

The Plant Press

THE ARIZONA NATIVE PLANT SOCIETY

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Plant Conservation...

Global context and local action: What we can do in Arizona

by Nancy Morin

Introduction

Over the past decades many plans, regulations, and guidelines have been developed at global and national levels in an attempt to halt the loss of biological diversity. Because of the global scale of the problem, it is sometimes difficult to know how individuals or local groups can help achieve this goal. Many issues, like commerce in endangered species, or laws restricting the use of noxious weeds, must be dealt with on state, national, or international levels. But much of the work that needs to be done to ensure the health of species and their populations can only be done on a local level. There are many, many ways that we, as citizens who care about the environment, can make significant contributions toward achieving the global preservation of biological diversity.

The United Nations Convention on Biological Diversity (CBD), which went into effect in December 1993, serves as a guiding principle for conservation in the U.S. (even though the U.S. is not a party to the convention) and it has the force of law for the 188 countries that have adopted it. It addresses three globally important goals:

- ❖ The conservation of biological diversity
- ❖ Sustainable use of its components
- ❖ Fair and equitable sharing of benefits

To achieve these goals, the CBD requires its adopting countries to: (1) develop a framework for a “plan for accomplishment”; (2) identify the components of biological diversity; (3) monitor species and habitats, paying particular attention to those requiring urgent conservation measures; and (4) identify processes and activities likely to have significant adverse impacts on the conservation and sustainable use of

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A school group inventories plants in a meadow at The Arboretum at Flagstaff.

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* Volumes 28 & 29 contain only one issue.



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President's Message *by Nancy Morin*

As people who love Arizona's native plants, ANPS members know that change is a natural process. Things change with the seasons, or from year to year. The same is true of organizations, and ANPS is no exception. Over the past years the Board, working with the membership, has developed strategic directions and worked to keep each part of the organization—chapters, publications, meetings, and communications—strong and growing. ANPS is a volunteer-run organization, with only one part-time staff member,

We are extremely fortunate to welcome Julie St. John as editor of the *Plant Press*. She has been producing newsletters, conference materials, catalogs, and all sorts of other materials for nonprofits for the past 10 years, including for Native Seeds/SEARCH and the Society for Ecological Restoration. She started in July and will work to get us back on schedule. Tina Ayers at Northern Arizona University agreed to be ANPS's website maven and *Happenings* editor.

This *Plant Press* is our first since we decided to have a theme or focus for each issue; most of the articles in this issue stem from papers given at the 2004 ANPS Annual Conference. We also will return to having some familiar and popular columns in each issue. To achieve this we have created a Publications Committee to work with Julie. For each issue a small team will recruit authors, work with them through review and revision, and be a resource for Julie. Erika Geiger has been working on a revision of the ANPS booklet *Desert Trees*. Here again, you will see a change—focusing more on native plants and providing more general ecological information about them. Reaching key groups to encourage use of native plants has been a high priority for us, and to this end Doug Green has developed a handout and talking points to use when addressing homeowners associations or developers.

Volunteers are the lifeblood of ANPS. I am grateful to everyone who helps make the Society a success and urge each and every member to participate actively in ANPS in any way they can.

We are excited to have very active ANPS groups in Yuma and Prescott, and hope other towns or communities that have people interested in native plants but are distant from other chapter centers will consider starting their own satellite subchapter.



Plant Conservation... Global context and local action *continued from page one*

biological diversity, and then maintain and organize data derived from this identification and monitoring.

Botanists from universities, natural history museums, botanical gardens, and governmental agencies around the world have now developed a **Global Strategy for Plant Conservation** that sets out specific goals for achievement toward plant conservation—basically the “plan for accomplishment” for plants on a global level. In this article I will highlight recommendations from both the CBD and the Global Strategy for Plant Conservation and how I think Arizona plant lovers and ANPS can help meet and carry out those recommendations on a local level.

Understanding and documenting plant diversity: you have to know what you have before you can save it!

The global goal is to compile a widely accessible working list of known plant species as a step towards a complete world flora. Obviously, this is an almost overwhelming goal—there are 250,000 to 350,000 species of plants worldwide—and one which will require participation down to the local levels. In Arizona, a broadly collaborative effort is underway to replace the current 50-year old *Arizona Flora*. Centered at the University of Arizona, the project is publishing family treatments as they become available through the Arizona Academy of Sciences. The treatments are based on existing literature and on plant specimens that botanists have deposited in herbaria. In a state as large and diverse as Arizona, there is still a great deal that needs to be learned about local flora. Plant life is not static; it changes in response to changes in the environment. We need to be documenting changes in plant distribution, whether it's new plants that have become established (including many weeds) or plants whose ranges have been influenced by the recent drought.

The need to understand and document our biological diversity has resulted in a hierarchy of taxonomic initiatives. These can be a little confusing so here is a description of what they are and how they fit together.

The CBD requires each country to have a “Clearing House Mechanism”—a mechanism through which other countries can access information about the home country's biodiversity. The mechanism in the U.S. is the **National Biodiversity Information Infrastructure**, part of the U.S. Geological Survey.

Species 2000 compiles lists of species within particular groups, and is doing this for all organisms worldwide. Funding and some of its logistics are provided in part by the Global Biodiversity Information Facility (GBIF).

For plants, the **International Organization for Plant Information** is producing both a global checklist and a revision of Linnaeus's famous *Species Plantarum*.

Information for the global checklist comes from continental floras such as *Flora of North America*, which is a multi-institutional, multi-authored work published by Oxford University Press. Many botanists in Arizona are contributing treatments or acting as reviewers for this major project, and it draws from regional floras like the *Intermountain Flora*, the *Arizona Flora*, and local floras and checklists.

