



Segoly



Newsletter of the Utah Native Plant Society

Vol. 11 No. 1

March/April 1988

When, Where, What

March 27
Sunday
9:00 a.m.

Conservation Field Trip
Devil's Slide Revegetation: Help establish habitat along the Weber River by planting willows, etc. The Utah Audubon Society is managing this BLM land with UNPS assistance. Call Ray Smith at 532-7384 for more information, or if you can bring gardening tools. Meet at the Taggart exit of I-84 in Weber Canyon.

April 27
Wednesday
7:00 p.m.

Cache Chapter Meeting
Rare Plants of Utah: Botanist Duane Atwood will review Utah's rare and endangered plants. Logan City Meeting Room.

April 28
Thursday
7:30 p.m.

Salt Lake Chapter Meeting
Introduction to the Spring Wildflower Families: No prior botanical knowledge is needed! UNPS botanists will show how to identify common spring flowers by family characteristics - the first step in becoming a competent wildflower connoisseur. Field trips in the foothills will be scheduled to expand your new knowledge, and summer sessions will follow if the meeting is a success. Meet in the Olpin Student Union Building "Den" at the University of Utah.

May 6 and 7
Friday &
Saturday

Annual Rare and Endangered Plant Meeting: This review and update of Utah's rare species will be hosted by the Glen Canyon National Recreational Area at the Bullfrog schoolhouse. Scheduled events also include a boat trip to a hanging garden above Lake Powell on Friday afternoon and a Saturday field trip up the Burr Trail. Camping and motel facilities are available. Contact Duane Atwood if you are planning to go (you must send \$15 in advance to reserve a boat). You can reach Duane at 625-5599 (days) or write to him at 316 West 2000 North, Layton, Utah 84041.

May 23
Saturday
(tentative)

Dwarf Bearclaw Poppy Field Trip
Visit this remarkable desert flower in full bloom and help with endangered plant research at the same time. We will visit Deanna Nelson's study site and inspect

Summer

other sites in the vicinity. A field search will be organized to survey other potential habitat and volunteers will be requested to help inventory the study plot. We can expect a good showing of desert wildflowers to add variety to this traditional spring field trip. Call Dave Wallace (466-2719) or Andy Boyack (278-8596) for more information. The May 23 date is tentative depending on bloom condition.

Planning is under way for a full schedule of field trips. Below is a partial listing and dates are tentative. As trip plans are finalized, additional information will be given in *Segoly*. For more information call Andy Boyack (278-8596) or Dave Wallace (466-2719).

May 14 - *Primula magueri* survey in Logan Canyon. The date for this trip is tentative depending on the stage of flower development.

July 4th Weekend - Great Basin National Park/Wheeler Peak: Last summer a small group of UNPS members went on this field trip and had a terrific time. The scenery is spectacular, the native plants and flowers breathtaking. Day hikes range in exertion level from lazy to marathon. The park also offers caves, Bristlecone pines, intriguing geology and several beautiful campgrounds. Dave Wallace will lead the trip again and it is a wonderful way to spend a holiday weekend.

July - Tony Grove Lake Wildflower Field Trip with Dr. Leila Shultz.

July 30 - Albion Basin Wildflower Walk with UNPS botanists.

August - The As-Nearly-Annual-As-Possible Mushroom Hunt with Dr. Frank Anderson. Mother Nature permitting, this is one of our best field trips. We need August rain in the Uintahs to bring out the mushrooms. The 1987 Mushroom Hunt was a great success, the mushrooms were delicious and we're hoping for a good hunt again this year

UNPS Board of Directors Elects Officers

The Board of Directors of the UNPS met at Lambs Cafe on February 11, 1988, and elected officers for the coming year. Elected were:

Chairman of the Board	David Wallace
President	Andrew Boyack
Secretary	Kathy Anderson
Treasurer	David Wallace
President Salt Lake Chapter	Helen Burnett
President Logan Chapter	Wayne Padgett

The following committee members were selected:

Conservation.	Alice Hreha Dave Gardner
Rare Plants	Duane Atwood Sherrel Goodrich
Newsletter	Lisa McClanahan Sharon Coons
Education	Janet Williams Debbie Noel
Plant Sale	Dave Okelberry
Membership	Pam Poulson
Seeds	Dick Page
Photography	Robert Fitts
Special Project (Poster)	Jo Stolhand

Pam Poulson reported that the Society's finances are in good shape as shown on the balance sheet she submitted. The Second installment on the *Arctomecon humilis* (Dwarf Bearclaw Poppy) Grant is now due. Membership as of February 11 stands at 307.

Duane Atwood reported on the *Arctomecon humilis* study being done by Deanna Nelson. The study has undertaken an ambitious program with which Society members could help during the flowering season in April and May. (If you have time available and would like to donate your time and energy to help Deanna make more progress, contact Dave Wallace at 466-2719 for more information.)

Duane also reported on the Threatened and Endangered Plant workshop held in St. George last year and the plans for the workshop to be held at Lake Powell this year. Also, efforts are under way to establish a Heritage Program in Utah. Utah is one of only three or four states that does not have such a program. Duane urged the Society to monitor the rare and endangered plant program of the various state and federal agencies in Utah.

