The Arizona Native Plant Society

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THE ARIZONA NATIVE PLANT SOCIETY

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Arizona Climate & Invasive Species:

A Climatologist's Perspective on Vegetation Management

by Michael A. Crimmins, Ph.D., Climate Science Extension Specialist, University of Arizona Cooperative Extension, Tucson, Arizona

Climate is critically linked to vegetation dynamics at many different spatial and temporal scales across the desert Southwest. Small-scale, short duration thunderstorm events in the monsoon season can bring much-needed precipitation to small patches of vegetation or create flooding events that can disturb the structure of vegetation across a landscape. 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 weather 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. There are many other arid places in the world besides the southwestern United States with similar vegetation communities, but the climate of Arizona has unique features important to the interaction between native species and non-native invasive species.

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President's Note

by Barbara G. Phillips

Why is this issue of the *Plant Press* devoted to the topic of non-native invasive plant species? The ANPS Board felt that publishing articles based on some of the excellent presentations at the November 2005 meeting of the Southwest Vegetation Management Association (**www.swvma.org/**) would be an excellent way to raise our members' awareness of how invasive plants are destroying our native plant communities, as well as foster communication between two organizations with similar goals of saving Arizona's unique flora.

I first became aware of how non-native grasses had the ability to destroy the Sonoran Desert when I did a repeat photography study at Tonto National Monument 18 years ago. That spring, I saw saguaros tumble between one visit and the next. They were killed in the course of twenty years by five repeat fires caused by red brome and Lehmann's lovegrass. Now we also have buffelgrass and Sahara mustard spreading throughout southern Arizona and Mexico like the wildfires they cause in their wake! You can begin reading about the threats these insidious usurpers pose in this issue and then visit the Arizona-Sonora Desert Museum website for more details (**www.desertmuseum.org/invaders**).

From the creosote bush community of the Sonoran Desert to the threatened San Francisco Peaks Groundsel, our treasured Arizona native plant communities and rare plant species are extremely threatened by non-native invasive species. I hope as each of you digests the articles in this issue you become a stronger advocate for Arizona native plants and their habitats. I urge you to follow up with the references and websites provided in this issue and on the ANPS website… and take up the challenge of protecting Arizona native plants!

Finally, many, many thanks to Carianne Funicelli for being our State Conservation Chair and best wishes as she continues to be a vigorous conservation advocate in the Tucson Chapter. Many thanks, also, to Nancy Morin, our outgoing President, who ably led ANPS for two years and now as Past President continues to provide insights and continuity to the Board and Society.

Arizona Climate & Invasive Species

continued from page one

Arizona's geographic location is just north of the subtropics around 35° north latitude. This latitude is common to most arid locations around the world in the northern and southern hemisphere. Intense convection located near the equator (inter-tropical convergence zone) induces a series of semi-permanent sub-tropical high pressure systems located around the globe at latitudes close to 30° north and south latitude. These high pressure systems bring warm, sunny and dry conditions to most of the locations they influence. Arizona is influenced by two prominent subtropical high pressure systems: the Pacific High and the Bermuda High. The Pacific High can bring extended periods of warm and dry conditions while the expansion of the Bermuda high into the Southwest can bring a moist, tropical flow necessary for summer thunderstorms. Arizona's geographic position is between active and wet weather patterns to the north in the winter and to the south in the summer. Dry and warm conditions are more likely to occur most of the time across the Southwest because of its geographic location. Native vegetation has evolved with this climatic regime and has adapted to take advantage of precious precipitation if and when it occurs.

The position and strength of these subtropical high pressure systems is of critical importance to short and long-term vegetation dynamics across the Southwest. A strong and firmly entrenched Pacific High can limit the passage of wintertime storm systems across the region, while a weak Bermuda High can limit the amount of monsoon moisture that is available for summer thunderstorms. The strength and position of these circulation features can vary on timescales from days to years. Sea-surface temperature patterns in the Pacific can have a strong influence on the subtropical high pressure systems. The El Niño-Southern Oscillation (ENSO, a three- to seven-year oscillation in sea-surface temperatures along the equator in the Pacific) has a pronounced effect on the strength and position of the Pacific High in the wintertime season. During La Niña conditions, the Pacific High strengthens and expands north across the eastern Pacific, dramatically limiting winter storm activity across the Southwest. La Niña winters have been overwhelmingly dry in the historical record. Twelve La Niña events in the last seventy years were accompanied by below-average winter precipitation (source: Western Regional Climate Center).

During El Niño winters, the Pacific High weakens and is displaced by a more active subtropical jet stream that can deliver winter storm systems and moisture directly to the Southwest. The track of this subtropical jet can be highly variable in the winter, so not all El Niño winters are abnormally wet for Arizona. Longer and shorter term variations in Pacific Ocean sea-surface temperature patterns linked to ENSO also affect winter precipitation amounts across the Southwest. The Pacific Decadal Oscillation is linked to the frequency of El Niño and La Niña events and can impact winter precipitation amounts on twenty- to thirty-year timescales (Gutzler et al. 2002, Brown and Comrie 2004).

Summer precipitation is tied to the strength and position of the subtropical Bermuda High. A strong Bermuda High can expand across the Gulf of Mexico into the Southwest, bringing a deep flow of moisture from the southeast. This moisture is critical for the development of monsoon thunderstorms. It is not clear why the strength and position of the Bermuda High varies from year to year or how this may be linked to ocean temperature variability. There are very weak statistical links between ENSO activity and summer monsoon precipitation for the Southwest, but the mechanisms are not well understood (Higgins et al. 1999).

The complex temporal variability in the Southwest climate described above has important implications for vegetation dynamics between native and non-native species. The fact that the Southwest is often arid means the important resource of soil moisture is often limited. Winter precipitation amounts can vary on timescales of three to seven years related to ENSO activity, with La Niña events bringing dry winters and El Niño events often bringing above-average winter precipitation. Because El Niño and La Niña activity also appear to vary on twenty- to thirty-year timescales, they can bring extended periods of dry winters (such as the droughts in the 1950s) or wet winters (such as were experienced in the 1980s and early 1990s).

The natural features of Southwest climate variability may provide the ideal environment for invasive plant species. Periodic droughts can stress all vegetation, including native species, limiting growth and recruitment, and even causing mortality and opening niches. When wet periods occur, whatever species are best suited to quickly take advantage of the moisture can flourish and potentially out-compete all others. This last very wet period during the 1980s may have provided the ideal conditions for some invasive grass species to have spread rapidly (Crimmins and Comrie 2004). Strategies

from quickly setting large amounts of seed to more efficient water use can create a competitive advantage that allows invasive species to eventually dominate a landscape by capitalizing on the unique seasonal, annual, and interannual climate variability of the Southwest.

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Photos

cover: Winter storm approaching Saguaro National Park , Arizona. Taken by Michael A. Crimmins, February 2004.

above: Winter storm building over Blue Range Primitive Area. Courtesy Julie St. John.

Buffelgrass in the Sonoran Desert:

Can we prevent the unhinging of a unique American ecosystem?

by Travis M. Bean[1] and Julio L. Betancourt[2].
[1]University of Arizona and [2]U.S. Geological Survey, The Desert Laboratory, 1675 W. Anklam Rd. Tucson, Arizona 85745

Buffelgrass (*Pennisetum ciliare*) is arguably the most destructive plant pest ever to strike the Sonoran Desert. By introducing a grass-fire cycle into an ecosystem with no adaptation to fire, buffelgrass is poised to unhinge a unique American ecosystem. In addition to compromising biodiversity and conservation efforts, buffelgrass threatens life and property in urban and suburban Tucson and Phoenix which have become infested with this perennial African bunchgrass. Buffelgrass now exists in dense, flammable stands along every major surface street and every highway in Tucson, with Phoenix only a few years behind. In fact, Tucson and Phoenix have now become the source of buffelgrass spread into the surrounding deserts via the increasing urban-wildland interface. Considering that ignitions are virtually unlimited along roadsides and in our cities, buffelgrass fires will continue to increase in frequency and magnitude unless immediate, aggressive action is taken to manage this pest.

