firebreaks around, along, or between the largest, contiguous buffelgrass/ fountain grass infested areas within the high priority buffelgrass infestation areas.
6. Revegetate treated areas with an appropriate local native plant palette as necessary following each 3-year treatment window.
7. Use integrated pest management (IPM) practices for mechanical, chemical, and biological control methods in selected areas, where appropriate.
8. Hire and train seasonal and year-round crews to identify and treat buffelgrass infestations in high priority areas using mechanical and chemical methods.
9. Expand buffelgrass-pulling volunteer events to focus on high priority areas.

### *Monitoring and Evaluation*

Monitoring is the repeated collection and analysis of information to evaluate progress in meeting resource management objectives. Field monitoring techniques include collecting measurement data, creating photographic documentation, conducting

observational field trips to treatment sites, and any other data collection necessary to document buffelgrass conditions. Evaluation techniques include research, synthesis of field data, extrapolation of results to inform future treatment efforts and other techniques as appropriate.

The monitoring and evaluation program provides the following services:

- a. Updates data on buffelgrass-free zones, new buffelgrass sightings, and existing buffelgrass treated sites;
- b. Differentiates between changes resulting from treatments versus external factors such as weather;
- c. Collects, analyzes, and evaluates the effectiveness of existing treatment programs;
- d. Determines priorities for future buffelgrass treatment decisions; and
- e. Prevents new infestations and re-infestations in treated areas.

The buffelgrass treatment programs being instituted by jurisdictions, land managers and others should be continuously updated and re-evaluated based on new priorities, trends, research, and information. Scientific data should be synthesized, relative costs and benefits determined and three-year treatment plans updated accordingly. The ongoing monitoring and evaluation program is a tool that decision makers can use to update and prioritize their operational buffelgrass management plan.

#### Management Goal 9: Buffelgrass Monitoring and Evaluation

Continuously document and evaluate the buffelgrass treatment programs in the region through research, analysis, and field monitoring to provide the most up-to-date and effective buffelgrass control treatments.

#### Implementation/ Action Items

1. Develop standardized training, data collection, reporting, and monitoring procedures and protocols that can be easily interpreted and implemented locally.
2. Share treatment and monitoring data among various management areas to update methods and tools and re-evaluate high priority areas periodically.
3. Quantify treatment control efforts and compare to the growth rate of mapped buffelgrass patches.
4. Analyze data input from a central buffelgrass mapping and monitoring control center annually.

### **MAPPING, DATABASE MANAGEMENT, AND INVENTORY**

Mapping and inventory efforts identify buffelgrass infestations and are used to prioritize treatment areas and control methods. Once infestation locations and sizes are known, treatment needs can be assessed, selected and prioritized based on the following criteria: size and location of infestation, fire-risk level, loss of high-value resources in native desert areas, costs of treatment, available funds, responsible parties and follow-up commitments for management and treatment. All treatment areas require follow-up treatment monitoring to assess results and provide data to update the maps.

*Mapping and Data Management*

Mapping is critical to the successful management of buffelgrass. Managers need to initiate and invest in buffelgrass surveys, mapping, prioritizing control efforts, assessing previously treated areas, and adopting on-going programs for long-term control. Mapping of buffelgrass survey results, infestation areas, and treatment areas is performed at different levels of sophistication by different organizations. The diversity of jurisdictional missions, resources, expertise, history, and landscapes has led to an equal diversity of implementation methods and metadata collection (associated information about surveys, infestations, and treatments) used in buffelgrass mapping. A summary of existing buffelgrass databases for southern Arizona is shown in Table 1.

**Table 1.** Existing spatial databases targeting buffelgrass surveys, infestations, and treatments in southern Arizona.

Database	Coverage	Roadsides <sup>1</sup>	Natural <sup>1</sup>	Area	Start	End <sup>2</sup>	Points <sup>1</sup>	Lines <sup>1</sup>	Polygons <sup>1</sup>	Survey <sup>1</sup>	Infestation <sup>1</sup>	Treatment <sup>1</sup>
Arizona-Sonora Desert Museum	Regional	C		Arizona, Sonora	2004	2004	X	X		C	X	
ASDM Invaders	Regional	X	X	Tucson Mtns, Tucson	2005	*	X	X	X	C	X	
Avra Valley (City of Tucson)	Local			Avra Valley city-owned lands	2007	*	X	X	X		X	
Coronado National Forest	Local	C		Catalina Mtns, Rincon Mtns, Santa Rita Mtns	2003	*	X	X	X		X	
Organ Pipe Cactus National Monument	Local	C	X	Organ Pipe Cactus NM	1997	*	X				X	X
Saguaro National Park	Local	C	X	Saguaro NP	1997	*	X	X	X		X	X
Santa Rita Experimental Range	Local	C	C	Santa Rita Experimental Range	2007	*	X	X	X	C	X	
Sonoran Desert Weedwackers	Local	X	X	Tucson Mountains	2000	*	X				X	X
Sonoran Institute	Local	X	X	Ironwood Forest National Monument	2007	*	X	X	X		X	
SWEMP	Regional	X	X	AZ, UT, NV, CO	1990	2007	X	X	X			
Tumamoc Hill	Local	C	C	Tumamoc Hill, A Mountain, Starr Pass, Tucson Mountain Roads	2005	*	X		X		C	

<sup>1</sup> A 'X' indicates that some records target this type of infestation (roadsides vs. natural), have this spatial type (points, lines, or polygons), or that this database contains this type of observation (survey, infestation, or treatment). A 'C' in one of these categories signifies a comprehensive collection (e.g., all roads or natural landscapes, recorded the location of all surveys, surveyed every infestation, recorded every treatment).

<sup>2</sup> End dates are given for projects with completion dates; ongoing data collection efforts are indicated with (\*).