Arizona has about 3500 species of plants—greater than Nevada, New Mexico, or Utah—and approximately 600 of these species are of conservation concern. While Arizona is floristically rich, its flora is poorly known. More plant collecting is needed, especially north of the Colorado River, on the Colorado Plateau, in the Arizona Strip region, on the Navajo Reservation, in Glen Canyon and the Grand Canyon, along the Mogollon Rim, and in the Eastern Mojave of western Arizona. The San Diego Natural History Museum has started an innovative program to

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Plant Conservation... Global context and local action

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An Arboretum volunteer transplants an Arizona cliffrose (*Purshia subintegra*) in a restoration project.



survey the plants of San Diego County using a large and well-trained volunteer crew. Such an approach might work well for Arizona.

Undertake a preliminary assessment of the conservation status of all known plant species at national, regional, and international levels.

While the U.S. Fish & Wildlife Service has national responsibility for rare species, plant conservation also comes under the authority of other federal and state land management agencies. These agencies also carry out inventory and research on rare plants.

Last October, in conjunction with its annual conference, ANPS sponsored a gathering of representatives from the U.S. Forest Service, National Park Service, Bureau of Land Management, State Heritage program, Arizona Game & Fish, and botanists from universities, botanical gardens, and museums to spend two days sharing their knowledge of the plants in Arizona of conservation concern.

Conserve Biological Diversity

To meet the CBD charge of conserving plant diversity, the Global Strategy for Plant Conservation has set a goal that 60% of the world's threatened species will be conserved *in situ* (in place, meaning where the species is located in the wild). The CBD recommends that each country establish a system of protected areas; develop guidelines for their selection, establishment, and management; promote the protection of ecosystems, natural habitats, and the maintenance of viable populations of species in natural surroundings; and establish buffer areas.

In the U.S., there are many state and federal efforts underway to achieve this goal, which is important

because 29% of the land—655 million acres—in the U.S. is federally managed. The BLM, which manages much of the federal lands in the west, is responsible for a total of 265 million acres. Yet individual landowners control more than half—about 59%—of the land in the U.S. and thus their cooperation can be essential in protecting species on site.

Many of the conservation plans, including recovery plans, were developed in the 1980s, in a time of particularly high precipitation. Evidence from tree ring data in the southwest suggests that the more recent low precipitation levels—from the late 1990s to present (heavy precipitation in 2004-05 notwithstanding)—is part of a return to natural aridity. Locally we can reevaluate the recovery plans to see if they will still be appropriate during a long-term drought. We should also determine what effect, if any, the recent six years of drought have had on rare plant populations and what it will mean for plant conservation.

RESTORATION

The CBD and Global Strategy ask countries to rehabilitate and restore degraded ecosystems and promote the recovery of threatened species through the development and implementation of plans or other management strategies. Specific targets for habitat conservation are to have at least 10% of each of the world's ecological regions effectively conserved; the protection of 50% of the most important areas for plant diversity assured, and at least 30% of production lands managed consistent with the conservation of plant diversity

In Arizona, there are some challenges to restoration that we can help with. Millions of acres are seeded post-fire, but for successful restoration we need to

have appropriate native seed available in quantity. Land management agencies are developing restoration guidelines that deal with such issues as determining appropriate genetic sources of seeds to be used. Volunteers are needed to collect seed, and botanic gardens and local nurseries are needed to grow plants in bulk as seed sources. Botanic gardens, nature reserves, and land conservancies with strong native plant communities can also serve as seed sources.

The Convention on Biological Diversity has specific recommendations for safeguarding species through *ex situ* (outside natural population sites) conservation:

- ❁ Adopt measures for *ex situ* conservation of components of biological diversity, preferably in the country of origin;
- ❁ Establish and maintain facilities for *ex situ* conservation of and research on organisms, preferably in the country of origin;
- ❁ Regulate and manage collection of biological resources; and
- ❁ Cooperate in providing financial and other support for *ex situ* conservation.

The target set by the Global Strategy is that by 2010 60% of threatened plant species be in accessible *ex situ* collections, preferably in the country of origin, and 10% of them included in recovery and restoration programs. *Ex situ* conservation is mostly undertaken by botanical gardens and arboreta—as seed and in living collections. Genetically viable samples of plant populations are also stored as seed in the National Seed Storage Lab in Ft. Collins, Colorado. The Center for Plant Conservation (CPC) is a national network of gardens, each of which takes on responsibility for plants in its region. CPC members in Arizona include The Arboretum at Flagstaff, the Desert Botanical Garden, and the Arizona-Sonora Desert Museum.

Ex situ conservation is an integral component in recovery plans. The CBD asks countries to adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into natural habitats under appropriate conditions. Reintroduction and subsequent monitoring of the health of these new populations is labor-intensive but very satisfying—another good activity that volunteers can help with.

An important goal of the Global Strategy is building capacity for the conservation of plant diversity such that the number of trained people working with appropriate facilities in plant

conservation is increased to achieve the targets of the strategy and that networks for plant conservation activities are established or strengthened at national, regional, and international levels. Locally we can help by training each other and new volunteers in the techniques that are used for plant conservation.

THE PROBLEM OF WEEDS

The CBD asks that countries prevent the introduction of, control, or eradicate those alien species which threaten ecosystems, habitats, or species. The Global Strategy Target is to have management plans in place for at least 100 major alien species that threaten plants, plant communities, and associated habitats and ecosystems.