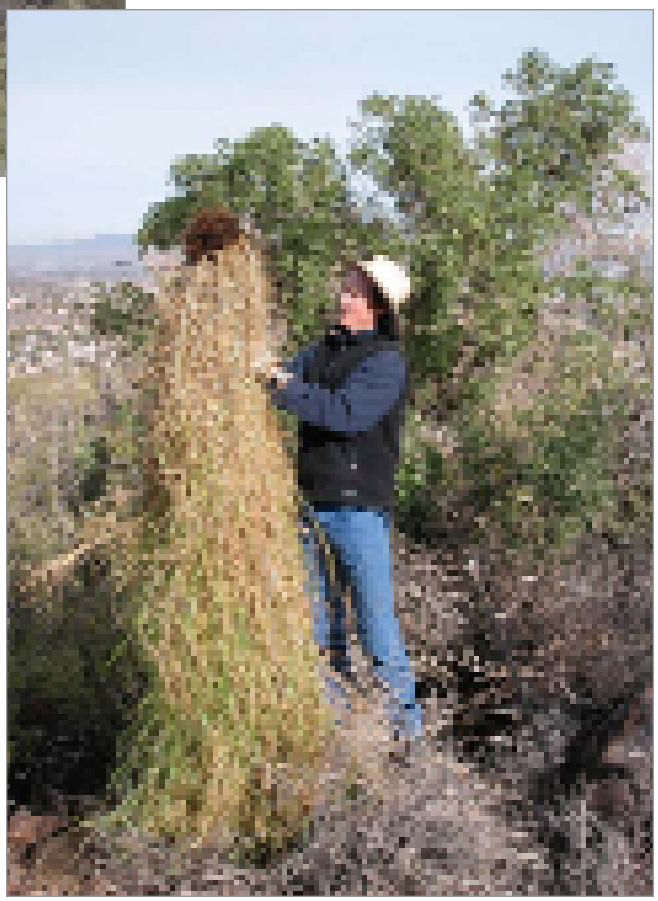
Although buffelgrass has a long history of introduction into Arizona, having been planted in Tucson as early as 1938 by the Soil Conservation Service, it wasn't until the 1980s and 1990s that it began to expand rapidly across the landscape. Buffelgrass first appeared at the Desert Laboratory on Tumamoc Hill in 1969, consisted of six small populations in 1983, and expanded to form a continuous paddock covering the east-, south- and west-facing slopes of the Hill by 2005. According to Danielle Foster from Saguaro National Park, buffelgrass populations in the Park have quadrupled in size during the last four years. Following the "S" shaped curve of expansion that is typical of most invasive species, buffelgrass appears to have reached its exponential expansion phase in the northern Sonoran Desert. As the landscape becomes saturated with the dense grassy fuels, widespread frequent fires will transform the familiar paloverde-saguaro associations into an Africanized savanna. This has already occurred on a massive scale in central and southern Sonora, where buffelgrass is being actively planted for cattle forage and, barring intervention, will surely happen in southern and central Arizona.

The first documented buffelgrass fire in Pima County occurred in February 2004 at the Duval Mine. In summer of 2005, several buffelgrass fires burned in urban and suburban Tucson. In May 2005, one buffelgrass fire burned along two miles of Interstate 10 on Tucson's eastside, stopping traffic. In November 2005, a homeless man was fatally burned in a buffelgrass fire just west of Davis Monthan Air Force Base. In their initial reports, local media referred to these as "brushfires," and opportunities were lost to inform the general public about the true cause of the fires, the extent of the buffelgrass problem, and potential mitigation of the fire risk by aggressive buffelgrass eradication measures. The increased fire risk presents mounting challenges to local fire departments, threatens utility infrastructures, and eventually may lower property values and raise insurance rates.

In natural areas, flammable stands now occur in Saguaro National Park, Organ Pipe National Monument, Ironwood Forest National Monument, Coronado National Forest, Pima County's Tucson Mountain Park, the City of Tucson's Sentinel Peak Park, the majority of Phoenix's system of Natural Parks and Preserves, and the University of Arizona's Desert Laboratory[1], to name just a few. Sonoran Desert habitat, the ecological backdrop to southern Arizona's lucrative ecotourism, resort, and development

Photos

page 4: One of our experimental plots (9A&B) where we tested different chemical and manual buffelgrass removal techniques.
left: This is the infested slope behind our offices which are on the national register of historic places. The slope itself is actually home to plot 11, which is one of the world's longest censused permanent vegetation monitoring plots.
below: "The Plant that Ate Travis" shows an enormous buffelgrass plant (7 ft tall by 8 ft wide) that we found growing on a broken water line behind our office.
Photos by Ben Wilder courtesy the authors.



industries, could become a thing of the past, leaving a monoculture of burning buffelgrass in its wake.

In April 2005, the tide began to turn with the Arizona Department of Agriculture's new listing of buffelgrass as a regulated and restricted noxious weed. This designation means that the state now has authorization to control buffelgrass infestations, but is only required to do so when the Arizona Department of Agriculture determines that critical resources are threatened. The listing also prohibits the importation of new buffelgrass strains from other states and territories. This is particularly important given recent release of "Frio," a winter-hardy buffelgrass cultivar now being planted successfully on ranches at 4000-5000 ft. elevations near Cananea, Sonora. Until this development, cold winter temperatures constrained the buffelgrass invasion mostly below 4000 ft. and limited its expansion in central and eastern Arizona.

In October 2005, the Pima County Board of Supervisors adopted Resolution 2005-265 to manage invasive species within the county. The language of this resolution calls for coherent organization of the County's invasive species management strategies. An important first step in controlling buffelgrass is aggressive roadside eradication, because roads are the primary vectors of spread for buffelgrass. Furthermore, management costs increase by an order of magnitude once buffelgrass escapes from the roadside. This means that all government entities with jurisdiction over roadsides constitute the first line of defense against buffelgrass so their involvement is essential. Another critical component of buffelgrass control is public education, not just about the consequences of invasion, but also about the need to reduce ignitions in the desert and thus buy time for eradication. Once buffelgrass burns, the chances for successful restoration become negligible.

Despite the advanced stage of spread, the costs of mitigation may be trivial compared to the eventual costs and consequences of doing nothing, which may be unacceptable to informed stakeholders.

[1] *The Desert Laboratory Buffelgrass Eradication and Outreach Project is funded by Kinder Morgan Energy Partners and Pima County.*

Sahara Mustard Invasion History and Patterns in Southwest Deserts

by Robin Marushia[1], Matt Brooks[2], and Jodie Holt[1].
[1]UC Riverside; [2]USGS Western Ecological Research Center