Dave Okelberry reported on the efforts of the UNPS in helping with a neighborhood landscaping project at Ninth South and Ninth West in Salt Lake City and on planting projects at the schools.

The education committee (Debbie Noel and Janet

Williams) has prepared a film strip and audio cassette on native wild plants for educational use in schools.

Jo Stolhand reported that the artwork on the Utah native plant poster is complete and ready to go to the printer. The Board voted funds to proceed with the printing.

Over 110 packets of wildflower seeds were sold at the UNPS native plant sale in September. Dick Page said that even more might have sold if we had a picture display of the flowers to show prospective buyers what the blooms would look like.

Dave Wallace reported on the Weber River project of the Audubon Society with which the UNPS has been helping. A working party (see calendar for information) is needed to plant willows along the river this spring.



Dr. Wallenstein Speaks at Chapter Meeting

Plant speciation was the subject of Dr. Wallenstein's talk at the February meeting of the Salt Lake Chapter. Dr. Wallenstein was introduced by Helen Burnett. He is a staff member of the plant biology department at the University of Utah.

Why do different plants grow in different places? Botanists are often asked and ask themselves this question according to Dr. Wallenstein. Some of the answers are relatively obvious. Plants require certain factors to live and grow. Sunlight is one factor, the source from which plants derive their energy. Nutrients and water are other factors. These come from a mixture of clay and humus in the soil which has the ability to attract and hold nutrients and water by ionic attraction and present them to plants in useable form. Factors such as temperature, seasonal changes and pollinators affect plant growth and reproduction.

In examining a geographical region the factors affecting plant growth vary from place to place. Some factors increase, some decrease forming an infinitely variable continuum. Plants, over millenia, have adapted to this continuum by forming a sort of continuum of their own; different plants adapting to certain specific combinations of growth factors in the soil and microclimate. Scrub oak prefers one combination, aspen another and subalpine fir still another. Plants, even today, continue as in the past to adapt both to changing growth factors such as a warming climate or changing land forms. As plant seeds reach new habitats by various means they also adapt to different conditions. They adapt by a process of natural selection forming slightly different plant characteristics. Over time, these slight differences accumulate and result in new varieties and eventually new species of plants.

Penstemon Report

Margaret Malm, Seasonal Ranger (Interpretive)
Zion National Park

Penstemon x jonesii Pennell in Zion National Park

1987 was a banner year in Zion for this natural hybrid between *Penstemon eatonii* Gray var *undosus* M.E. Jones (Eaton penstemon) and *Penstemon laevis* Pennell (Royal penstemon). I first sighted it in Zion some years ago (although mine was not the first sighting), but have been coming up empty handed for some years in further searches - or, at least, I thought I was. However, it made its appearance in abundance and great and colorful variety last spring. The first indications that something special was under way was the sighting of an unusual penstemon on the Canyon Overlook Trail, closely followed by another sighting on the East Rim Trail which looked sufficiently like the hybrids I had seen before to tip us off. In late May I stumbled across a small canyon full of them, on the east side. It is a surprising hybrid, at least to me, because one parent, the Eaton, is hummingbird pollinated while the Royal appears to be bee pollinated. Apparently the hummers visit it too, at least some years!

Most of the plants resemble the Eaton penstemon except for two things: the color; and the fact that the flowers generally do not nod like the Eaton's usually do, but either stand straight out or point up. The foliage is like the Eaton's. As far as color, I've seen, this year, light coral pink, beautiful medium and deeper pinks, many shades of ruby red, and red violet; occasionally so dark I term it 'wine'. Those of my original sighting some years ago were a deep red violet 'wine' color, sometimes with splotches of very dark blue. I saw only one plant with the wine-colored flowers this time, and no bicolored ones. Most of the plants were found on Zion's east side, many of them in a single relatively small recess just north of the road. The funny thing is that while a few Eatons were in evidence at most of the places the hybrids were found, the Royal was not. The ones on the East Rim Trail were far from the nearest Royal, as far as I know.

I also theorize (but have not been able to confirm with an expert) that some of the plants in the usual Checkerboard Mesa area haunt of *Penstemon laevis* that we have been calling *P. laevis*, are actually also the hybrid, since they have shiny leaves and red-violet flowers rather than the glaucous leaves and blue flowers the books describe for the Royal. This would mean that the hybrid also occurs as red-violet ones that have the inflated flower tube of the Royal - and we might expect to find other colors with inflated flowers also.

There is also a population of penstemons in Refrigerator Canyon and at Scout's Lookout that bear further investigation.

I did not have the opportunity to check to see if any of the plants set seeds. Spring of 1988 should be very interesting! Y'all come!

Spring in Zion National Park

Jo Stolhand

It is a good day to stay inside curled up near the fireplace with the new seed catalogues. Pictures of flowers send the mind wandering and heart wishing for the cool Spring days when the first wildflowers appear. Is there no end to this cold and wind? Well, April is out there somewhere and it is a great time to see Zion National Park.

Actually, the first of April is late for many of Zion's wildflowers and a bit early for the cactus. But if your spirit warms to the bright reds of penstemon and paintbrush, the yellows of deerclaw, desert marigold, primrose and puccoon, and the deep blues of penstemons, spiderwort and yellow-eyed lupine; if your senses reel with the early morning fragrance of sand verbena and *Gaura*; then you should plan a trip to Zion National Park this Spring. You can purchase Plants of Zion National Park by Ruth Ashton Nelson at the Park's Visitor Center. The pictures and drawings by Tom Blauie make it an easy to follow guide for even the novice.