Weeds are second only to habitat destruction (urban sprawl, agriculture) as threats to plant diversity. Weeds reduce the amount of light, water, nutrients, and space available to native species, alter hydrological patterns, soil chemistry, moisture-holding capacity, and erodibility, and change fire regimes. Forty-two percent of the nation's T&E species have declined because of weeds. At least 5000 exotic plant species are now established in the U.S. and non-native weeds are spreading and invading approximately 700,000 hectares of U.S. wildlife habitat per year.

Noxious weeds are invading western wildlands at a rate conservatively estimated to be nearly 5000 acres a day. An aggressive invader in California, yellow star-thistle (*Centaurea solstitialis*), now dominates more than twelve million acres of northern California grasslands.

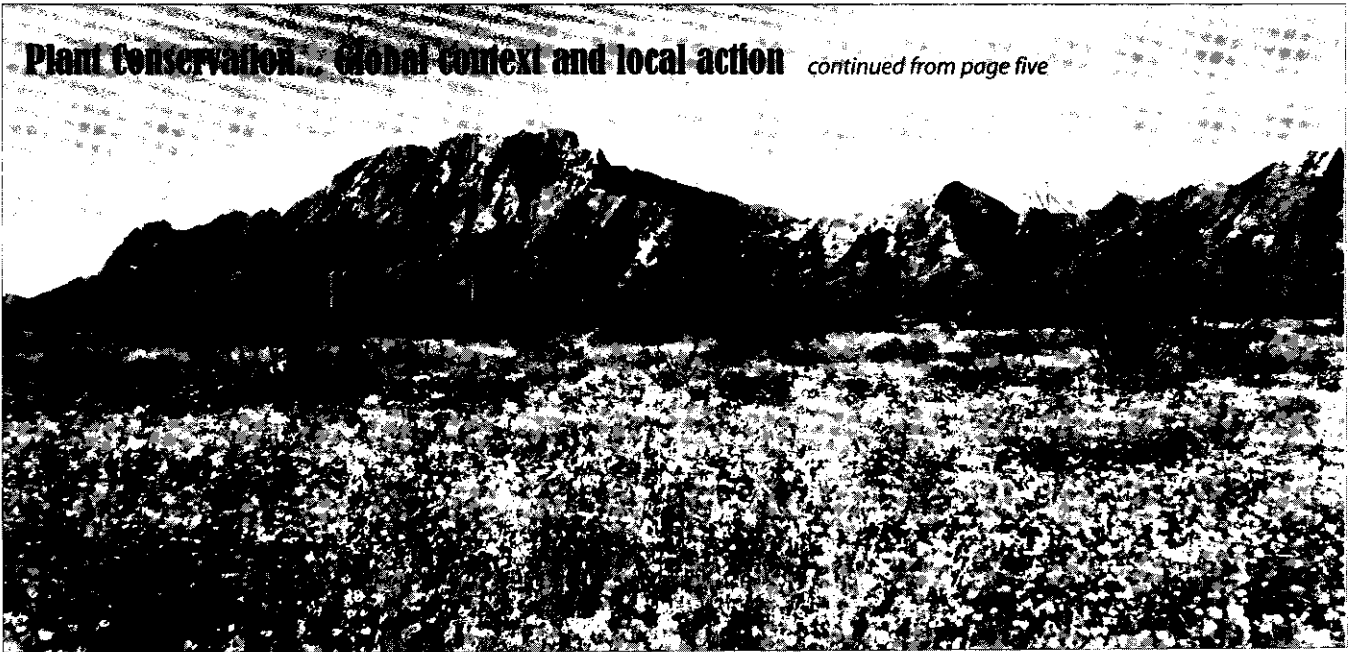
Weeds may irrevocably change natural processes. Before the invasion of cheatgrass in Idaho and Utah, fires might have burned once every 60 to 110 years; with cheatgrass, fires are now burning every 3 to 5 years. This has led to a decline in native shrubs and other vegetation which cannot adapt to the new fire regime, clearing the way for competitive monocultures of cheatgrass which now dominate 5 million hectares in the two states. Weed prevention and removal must be a high priority and is another way in which we all can contribute toward making a difference.

SUSTAINABLE USE

Additionally, the Global Strategy addresses ways in which plant diversity can be used sustainably. By 2010 it targets that:

- ❁ No species of wild flora will be endangered by international trade;

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❖ 30% of plant-based products will be derived from sources that are sustainably managed; and

❖ There will be a halt to the decline of plant resources, and the associated indigenous and local knowledge, innovations and practices that support sustainable livelihoods, local food security and health care.

Local efforts can help with preserving local knowledge. It is important that we respect, preserve, and maintain knowledge, innovations, and practices of indigenous and local communities. The Global Strategy goal is that by 2010, 70% of the genetic diversity of crops and other major socio-economically valuable plant species are conserved, and that associated indigenous and local knowledge are maintained.