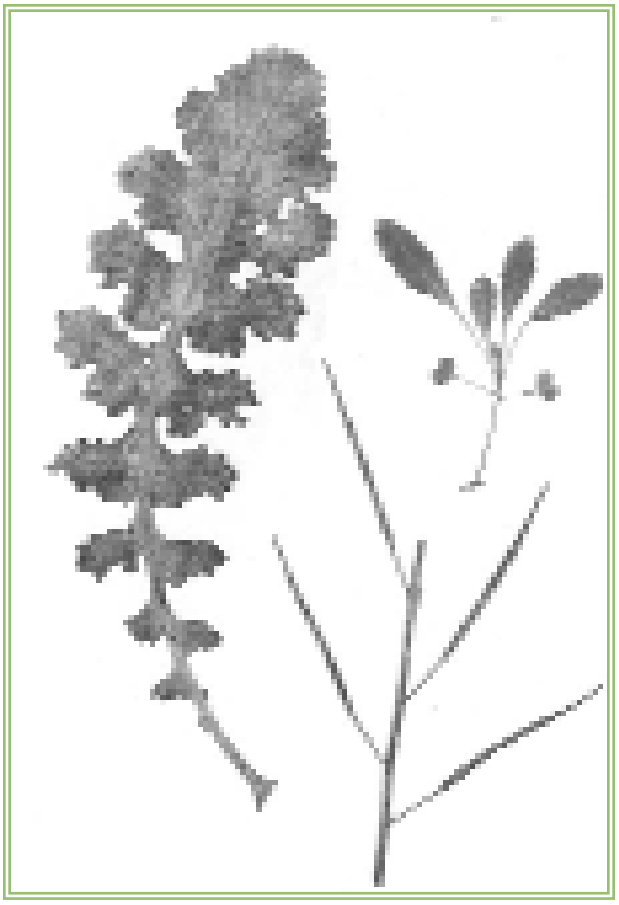


Photo of Brassica herb specimen courtesy F.E. Northam

Brassica tournefortii, commonly known as Sahara mustard, is one of a suite of invasive mustards currently expanding their range throughout the southwest. Sahara mustard is of particular concern currently because it is one of a handful of species able to invade the Mojave and other arid desert environments. The record precipitation during 2004-2005 revealed the unprecedented extent of Sahara mustard invasion throughout the southwest deserts and has highlighted a critical need for shared information on the biology, prevention, and control of this plant among land managers.

Sahara mustard was first introduced into Coachella Valley, California, during the 1920s, probably as a contaminant of date palms from the Mediterranean and Middle East where it is native. It was considered to be a ruderal weed of roadsides and disturbed areas for many years, and was not recognized as a major threat to natural areas until the 1980s. Since introduction, Sahara mustard has become a common plant in the Sonoran Desert of California and Arizona, and in the interior cismontane valleys of Southern California, and is increasingly found throughout the Mojave Desert of California, Nevada, Arizona, and Utah. Sahara mustard is also found the Great Basin Desert in the Owens Valley of California and the Colorado Plateau in Utah, and is also present in Mexico.

Sahara mustard disperses seeds ballistically from mature siliques, but Sahara mustard is also nicknamed "tumble mustard" because it resembles tumbleweed when whole plants move long distances by wind. Birds and rodents may also disperse seed, but the extent of this is unknown and may vary by site. Sahara mustard invades sandy and disturbed soils, making both paved and unpaved roadsides excellent vectors for spread into new habitats. Matt Brooks at the USGS has documented a greater density of Sahara mustard near roads than away from roads, but this difference is not apparent in sandy sites. In addition, many new introductions may be occurring from using seed-infested soils for road building or maintenance.

Rainfall appears to be linked with patterns of Sahara mustard invasion. Although some germination seems to occur in most invaded sites during most years, the greatest dominance of Sahara mustard seems to occur during years of high precipitation. Seed production and dispersal are therefore likely to be high during wet years, giving Sahara mustard the opportunity for tremendous expansion of invasion that may not be apparent until the next wet year. Seed dormancy and longevity are still unknown in Sahara mustard, but research is currently underway to investigate the seed characteristics and germination thresholds.

As with many invasive species, prevention is the best method of controlling Sahara mustard invasion. Land managers should be vigilant — especially in sensitive areas with sandy soils such as dunes and ephemeral washes — and use clean road-building materials, and control roadside infestations before they can establish in wildland areas.

Sahara (Asian/ African) Mustard:

A Desert, Urban and Agricultural Weed of the Southwestern U.S.

by F. E. Northam, Tempe, AZ, **fnortham@msn.com**

Sahara mustard occurs in Coconino, Gila, Maricopa, Mohave, Pima, Pinal, Yuma, (**seinet.asu.edu**) La Paz, and Graham Counties in Arizona (Northam 2005). The earliest University of Arizona herbarium record is 1957 from the Yuma area (Mason 1960). It is presently well established on hundreds of thousands of acres from northwest Mohave County to Camp Verde to the Tonto Basin, south to the U.S./Mexico border and west to the Colorado River, with scattered populations in southeast Arizona.

Sahara mustard leaves are simple, but divided into blunt lobes that decrease in size toward base of leaf; the lowest lobes are small scale-like segments of foliar tissue. Leaf margins have a fringe with ciliate hairs. Lower stems and leaves have numerous stiff (hispid) hairs. Growth varies according to moisture availability: flowering stalks range from 5 inches to 4 feet. Basal rosette leaves range from 3 to 24 inches long depending on site conditions and plant density. Pale yellow petals appear in early February; plants will flower through late May if spring rainfall is abundant, and can also flower in November and December if late-September/early-October rainfall occurs. Seeds develop in stout, straight siliques (pods); siliques are 1.5 to 3 inches long and approximately 1/8 inch wide.

As a winter annual forb in Arizona's desert regions, seedling germination occurs any time moisture is available from October to March. Multiple germination events are possible as winter precipitation becomes available. As a result, weed control measures on a specific site in late fall may need to be repeated during the following spring. New infestations establish from seeds dispersed when broken inflorescences are moved by wind (tumble weeds); in straw mulch harvested from infested wheat, barley and oat fields; weed-infested alfalfa hay bales; or by vehicles, animals or people moving through patches after seeds mature.

Arizona environments infested by Sahara mustard:

- Newly seeded alfalfa fields prior to first harvest in February or March
- Cultivated field borders, fence rows, irrigation berms
- Winter grain or winter vegetable crops
- Road rights-of-way, especially where fill material was used to build roadbeds; shoulders and turnouts
- Abandoned cropland awaiting urban or industrial development
- Desert land, particularly sandy sites such as washes or under creosote bushes
- Severely disturbed sites below 2000 feet elevation with bare soil where native vegetation was mechanically removed
- Natural sand dunes

Eradication is impossible. Unpredictable seedling emergence due to variable precipitation cycles means seedling and rosette identification is essential for timely control treatments. Fire/flaming destroys aboveground seeds and prevents wind dispersal but probably has little impact on soil seed bank. Mechanical and hand methods effectively destroy emerged plants but, if multiple germination events occur, frequent re-treatment is needed. Mowing dry mature Sahara mustard will breakup the tumbleweed structure of these plants; however, equipment will need to be cleaned before leaving the infested area. Biocontrol is unlikely because cabbage, broccoli, cauliflower and Brussel sprouts are closely related species of *Brassica*. Several chemicals can be applied when mustard plants are in seedling or small rosette stage; however, no multiple-site/multiple-year research specifically for Sahara mustard control has been published for the southwestern US.

Fire Hazard Reduction Strategies

- Stop seed production where possible
- Prevent seed dispersal
- Control dense populations on rights-of-way and other urban/industrial land
- Monitor non-infested land and remove initial colonies before they produce seeds
- Accept reality of weed control as a permanent management activity for all land managers

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Photos
top: Adult bull thistle plants on study site.
center: Pile burning on study in 2001.
bottom: Debra Crisp (right) and Dr. Carolyn Sieg (Rocky Mountain Research Station) at study site.
Photos and Figures 2A and 2B courtesy Debra Crisp.