A shared single, comprehensive database is needed for a regional cross-jurisdictional team focused on controlling buffelgrass to be able to plan, assess, and prioritize the mapped data. Providing tested guidelines and methods and good examples of metadata information is helpful to new mapping participants, and can serve as building blocks for developing a single, comprehensive regional mapping database system that all partners can use.

An operational cross-jurisdictional database needs a central point of coordination to organize and maintain the original data and a 'new' synthesized map database from which planners can derive survey, infestation, and treatment maps according to organization, location, year, density, and management party.

#### Management Goal 10: Mapping and Data Management

Ensure that all jurisdictions and entities can easily access and share existing information to guide buffelgrass management decisions, improve treatment efforts, and provide a single, comprehensive method for inputting data for the benefit of all partners and public and private stakeholders.

#### Implementation/ Action Items

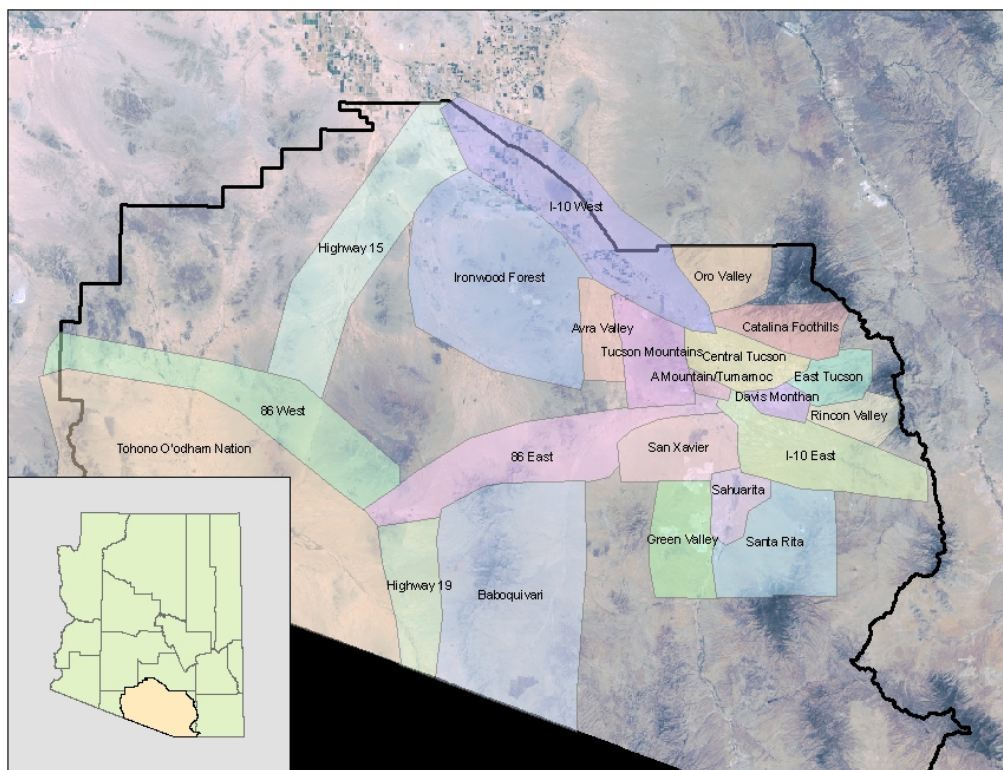
1. Create an interactive mapping system that identifies the location and extent of buffelgrass infestations and becomes a tool in assessing and determining treatment efforts.
2. Provide a standard mapping and inventory approach for roadside and wildland mapping that can be used by jurisdictions and the public.
3. Establish common metadata standards for data access and input across jurisdictions.
4. Create a regional cross-jurisdictional team (including GIS or related departments or personnel of jurisdictions where buffelgrass is likely to encroach into or spread from) that oversees and manages a single, comprehensive database for data storage and data input by all regional jurisdictions and agencies.
5. Compile a list of existing inventory gaps with mapping to be shared and assigned among partners.
6. Map and categorize high-priority buffelgrass infestation areas based on buffelgrass population size, density, location, and effect on sensitive species, high resource value areas, designated public preserves and conservation areas, risk to human life and property and impacts to tourism.
7. Update the high priority, large buffelgrass infestation map annually and key these areas to ownership, responsible party, and/or management jurisdictions.

#### *Management Areas*

Due to the large geographic area this strategic plan incorporates, it may prove difficult to leverage resources across the entire region. However, by working within smaller management areas, land managers can work more effectively with homeowner's associations, NGOs, volunteer groups and others in their control efforts.

The Buffelgrass Working Group provisionally identified twenty-one (21) distinct management areas within the geographic region addressed by the Plan, which coincides with the Pima-Santa Cruz Basin Cooperative Invasive Species Management Area (Figure 3 and Table 2). These management areas may be refined and additional management areas may be identified in the future, as needed.

Pima-Santa Cruz Basin Cooperative Invasive Species Management Area  
Buffelgrass Management Areas



**Figure 3.** Provisional buffelgrass management areas within the Pima-Santa Cruz Basin Cooperative Invasive Species Management Area.

**Table 2.** Buffelgrass management areas, listed alphabetically.

86 East	Davis Monthan	Ironwood Forest
86 West	East Tucson	Oro Valley
A Mountain/ Tumamoc	Green Valley	Rincon Valley
Avra Valley	Highway 15	Sahuarita
Baboquivari	Highway 19	San Xavier
Catalina Foothills	I-10 East	Santa Rita
Central Tucson	I-10 West	Tohono O'odham Nation
		Tucson Mountains

Long-term management priorities should focus on securing safety for life and property first, then addressing roadsides to prevent further spread. Next, priorities should focus on smaller populations in key natural areas, and finally on the large dense stands that

are serving as a seed source for regional spread. Effective invasive species management is similar to wildfire management: first contain the spread, establishing a perimeter from which to work inward, tackling the smaller satellite populations first and the largest, densest stands of plants last. Based on this prioritization system, approximately a dozen buffelgrass hotspots have been geographically delineated for the greater Tucson region (Figure 4).