Coal Pits Wash west of Rockville is an excellent area to investigate the flora of the Lower Sonoran Zone, or take the Watchman Trail near the Visitor's Center which climbs from Lower Sonoran to Upper Sonoran. A contrast to these arid areas is Weeping Rock in Zion Canyon, which is Lower Sonoran, but where the seepage supports a totally different form of plant life such as the crimson monkey flower, shooting star and maidenhair fern.

While strolling along the Emerald Pool Trail (Upper Sonoran) photographing and ticking off the names of wildflowers, I realized there were two different species of red penstemon. Some would differentiate *P. utahensis* and *P. eatonii* by the flower. *P. utahensis* has flower lobes which spread open at maturity while those of *P. eatonii* stay funnel-form. Seeing mostly buds and immature flowers I had missed these characteristics, but the difference in lower leaves was obvious. While both have the opposite leaves associated with penstemon, *P. eatonii* has broad clasping leaves and *P. utahensis* has narrow leaves.

To get to the Transition Zone you can hike up out of the canyon or drive up to the East Entrance. Slickrock paintbrush is the visually dominant flower in the red sandstone on the upper part of Angel's Landing Trail and on the road climbing east above the tunnel. One hundred feet north of the East Entrance sign we spotted spiderwort, blueticks and cactus. Although the blooming season of the Transition Zone is behind the rest of the Park, you might also find fritillaria, heartleaf twist flower, *Cryptantha* and blue penstemons.

A four day trip to Zion National Park which included an overnight backpack into Kolob Arch netted us over seventy species of flowering plants, fresh air and sunshine. Not a bad cure for cabin fever or winter blahs, or to celebrate the end of winter hibernation.



UNPS Sego Lily

C/O Lisa McClanahan
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Pick A Wild Bunch

The Utah Wildflower poster is ready to go to press. Twenty eight full color, life-size illustrations of flowers native to Utah will be presented on a large 23" by 34" poster ready for framing. The poster combines the botanically accurate artwork of David Gardner and calligraphic labeling, resulting in a poster of which the Utah Native Plant Society can be proud. A leaflet written by Dr. Elizabeth Neese details interesting facts and habitat for each native plant. The leaflet will accompany each poster to help you find and identify the native plants illustrated.

The poster committee is very excited about the forthcoming publication and is moving on to the challenges of marketing. We are sending flyers to all our members, offering the opportunity to order the poster immediately. The posters will be distributed in early April, either by mail or at the April UNPS Salt Lake Chapter Meeting. Advance orders will be a great help in covering the expense of printing and assure filling your order promptly.

Send flowers to a friend with a Utah Wildflower poster or make copies of your order form and let friends order their own flowers.

Posters can be ordered for \$10.00 per poster plus \$1.50 to cover postage and handling. If you plan to pick your posters up at the April meeting there will be no charge for postage and handling. Order your posters from:

Utah Native Plant Society
P.O. Box 520041
Salt Lake City, Utah 84152-0041

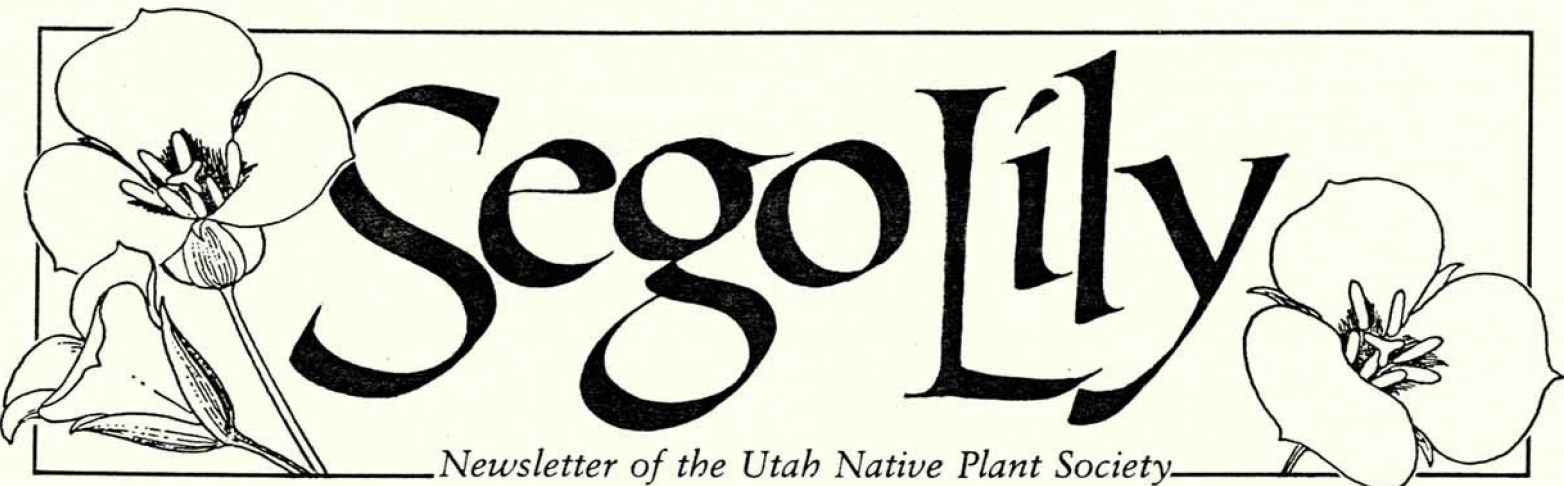
**Salt Lake Chapter Meeting**

Larry England gave an informative talk and slide presentation on threatened and endangered wild life at the January Salt Lake Chapter Meeting. Mr. England is a botanist with the U.S. Fish and Wildlife Service.