A Vignette on a Not-So-Invasive Invasive:

Bull thistle response to slash pile burning

(A story about a fascinating yet bothersome European invader)

by Debra Crisp, Botanist, Coconino National Forest. **dcrisp@fs.fed.us**

I became interested in bull thistle *(Cirsium vulgare* (Savi) Tenore), a species native to Eurasia, while I was conducting weed surveys on the Coconino National Forest in 1997 and 1998. Populations of bull thistle were nearly always present on sites where slash from timber sales or tree thinning operations had been piled and burned, but were rarely observed elsewhere unless the area had been disturbed. I wondered what caused this and chose to study bull thistle for my Masters of Science in Forestry degree from Northern Arizona University, School of Forestry.[1]

Bull thistle is a biennial plant that occupies disturbed sites in areas where it is both native and exotic. In Eurasia, it grows in disturbed sites such as road edges, old fields and dunes. In the Netherlands, it grows in areas called "dune slacks" where it occupies areas under shrubs. Bull thistle now grows on all continents except Antarctica. In northern Arizona it grows in disturbed areas such as roadsides, wildfires, and old slash pile sites.

I began my study in July 2001 in the Slate Fire on the Coconino National Forest. The fire burned in April 1996 during the beginning of a severe drought. After the fire, the U.S. Forest Service removed some fire-damaged trees and then seeded the area with a seed mix containing native grasses. The fire area became infested with bull thistles sometime after the wildfire and timber cutting occurred.

As I began my research, I initiated a study designed to determine how slash pile burning and vegetation removal contribute to the persistence of bull thistle on slash pile sites. I studied the effects of pile burning on buried seed samples and also looked at the above-ground effects of the slash pile burning and removal treatments on bull thistle as compared to no treatment. I found that seeds buried under slash piles, which were then burned, had higher mortality than those buried in untreated plots or in areas where only vegetation was removed. As a result of my study, I determined that burning severely reduces the number of viable bull thistle seeds that were present on the site before burning and, therefore, bull thistle may be introduced into newly disturbed sites from seeds transported from other areas, either from nearby plants or by being transported to the site by humans or animals. The seeds of bull thistle (see Figure 1, next page) and many other members of the aster family (Asteraceae) are equipped with a specialized structure called a pappus, which looks like a small parachute or umbrella. The pappus allows the seed to travel on the wind to a new location away from the parent plant and establish a new plant on a suitable site.

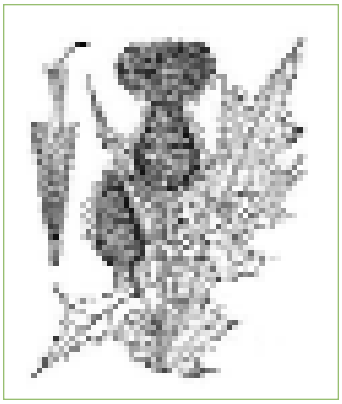
Many biennial plants including bull thistle follow a population structure known as a metapopulation. Separate small groups of a species exist in areas

of suitable habitat within a larger area where the habitat is unsuitable for them (see Figure 2, right). Suitable habitat may be bare ground or openings in the existing vegetation created by fire, vegetation removal, or even by digging animals. Over time, as the effects of the disturbance diminish and more competitive plants, such as perennial grasses, occupy the site, it becomes unsuitable for the species needing disturbance. Then most, but not all, of the disturbance-dependent biennial plants die out. When new disturbance habitat is created, seeds from a nearby surviving group invade the newly created habitat. During my study, bare ground remained higher on the burned plots and in areas where I removed vegetation but I did not see increases in the number of bull thistles. I attributed this "lack of response" to the lack of precipitation in the area. The annual precipitation for 2002 was well below the 50-year normal for the area and had a negative effect on all plants, including bull thistle.

Human transportation of bull thistle seeds can be through contaminated products such as seed mixes or on clothing, shoes or vehicles. Animals can transfer seeds in their fur or feathers. That is why it is important to avoid parking or camping in invasive exotic plant populations and to clean vehicles, clothing, shoes and pets when leaving an area with invasive exotics.

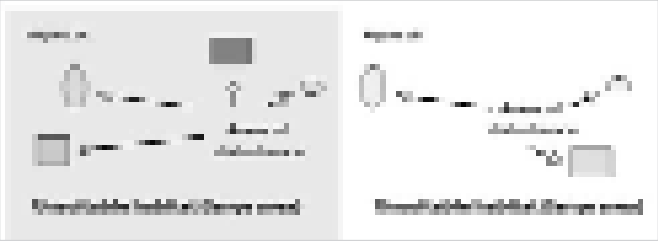
My study of bull thistle was a fascinating, exciting and sometimes challenging experience. I reviewed many articles of literature on a diverse array of topics including, bull thistle, biennial plants, disturbances, various aspects of exotic species and invasions, and seed banks. This wide array of subjects provided a wide base of knowledge for my future use. In addition, I spent many days at my study site and observed the changes to the site over time. Many trees damaged in the fire in 1996 fell to the ground on windy days posing a challenge to those brave enough to stay at the site, but there were fantastic views of the San Francisco Peaks and other nearby mountains including Kendrick, Slate and Red Mountains. A severe thunderstorm one afternoon sent me running for cover, but I viewed the awesome power of nature that day. I often observed birds and small animals on the study site and was able to observe a generation of American kestrels raised on the site.

Perhaps the most challenging aspect of my study was a below-normal precipitation pattern that seems to persist throughout Arizona even as I write this article. Some of the responses I expected to occur did not happen because there was little or no precipitation. Bull thistle was almost completely absent from the site during 2002, making "results" for this study hard to find. Precipitation patterns can affect the distribution and abundance of exotic weedy species as well as the native plant community. Some exotic species seem to take advantage of the dry conditions and absence of other plants to expand their range or abundance while some species such as bull thistle decrease in abundance during dry years. Understanding the relationships between non-native species and long-term weather patterns could help us better predict the patterns of future invasions.



Figures

left: Figure 1. Line drawing showing bull thistle flowers, seeds and leaves. The pappus present on the seed allows the seed to be transported on air currents. Illustration is from USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada.* Vol. 3: 549.



above left: Figure 2A. Disturbed areas within a larger area of no disturbance are available for occupation by biennial species such as bull thistle.

above right: Figure 2B. As time passes, some areas of disturbance become occupied by more competitive plants making them unsuitable for bull thistle but a new area (rectangle) is created by disturbance. Seeds from bull thistle plants remaining in the two ovals can invade the new area.

[1]*I would like to acknowledge some of the many people who made my study possible and those who devoted their time and energy during the study. These include my academic advisor, Dr. Laura DeWald, formerly of Northern Arizona University and currently at Western Carolina University, Cullowhee, NC; Dr. Carolyn Sieg and the staff at Rocky Mountain Research Station in Flagstaff; Dr. Barbara G. Phillips, U.S. Forest Service; Dr. Tom Kolb, Northern Arizona School of Forestry; and last, but not least, I thank my family for their assistance and many hours spent in the field during my study.*

Can Natural Resource Conservation Districts Provide the Structure for Weed Management Areas in Arizona?

by Tim Morrison, Executive Director, Arizona Association of Conservation Districts

An assessment of the current weed management activities in the state is a necessary component of matching the infrastructure needs of weed management to the local conditions and opportunities. The Governor created the Invasive Species Advisory Council (AISAC) April 1, 2005. One of the principal objectives of the participating state agencies is to "conduct an evaluation of their current statutory authorities, rules and programs relevant to invasive species management" including "current invasive species activities." On October 18, the Council has met and assigned duties to five working committees and state agencies committed to submitting a summary of responsibilities and actions.

Effective weed management in the state of Arizona could be accomplished by using the framework of Natural Resource Conservation Districts (NRCDs) already existing in the state of Arizona within existing statutory frameworks of local and state government. Soil and Water Conservation Districts (SWCDs) occur on Tribal lands within the state of Arizona and they have capabilities similar to the NRCDs.

A non-exhaustive search of the Arizona Revised State Statutes provides a glimpse into the existing opportunities for weed management at the local watershed and regional level in the state. We suggest the use of the Legislative website to see the full content of the statutes (see box on next page): **www.azleg.state.az.us/ArizonaRevisedStatutes.asp**.