**Figure 4.** Known regional buffelgrass 'hot spots' identified by the Buffelgrass Working Group (see Appendix 4 for more information).

## **CONTINGENCY PLANNING**

In spite of a major increase in awareness about the buffelgrass threat on the part of jurisdictions, public land managers, NGOs, lawmakers, private landowners and managers, the state legislature and the public, both the awareness level and the commitment of resources and manpower are lagging behind the massive spread of buffelgrass in the region. As a result of this lag in action, some vulnerable areas of the Sonoran Desert have crossed a threshold where it is essential to immediately prepare contingency plans to protect life and property from the devastating wildfire potential of this rampantly spreading flammable grass. The Catalina Foothills are one such area.

### Management Goal 11: Wildfire Contingency Planning if Control is not Possible

Develop a contingency plan to protect life, property and high-resource-value areas if buffelgrass control is not attainable.

Implementation/ Action Items

1. Contribute to the regional fire management plans for public jurisdictions, private landowners, and fire districts to anticipate fire risks associated with buffelgrass.
2. Develop a firebreak implementation plan that addresses the following:
  - a. Plan should include training and mobilization tactics for implementing firebreaks that will minimize the extent and intensity of buffelgrass-fueled wildfires.
  - b. Permanent firebreaks should be strategically located to block the spread of fire from roadsides into developed and/or natural areas and vice versa.
3. Contribute to fire management/ mobilization plan development to address the specific limiting factors related to the target area location and physical site conditions.

**RESEARCH**

Traditionally, invasive species research has concentrated on understanding the consequences of invasions on ecosystem structure and function, while mitigation and adaptation have received less attention. This holds true for traditional research on buffelgrass invasion as well. Ironically, much of the buffelgrass research to date has concentrated on improving its establishment under cultivation for cattle forage or erosion control. As buffelgrass invasion accelerated in the 1980's, the research focus began to shift gradually towards evaluating impacts in both urban and natural areas. There is still a dearth of critical science, however, to support and evaluate buffelgrass control methods, restoration after treatment, or adaptation in the event that control fails and fire-resistant desert becomes flammable grassland. Products resulting from research conducted on buffelgrass are needed within 1 to 3 years to support an aggressive control program. The long-term goal of this control program is to reduce ecological and economic risks associated with buffelgrass invasions in Arizona.

A preliminary list of buffelgrass research needs is provided below and a detailed description of each research need is available in Appendix 6. It is anticipated that this list will be further developed and updated as this plan is implemented and research is completed.

- a. Development of a coordination center and data clearinghouse
- b. Evaluation of mechanical and chemical control methods (including site characteristics, and timing and repetition of treatments)
- c. Use of remote sensing to map and monitor buffelgrass
- d. Development of phenological models for green-up and herbicide application
- e. Realistic spread and niche models for different strains of buffelgrass that take into account landscape structure, pathways of dispersal, and climate variability and change
- f. Restoration of treated or burned areas
- g. Modeling of fuel loads, ignition sources, fire behavior, fire risks, fire frequency and intervals, and the resulting fire impacts as patches coalesce and invasion progresses

- h. Impact of buffelgrass invasion on critical habitat and rare species
- i. Unintended impacts of herbicides
- j. Cascading effects of buffelgrass on native species
- k. Riparian area impacts following buffelgrass wildfires
- l. Web-based Decision Support Systems (DSS)

**Management Goal 12: Research**

Obtain scientific data on the effects and efficacy of buffelgrass control on the biophysical ecosystem (Sonoran Desert) as well as on local social structures and perceptions, to inform the development of future management goals and priorities.

**Implementation/ Action Items**

1. Contribute, compile, maintain, and update buffelgrass research information, and make it available to stakeholders through the Coordination Center.
2. Support buffelgrass research efforts initiated and conducted regionally by direct funding, providing in-kind contributions or by other means.
3. Identify and prioritize applied science needs and other information gaps annually, in support of buffelgrass management in Arizona, and distribute a list of needs to research stakeholders.
4. Create a feedback mechanism whereby biologists, researchers and land managers can share information obtained through various on-the-ground activities (research, inventory & monitoring and treatment/control) that will further inform future decisions and research.

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## **PROGRAM IMPLEMENTATION**

### **LABOR RESOURCES**

There are a variety of labor resources available to conduct buffelgrass management activities that include volunteers, fee-based groups (such as youth organizations), and contractors. Each of these groups may be used independently or together to accomplish long-term management objectives. Internal labor resources (agency staff) are not discussed in this section though should also be taken into consideration when developing operational and implementation plans.

#### *Volunteer Groups*

Volunteers can provide the labor resources for manually removing and mapping invasive grasses and entering the data into a computerized record. In some cases, volunteers can be used to treat infestations with herbicide IF they have the proper Arizona Applicator's License for herbicide. By using volunteers and allocating a limited expenditure of staff time to manage the volunteers, the agency gains much-needed assistance from a diligent, educated work force.

#### ASDM – Invaders Program

ASDM's Invaders Program utilizes trained volunteers (Citizen Scientists) to map invasive species within designated project areas of the Sonoran Desert Region. Small groups of volunteers may also be mobilized to conduct educational outreach or research activities for invasive species.