The presentation covered a few well publicized species such as the bald eagle, Peregrine falcon, whooping crane and the black footed ferret as well as many other, lesser known rare species such as the desert tortoise and species of fish in the Colorado River system. Among the threatened plants were the dwarf bearclaw poppy and *Primula magueri*. The Society has made field trips to see both rare plants and is presently funding a study of the dwarf bearclaw poppy by Deanna Nelson, a student at BYU. Pictures of a rare buttercup were shown which at one time was thought to be extinct but has since been rediscovered by Kathy Mutz near Panguitch.

Many of the threatened plants, including cacti and other species, that Mr. England showed are endemic to the arid areas of southern and eastern Utah and adjacent states. Some are specific to the soils of certain geological formations and have a very limited range. Although Mr. England did not elaborate on the factors threatening these wild life species, it was evident that many were man caused through grazing, ORV damage, pesticides, flow alterations in the Colorado River drainage system and the taking of plants, particularly cactus, by collectors. Oil shale development could pose a future hazard to several of the rare plants.





Sego Lily

Newsletter of the Utah Native Plant Society

Vol. 11 No. 2

June 1988

When, Where, What

June 23
Thursday
7:30 p.m.

Salt Lake Chapter Meeting
Lecture by Dr. Shaw on alpine flora.
Meet in the Olpin Student Union
Building "Den" at the University of Utah.

June 25
Saturday
10:00 a.m.

Uinta Field Trip
One of our most popular field trips, this trip is an excellent introduction to the flora of the Uinta mountains. For the beginning flower fanatic, this is a wonderful trip with several long time members on hand to help with plant identifications and answer questions about habitats. The trip covers nearly the entire range of vegetation zones in the Uintas. For the more experienced plant person, there are always new discoveries to be made and old friends to tramp around with. The trip travels along the Mirror Lake road from Kamas to Bald Mountain Overlook. The trip begins at the ranger station on Highway 150 in Kamas. The ranger station is on the south side of the road several blocks after you turn onto the Mirror Lake road (Highway 150) in Kamas.

July 2
Saturday
10:00 a.m.

Tony Grove Lake Field Trip
A terrific field trip sponsored by the Cache Valley Chapter and led by Leila and John Shultz. The field trip begins at the Tony Grove Lake Campground. Travel time to the campground from Salt Lake is about 2 hours, 45 minutes. From Logan, take Highway 89 east from Logan for about 30 miles to the Tony Grove Lake turnoff. The campground is five miles farther. Late arrivals can easily join the trip as the group circles the lake. Leila Shultz is curator of the Utah State Herbarium. She knows the area well and makes this a special trip every year.

July 2, 3, 4
Saturday -
Monday

Great Basin National Park Field Trip
Last year was the first year UNPS has traveled to Nevada for this trip. A small

July 16
Saturday
9:00 a.m.

group made the trip and had a wonderful time. It's a long drive to our newest National Park but very much worth the effort. Bristle cone pines and cool beautiful days highlighted the trip. The meeting point for group activities is the Wheeler Peak campground entrance at 9:00 a.m. on Saturday. (Plan to arrive Thursday or Friday if possible, the Wheeler Peak campground will probably fill early.) Vegetation zones within easy reach range from sagebrush in the park's lower elevations to alpine on 13,000' Wheeler Peak and everything in between. An additional attraction is the park service tour through Lehman Cave. Call Andrew Boyack (278-8596) for more information.

Albion Basin Field Trip
Join us to hike through the spectacular summer scenery and flora of the high Wasatch mountains. The trip begins at the east end of Alta Resort's parking lot at the top of Little Cottonwood Canyon. (Where the pavement ends.) Take a cool break from the midsummer heat in Albion Basin and enjoy some of the most varied expanses of wildflowers to be found in Utah. This trip consistently gets rave reviews and produces an extensive plant list. Bring a sweater or light jacket and sunscreen along with your lunch and hiking shoes for a very enjoyable time.

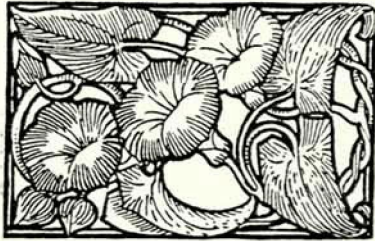
August 25
Thursday
7:30 p.m.

Salt Lake Chapter Meeting
Can it possibly be time to announce the As-Nearly-Annual-As-Possible Mushroom Hunt Meeting again? This is an early announcement so we can all mentally request rain for the mushrooms. The hunt is scheduled for August 27, rain and mushrooms permitting.