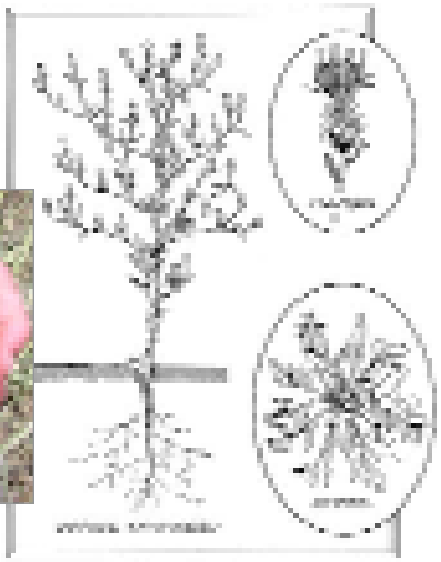
The NRCDs in the state have cooperation statutes specifically allowing them to administer and implement weed management programs within the watersheds and sub-basins of Arizona. The powers conferred among the NRCDs in Arizona provide an existing framework for cooperation with *local* (including other Districts), *state* and *federal agencies in their implementation of invasive species management on private, state and federally managed lands regardless of political boundaries; and to network and coordinate with, and support ongoing voluntary weed management groups in Arizona.* The NRCD can *conduct surveys, investigations and research relating to...eradication of noxious growths and such other measures as will aid farm and range operations, disseminate information pertaining thereto, and carry on research programs with or without the cooperation of the state, the United States or agencies thereof* (emphasis added).

An NRCD may also conduct demonstration projects on lands owned or controlled by the state with the consent and cooperation of the agency and on lands within the district with the consent of the owner in order to demonstrate the means, methods and measures by which soil and soil resources may be conserved. An NRCD may cooperate and enter into agreements with a landowner, any agency or subdivision of the state or federal government to carry on programs of watershed improvement including the eradication of noxious growth on grazing lands, all within an individual farm or ranch and based on conditions as the supervisors deem necessary. An NRCD can make available machinery and equipment, fertilizer, seed and such other material or equipment to assist landowners to carry on authorized operations.

Based on the foregoing, the AISAC may conclude there is existing statutory language that would support an integrated approach to effective weed management for all lands in Arizona; and the time-tested and proven partnership with the United States Department of Agriculture, Natural Resources Conservation Service (a federal agency) demonstrates the capability of Conservation Districts to cooperate with organizations and agencies and implement programs and projects in the local jurisdictions.

Biocontrol of Invasive Weeds

by Laura Moser, Coconino National Forest. **lmoser@fs.fed.us**



Invasive exotic plants are infesting Arizona's wildlands at an alarming rate. As these plants displace our native flora they alter the composition, structure, and function of our ecosystems. One of the main reasons these exotics are able to out-compete our native plants is the lack of natural enemies in our landscape. Classical biocontrol takes advantage of this to introduce selected host-specific, plant-attacking insects, mites, nematodes, and pathogens from the invasive plant's native lands. Biocontrol should not be expected to eradicate a weed population on its own but can significantly reduce the density and extent. Working in cooperation with APHIS and the San Francisco Peaks Weed Management Area, Coconino National Forest is taking these biocontrol measures:

Diffuse knapweed (*Centaurea diffusa)* is an allelopathic, tap-rooted, perennial tumbleweed that has been accused of everything from increasing erosion to inhibiting growth of neighboring species. In the summer of 2005, eight thousand insects *(Larinus minutus* and *Bangasternus fausti)* were released on dense diffuse knapweed populations.

Dalmation toadflax *(Linaria dalmatica)* is the most widespread invasive exotic on the National Forest; it covers over 150,000 acres in Northern Arizona. In an integrative program including hand-pulling and herbicide spot treatments, a host-specific stem weevil, *Mecinus janthus*, has been introduced to feed on leaves and stems.

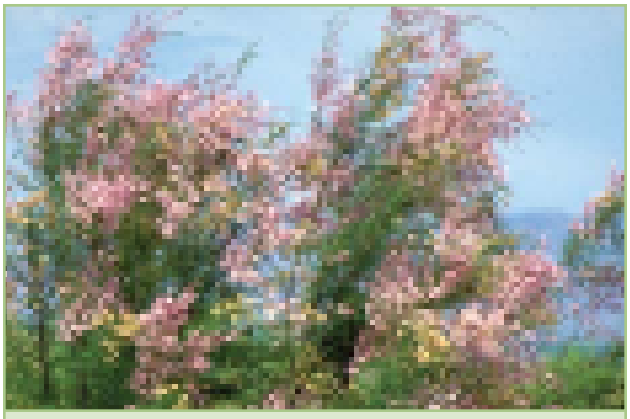
State Statutes Providing Opportunities for Weed Management at Local Levels

Title 48: Special Taxing Districts, Chapter 2: Antinoxious Weed Districts, Article 1: General Provisions. Provides for a landowner petition and election by qualified electors to create an antinoxious weed district wholly within a county. And includes funding of district enforcement dependent on county supervisor adoption of tax levy.

Title 3: Agriculture, Chapter 2: Regulatory Provisions, Article 1: Dangerous Plant Pests and Diseases. Appears to provide for state/local government coordination of noxious weed management activities and may create funding opportunities for local governments' weed management activities, dependent on the direction of the state Department of Agriculture and funding by the Legislature.

Title 11: Counties, Chapter 7; Intergovernmental Cooperation. May provide the capability of federal, state and local governmental units to combine purposes and thereby programs of weed management that cross political boundaries (watershed approach). Funding mechanisms are not included, but a budgetary reality is required as part of any agreement.

Title 37: Public Lands, Chapter 7: Natural Resource Conservation Districts, Article 1. The statute provides for a legislative purpose in direct line with the needs of natural resource management including weed management activities by a local governmental unit working in cooperation with state and federal government agencies. With this in place the only need then is for the Legislature to create the necessary funding levels in their budgetary process for the NRCD to either increase present weed management efforts or institute responsible and accountable weed management programs in concert with local, regional and/or state-wide needs.



ETHNOBOTANY: PEOPLE USING PLANTS

Going with the Flow:

Indigenous Uses for Exotic Plants

by Jessa Fisher, Flagstaff Chapter President

Indigenous peoples such as the Hopi, Diné (Navajo), Tohono O'odham (Papago), Akimel O´odham (Pima), and many others groups call the desert Southwest their home. For centuries, their land-based communities depended on native plants for food, shelter, medicines, dyes, craft materials, and for ceremony. When Spanish and Northern European settlers arrived and settled in this area in the 1700s and 1800s, they brought with them many species of exotic plants which spread rapidly, having no biological controls. Some plants came unknowingly, like species of brome grass (*Bromus* spp.) in feed grain supplies, while others, like salt cedar (*Tamarix* spp.) were introduced purposefully for use as a wind-break and as an ornamental. Whatever the reason, these plants have spread like wildfire, and some are so common and well-established that they have been incorporated into indigenous ways of life.

