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Invasive Plants in Arizona's Forest's and Woodlands

Climate Change and Variability in Southwest Ecosystem Series

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Climate is critically linked to vegetation dynamics at many different spatial and temporal scales across the desert Southwest. Small-scale, short duration monsoon season thunderstorms can bring much needed precipitation to small patches of vegetation or can initiate widespread flooding. Long-term variations in climate related to ocean circulation patterns can create multi-decade wet or dry periods that can promote large-scale, episodes of recruitment of certain species (wet periods) or large-scale mortality (dry periods) (Allen and Breashears 1998).

Species native to the desert Southwest have evolved with this complex variability and have special adaptations to take advantage of ephemeral moisture sources and to endure long drought periods (Dimmit 2000). Competition for resources (moisture, light, nutrients) is fierce in the often resource-limited environments of the Southwest and the delicate balance between native species can be quickly disrupted by more competitive exotic species. Other arid places in the world besides the southwestern United States support similar vegetation communities, but the climate of Arizona has unique features important to the interaction between native species and non-native invasive species.

The US Global Change Research Program (Carter, 2003) described the mounting issue of climate variability and invasive plants as follows: "Some native species are unlikely to be able to adapt fast enough to the changing climate regimes, resulting in a lowered competitive edge and weakened resistance of ecosystems to infestations by invasive plants and animals. Potential impacts include shifts in the relative abundance and distribution of native species, significant changes in species richness and communities, and local extinctions of native species. Subtle changes in the diurnal (day/night) or seasonal patterns of temperature have also been shown to affect plant community composition."

Figure 1. Tamarisk (Tamarix spp. L.) growing along the Colorado River. (Photo courtesy of Steve Dewey, Utah State University, www.forestryimages.org).

Invasive species are non-native (exotic) species whose introduction is likely to cause environmental or economical damage, or to harm human health (Executive Order 13112, 3 February 1999). Increasing evidence suggests that direct or indirect impacts of extreme climate variations may give some invasive plants a competitive edge over a number of native species (Dukes and Mooney 1999). For example, extreme droughts may result in the loss of some native species, but enhance populations of invasive plants that are better adapted to warm and dry conditions and have high reproductive rates. Riparian zones of the southwest are highly influenced by year-to-year variations in both precipitation and temperature. In Arizona lowlands, riparian zone degradation has been linked to the invasion of tamarisk (Tamarix spp.), a non-native invasive shrub. With long-term continued warming and drought, tamarisk has the potential to invade higher elevation riparian zones and displace native plant species such as cottonwood

(Populus spp.) and willow (Salix spp.). Once established, tamarisk is very difficult to remove, even with a return to wetter and cooler conditions.

As climate variability increases, each species within an ecological community will respond individually. With current information, it is impossible to know specifically how climatic changes will impact native plant populations or how invasive plants will respond. It is certain, however, that no two plants will respond in the same way to any given change. Regardless of the instigating factors, the establishment of invasive plants would likely be assisted if the current ecosystem breaks down (Wagner and Stohlgren 2000).

Effects of Landscape Disturbances on Invasive Plants

A number of invasive plants thrive in disturbed areas, so increases in disturbed areas associated with climate variability could assist in the spread of this group of invasive plants. Studies conducted in areas burned in stand-replacing wildfires in the state's forests and woodlands have revealed that a number of non-native invasive plants are quick to establish in severely burned areas. Dalmatian toadflax (Linaria dalmatica), an invader originally found in the Mediterranean region, expanded in the San Francisco Peaks Wilderness Area following the 2001 Leroux Fire north of Flagstaff (Dodge 2004). Cheatgrass (Bromus tectorum), one of the most invasive species in the Intermountain west, was common on severely burned areas of a 1996 wildfire (Crawford et al. 2001), and was still common nine years later (Sabo 2006). Further, both of these species are apparently drought tolerant, as they survived and even expanded during the severe drought of 2002. Experimental studies of the invader diffuse knapweed (Centaurea diffusa) indicate that it is favored in severely burned areas and is extremely drought tolerant (Wolfson et al. 2004). Recent studies suggest that increased wildfire activity in the western U.S. in recent decades is associated with increasing spring and summer temperatures and earlier spring snowmelt (Westerling et al. 2006). If such trends continue, the concern is that a number of invasive plants will spread out of control in response to these large landscape-level disturbances.