All meetings and field trips are open to anyone who would like to join us. On the field trips bring a lunch, water and outdoor clothing. For more information on trips and meetings, call Andrew Boyack (278-8596).

September Events

- September 22 Salt Lake Chapter Meeting
Dr. Howard Stutz will speak on desert plants, particularly the *Chenopodiaceae*. This is a lead in to the September 24 field trip.
- September 24 Desert Plants Field Trip
Last year, this trip gave a fascinating overview of the west desert and alkali basin plants by Dr. Stutz. The trip begins with an optional overnight camp out at the Oquirrh campground on Friday night (and possibly a pancake breakfast.) For anyone who can't join us Friday night, the trip begins at 8:00 a.m. in the Oquirrh town campground.



National Events

- August 7 - 11 Eleventh North American Prairie Conference, University of Nebraska at Lincoln. For information, contact Dr. Thomas Bragg, Dept. of Biology, University of Nebraska, Omaha NE 68182 (402-554-3378).



Threatened and Endangered Plants Summary

(This listing, provided by Larry England of the U.S. Fish and Wildlife Service, was presented at the Rare and Endangered Plant Meeting, May 6 and 7 at Glen Canyon National Recreation Area. Additional information presented at the meeting will appear in this and future issues of **Sego Lily**.)

Arctomecon humilis:
Papaveraceae: Dwarf bearclaw poppy/Coville bearclaw poppy. Utah Native Plant Society (UNPS) Brigham Young University (BYU) life history and ecological study is continuing. ARS/Utah State University (USU) Bee biology lab has begun investigating the reproductive biology and pollination system of the plant. Bureau of Land Management (BLM) Fish and Wildlife Service (FWS) monitoring study is continuing. The UNPS inventory, conducted in April showed perhaps 50% or higher mortality in the Red Bluff population and no significant recruitment. The Red Bluff and Warner Ridge locations may be recommended as Areas of Critical Environmental Concern (ACEC). There is some indication that the Red Bluff population may be genetically distinct from the other populations.

Asclepias welshii:
Asclepiadaceae: Welsh's milkweed. Listed as threatened in October, 1987, the Coral Pink Sand Dunes State Park

has been designated as critical habitat. The Utah State Park System, BLM and FWS plan to initiate monitoring studies this year.

Astragalus montii:

Fabaceae: heliotrope milkvetch. Listed as threatened in November 1987 with critical habitat. The Forest Service (FS) FWS monitoring study is continuing.

Astragalus montii:

Fabaceae: Rydberg milkvetch. A delisting proposal is under review in FWS Denver Regional Office for this plant.

Cycladenia humilis var. *jonesii*:

Apocynaceae: Jones cycladenia. Monitoring studies are planned to begin this year on BLM sites in eastern Utah.

Echinocereus engelmannii var. *purpureus*:

Cactaceae: purple hedgehog cactus. FWS is finalizing the Woodbury report. FWS will prepare a delisting proposal during 1988.

Echinocereus triglochidiatus var. *inermis*:

Cactaceae. FS monitoring study is continuing on this eastern Utah species. BLM/FWS plan to initiate monitoring studies.

Erigeron maguirei var. *maguirei*:

Asteraceae: Maguire daisy. BLM plans to inventory the San Rafael Swell for additional populations. The FWS plans to determine the taxonomic validity of *E. m.* var. *harrisonii*.

Glaucocarpum suffrutescens:

Brassicaceae: Rollins thelypody. This species, an oil shale endemic, was listed in October, 1987. BLM/FWS plan to initiate monitoring studies.

Pediocactus despatnii:

Cactaceae. BLM/FWS plan to initiate monitoring studies, budget and manpower permitting. The species was listed as endangered in September, 1987.

Pediocactus sileri:

Cactaceae: Siler cactus. BLM/FWS monitoring study is continuing. The species is found in the Arizona Strip and Warner Ridge areas of southern Utah. With this species as with most other cactus species except *Opuntia*, the principal threat seems to be collection of the plants by both commercial and private cactus collectors.

Phacelia argillacea:

Hydrophyllaceae: clay phacelia. In June of 1987, sheep were bedded for 3 days on the only known site of this species, causing a drastic decline in the number of individuals. Only known one individual survived the winter. Re-examination of the site this year located one plant as of April, 1988; 20 to 30 plants in May. Presumably, there are seeds in the soil available for the species usual late summer germination. The plant is found on Green River shale. The State Arboretum of Utah, the Center for Plant Conservation, Native Plants, Inc. and FWS are planning a rescue operation to include close monitoring of the habitat for new seedlings, protection from grazing, establishment of seedlings in botanical gardens and tissue culture propagation. The Nature Conservancy is continuing efforts to acquire the species habitat, so far, without success.

Primula maguirei:

Primulaceae: Maguire primrose. FS/FWS plan to initiate monitoring studies in the Logan area. The UNPS Cache Valley Chapter combined a field trip and *Primula* survey in Logan Canyon on May 14. (See following field trip report by Andrew Boyack.)

Sclerocactus glaucus:

Cactaceae: Uinta Basin hookless cactus. BLM/FWS plan to initiate monitoring studies. This plant and the following one, *S. wrightiae*, are under serious threat from commercial cactus collectors.