The Diné have taken many plants that we today look at as a nuisance and have found a special use for them. Traditional Diné elders think of plants as people, the Growing People. They use the plants that were mentioned in their creation stories, and although these introduced plants have not been around since the beginning, they have been slowly included as uses for them have been found. All

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Photo
Salt cedar. *Courtesy Steve Dewey, Utah State University, www.forestryimages.org*

Computer Tools for Weed Information and Data Sharing

by Kathryn Thomas, U.S. Geological Survey, Southwest Biological Science Center, 520.670.5534.
Kathryn_A_Thomas@usgs.gov

The Southwest Exotic Plant Information Clearinghouse (SWEPIC) and the Southwest Exotic Mapping Program(SWEMP) offer a variety of computer tools that can help weed managers. SWEPIC is a website (**www.usgs.nau.edu/SWEPIC/index.asp**) hosted by the U.S. Geological Survey's Southwest Biological Science Center that provides a regional "first-stop" entry to information about invasive plants of concern to Southwestern land managers. Species Profile pages are provided for nearly 350 invasive non-native plants and include the plant's impact ranking by the California Invasive Plant Council (Cal-IPC), the Arizona Wildlands Invasive Plant Group (AZ-WIPG)), and NatureServe (a non-profit conservation organization); the plant's status as a noxious weed in the Southwest; any evaluations the plant may have had with the Alien Plant Ranking System(APRS) developed by the National Park Service; and links to other important sources of information on the plant. APRS is a downloadable application that prioritizes decisions for site-level management of invasive non-native plants. Information and download of the Alien Plant Ranking System is also available on SWEPIC, as is information on the activities of the AZ-WIPG and the findings of their recent evaluation of the impact of 75 invasive plants on wildland ecosystems.

SWEMP is part of a network of data sharing. The SWEMP regional database compiles data collected at weed infestation sites and contributed to SWEMP into a regional database. With its most recent update, the SWEMP regional database has over 24,000 infestation records for more than 100 invasive plants. The regional data are then passed back to the local managers through SWEPIC in several ways. You can view the distribution of weeds with an interactive map (see Maps link on SWEPIC) which lets you choose which weed distribution you would like to view, choose the scale background of the map display, and print out a "maplet." Another way of viewing parts of the database is with the data query tool (see the Data Query link on the SWEMP

continued next page

SPOTLIGHT ON A NATIVE PLANT

Arizona Sneezeweed:

A Threatened Northern Arizona Endemic

by Barbara G. Phillips, Zone Botanist, Coconino, Kaibab, and Prescott National Forests, bgphillips@fs.fed.us

Arizona sneezeweed (*Helenium arizonicum*), a beautiful native endemic perennial, is a Forest Service Sensitive species most easily recognized when it is in bloom in July through September. Each plant has three-lobed yellow to orange ray flowers and purplish brown, globular disk flowers up to 2 inches wide (see photo, right) at the tops of several stems.

The plant grows in wet areas such as moist drainages, lakeshores and ponds from the Mormon Lake area southeastward into the White Mountains (7,000 to 9,000 ft.) in central Arizona. Unfortunately, a large population in one of these meadows is heavily infested with one of the nastiest weeds to invade the West — leafy spurge *(Euphorbia esula)*. This pernicious plant causes large economic losses and substantial habitat damage in areas of the northwestern United States, where it is widespread.

In 1999, a large population of leafy spurge estimated to cover more than sixty acres was detected in the Brolliar Park area on the Coconino National Forest (see photo, above). This weed is difficult to control because it regenerates from both seed and adventitious root sprouting. Additionally, it forcefully expels seeds, which can travel more than 15 feet from the parent plant

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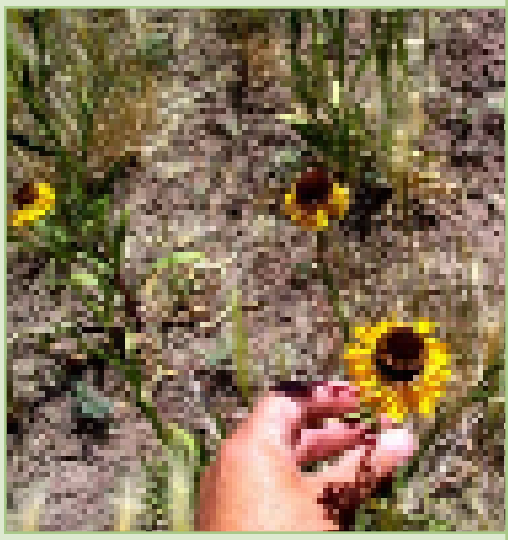


Photos
top left : Coconino National Forest employees assess Brolliar Park population of leafy spurge.
above : Arizona sneezeweed – a Northern Arizona endemic plant.
Photos courtesy Barbara G. Phillips

Computer Tools for Weed Information and Data Sharing *from previous page*

portion of SWEPIC). You can choose one or more criteria to filter the data and then download the filtered data. This tool allows representatives of weed management areas to download periodically all the data contributed by the various collaborators in the weed management area. The third way to obtain the database is to download the entire regional database. Collaborators are welcome; you can get more information on how to collaborate with SWEMP by going to the SWEMP link on the SWEPIC site or contacting the project leader, Dr. Kathryn Thomas at Kathryn_A_Thomas@usgs.gov.

The USGS Southwest Biological Science Center SWEMP team and the University of Arizona Extension are currently collaborating on a project to make the pipeline of data collection flow from the field infestation site, to the land manager's desktop, to SWEMP, and back again, making regionalized data easier and more efficient. The project will refine a system for land managers to collect weed infestation data in the field using a handheld computer linked with a geographical positioning system (GPS). It will also provide ways to download that data into his/her personal computer directly or into a modification of the Weed Information Management System (a database management application). The project will also provide ways that are more efficient for a land manager to export portions of the field data to SWEMP for inclusion into the regional database. The products of this project should be available through SWEPIC by winter of 2007.

Long-term Vegetation Trends as Influenced by Climate and Management

by John H. Brock, Professor, Department of Applied Biological Sciences, Arizona State University Polytechnic Campus, Mesa, AZ 85212. **john.brock@asu.edu**

Arizona's major biotic communities provide a biodiversity base matched by few other states. Vegetation is the prime product of terrestrial ecosystems and is influenced by climate, fire and animals. Ecosystems are in constant change, reflecting actions by climate, fire regimes, animals (including humans) and land management practices. The working hypothesis is that vegetation change is occurring with management and is strongly driven by atmospheric climate change.

Arizona has a history of periodic droughts. Within the past century there was drought in the teens, thirties, fifties, seventies, and then in the late nineties continuing into the new century. The year 2002 was the driest in the records since the 1400s, based on tree ring data. Precipitation change could be reflected in the frequency and magnitude of events, i.e., large storms with few events per year which could lead to a simultaneous pattern of floods during droughts. The precipitation events may be altered in timing; for example, a late-arriving summer monsoon thunderstorm season could affect warm season plant growth in most of Arizona. Earlier snowmelt from decreasing snowpacks could also be an effect of precipitation change. Under a drier climate scenario, mesophytic plants could lose vigor and presence on the landscape and be replaced by drought-tolerant species. Wetlands and riparian areas could shrink. Biodiversity would likely decrease with the loss of plants that require more water for a successful life cycle.

Temperature change is a result of global warming due to the greenhouse effect and depletion of the high altitude ozone layer. The observed "hockey stick" rise in air temperatures in the past two decades illustrates this environmental factor. Warming climate could lead to longer growing seasons, perhaps earlier flowering and seed set with changes in plant phenology. This has implications to the food web, pollinators, and migratory animals (particularly birds). Warming temperatures could influence fire events, which in theory, could increase in frequency. Change in vegetation could be from an herbaceous dominance to arid-climate-type half-shrubs and woody plants. Isotherms could change and the vegetation response could be a northward and/or upper elevation migration of cool-season-type species.

Changes in atmospheric gases also are contributing to environmental changes. Carbon dioxide (CO_2) concentration in the atmosphere has increased since the beginning of industrialization and modern urbanization. There are historic atmospheric cycles of CO_2 but they are in a timeframe of millennia, not hundreds of years or decades. Increased CO_2 can be a boon to plants, by providing one of the base materials for photosynthesis. Research indicates that plants with C3 carbon metabolism gain more from elevated CO_2 than do C4 plants. Increased CO_2 levels tends to favor weedy plants and could change plant water-use-efficiency since the stomates would close more rapidly by completing photosynthesis sooner and with lower evapo-transpiration. Nitrogen (N) in the atmosphere has also been increasing, especially around urbanized areas, primarily from vehicle emissions contributing to air pollution. Increased atmospheric N is theorized to aid invasive plants like red bromegrass (*Bromus rubens*) in the warm deserts. The southwestern landscapes are often

N poor and deposition of N in rainfall and dry precipitate may be aiding the success of invasive cool season annuals like red bromegrass, which is capable of growth at lower temperatures than are many of the native species. Invasive species are expressing themselves because of elevated CO_2 and N, with plant communities being transformed in composition and processes.