**Contact:** **Alix Rogstad** <[arogstad@desertmuseum.org](mailto:arogstad@desertmuseum.org)>  
**520.883.1380 x 133**

#### Buffelgrass Community Action Volunteers

A group of locally trained volunteers are currently available for various projects within Pima County including group presentations (outreach and education) and manual grass removal. These volunteers are trained specifically to assist homeowner's association groups and local residents in their efforts to eradicate and control buffelgrass on private property.

**Contact:** **Environmental Education Department**  
<[eeducation@pima.gov](mailto:eeducation@pima.gov)>; **520.615.7855**

#### Saguaro National Park Buffelgrass Volunteers

After observing the success of other volunteer efforts in the region, Saguaro National Park implemented a monthly buffelgrass pulling effort to manually remove buffelgrass within both East and West Districts of the park in 2007. The volunteer efforts are coordinated with other on-going invasive species management activities within the park such as herbicide treatments.

**Contact:** **Bethany Hontz** <[Bethany\\_hontz@nps.gov](mailto:Bethany_hontz@nps.gov)>

**Sonoran Desert Weedwackers (SDW)**

Formed in 2000, the SDW work only on Pima County properties and primarily within Tucson Mountain Park (TMP). They use a two-pronged strategy to defend TMP against invasive grasses: reconnaissance and eradication. Reconnaissance is conducted at least once per month, where a team of 2-4 people hike throughout the park, eliminating small isolated populations, mapping larger infestations using GPS coordinates and monitoring areas where invasive grasses have been removed in the past. Routes to the patches are recorded; size of patches, area and approximate number of plants are noted. Another volunteer records the data collected by the reconnaissance group on a spreadsheet maintained by the Arizona-Sonora Desert Museum. It is estimated that approximately 4,000-5,000 acres have been cleared and revisited; another 4,000-5,000 acres have been mapped with areas tagged for future eradication; and a total of 15,000 of 27,000 acres in TMP have been surveyed. Following reconnaissance, treatment areas are identified for manual removal and volunteers are directed to the highest priority areas. As of December 2007, 7,300 volunteer hours have been logged and an estimated 73 tons of invasive grasses have been manually removed.



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**Contact: Environmental Education Department  
<eeducation@pima.gov>; 520.615.7855**

*Fee-Based Groups*

**American Conservation Experience (ACE)**

ACE is a non-profit conservation corps that offers opportunities for both American and international volunteers, over the age of 18, to take part in challenging outdoor projects throughout the Southwest, including invasive species management and re-vegetation work. Volunteers contribute 40 hours of work each week in exchange for housing and food at project sites.

**Contact: Chris Baker <cbaker@usaconservation.org>  
<www.usaconservation.org>; 928.699.1068**

**Coconino Rural Environment Corps (CREC)**

Based in Flagstaff, CREC provides employment and career development opportunities for youth and young adults while completing work that benefits the environment. They offer two distinct programs NACC for 18-25 year-olds and YCC for 15-18 year olds. Crews of 6-8 people come pre-trained and fully-equipped for highly specific conservation projects, including invasive species management. CREC provides payroll, insurance, workman's compensation insurance and health insurance to their employees working on projects.

**Contact: Allison Laramée, CREC Projects and Partnerships Coordinator  
<www.crecweb.org>; 928.679.8163**

Southwest Conservation Corps (SCC)

SCC is a non-profit employment, job training, and education organization based in Colorado that has an office in Tucson, Arizona. SCC hires young adults ages 14 to 25 and organizes them into crews focused on completing conservation projects on public lands.

**Contact: SCC <[www.sccorps.org](http://www.sccorps.org)>; 520.884.5550**

Student Conservation Association (SCA)

The Student Conservation Association is a nonprofit organization that offers conservation internships and summer trail crew opportunities to more than 3,000 people each year. SCA members complete projects in a variety of conservation disciplines, including invasive species management, on America's public lands.

**Contact: Beth Erdey, Recruitment Representative, Western Region  
<[www.thesca.org](http://www.thesca.org)>; 603.543.1700**

*Contractors*

Multiple landscaping contractors are available in the Tucson metropolitan area, a number of which have attended buffelgrass identification and eradication classes sponsored by Pima County and Buffelgrass Working Group partners (Appendix 9). Prior to contracting with a particular project contractor for landscaping services, it is important to verify their knowledge of buffelgrass by discussing with them how best to effectively identify it, remove it, and properly dispose of it.

**IMPLEMENTATION TABLES**

The implementation tables on the following pages are provided for each of the Strategic Goals outlined in the BUFFELGRASS MANAGEMENT OBJECTIVES, STRATEGIES, AND ACTIONS section found beginning on page 9 of this document. The implementation tables have been developed for use in long-range planning for buffelgrass management activities and should be updated annually.

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**Table 3. Implementation Table for Organization, Leadership and Partnerships**