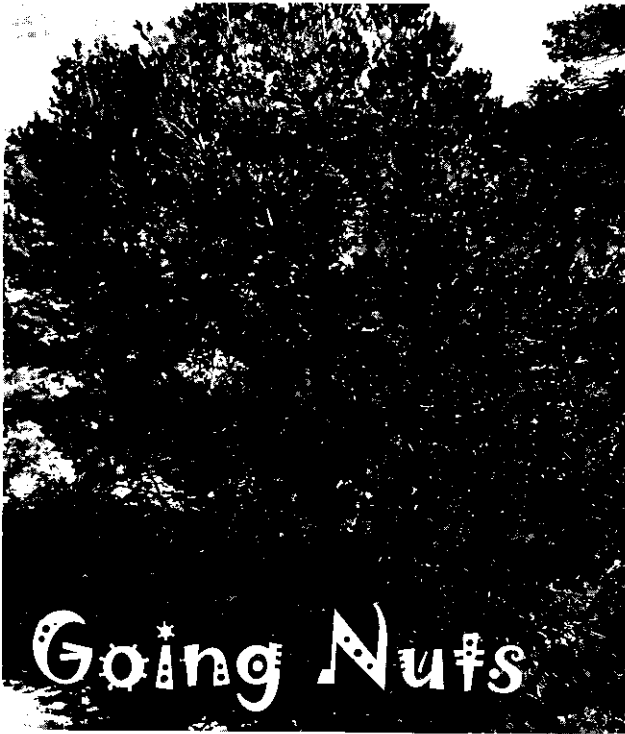
In Conclusion

The Arizona Native Plant Society can help achieve all of these goals by working with Arizona's academic institutions, federal and state agencies—especially their botanists, botanical gardens and arboreta, and natural history museums. We can use our natural interest in and love of native plants, enhance them with training in specific techniques, and then provide the volunteer workforce so desperately needed for plant conservation. Only by achieving conservation goals locally can we ever hope to make progress on plant conservation globally.

For more information about the CBD and the Global Strategy for Plant Conservation
www.biodiv.org/



Roaring Springs prickly poppy (*Argemone arizonica*).
Photo courtesy The Arboretum at Flagstaff.



by Kevin Dahl, Executive Director,
Native Seeds/SEARCH

“Do you know that many parts of a pine tree are edible?” asked wild foods author Euell Gibbons (*Stalking the Wild Asparagus*) in my favorite TV commercial of the 70s. For years when hiking I would stop at the first ponderosa and mimic him. Then someone would pretend to eat a toadstool and die a horrible death, choking out the commercial’s tagline, “reminds me of the taste of wild hickory nuts.”

While hickory nuts aren’t in our state, one nut (not the two-legged kind) native to the Southwest is worth the effort to find and collect. And it comes from, yes, a pine tree: the piñon pine.

Piñon trees are smaller than other pines and grow at lower elevations, between 4,000 to 7,500 feet. Usually found with juniper trees, they dominate vast landscapes that form a biotic community ecologists have sometimes called piñon-juniper woodlands. You can recognize the trees at a distance by their spreading, irregular shape, their rounded crown and a trunk that is often crooked.

Piñon trees have short needles that are 1/2 to 2 inches long and usually paired together, but can also be in clusters of 1 or 4. Piñon cones are egg-shaped and short, 1-1/2 to 2 inches long, with thick, blunt scales. When fully opened, the cone looks something like a wooden flower.

Pinus edulis. Photo by Dave Powell, USDA Forest Service, courtesy of www.forestryimages.org

Early in the fall, the cones are closed and should be collected whole. Twist or unscrew them off the branch. When spread on sheets to dry, they will open in about a week. Shake vigorously to release the nuts, twenty or more per cone. For a backpacking treat, toss a few unopened cones on campfire coals for 10-20 minutes and retrieve them when the scales have opened. When you find cones already opened on the trees, you can collect piñon nuts from the ground.

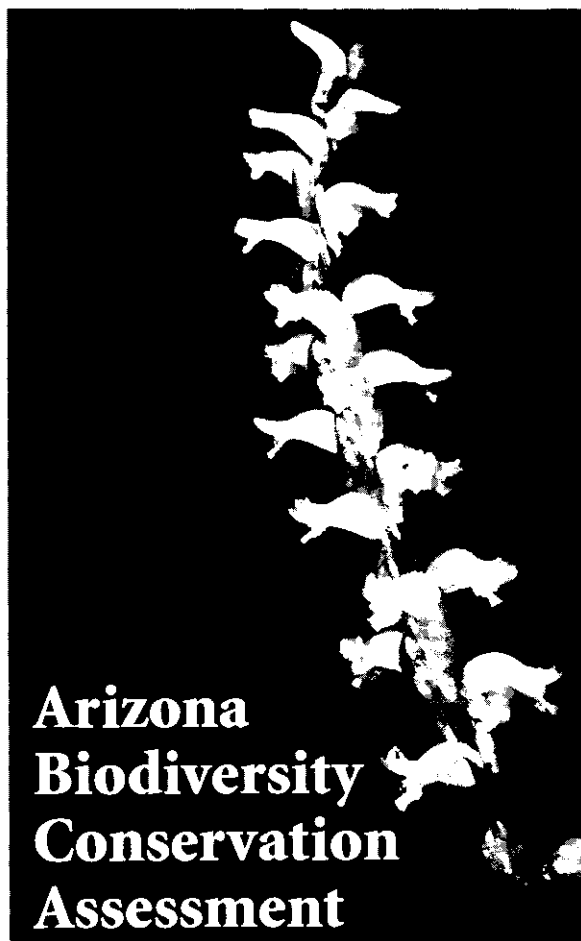
The biggest problem with collecting piñon nuts is getting covered with pine pitch. Try working during cool fall mornings when the pitch is less sticky, and remember to wear old clothing. Remove the almost inevitable pitch from hands and other body parts with cooking oil rather than irritating turpentine or paint thinner.

The thin shell covering the kernel is easily removed from nuts of the common southwestern piñon tree, *Pinus edulis*, or California’s single-needled piñon, *Pinus monophylla*. Raw or roasted nuts can be cracked with your teeth like a sunflower seed. Roasting (anywhere from 20 minutes in a high temperature oven to an hour at 200 degrees) imparts a smokey flavor, allows the nuts to be stored longer, and makes the shells easier to crack. Border piñon, *Pinus discolor*, found in southeastern Arizona, has a shell that makes it one tough nut; you must use a hammer to open it.