Most land management techniques were developed last century during a pluvial period, compared to the long-term arid Southwestern climate. I believe management techniques need to be modified for aridity and not maintained based on the concept of "this is what is appropriate for when it rains again." Change in vegetation from climate and management modifications is always difficult to predict without extensive research. Arizona vegetation trends are favoring desertification and colonization of communities by non-native invasive species. I can't predict exactly what will happen to our vegetation communities, but I do ask you to ponder what might happen. I believe the science of environmental change is fairly clear. Change is a constant of nature.

Photos

page 14: These photos illustrate the influence of invasive plants on fire regime and vegetation change in the upper Sonoran Desert. The left photo is from May 2005 with the maroon colored plants being red brome grass green foreground being annual mustards. The right photo is same site in August 2005 after a summer wildfire. The stem succulent dominates of the Sonoran Desert have been greatly impacted by this summer fire and it will take many years of succession to return this site to the original community structure.

above: Change in forest expansion as a result of drought and pine bark beetles. Ponderosa pine on the current forest edges and low potential sites have a high rate of mortality. The forest boundries are being reset from its expansion during the recent southwestern "wet" cycle of climate. *Photos courtesy John Brock.*

Going with the flow *continued from page 12*

plant information comes from the book *Nanise': A Navajo Herbal* by Vernon O. Mayes and Barbara Bayless Lacy.

Cheatgrass *(Bromus tectorum)* is an annual weedy grass which is commonly seen dominating disturbed areas in Northern Arizona. One of its Diné names is *Ye'iibe'ets'os*, or "God's Plume." It is used medicinally and ritually in at least four different healing ceremonies. Horehound *(Marrubium vulgare)* has the Diné name of *Azee'nidoot'eezhii?ibáhígíí* or "grey knotted medicine." It is a naturalized, aromatic weed in the mint family with thousands of seed heads which attach onto clothing and fur. It is used ceremonially to treat lung disorders and fevers, and is also used for indigestion, colds, and coughs. Russian Thistle *(Salsola* spp.) is called *Ch'il deeníní*, or "sharp plant" by the Diné. It is a spiny, variable annual herb often growing in shrubby and impenetrable masses. It is used to treat influenza and smallpox, and ashes of the burnt plant are made into a lotion. One last non-native plant used by the Diné is salt cedar *(Tamarix* spp.), or *Gad ni'ee?ii bí?átah ?ichí'ígíí*, meaning "Rocky Mountain Juniper with red flowers." In this case the name gives away the plant's uses. *Gad* means juniper in Diné, and because this plant is a tree which looks like and grows in similar places to Rocky Mountain Juniper, it can be used as a substitute for the native juniper in smoking ceremonies or to make heald sticks used in weaving.

Although exotics tend to get a bad rap, they do have beneficial uses, too, which the Diné and other Southwestern tribes can attest to.

Arizona Sneezeweed *continued from page 13*

and are coated with a sticky substance that can stick to passing animals. The roots of leafy spurge can grow as deeply as 30 feet into the soil. These traits as well as the "history" of habitat degradation in other areas make leafy spurge a direct threat to the local population of Arizona sneezeweed in Brolliar Park. Since the weed's discovery in 1999, the U.S. Forest Service has been able to prevent leafy spurge seed set by sheep grazing and weed-wacking; and plans to continue controlling this highly invasive species using a variety of methods including herbicides. Controlling leafy spurge will benefit not only the beautiful rare endemic, Arizona sneezeweed, but will also contribute to overall ecosystem health in the area.

In Memoriam

Henry Browne "H.B." Wallace
18 Sep 18, 1915 – 7 Aug 2005

H.B. Wallace would have been 90 years of age on September 18, 2005. He lived a wonderful life in Arizona and Colorado for many of the past years. His Wallace Desert Gardens in North Scottsdale was a prized possession upon which he had placed a conservation easement to ensure of its lasting protection. The 80-acre, world-class cactus, succulent, and plant arboretum is a grand collection of specimens from all over the world, as well as our native plants of Arizona.

A native Iowan, H.B. was son of Henry A. Wallace, former Secretary of Agriculture and U.S. Vice President during President Franklin D. Roosevelts' tenure.

Some of us were priviledged to visit the Desert Gardens and listen to H.B.'s botanical and personal stories. A group of ANPS State Conference attendees visited H.B.'s Garden in September, 2004 on one of our scheduled field trips. On Sunday, September 18, 2005 a Memorial was held for H.B. at his home and garden. We were pleased to be there in behalf of ANPS, to socialize with his many friends and hear the recollections about his life. What a man he was! He will be sorely missed by the botanical world. Our sincerest condolences to the Wallace family on their loss of H.B.

— Submitted by C. Douglas Green, ANPS Board of Directors

Early Detection Rapid Response to Invasive Species in Forested Areas of Arizona

by Beverly Loomis, and Tom DeGomez. University of Arizona Forest Health Program, School of Natural Resources, PO Box 15018, NAU, Flagstaff, Arizona 86011. **bloomis@ag.arizona.edu**

Populations of noxious-invasive weeds are increasing exponentially in Arizona and are threatening forests. The University of Arizona Forest Health program received a $50,000 grant from U.S. Forest Service in late 2005 to fund early detection rapid response weed teams. The goal is to control or eradicate these weeds on non-federal municipal and private properties in Arizona that threaten federally forested areas. Efforts are to be centered on control and eradication with a minimal effort on mapping and education. Treatment involves Integrated Pest Management including herbicides by certified applicators in partnership with property owners and the University of Arizona. Property owners, regardless of property size or municipal affiliation, are required to match federal dollars on a 50-50 basis. Federal lands are not eligible through this program.

So far Early Detection Rapid Response Plans were received from the following weed teams who plan to control noxious invasive weeds in the 2006 growing season of these, mostly high, elevations — **Coconino National Forest** to treat noxious invasive weeds on the private property side of the NFS boundaries; **Mountain Meadow Farm**, a private permaculture farm; **Fredonia NRCD** to treat thistles, camelthorn, Russian knapweed and prickly poppy on private and state land; and **Envirosystems Management, Inc** received EDRR funding this past season to treat about 6 pieces of private property in the Flagstaff area, mostly for diffuse knapweed.

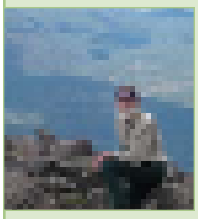
*We are hoping other forested areas of Arizona will indicate they want to participate as plans need to be made **now** in order to be ready to respond as the plants emerge.*

Activities of the Phoenix Chapter

The Phoenix chapter, through its dedicated members, has been active in various activities:

❧ Michael Plagens is working with the Cities of Phoenix and Gilbert to help identify plants on the Rio Salado project and the Gilbert waste water control sites.
❧ Chris Trask is serving on the Governor's Invasive Plant Committee to come up with ways to control invasive plants in Arizona.
❧ We have had some good programs in the past few months covering subjects such as how we eliminate invasive plants with Ed Northrum, and the effect of fire on the plants of the Sonoran Desert: devastating.