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 1: Buffelgrass Working Group</u></p> <p>Maintain the Buffelgrass Working Group as an effective coordinating and advisory group for buffelgrass management and control in southern and central Arizona.</p>	1. Jurisdictions, agencies, and other key stakeholders identify one or more partner representatives to serve on the Buffelgrass Working Group.			
	2. Nominate and elect co-chairs to lead the working meetings of the Buffelgrass Working Group between January 2008 and January 2009.			
	3. Refine the boundaries of management areas, identify stakeholders, and create annual operational plans to coordinate all buffelgrass treatments within the geographic area.			
	4. Identify key stakeholders to participate in the prioritization process for high value areas, and host a management area forum to prioritize treatment areas.			
<p><u>Management Goal 2: Create Buffelgrass Coordination Center</u></p> <p>Identify a non-profit organization that can house a centralized Buffelgrass Coordination Center to serve as the informational network, volunteer network, and fiduciary agent that will receive and distribute funds for high priority actions throughout the region.</p>	1. Identify an existing centralized 501(c)3 non-profit that can serve as a fiduciary agent to receive and expend dollars for long-term, prioritized buffelgrass management within the geographic area.			
	2. Identify, develop and broker funds and personnel to implement buffelgrass management within the geographic area.			
	3. Identify a mechanism for funding a Coordination Center Director/ Development Officer position (1.0 FTE), a Weed Specialist/ Restoration Ecologist (1.0 FTE), and a GIS Informatics Technician (1.0 FTE) that will support regional buffelgrass management efforts through garnering financial support (cooperative agreements, donations, grant management, etc.), facilitating buffelgrass information exchange, and gaining public support for buffelgrass management efforts.			
	4. Develop a process whereby prioritized buffelgrass projects receive funds and treatment summaries are submitted to inform long-term management decisions.			
<p><u>Management Goal 3: Creating Public and Private Partnerships</u></p> <p>Identify and provide information to partners to facilitate their implementation of buffelgrass management.</p>	1. Educate regional and local leaders, agencies, utilities and other organizations regarding buffelgrass impacts to the Sonoran Desert environment, economy, and community health and safety.			
	2. Identify benefits to partners for providing contributions of direct funding, in-kind match, volunteers, tax incentives, etc.			
	3. Educate land managers, developers, private land owners and the public about buffelgrass treatment and control programs, the associated wildfire risks, threats to life, property and the natural desert, and their associated responsibilities. Make these contacts through Southern Arizona Home Builder's Association (SAHBA), the development community (engineers, architects, landscape architects, surveyors, landscape contractors, and construction managers, among others), title companies, real estate agencies, property management companies and various residential and commercial associations.			

**Table 4.** Implementation Table for Legislation, Codes and Ordinances

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 4: Buffelgrass Legislation</u></p> <p>Increase awareness within the ranks of the Arizona State Legislature and U.S. House and Senate to the buffelgrass crisis so that legislation will be brought forward to provide funding and support for buffelgrass management within Arizona.</p>	1. Identify a group of Arizona State Legislators and U.S. Congress members who will 'champion' the buffelgrass crisis. Provide them with all necessary information to develop, introduce and pass legislation addressing buffelgrass in Arizona.			
	2. Develop legislation which enforces requirements that public and private property owners implement buffelgrass management programs on their landholdings.			
	3. Coordinate and host site visits for policy makers, law makers, and staff members to areas with buffelgrass problems to increase their awareness buffelgrass issues.			
	4. Develop and present periodic updates to policy makers, legislative liaisons and other interested parties regarding the buffelgrass problem.			
<p><u>Management Goal 5: Buffelgrass Codes and Ordinances</u></p> <p>Assist local jurisdictions in amending or developing new codes, ordinances, zoning requirements and other requirements addressing the eradication and control of buffelgrass on all public and private lands within their jurisdictions, and coordinate efforts to reach regional consistency in the control and enforcement of buffelgrass requirements.</p>	1. Create and facilitate an inter-jurisdictional subcommittee comprised of local government staff members to identify local needs and develop appropriate scale-dependent buffelgrass control standards.			
	2. Obtain support from decision makers to create, implement and enforce codes, ordinances, zoning requirements and other actions that address buffelgrass control.			

**Table 5.** Implementation Table for Education, Outreach, and Volunteer Programs

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 6:</u> <u>Buffelgrass Education and Outreach</u></p> <p>Expand public understanding of how buffelgrass impacts the natural resources, human communities, and economies of the Sonoran Desert Region.</p>	1. Develop a regional media program by coordinating preparation and presentation of television spots, ad campaigns, and public service announcements.			
	2. Create effective informational materials in partnership with existing educational groups, about the nature, characteristics, and impacts of buffelgrass on the environment, economy, and quality of life, including potential impacts to threatened and endangered species, water quality, and wildfire.			
	3. Distribute informational materials across the community and the region, including providing briefing packages and presentations for national, state, and local officials; the development community; K-12 students ; and other key communities.			
	4. Obtain funding for a dedicated webmaster (at least 0.5 FTE) for the development and maintenance of a buffelgrass website that promotes information dissemination to stakeholders.			
	5. For partners who have data important for a central repository, provide database management training on data access and collection, metadata specifications, and uploading procedures for a mapping database link located on the buffelgrass website.			
<p><u>Management Goal 7:</u> <u>Buffelgrass Volunteer Awareness</u></p> <p>Increase awareness of the availability to use or join volunteer programs for buffelgrass eradication and education efforts in the Sonoran Desert Region.</p>	1. Continue to use and promote established curricula for training buffelgrass eradication and education volunteers.			
	2. Provide information via the buffelgrass website to established and potential volunteers about existing opportunities for their involvement and encourage individuals to participate regularly.			
	3. Host annual volunteer gatherings to acknowledge and celebrate the work that volunteers contribute to the buffelgrass management efforts. All partners will participate in the gatherings by providing information back to the volunteers regarding successful management as a result of volunteer efforts.			