Piñon nuts are rich in protein (14.6%), fats (61.9%) and calories (more than 3,200 per pound!). They are sometimes available commercially in northern New Mexico, which honors the piñon as the official state tree. Drought and bark beetles have caused a lot of damage in some areas, making nuts for sale harder to find. Like nuts from Italian stone pine trees, sold in stores as pine nuts or pignolas, piñon nuts can be used to make pesto or just added to your favorite dish.

Gibbons told us that many parts of a pine tree are edible. This is true. The inner bark is a bitter-tasting survival food. Tea made from pine needles is almost palatable. Even pine pitch can be chewed like gum (and is said to clear a head cold when you do this). But the very best part of a pine tree is the delicious piñon nut. This fall, let’s go nuts out there!

This article first appeared in *Desert Skies*, Fall 1985. For more information on piñon trees: *The Piñon Pine: A Natural and Cultural History* by Ronald M. Lanner (University of Nevada Press, Reno, 1981). Kevin Dahl is author of *Wild Foods of the Sonoran Desert*, and a former *Plant Press* editor.



Arizona Biodiversity Conservation Assessment

by **Brian Nowicki**, *Endangered Species Policy Coordinator, Center for Biological Diversity*

Plant Species of Concern

The Center for Biological Diversity is coming to the end of its project to identify successes and shortcomings of efforts to manage imperiled species throughout Arizona and to provide specific recommendations to improve management efforts for imperiled species and their habitats. To do this we've compiled information from federal documents, agency reports, and academic literature to determine the population status and management actions for each species.

There are 80 species in Arizona that are listed as Threatened or Endangered under the Endangered Species Act, or are candidates for listing, proposed for listing, or have conservation agreements. These

include the twenty-three plant species listed in the adjacent box (right).

The majority of these plants are narrow endemics—restricted to specific sites or soil substrates. This makes the species naturally relatively rare and particularly susceptible to habitat loss and site impacts. Most of these species have been threatened by habitat loss from development, road-building, and mining; and habitat degradation from cattle grazing and even trampling by human feet or off-road vehicles. Of course, many are also seriously threatened by drought, invasive exotics, and illegal collection.

The protection and recovery of these species is going to depend on management actions specific to each species and site. For example, the main population of San Francisco Peaks groundsel was threatened primarily by trampling of hikers on a recreational trail on the San Francisco Peaks. Signage and fencing helped to protect the population. On the other hand, the Huachuca water umbel is threatened by the reduction of water flows in the San Pedro River watershed. Protection of the water flow, as well as of the stream banks where the umbel lives, will require watershed-wide cooperation and management.

The Waiting List

There are currently 286 federally listed candidate species nationwide. Candidate species are plants and animals for which the Fish and Wildlife Service has determined that listing under the Endangered

Plant Species of Concern in Arizona

- Arizona agave *Agave arizonica* (Endangered)
- Gooddings onion *Allium gooddingii* (Conservation Agreement)
- Kearney's blue-star *Amsonia kearneyana* (Endangered)
- Sentry milk-vetch *Astragalus cremnophylax* var. *cremnophylax* (Endangered)
- Holmgren milk-vetch *Astragalus holmgreniorum* (Endangered)
- Navajo sedge *Carex specuicola* (Threatened)
- Arizona bugbane *Cimicifuga arizonica* (Conservation Agreement)
- Cochise pincushion cactus *Coryphantha robbinsorum* (Threatened)
- Pima pineapple cactus *Coryphantha scheeri* var. *robustispina* (Endangered)
- Nichol's Turk's head cactus *Echinocactus horzonthalonius* var. *nicholii* (Endangered)
- Arizona hedgehog cactus *Echinocereus triglochidiatus* var. *arizonicus* (Endangered)
- Acuña cactus *Echinomastus erectocentrus* var. *acunensis* (Candidate)
- Lemmon's fleabane *Erigeron lemmonii* (Candidate)
- Huachuca water umbel *Lilaeopsis schaffneriana* var. *recurva* (Endangered)
- Siler pincushion cactus *Pediocactus sileri* (Threatened)
- Peebles Navajo cactus *Pediocactus peeblesianus* var. *peeblesianus* (Endangered)
- Brady pincushion cactus *Pediocactus bradyi* (Endangered)
- Paradine plains cactus *Pediocactus paradinei* (Conservation Agreement)
- Fickeisen plains cactus *Pediocactus peeblesianus* var. *fickeisemae* (Candidate)
- Arizona cliffrose *Purshia subintegra* (Endangered)
- Arizona willow *Salix arizonica* (Conservation Agreement)
- San Francisco Peaks groundsel *Senecio franciscanus* (Threatened)
- Canelo Hills ladies' tresses *Spiranthes delitescens* (Endangered)

Species Act is warranted, but that listing is precluded by other priorities. Unfortunately, candidate status provides no legal protections and many species have been waiting for 30 years. We have 11 such species in Arizona, including 3 plants:

- Yellow-billed cuckoo (*Coccyzus americanus*) since 1982
- Zuni bluehead sucker (*Catostomus discobolus yarrowi*) since 1985
- Stephan's riffle beetle (*Heterelmis stephani*) since 1984
- Three-Forks springsnail (*Pyrgulopsis trivialis*) since 1989
- Relict leopard frog (*Rana onca*) since 1982
- Huachuca springsnail (*Pyrgulopsis thompsoni*) since 1989
- Sonoyta mud turtle (*Kinosternon sonoriense longifemorale*) since 1997
- Page springsnail (*Pyrgulopsis morrisoni*) since 1989
- Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*) since 1975
- Lemmon's fleabane (*Eregron lemmonii*) since 1975
- Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*) since 1975

Imperiling Legislation

Earlier this summer, Rep. Richard Pombo (R-CA)—chair of the House Resources Committee and Congress's loudest opponent of the Endangered Species Act—circulated a draft bill that would greatly undermine the protections of the Endangered Species Act. Pombo initially hoped to move the bill quickly through his committee and out the door, but it was leaked by a member of the committee, and the draft bill quickly became the object of criticism and skepticism.