We will have some interesting programs in the future: in April, Scott Bates of ASU will present on lichens, and in May, Hoskie Schafsma of ASU will present on the use of land along the Cave Creek Wash by the Hohokam. We will not have a meeting in February having decided to combine our meeting with the Annual Botanical Conference at the Desert Botanical Garden. —*Doug Newton*



RESEARCH AROUND THE STATE:

Vascular Flora of the San Francisco Peaks in Preparation

Will Moir, retired Forest Service research ecologist, is busy compiling a Flora of the San Francisco Mountains. Part of the project is to find historical collections in herbaria and sort out misidentifications and update names. Some of the early collectors of the Peaks flora include Rose Collom, Elbert J. Little, J.W. Toumey, C.H. Merriam, and Gus Pearson. Will currently has over 800 records for vascular plant taxa for the Peaks. This summer he is actively hunting for species that have not been collected in the San Francisco Peaks in the past 20-80 years. Will is currently revising keys to the species for each vegetation community. Visit the Deaver Herbarium website (**www4.nau.edu/deaver**) for an up-to-date version of Will's flora. — *Tina Ayers*

Porterella Rediscovered

Last spring Kyle Christie, a M.S. botany student at NAU, rediscovered fleshy porterella (*Porterella carnosula*), which had not been collected since 1927 in Arizona. *Porterella,* an ephemeral annual related to *Lobelia*, is native to vernal pools in the Great Basin and Central Valley of California. The closest known populations are reported from Sevier County, Utah. The four collections from Arizona were made between 1906 and 1927 near Fort Valley and on the southern slope of Mt. Agassiz. Kyle was riding his bike near Fort Valley when he saw thousands of tiny blue flowers in a wet meadow. Seeds of many vernal pool plants remain dormant in the soil for decades. The seeds germinate only after months of inundation and the seedlings are basically rooted aquatic plants that flower, set seeds, and die rapidly as the pools of water dry up. —*Tina Ayers*

BOOK REVIEW

Rainwater Harvesting for Drylands Volume 1: Guiding Principles to Welcome Rain into Your Life and Landscape

For years author Brad Lancaster has sought out practical ways to create water-harvesting systems, figuring out what works well and applying it to his own home and numerous other projects. His vast array of knowledge is now available, in inviting and usable form, in a book that enables the reader to assess on-site resources (rainwater, topsoil, sun, plants, and more) and build an integrated, multi-functional landscape. As Gary Nabhan writes in the foreword, "There is both quantitatively-informed precision and beauty in what Brad has implemented, and this combination is a rarity in the modern world. Technological fixes have grown increasingly ugly, but as you can see from the drawings and photos in this masterwork, Brad's designs sing to us as they solve our water shortages." The simple techniques (and the principles behind them) can help anyone bring a site to life, reduce cost of living, endow the landowner and the "community with skills of self-reliance and cooperation, and create living air conditioners of vegetation growing beauty, food, and wildlife habitat." The amazing stories of people who have successfully welcomed rain into their life provide ample inspiration to get started.

by Brad Lancaster. Foreword by Gary Paul Nabhan. Rainsource Press, Tucson: 2005. 183 pages, paperback. $24.95.

ANPS Merchandise

You can purchase ANPS t-shirts, booklets and posters from our local chapters or by mail order. In addition, you can find posters at the Arizona-Sonora Desert Museum, Audubon Society, Boyce Thompson Arboretum, Desert Botanical Garden, Organ Pipe National Monument, Saguaro Park (East and West), The Arboretum at Flagstaff and Tohono Chul Park.

Questions? Sending an international order? Please contact Nancy Zierenberg at anps@aznps.org

ANPS T-shirts

Sacred Datura, Dark purple or Khaki, Gildan pre-shrunk Ultra 100% cotton.
Specify **S M L XL** or **XXL**

Member price: **$16.00**
Non-member price: **$18.00**

Shipping/handling: $3.00 plus $1.00 for each additional tshirt mailed to the same US address.

ANPS Posters

Wildflowers of Northern Arizona
Sonoran Desert Wildflowers

Member price: **$10.00**
Non-member price: **$12.00**

Shipping/handling: $2.50 plus $0.50 for each additional poster mailed to the same US address.

Wholesale pricing*:

10-49	**$6.00** each
50+	**$5.00** each

**Shipping/handling are an additional charge and depend upon the size of order. Please contact Nancy Zierenberg for specifics on shipping costs.*

ANPS Booklets

Desert Butterfly Gardening
Desert Bird Gardening
Desert Grasses
Desert Ground Covers & Vines
Desert Shrubs
Desert Wildflowers
Desert Accent Plants (out of print, to be revised)
Desert Trees (new edition available February 2006)

Price per booklet ordered includes postage for US addresses only:

1-9	**$3.50** each (any combination of titles)
10-49	**$2.75** each (any combination of titles)
50+	**$2.10** each (any combination of titles)

For booklets shipped outside the US, there are no quantity discounts; all are shipped via airmail.

ANPS Bumpersticker (more to come!)

Grow Native **$1.00** each (price includes postage)

For order forms, please visit the ANPS website at **www.aznps.org**
Please send your order to:

Arizona Native Plant Society, PO Box 41206, Tucson AZ 85717

Don't forget people on your gift list.
And thank you for your order!

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The Arizona Native Plant Society

Upcoming Issues: Rare Plant and **Pollinators!** Contact *Plant Press* Editor, Julie St. John, at gui@igc.org for more information on contributing articles, illustrations, photographs or book reviews on this topic.

The Plant Press is a benefit of membership in the Arizona Native Plant Society. Suggestions are welcome for book reviews, and articles on plant use, conservation, habitats, and invasive species

Special thanks go to Barb Phillips for pulling this all together and to all who contributed time and effort: Tina Ayers, Travis Bean, Julio Betancourt, John Brock, Matt Brooks, Michael Crimmins, Debra Crisp, Tom DeGomez, Jessa Fisher, Doug Green, Jodie Holt, Beverly Loomis, Robin Marushia, Nancy Morin, Tim Morrison, Doug Newton, F.E. Northam, Kathryn Thomas and Nancy Zierenberg. A belated thanks to Dr. Jack Herring for contributing his presentation to our last issue.

New Members Welcome!

People interested in native plants are encouraged to become members. People may join chapters in either Phoenix, Flagstaff, Prescott, Tucson, Yuma, or may choose not to be active at a chapter level and simply support the statewide organization. For more information, please write to ANPS at the address below, visit the ANPS website at **www.aznps.org**, or contact one of the people below.

Phoenix Chapter: Doug Newton	602.438.9628
Flagstaff Chapter: Jessa Fisher	928.527.8882
Prescott Chapter: Carl Tomoff	928.778.2626
Tucson Chapter: Nancy Zierenberg	520.882.7663
Yuma Chapter: Mar-Elise Hill	mar-elise.hill@azwestern.edu

Membership Form

Name: _____

Address: _____

City/State/Zip: _____

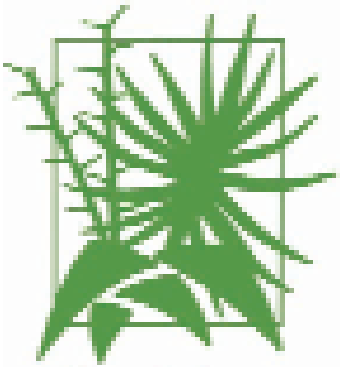
Phone/Email: _____

Chapter preferred: ❑ State only ❑ Flagstaff ❑ Phoenix ❑ Prescott ❑ Tucson ❑ Yuma

Enclosed:

❑ $15 Senior (65+)
❑ $15 Student
❑ $25 Family/Individual
❑ $40 Organization
❑ $60 Commercial
❑ $75 Sponsor
❑ $100 Plant Lover
❑ $500 Patron
❑ $1,000 Lifetime

Mail to: Arizona Native Plant Society, PO Box 41206, Tucson AZ 85717



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