**Table 6.** Implementation Table for Buffelgrass Treatment Strategies

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 8: Buffelgrass Treatment</u></p> <p>Public and private land owners and managers should protect life, property, and natural and cultural resources by preventing, controlling and reversing the spread of buffelgrass.</p>	1. Those who have responsibility to treat buffelgrass should institute a minimum three-year treatment and management program, including identifying and obtaining the associated funding for each high priority buffelgrass infestation area.			
	2. Treat new buffelgrass patches in identified high priority-high risk buffelgrass infestation areas.			
	3. Treat high priority large buffelgrass populations starting along the patch perimeter and treat the infestation inward to reduce seed spread from the outer perimeter into adjacent non-infested areas.			
	4. Treat buffelgrass populations along roadways in high priority areas where they are the vector of buffelgrass spread.			
	5. Create firebreaks around, along, or between the largest, contiguous buffelgrass/ fountain grass infested areas within the high priority buffelgrass infestation areas.			
	6. Revegetate treated areas with an appropriate local native plant palette as necessary following each 3-year treatment window.			
	7. Use integrated pest management (IPM) practices for mechanical, chemical, and biological control methods in selected areas, where appropriate.			
	8. Hire and train seasonal and year-round crews to identify and treat buffelgrass infestations in high priority areas using mechanical and chemical methods.			
	9. Expand buffelgrass-pulling volunteer events to focus on high priority areas.			
<p><u>Management Goal 9: Buffelgrass Monitoring and Evaluation</u></p> <p>Continuously document and evaluate the buffelgrass treatment programs in the region through research, analysis, and field monitoring to provide the most up-to-date and effective buffelgrass control treatments.</p>	1. Develop standardized training, data collection, reporting, and monitoring procedures and protocols that can be easily interpreted and implemented locally.			
	2. Share treatment and monitoring data among various management areas to update methods and tools and re-evaluate high priority areas periodically.			
	3. Quantify treatment control efforts and compare to the growth rate of mapped buffelgrass patches.			
	4. Analyze data input from a central buffelgrass mapping and monitoring control center annually.			

**Table 7.** Implementation Table for Mapping, Database Management and Inventory

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 10: Mapping and Data Management</u></p> <p>Ensure that all jurisdictions and entities can easily access and share existing information to guide buffelgrass management decisions, improve treatment efforts, and provide a single, comprehensive method for inputting data for the benefit of all partners and public and private stakeholders.</p>	1. Create an interactive mapping system that identifies the location and extent of buffelgrass infestations and becomes a tool in assessing and determining treatment efforts.			
	2. Provide a standard mapping and inventory approach for roadside and wildland mapping that can be used by jurisdictions and the public.			
	3. Establish common metadata standards for data access and input across jurisdictions.			
	4. Create a regional cross-jurisdictional team (including GIS or related departments or personnel of jurisdictions where buffelgrass is likely to encroach into or spread from) that oversees and manages a single, comprehensive database for data storage and data input by all regional jurisdictions and agencies.			
	5. Compile a list of existing inventory gaps with mapping to be shared and assigned among partners.			
	6. Map and categorize high-priority buffelgrass infestation areas based on buffelgrass population size, density, location, and effect on sensitive species, high resource value areas, designated public preserves and conservation areas, risk to human life and property and impacts to tourism.			
	7. Update the high priority, large buffelgrass infestation map annually and key these areas to ownership, responsible party, and/or management jurisdictions.			

**Table 8.** Implementation Table for Contingency Planning

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 11: Wildfire Contingency Planning if Control is not Possible</u></p> <p>Develop a contingency plan to protect life, property and high-resource-value areas if buffelgrass control is not attainable.</p>	<p>1. Contribute to the regional fire management plans for public jurisdictions, private landowners, and fire districts to anticipate fire risks associated with buffelgrass.</p>			
	<p>2. Develop a firebreak implementation plan that addresses the following:</p> <ul style="list-style-type: none"> <li>a. Plan should include training and mobilization tactics for implementing firebreaks that will minimize the extent and intensity of buffelgrass-fueled wildfires.</li> <li>b. Permanent firebreaks should be strategically located to block the spread of fire from roadsides into developed and/or natural areas and vice versa.</li> </ul>			
	<p>3. Contribute to fire management/ mobilization plan development to address the specific limiting factors related to the target area location and physical site conditions.</p>			

**Table 9.** Implementation Table for Research

Management Goal(s)	Action Description	Time Frame	Funding Source(s)	Lead Entity/ Implementing Agency
<p><u>Management Goal 12: Research</u></p> <p>Obtain scientific data on the effects and efficacy of buffelgrass control on the biophysical ecosystem (Sonoran Desert) as well as on local social structures and perceptions, to inform the development of future management goals and priorities.</p>	1. Contribute, compile, maintain, and update buffelgrass research information, and make it available to stakeholders through the Coordination Center.			
	2. Support buffelgrass research efforts initiated and conducted regionally by direct funding, providing in-kind contributions or by other means.			
	3. Identify and prioritize applied science needs and other information gaps annually, in support of buffelgrass management in Arizona, and distribute a list of needs to research stakeholders.			
	4. Create a feedback mechanism whereby biologists, researchers and land managers can share information obtained through various on-the-ground activities (research, inventory & monitoring and treatment/control) that will further inform future decisions and research.			

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## COST ANALYSIS AND BUDGETING

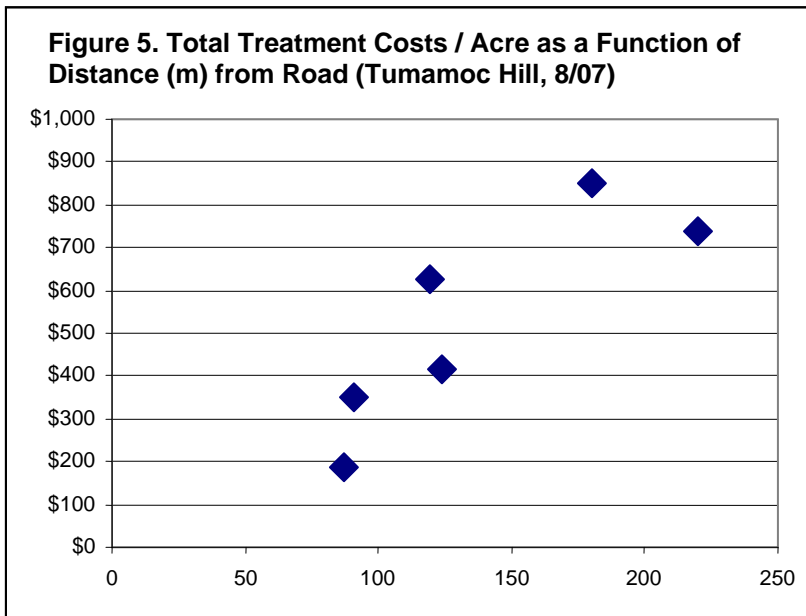
It has been said that the current annual environmental, economic, and health-related costs of invasive species exceed those of all other natural disasters combined.