The following are some of the more egregious provisions of the bill, cynically entitled the "Threatened and Endangered Species Recovery Act":

- ☛ **Eliminate the Requirement to Recover Endangered Species.** The Pombo bill would remove the requirement for the federal government to recover species, substituting instead the lower requirement to protect endangered

species from extinction. It would also remove the requirement that federal biologists implement recovery plans.

- ☛ **Prevent the Listing of Imperiled Species.** The Pombo bill would require that a species be imperiled "throughout all of its current range" before being listed. Using this standard, not even the bald eagle would have qualified for listing.

- ☛ **Remove Protections for Threatened Species.** The Pombo bill would prohibit federal agencies from issuing national protections against unregulated take of threatened species and prohibit the designation of critical habitat for threatened species.

- ☛ **Remove Critical Habitat Protections.** The Pombo bill would prohibit the designation of new critical habitats on virtually all federal lands and effectively repeal most existing critical habitat designations by prohibiting their implementation on these same lands.

- ☛ **Politicize Scientific Decision-Making.** The Pombo bill would brush science aside by allowing the Secretary of Interior to develop a definition not only of what constitutes the best science, but what science is even to be considered "relevant."

- ☛ **Repeal the Endangered Species Act in its entirety in 2015.** The Pombo bill would not only repeal the Endangered Species Act in 10 years, it would eradicate all existing requirements and agreements to protect endangered species.

Had Pombo's bill been made law in 1973 instead of the Endangered Species Act, there would likely be no bald eagles, wolves, grizzly bears, Florida panthers, or desert pupfish in the continental U.S. today. If it is made law now, hundreds of endangered species could become extinct.

Rep. Pombo has said that he intends to introduce his bill after the August recess. While it is likely that the most egregious provisions of this draft will be removed before Rep. Pombo can hope to move his bill, his intentions toward endangered species protections are clear.

Climate Change and its Implications for Plants, Water and People

by Dr. Jack Herring, Environmental Studies Program, Prescott College

Plants as Indicators of Paleoclimate

We now have amazing sources of information that give us an idea of what the climate has been like over the past 500 million years.

Tree rings provide a useful record of climate change in the Southwest covering 2000+ years. Packrat middens provide a good record during the last 50,000 years, and pollen from terrestrial sediment cores go back 1 million years. The plant fossil record provides circumstantial evidence of past climate over the past 400 million years, and isotopic composition of phytoplankton shells from marine sediment cores go back more than 500 million years ago.

Some Conclusions about the Dynamics of Global Climate

This new evidence has allowed us to draw some conclusions about the dynamics of the global climate.

There have been large swings over the past half billion years, probably due to changes in CO₂ driven by plate tectonics. Global climate has bounced between two fairly stable equilibrium states:

Hot house state is a largely tropical planet
(even at arctic and antarctic latitudes!)

Ice house state is a largely (completely?) frozen ocean

Over the last 100 million years, the Earth saw a transition from a hot house to an ice house. The last 2.5 million years of ice house has seen a steady oscillation

between glacial conditions and interglacial. This oscillation is apparently triggered by changes in the Earth-Sun orbital geometry and amplified by consequent changes in atmospheric CO₂ and other greenhouse gases.

Earth's emergence from the last ice age began about 15,000 years ago and was complete by 10,000 years ago. This was punctuated (in the Northern Hemisphere) by a rapid, but temporary, return to colder conditions that was apparently caused by a shutdown of the Atlantic Gulf Stream.

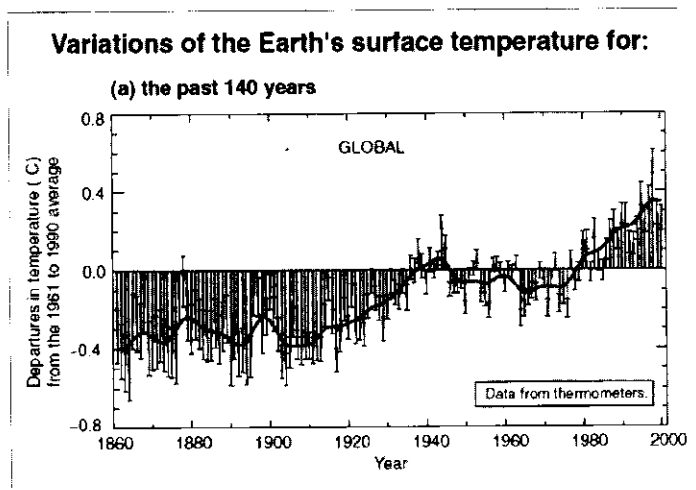
The last 10,000 years has seen a remarkably stable global climate, which has allowed the development of agriculture. The next major shift in the "natural" climate would be onset of another glacial period. The orbital configuration suggests that this is about 10,000 years in the future.

Anthropogenic Perturbations to the Global Climate

Human activity has resulted in the addition of several greenhouse gases to the atmosphere, including CO₂, CH₄, CFCs, N₂O and O₃. It has also caused the addition of particulate matter to the atmosphere, and there are changes in planetary reflectivity (albedo) due to land use changes. Fossil fuel combustion and biomass burning currently release about 7 billion metric tons of carbon (as CO₂) annually. About half of this ends up in the atmosphere, and the rest goes into the ocean and into some poorly understood terrestrial sinks.