Sclerocactus wrightiae:

Cactaceae: Wright fishhook cactus. A NPS/FWS monitoring study is continuing and FWS plans to initiate joint monitoring studies with BLM on other populations.

Townsendia aprica:

Asteraceae: "last chance townsendia" (Ed. - no I didn't make that one up. It appears in the Illustrated Manual of Proposed Endangered and Threatened Plants of Utah, U.S. Fish and Wildlife Service, 1979.) As of 1979, one of the two known populations of this species had been exterminated by a gypsum mining operation. The remaining population was threatened by livestock. The FS, BLM and FWS plan to initiate monitoring studies.

Gilia caespitosa:

Polemoniaceae: Rabbit Valley gilia. An ecosystem listing package and an endangered proposal will be submitted in 1988.

Pediocactus winkleri:

Cactaceae. A threatened species proposal and ecosystem listing package will be submitted in 1988.

Schoenocrombe barnebyi:

An ecosystem listing package and threatened proposal will be submitted in 1988.

Lepidium barnebyanum:

A listing package will be prepared for this species in 1988.

Ranunculus acriformis var. *aestivalis*:

Ranunculaceae: autumn buttercup. This late flowering *Ranunculus* was initially collected in 1894 near Panguitch, Utah. It was located again by L. Benson in 1948. Benson recommended that the only known population should not be "unduly collected as it was barely holding its own". As of 1979, the plant had not been recently collected and was thought to be possibly extinct. In 1983, a single population of the species was located in a pasture and numbered approximately 400 individuals. The most recent survey located only 10 to 20 individuals in an area still subject to grazing. The Nature Conservancy is attempting to acquire the land where the population is located.

Editor's Note:

The extinction or possible extinction of a species is deplorable for too many reasons to discuss in less than a massive book. But as a follow up to the Status Summary I would like to reprint the following brief article from the

"Threatened Plants Could Harm Medicine"

As many as 60,000 plants with valuable medical properties are likely to become extinct by 2050, according to organizers of a recent conference sponsored by the World Wildlife Fund and the World Health Organization, says the New York Times. "This means one in every four of the world's medicinal plants is threatened," said British biologist Hugh Synge. He said that 80 percent of the world's people rely on medicinal plants, which are important in industrial countries as well as developing nations. Peter P. Principe, a researcher, said, "In the United States, 25 percent of the prescriptions that are being filled are filled by drugs derived from plants." Synge said, "These shortages are intimately linked with the decline of forests and vegetation."



Bearclaw Poppy Filmstrip Popular in St. George

Andrew Boyack

Janet Williams sent eight copies of the Bearclaw Poppy film strip and cassette produced by her with UNPS funding to the schools in St. George this spring, hoping they would be used in classrooms to help increase awareness of the plant. The film strip combines photographs of the plant and its habitat with information on the species' endangered status.

On May 9, we received a call from Marilyn Matthews, a teacher at the Hurricane, Utah Middle School, asking if we could send her a copy of the film strip. She told us she had tried to borrow a copy from the schools in St. George, but found that the film strips were so popular that all eight of them were booked solid to the end of the school year. We did not have a copy available in Salt Lake, but Janet immediately set about having several slide sets and cassettes made from the original materials. One of these sets was sent to Ms. Matthews in Hurricane within the week.

UNPS now has one film strip and several slide sets available for loan. If you would like to show the program or know someone who would, contact Andrew Boyack (278-8596) or Dave Wallace (466-2719).

Janet Williams and Debbie Noel deserve a fervent thank you and congratulations for producing a film strip that has been so well received. Getting information of such value to the widest possible audience helps in UNPS efforts to preserve and protect the dwarf bearclaw poppy (*Arctomecon humilis*).



(Note: The following article from the **Natural Areas Journal** contains the substance of and amplification on material presented by Donald Falk at the Threatened and Endangered Plants conference.)

Integrated Conservation Strategies for Endangered Plants

Donald A. Falk

Introduction: Until recently, few botanical gardens and arboreta had developed programs specifically to support conventional plant protection efforts. Individual staff had attempted offsite research and propagation (for instance, the pioneering work on prairie restoration in the 1930's by John T. Curtis at the University of Wisconsin Arboretum), but cooperation was generally ad hoc more than systematic and lacking national coordination. The entry of offsite ex situ programs - those managed by botanical gardens, arboreta, seed banks and offsite research facilities - into the field of plant protection may be one of the most significant recent developments in conservation practice.

It is still too early to say that cooperation between onsite and offsite natural resource professionals is universally accepted, or even that the effectiveness of such joint efforts has been conclusively demonstrated. Many technical and philosophical questions remain about how such work should be carried out and its proper role in plant protection strategy. These questions will continue to intensify as more agencies around the country explore the potential of such efforts.

In an increasing number of cases, however, collaborative projects are being successfully undertaken. By exploiting the relative strengths of several protection methods, the cooperating agencies can achieve the greatest overall degree of protection. Such efforts share an underlying assumption that for any given population, species, community type, or land parcel there is an optimal combination of protection techniques that may be applied. It is this use of diverse approaches that constitutes an integrated conservation strategy.

The Historical Context of Endangerment and Conservation: Before describing current cooperative efforts, it may be helpful to consider the complexities of endangerment itself, for it is the multiplicity of threats to species survival that compels an integrated approach. In addition, the historical evolution of concepts and methods of conservation practice in the last century can help us understand precedents for current developments.