### PROJECTED RESOURCE COST

**NOTE: Since treatment of buffelgrass infestations requires follow-up treatment in subsequent years, it is important to recognize that each of the projected costs below reflect treating an infestation only once. The total cost of treating a particular infestation over 2 to 3 years should be calculated based on the type of treatment used.**

Control costs vary by control method (spraying vs. pulling), buffelgrass density, slope of terrain, distance from road, and distance from water source for chemical mixing. Some estimates for roadside treatment average from about \$40 per acre for a spray treatment using a large truck with spray booms, to about \$97 per acre for hand wand spray applications.

Away from roadsides, costs can increase substantially. For large treated areas on Tumamoc Hill in August, 2007, costs ranged from \$188 per acre to \$850 per acre, with an average cost of about \$418 per acre. Costs varied by distance from road/ water source, slope, whether the area was treated previously, and buffelgrass density, which is also affected by previous treatments. Labor costs were estimated at an average of \$18.50 per hour. Variable materials costs were about \$88 per acre. Figure 4 shows the relationship between treatment costs and distance from road (in meters).



At Tumamoc Hill, treatments required an average of 17.8 hours per acre, but this varied from 10 hours per acre to 40 hours per acre. Hours here include both crew time and supervisor time.

**ITEMIZED TREATMENT-PER-ACRE COST TABLE**

Treatment costs are highly variable due to equipment costs, the treatment option used, personnel or volunteer labor costs, size of infestation treated, and travel distance required to access the buffelgrass infestation. There is no proven method for incorporating all of these variables into a single cost per acre; however the table below is intended to be used as a tool to inform management planning. The information has been derived from cost averages of treatments for buffelgrass infestations along highways, on natural areas in Pima County, at Saguaro National Park, and at Tumamoc Hill; and assumes a moderate infestation level (40-50% buffelgrass per acre).

**Table 10.** Per-acre cost table for buffelgrass treatment options.

Treatment	Invested Hours/Acre <sup>1</sup>	Fixed Equipment Costs <sup>2</sup>	Chemical Cost/Acre <sup>3</sup>	Total Cost/Acre Treated <sup>4</sup>	In-Kind Value <sup>5</sup>
Pulling – backcountry or frontcountry volunteer crew of 10 <sup>6</sup>	75	\$175	na	\$215	\$1,351
Pulling –backcountry or frontcountry hired crew of 10 <sup>6</sup>	18	\$175	na	\$405	na
Herbicide – roadside (2,500 gal-tank truck)		na		\$75	na
Herbicide – roadside (200 gal-tank truck)		na		\$160	na
Herbicide – backcountry (low – moderate slope)	7	\$7,700	\$70	\$200	na
Herbicide – backcountry (moderate – steep slope)	18	\$7,700	\$70	\$400	na

<sup>1</sup>Includes travel to site (0.5 hr), volunteer coordination, hiking, mapping, spraying, mixing chemicals, cleaning equipment, follow-up visits.

<sup>2</sup>Includes fixed cost of digging bars (\$20/ea), and safety gloves (\$50/40pr), and recurring costs of trash bags (\$50/project) for projects completed using volunteer labor. Includes fixed costs for spraying equipment (backpack sprayers, lumbar support, snake leggings, chemical spray vest, and one chemical spill pallet) for projects completed using herbicide treatment.

<sup>3</sup>Average of 33oz of chemical per acre (~5.5 gallons of chemical-water mixture per acre) plus marker dye.

<sup>4</sup>Includes costs for labor (\$20/hr) and chemical only.

<sup>5</sup>Value provided by volunteer labor (using the 2006 in-kind contribution rate of \$18.77/hr).

<sup>6</sup>Includes required time for identification training and protocol demonstration.

The cost of hiring a crew will depend on what type of crew, how many persons on the crew, and whether lodging and food are required. A formalized cost for hiring a crew for a specific project may be obtained through the organization or agency with which you will contract work.

## **FUNDING SOURCES**

The current acreage of buffelgrass infestation in southern Arizona is difficult to quantify, given incomplete mapping, but is estimated to range in the tens of thousands of acres and could be more. The least expensive treatment entails spraying with glyphosate either from trucks along roadsides or by backpack sprayers in open space, at a cost that usually exceeds \$300/acre. Thus, to treat 100,000 acres one time it would cost \$30 million. Given that a minimum 3-year treatment is required to effectively control buffelgrass, this would likely equate to more than \$90 million for a 'single treatment' after cost increases are taken into account. As a comparison, all jurisdictions combined have treated no more than a few hundred acres in a given year, including 2007. At best, the dollar investment in buffelgrass control has probably not exceeded \$150,000 in any given year. Clearly, effective and sustainable buffelgrass control will require new and generous sources of funding.

Present vegetation management units and budgets within each jurisdiction will need to be redirected to focus on buffelgrass removal. To some extent, this is already happening. For example, both Saguaro National Park and Organ Pipe Cactus National Monument have been allocating funds to buffelgrass removal. Arizona Department of Transportation (ADOT) is also devoting resources to spraying on their right-of-ways, Pima County Department of Transportation (PCDOT) is directing their landscape contractor to remove buffelgrass under their existing contract, the City of Tucson Parks and Recreation Department is conducting on-going treatment on A-Mountain, and Tucson Water is addressing buffelgrass infestations on City-owned lands in Avra Valley. While this is encouraging, existing capabilities and funding in most jurisdictions are limited, and new funds will be required to scale up control activities to match the rate of buffelgrass expansion. These new funds could come from a variety of public and private sources and could be centralized and managed by a 501(c)3 non-profit Special Purposes Fund set up specifically for buffelgrass control, as described by this Strategic Plan. In particular, this Special Purposes Fund could be set up to receive year-end funds from different levels of government.