Figure 2. Dalmatian toadflax is an invasive plant of forests and woodlands in Arizona. (Photo courtesy of Bob Nowierski, Montana State University, www.forestryimages.org).

Figure 3. Diffuse knapweed is becoming more common on disturbed sites. (Photo courtesy of Wade Albrecht).

As suitable habitats (environmental niches) for individual species shift due to climatic variability, species have the potential for reestablishment into new areas. Some of these species will likely be benign in their new environments, but others may contribute to a shift in the overall vegetative community because of their unique growth or responses to stimuli such as fire. After reviewing currently available research, the Arizona Wildlands Invasive Plant Working Group (AZ-WIPWG) categorized invasive plants documented in Arizona. Many of the 74 invasive non-native plants listed by AZ-WIPWG as having severe to substantial ecological impacts on ecosystems in Arizona are found in forest and woodland communities (AZ-WIPWG 2005). Many of these could become more widespread if warming trends continue.

Recommendations for Land Management

It is critical that land managers obtain early knowledge of the presence of invasive species in the areas they manage, and that they have a "rapid response" system in place to react quickly to newly detected populations. Populations of invasive species can be quickly eradicated when they are small, but if allowed to establish and spread, containment can become cost-prohibitive (Sieg et al. 2003).

A coordinated approach is a requirement for invasive species treatment strategies. Various temporal and spatial scale options should be included in treatment strategies. Since invasive species do not recognize political boundaries or borders, it is important that land managers at all levels better coordinate treatments. Managers from different agencies and groups should work together to identify invasive species priorities, as well as how and what treatments will be applied. Land management treatments may also become an important learning opportunity for other land managers, policy makers, or the public.

Even with individual species behavior and management changes, there will be a need for policy changes to occur for impacts to be visible. Without a statewide invasive species coordinator in Arizona, coordination of information on invasive species has fallen to those working with regional

cooperative weed management areas (CWMA's and WMA's.

Management – At present, recommendations can be developed using an integrated approach to controlling invasives. Herbicides and cultural methods are available and in some instances biological control agents can be effective. Local communities may not readily accept some management options, such as herbicides, when treating public lands. In these instances, it is important to involve stakeholders in management plan development and in fact, federal statutes require public input when conducting treatments on federal lands.

Public Awareness

There is a critical need for the public to be aware of the issues surrounding invasive species on the landscape, and the ecological consequences of the presence of invasive species to habitats in Arizona and the Southwest. Challenges to communicating forest and climate science include complex and confusing concepts, a lack of research addressing specific forest-climate interactions, and a lack of research pertaining specifically to Southwest ecosystems. Therefore, it may become necessary to simplify the details initially when communicating forest-climate science. Ultimately, it is important that educators demonstrate the complexity of all of the interplaying issues, in order to communicate no false impressions of an "easy solution" for land managers.

Research Needs

In Arizona more information is needed for known invasive species, such as location of established populations, population densities and rate of dispersal, and the habitats they invade. Knowing the climate sensitivity of these and other invasive species is important for projecting how these species will react to changes in the climate (whether cooler or warmer, wetter or drier).

Should each of the 74 species identified in Arizona be treated equally in management plans? Cheatgrass has invaded millions of acres throughout the Southwest; should it be treated the same as yellow starthistle (Centaurea solstitialis) which is relatively localized in the areas it has infested but is spreading at an alarming rate? Most would argue that more resources should be focused toward containing the starthistle rather than trying to control a pervasive species such as cheatgrass. Maybe some invasives are just going to be part of the landscape and there will be few resources allocated to their management. Changes in climate may greatly influence the effect invasives have on the landscape, possibly for the better, maybe for the worse.

Land managers need information on likely plant response scenarios for the wide range of potential climate changes that may occur. Though a daunting task, each of the 74 species that are currently of interest in Arizona need to be analyzed for their growth potential if global warming continues. Likewise, projections would be valuable for native and currently non-invasive non-native species.