The Intergovernmental Panel on Climate Change (IPCC) was chartered by the United Nations and the World Meteorological Organization to assess the state of climate science. It released its third assessment in 2001. The panel is a weird mix of science and politics but is still the most authoritative summary of climate change. IPCC's assessment of variations of Earth's surface temperature over past 140 years is that there has been a 0.8% change in temperature, most since the mid-1970s.

Cloud feedbacks to climate are poorly understood. Increasing sea surface temperature should cause more



rapid evaporation and more cloud cover. Particulate matter changes cloud properties due to their role as condensation nuclei. The response of ocean circulation to changes in global atmosphere might include a slowdown of the Gulf Stream, stagnation and loss of productivity, and/or a slowdown of ocean uptake of CO₂.

“What if” scenarios of climate models have limits. They are rudimentary with regard to all factors relating to climate. Looking at the year 2100, climate models predict a 2.5 to 4 degree warming over that period. We are now seeing human interference in climate record, especially over the last 25 years, and CO₂ is expected to double by 2060. Everything about plant environments is changing, not just climate change, but also CO₂ fertilization (C₃ vs. C₄ vs. CAM photosynthesis), anthropogenic nitrogen input, elevated ground-level ozone, role of fire, and the island effect.

Is there regional climate change happening as with global change? There is an amazing correspondence in Prescott temperature changes: it is the low temperatures that are changing. The greenhouse gasses effect plays a predominant role at night.

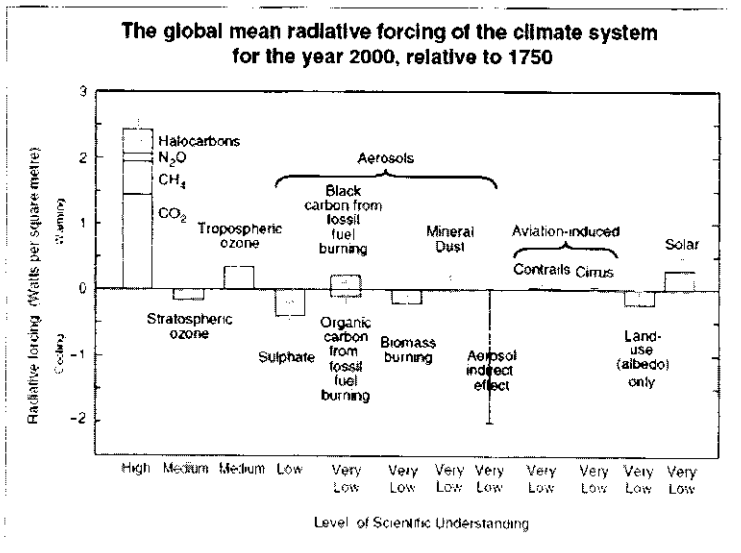
Ocean Cycles and Climate Change

In his paper, “Understanding a possible correlation between El Niño occurrence frequency and global warming” (*Bulletin of the American Meteorological Society*, Vol. 80, No. 2), A.G. Hunt describes the relationships between the following cycles:

- ☞ 3 to 7 year cycle of ocean temperatures in the equatorial Pacific (El Niño/Southern Oscillation: ENSO)
- ☞ 40 to 60 year cycle of ocean temperatures in the North Pacific (Pacific Decadal Oscillation: PDO)
- ☞ 60 to 100 year cycle of ocean temperatures in the Atlantic (Atlantic Multidecadal Oscillation: AMO)

ENSO tends to be amplified or damped by the PDO (warm PDO tends to amplify and lengthen warm ENSO events). A warming ocean surface is El Niño-like, and some research indicates that a period of warming climate favors more frequent El Niño events.

In a 2129-year reconstruction of precipitation for northwestern New Mexico, it has been observed that warm periods coincided with major droughts, while



wetter periods were cold. There is not a cold-wet and warm-dry oscillation until later, when the climate was warm AND wet in the 1950s.

What Should We Expect?

The initial expectation would be an increase in overall monsoon activity, yet models are inconclusive for both summer and winter precipitation. If El Niño does become more frequent, then we should expect more winter precipitation, but not necessarily in the form of snow. In regards to soil moisture, higher temperatures could negate increases in precipitation. The transition from snow to rain could reduce infiltration efficiency, leading to a likely type conversion in vulnerable plant communities such as ponderosa pine.

The Current Drought In Perspective

In June, the USGS declared that the last five years in the Southwest represents the worst drought in 500 years, but later withdrew that claim (visit water.usgs.gov/pubs/fs/2004/3062/pdf/fs2004-3062_version2.pdf). The three-year period from 2001 to 2003 had the lowest flow at Lee's Ferry in the last 100 years. The Navajo Generating Station in Page is about to drill new water intake tubes at Lake Powell. As Lake Powell continues to drop, the Bureau of Reclamation says the worst case (continued severe drought) would drop the lake below the intakes for the turbines in about 3 years.

Resources

For an authoritative assessment on preparing for a changing climate consult ispe.arizona.edu/research.swassess.pdf.complete.pdf

For winter precipitation increase and vegetation change and the Thompson et.al. Model, visit geochange.er.usgs.gov/swimpacts.biology.veg_chg_model



Desert Yards and Desert Insects *by John Alcock*

Even in a highly urban setting, having a xeriscaped front or back yard with a smattering of native plants creates something of an oasis for Sonoran Desert insects. For persons willing to think small, the presence of desert bugs provides a delightful opportunity to get to know about some creatures that really belong here. The chance to do some self-educating on the entomological front adds an extra dimension to the pleasures that come from converting a midwestern-style lawn to an honest-to-goodness desert yard.