The Complexity of Endangerment

The multidimensional phenomenon of endangerment poses a constant challenge to devise new and effective ways to protect both species and habitats. Many causes of endangerment can be effectively controlled by protective ownership of the land. In particular, threats of natural area destruction due to commercial and industrial development, construction activities, hydro projects, mining, logging, and other economic uses of land can be directly addressed by a range of land protection measures. It is axiomatic of our contemporary practices that land protection should always be a primary element in any conservation strategy.

But there are certain kinds of threats that are extremely difficult to control, even with protective ownership. Among these are fungal blights and other infections, competition from introduced exotic plants, and destructive grazing by feral animals such as goats and sheep. Control of other impacts, such as off-road-vehicle use, illegal collecting, and vandalism may depend on the effectiveness of fencing and surveillance. Mediation of ecological factors such as forest succession and fire may require scientific knowledge that in some cases is not readily available.

Consider the case of the Florida torreya (*Torreya taxifolia*), a small tree in the yew family (Taxaceae) found in four counties along the Apalachicola River in northwest Florida and Georgia. Much of the torreya's habitat is on land protected by the Florida Park Service, the U.S. Army Corps of Engineers, The Nature Conservancy, and several city parks. The species is threatened, however, not by destruction of its current habitat but by a fungal blight that kills nearly all the mature trees in the wild before they reach reproductive age (U.S. Fish and Wildlife Service, 1986). Affected trees become defoliated and generally die, although they may send up stump sprouts that themselves eventually become infected. Attempts to control the pathogen by chemical or management means generally have been unsuccessful.

Partly for this reason, the U.S. Fish and Wildlife Service Recovery Plan recommended that "one of the objectives of [the] recovery plan is to produce a genetically diverse collection of sexually mature, reasonably healthy trees in cultivation to preserve a representative gene pool which will serve as stock for eventual reintroduction into the tree's habitat." Other recovery objectives include identification of the pathogen, development of management techniques that might allow torreya trees to reach reproductive size and age, and establishment of cultivated populations at several botanical gardens to determine the optimal climate for the species.

As this example shows, a multidisciplinary approach undertaken through the collaboration of several different institutions may provide the best protection against extinction. Such cases may become the rule rather than the exception as the threats to species survival intensify.

Evolution of conservation goals and practices

Conservation is not a static concept; it has carried many different meanings even within the last century. Both the methods and the goals of conservation are in constant flux, influenced largely by our increasing scientific understanding of the dynamics of natural systems. But there is a parallel shift that is more philosophical (normative, to be precise), that speaks not to how we protect but to what we are trying to accomplish. Although at any given time we tend to accept a prevailing model, our notions of how and why we protect have been evolving steadily.

The first significant movements for wilderness preservation in the United States were in the middle and late nineteenth century. Land was seen either as a potentially useful economic resource requiring long-term protection or as an expression of nature meriting protection in its own right. The great conservation landmarks of that era - Yosemite Valley, Yellowstone

National Park, the Adirondack forest preserve - reflect this dual intent to preserve both an economic resource and inherent natural values.

During this period there was essentially one protection tool - land acquisition by government. Much of the acquisition of land by federal and state governments during this period and into the early twentieth century was oriented toward conserving timber, water, mineral, and range resources \for long-term sustainable exploitation. (For a fascinating study of the conservation thinking of this period, see Hays, 1959). Even during the Progressive Era, the protection of nature for its own sake (a struggle led by John Muir and others) often took second place to conservation for resource management.

Eventually, land acquisition began to be supplemented by a broadened repertoire of other tools. Two developments influenced this change. First, interested citizens and professionals began to recognize that there were a number of other ways to protect natural values of interest, including legislation, zoning, easements, and differential taxation. The elaboration of protection measures continues today, for example, with the growth of land registry programs such as those promoted by The Nature Conservancy. Second, the insights of the science of ecology began to change the way we viewed the land and natural communities - to change, in fact, our view of what we were protecting. The emphasis began to shift from sheer acreage to protection of communities and habitats, accompanied by the notion of "stewardship" of nature and natural areas.

Among other things, stewardship implies a recognition that we may choose to actively manage an area or a population instead of simply letting natural processes take their course. Management is, in fact, basic to the day-to-day practice of stewardship. Much current management practice, for example, is devoted to altering successional development by using prescribed burns, forest thinning, and restoration practice.

But the goals of conservation have continued to evolve in the past twenty-five years with increasing emphasis on preservation of genetic diversity. Flowing once again from changing scientific models, the conceptual basis for protection has shifted to the identification and preservation of naturally-occurring genetic variation. This has led to a renewed interest in protecting populations as well as natural community types and whole species and has sparked research interest into each of these areas.

For purposes of this paper, we have accepted natural areas management as a standard conservation practice, not a contradiction in terms. Moreover, to achieve the required degree of protection, we are willing to intervene actively in natural areas to a degree that would have been considered unthinkable a century ago (Turner, 1985).