Research needs identified by participants at the workshop "Climate Change & Ecosystem Impacts in Southwest Forests and Woodlands" in February 2005 include:

1. Identify areas that are currently free of non-native invasives, and develop strategies to keep the identified areas "weed"-free indefinitely. (Inventory and Strategy Development)
2. Quantify the benefits of specific biological control agents in Arizona specific environments/habitats. Assess the effectiveness and impacts of using biological control agents in Arizona in specific environments for invasive species control.
3. Quantify the effectiveness of herbicide treatments on invasives of interest.
4. Identify key elements that indicate a particular species is "invasive" to a site, and how these compare to the defining elements of "native" species on the same site. Use this information in quantitative risk analyses of invaders (Lodge et al. 2007).
5. Synthesize current knowledge for Arizona environments/habitats as it relates to climate variability.
6. Determine improved strategies for establishing native plants on disturbed sites that allow native plants to out-compete invasive plants.
7. Identify ways to determine specific management "future conditions" based on predicted climate changes and what the cost will be for implementation (dollar figures as well as environmental).
8. Differentiate among species adaptations to climate variability as compared to those adaptations occurring without climate variability. Determine the true range (environmental envelopes) of native plants.
9. Conduct additional research on the basic biology of invasive plants (species establishment, locations, densities, habitats, rate of dispersal, etc.).
10. Develop a strategy for prioritizing research objectives for the Southwest as a whole.
11. Conduct case studies and surveys on the status of public knowledge and determine gaps in information transfer. (What does the public already know? What does the public want to know? What does the public not know about the situation in Arizona?)
12. Develop and utilize new strategies for translating and communicating research findings for various audience groups to allow current research to reach the public in a marketable manner, which encourages public involvement and positive action.
13. Identify strategies for research coordination that improves researcher interactions as well as communication with land managers and the general public.

Additional Sources Of Information

Additional information may be obtained on invasive species and climate variability via the following sources:

Local (Community) Resources

- Botanical gardens
- Arboreta
- Various local plant nurseries
- Herbaria
- Cooperative Weed Management Areas (CWMAs and WMAs) www.swvma.org/resources.html
  - Borderlands CWMA (Ajo)
  - Eastern Arizona WMA (Holbrook)
  - Central Arizona WMA (Phoenix)
  - Four Corners WMA (Monticello, UT)
  - Grand Canyon WMA (Flagstaff)
  - King of Arizona CWMA (Yuma)
  - Lower Colorado River Giant Salvinia Task Force (Boulder City, NV)
  - Moenkopic WMA (Tubac City)
  - Mohave WMA (Kingman)
  - Pima Santa Cruz Basin CISMA (Tucson)
  - San Francisco Peaks WMA (Flagstaff)
  - Southern Utah-Northern Arizona CWMA (St. George, UT)
  - Southeastern Arizona WMA (Willcox)
  - Southwest VMA (Phoenix)
  - Tonto WMA (Young)
  - Verde Valley WMA (Camp Verde)
  - Yavapai WMA (Phoenix)
- Arizona Native Plant Society (74 fact sheets on Arizona invasive weeds)
- Southern arizona Bufflegrass Coordination center

State Resources

University of Arizona Cooperative Extension. www.extension.arizona.edu

Northern Arizona University – School of Forestry and Ecological Restoration Institute. www.nau.edu/cefns/forestry

Arizona Wildlands Invasive Plant Working Group

Southwest Vegetation Management Association (SWVMA) (www.swvma.org)

Federal Resources

USDA Forest Service

Bureau of Land Management (BLM)

Additional Internet Resources

PLANTS database (http://plants.usda.gov)

Invaders Database System (http://invader.dbs.umt.edu)

Southwest Exotic Plant Information Clearinghouse – information on southwest weeds (www.usgs.nau.edu/SWEPIC/index.html)

Encycloweedia (www.cdfa.ca.gov/ipc/encycloweedia/encycloweedia_hp.htm)

Invasive and Exotic Species of North America (www.invasive.org)

Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands. www.cal-ipc.org/ip/inventory/pdf/criteria.pdf

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