For example, consider what happens when you put some brittlebush (*Encelia farinosa*) in your very own patch of restored desert. Brittlebush is one of the easiest native plants to establish in a yard that has been stripped of its Bermuda grass and turned back into a gravel-strewn "wasteland." This desert perennial can be transplanted with the greatest of ease; it grows quickly and at times almost too exuberantly; the plant requires almost no supplemental water after the initial week or so; it flowers freely and sets seed in abundance with the result that seedlings pop up around mature brittlebush; these youngsters can be dug up and moved to new locations in the yard where some other brittlebushes will look good.

And as I say, these plants attract desert insects galore. Just how the little tephritid flies with their mottled wings manage to find a suburban stand of brittlebush is beyond me but they do manage this trick. And I get a small but real kick out of watching these greenish bugs waving their nifty little wings as they wander around a flowerhead looking for females to mate with or a flowerbud in which to lay their eggs, depending on the sex of the individual.

Then there are the aphids and aphid-eating predators that also wing in to take up residence on brittlebush in the spring. Brittlebush aphids are even smaller and more delicate creatures than the tephritid flies that adopt this plant as home but the size and fragility of aphids does not prevent them from finding and then setting up shop on their favorite desert plants in my front yard.

Founding female aphids reproduce as if there were no tomorrow and they often do so without benefit of mating. Indeed many aphids forego sexual reproduction altogether in favor of parthenogenesis or virgin births, a small miracle that can take place next to your home provided you have the requisite brittlebush (or some desert milkweeds, *Asclepias subulata*, which are also extremely popular with the aphid crowd). From one adult female many daughters flow, so that a founder aphid or two soon produces a whole host of baby aphids lined up on brittlebush flower stems. Each little aphid stabs its beak into the plant from which it withdraws water and nutrients, the basics for growing bigger and reaching an asexual adulthood as well.

Where there are aphids, there are aphid consumers. If you have enough desert vegetation out front or back, verdins are likely to show up from time to time to harvest some aphids and any other edible insects on hand. In addition to these little birds, some ferocious insect predators also like nothing better than an aphid-rich meal. Ladybird beetles are perhaps the best known of these insect hunters. Brightly colored adults motor up and down the brittlebush stems attacking their prey. In due course the well-fed adults produce offspring, spiky-looking little grey and pink larvae that



PHOTOS, LEFT TO RIGHT:
A male carpenter bee fueling up at the palo verde.
A syrphid or hover fly on brittlebush.
A megachilid bee at a prickly pear flower in the author's front yard.
The author's front yard; note the large brittlebush in the center.
A palo verde in flower in the author's yard.

All photos courtesy John Alcock.

crawl over the brittlebush grasping apparently helpless aphid victims in their formidable jaws. Thus, you, the homeowner and insect observer, can claim to have created an entire ecosystem for your viewing pleasure. The brittlebush captures sunlight and converts it into plant compounds, some of which nourish herbivorous aphids, which in turn provide the nutrients and energy needed to sustain the predatory component of the ecological pyramid in your homemade yard.

And there is no need to restrict yourself just to brittlebush and the insects that specialize on this resource. Why not have a foothills palo verde (or three) in your yard? In the spring, this small tree (*Parkinsonia microphyllum*) puts on a riotous flower show for several weeks, even a month, at least in good years when the whole tree will be covered in small but very attractive yellow flowers. The pollen and nectar supplied by these flowers feeds a battalion of insect pollinators ranging from very small native bees to very large ones, most notably and conspicuously, carpenter bees in the genus *Xylocopa*.

The females of this diverse array of pollinators harvest flower food in order to supply their offspring with the energy and chemical compounds needed if a tiny grub in a bee nest is to mature into a full grown larva, which then metamorphoses into a pupa before making the final transition into an adult. In a typical urban or suburban yard, all these wonderful and totally harmless bees are absent. In a properly xeriscaped yard with the appropriate foodplants, however, the bees come by the dozens or hundreds, converting a flowering palo verde into a springtime Christmas tree festooned with black, black and white, orange, and even multi-colored yellow and green species. Take note of the megachilid contingent; these

bees place the pollen they collect on the hairy underside of their abdomen rather than on their hindlegs, illustrating the point that in nature there is almost always more than one way to skin a cat.

And pay attention to the sexual dramas that take place around a foothills palo verde when several male carpenter bees decide to attempt to mate with a foraging female. Because pollen-collecting females have almost certainly mated already and so have in storage sufficient sperm to last them throughout their lives, they are rarely receptive to approaching males. Nonetheless, one or more males may persist in trying to pounce on a female on a flower. Sooner rather than later, your average female carpenter bee decides to put an end to this harassment, which she accomplishes by flying off the flower and turning to face her pursuer(s). She then slowly rises up higher and higher into the air, trailed for a time by one, two or three smaller black males who eventually give up the game and fly off to find another female to annoy.

My point is that xeriscaped yards with native plants are attractive to more than enlightened homeowners and their human neighbors. Each and every truly native plant that you install in your desertified yard will doubtless attract some special native insects with their own agendas. Learning about these miniature yard visitors and their lives can be fun for even a casual observer, enriching one's citified existence as you celebrate the genuine plants of the desert and all the creatures, large and small, but mostly small, that depend upon them.



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Desert Grasses

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Desert Wildflowers

Desert Accent Plants (out of print, to be revised)

Desert Trees (new edition available Fall 2005)

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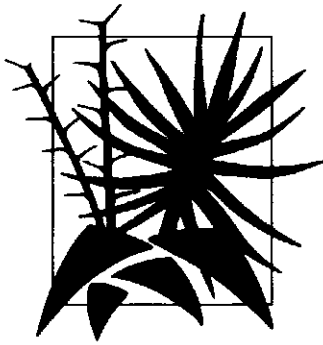


Next Issue: Pollinators!
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