There are a number of funding options available for achieving buffelgrass management objectives including government funding (county, state, and federal), corporate funding, private funding, and grant funding.

### *Government Funding*

#### Pima County Government

Pima County has the option of leaving the costs of buffelgrass control up to voters in a bond issue. Bonding is the standard method by which the County pays for capital improvement projects and land acquisitions, and it should be explored whether buffelgrass control could be framed as a critical fire suppression and conservation measure that would lower risks to public safety and natural resources, while saving the public money in the long run.

Another mechanism that should be explored is the identification of a funding base to eliminate buffelgrass on, and quarantine properties being set aside for conservation under the Sonoran Desert Conservation Plan.

#### State Government

State government could appropriate funds for buffelgrass control through the State Legislature. There is the possibility of Tucson representatives in the State House supporting an appropriations bill that could set aside money in a Special Purpose Fund for buffelgrass control. The premise of such a bill would be the following: The Special Fund would provide a 50-50 match to government and public entities that propose buffelgrass removal projects. These projects have to address specific priorities that are identified in this Strategic Plan, and would have to comply with mapping and monitoring requirements described in the Plan. The Special Purpose Fund would be managed through the Coordination Center (a 501(c)3 non-profit organization capable of accepting and distributing both public and private funds).

#### Federal Government

Federal government agencies should significantly increase their base funding for buffelgrass and other invasive species control on federal lands. The National Park Service's Centennial Challenge Program, which sets aside matching funds for community collaboration with specific national parks is one possibility for obtaining federal funding. Additionally, the Buffelgrass Working Group should explore the appropriations request process to receive direct Congressional appropriations for buffelgrass control in Southern Arizona. These funds could be received and managed by the Coordination Center.

The Department of Interior has funded the Healthy Lands Initiative with \$22 million for the BLM, USGS, and the U.S. Fish and Wildlife Service to develop healthy landscapes based on a watershed approach with partners and community collaboration. This is a multi-year process designed to effectively treat problems such as invasive species over broad areas so that islands of seed sources are not left to continue the problem in the future. The Initiative is designed to strengthen budget justifications to Congress and to identify issues and funding priorities for future years. The Buffelgrass Working group suggests seeking funding for buffelgrass control under this initiative and other initiatives as appropriate.

#### *Corporate Funding*

Two models exist for direct involvement of the corporate sector in funding buffelgrass and invasive species management. First, since 2004, Kinder Morgan, Inc., a petroleum pipeline company, has co-funded with Pima County the buffelgrass outreach and eradication demonstration project at the Desert Laboratory on Tumamoc Hill. Kinder Morgan has promised funding for three additional years (2008-2010). Second, Pima County has negotiated two separate arrangements with the Starr Pass Marriott and Wal-Mart to fund environmental enhancement, including buffelgrass control.

In the case of the Starr Pass Environmental Enhancement Fund, on September 1, 1998, Starr Pass Resort LLC and Pima County entered a 20-year “Allocation and Use Agreement.” This legal instrument invoked a mechanism for collection of an Environmental Enhancement Fee (EEF) that consists of 2% of all sales at the Marriott Resort Hotel adjacent to Starr Pass, a master planned community on the east slope of the Tucson Mountains, Pima County, AZ.

The Agreement stipulates that 75% of the EEF collected from the opening of the Starr Pass Marriott in January 2005 to January 2016 will be allocated 75% to Starr Pass and 25% to Pima County. From January 2016 to January 2026, the allocation will shift to 25% Starr Pass Resort and 75% Pima County. Pima County is responsible for investing and reinvesting the assets of a Maintenance and Acquisition Fund that will enable the County to extend the program after expiration of EEF in 20 years. Although buffelgrass control is only one of many objectives for the Starr Pass EEF, this arrangement suggests one model for corporate involvement, particularly by existing and planned resorts. There are other models, which should be explored through discussions between business leaders, chambers of commerce and local government officials.

#### *Private Funding*

The general public is impassioned about the Sonoran Desert, and there should be a vehicle for individuals to donate to the overall buffelgrass control effort. The Coordination Center could manage and distribute funds donated by the general public or even corporations.

#### *Grant Funding*

Grant funding may provide much-needed resources for buffelgrass management projects and many grant opportunities exist through local, regional and national sources. It is likely grant funding will accommodate only a *portion* of the total dollars needed to achieve buffelgrass management goals since invasive species grants are cyclical in nature, sometimes are highly competitive, and are never guaranteed, thus are undependable from year-to-year. Costs associated with managing the grant (record keeping, communication with funders, compiling and submitting reports, etc.) need to be taken into account when submitting a funding application.

## **APPENDICES**

1. Buffelgrass Management Partners
2. Memorandum of Understanding
3. Glossary and Acronyms
4. Regional Buffelgrass Hot Spots
5. Control Methods
6. Preliminary List of Research Needs
7. Example Documents
8. Buffelgrass Education and Outreach Materials
9. List of Buffelgrass-Trained Landscaping Companies
10. List of Invasive Species Resources
11. Existing Authorities and Programs
12. Section 1204 of the National Invasive Species Act of 1996
13. Executive Order 13112 (3 February 1999)
14. Arizona Executive Orders (EO 2005-09; EO 2007-07)
15. Arizona Statutes and Regulations Pertinent to Invasive Species
16. Annual Operating Plans