Good stewardship, however, requires good information, especially about the biology of the taxa and communities we are trying to protect. And such information is sadly lacking for most of the endangered plants of the United States. For instance, for most rare taxa we do not know the pattern or extent of intraspecific genetic diversity and must either guess or extrapolate from related or ecologically analogous taxa. Similarly, we have reliable life history data for relatively few endangered plants; most have never been studied. Managers often must resort to

guesswork or analogy, designing management practices on an inadequate base of scientific data. This may be one area where offsite research programs can contribute substantially to the field of natural areas management.

Types of Onsite-Offsite Cooperative Projects:

Cooperative onsite and offsite plant protection efforts are extremely varied. Many involve exchange of actual plant material, while others encourage research or public education at offsite institutions such as botanical gardens and arboreta. Summarized below are examples of cooperative efforts in the United States illustrating the wide range of collaborations being explored.

Recommendation

A basic type of interaction is one in which a land-managing agency is asked to recommend priority taxa for inclusion in an offsite conservation program. The offsite organization (a botanical garden, for instance) may approach an onsite agency simply because the latter has more detailed, current knowledge of the status of plants in the wild. A plant may be recommended because survival of a population (or an entire taxon) is uncertain or because management assistance is needed with a particular group of plants. Heritage and natural areas programs are frequently involved in providing guidance of this sort. Formal ranking systems of the U.S. Fish and Wildlife Service and The Nature Conservancy are also basic tools in setting conservation priorities, but other information that may be too anecdotal or recent to be reflected in national rankings may also be useful.

Permitting

Agencies concerned with wild populations often are empowered to issue permits for collecting and other fieldwork. In addition to the U.S. Fish and Wildlife Service, special permits for endangered species work may be required by the U.S. Forest Service and other federal agencies. Moreover, many state agencies require separate permits (McMahan, 1984, 1987) and can assist in obtaining permission from private landowners who otherwise may be reluctant to grant entry.

Field Work

A more active role is often played by agencies that, either by request or their own preference, assist in actual field work. For instance, heritage program staff, state botanists, and U.S. Fish and Wildlife Service personnel frequently accompany garden staff of collecting trips, since they are likely to be familiar with the plant as it grows in the wild and may have visited the site previously. In other cases, the onsite agency staff themselves collect the required material and then convey it to the participating garden; this procedure is frequently followed when locality information is considered sensitive or when collecting can be carried out as part of a trip scheduled for another purpose.

Conservation Collections

Committed as they are to protecting the land and the species that grow on it, onsite agencies frequently recognize species that are in trouble despite their best efforts. Disease, grazing, and off-road-vehicle impact are just a few of the threats that may be difficult to prevent. In such instances, an agency may support the

establishment of an offsite conservation collection. There are numerous cases around the world of plants that would be extinct if not for living offsite collections; examples include *Sophora toromiro*, *Franklinia alataamaha*, *Kokia cookei*, and *Stephanomeria malheurensis*. The survival of these taxa demonstrates the value of keeping plants alive offsite to prevent total extinction (see Gwaith and Schmeidler, 1987 and Evans and Bohn, 1987 for other examples. Such collections are significantly more valuable if they are designed to be genetically representative of the wild populations (Center for Plant Conservation, 1986). The U.S. Fish and Wildlife Service, for instance, includes establishment of cultivated populations and seed banks as recovery actions for endangered plants (for example, see U.S. Fish and Wildlife Service, 1986, 1987).

Rescue

One of the earliest applications of offsite conservation (was rescuing plants or even whole populations) that were in danger of imminent destruction. Such circumstances arise when the habitat remains in nonconservation ownership, and legislative and legal efforts to protect the plants have failed or do not apply (the Endangered Species Act, for instance does not protect even the most endangered plants if they are on private land and not involved in a federally-supported project, interstate transport, or commercial distribution; see McMahan, 1980). Rescue may also be required when protective acquisition of the site has proven too expensive or has not been attempted.

Some botanic gardens and arboreta have operated continuing rescue operations for many years. The North Carolina Botanic Garden, for instance, has been involved in the rescue of endangered plants for more than fifteen years; the New England Wild Flower Society and other gardens have also conducted regional rescue efforts. In addition to private commercial development, plant populations have been rescued from mining sites, road construction, even construction of recreational hiking trails! (Falk and Thibodeau, 1986). Rescue should always be seen as a last resort, of course, since it implies that the battle to protect the site itself has been lost. But as a practical matter, it may be a better alternative on unprotected land than losing rare and valuable forever.

Propagation and Distribution

Many groups of plants are seriously threatened by illegal wild collecting, including cacti and other succulents, pitcher plants, orchids, and lilies. Survival of wild-collected plants through the rigors of transport and sale is notoriously low; the digging of plants is essentially a disguised form of outright destruction for profit (Campbell, 1980, Bennett et al., 1987). To decrease the market for illegally collected plants, land managing agencies may recommend development of propagate nursery stocks for commercial distribution. "Flooding the market" with well-propagated plants along with stricter enforcement of wild collecting and import regulations, can undercut the market for wild material and significantly reduce collecting pressure.

Not all wild collecting is for commercial purposes, however; some of it is conducted by overzealous amateurs. A site for one of the rarest western lilies, for example, has twice been seriously depleted following the

publication of a detailed site and locality description (Skinner, personal communication). The "smoking trowel" is often in the hands of someone who presumably loves plants.

Revegetation

Some of the most interesting and constructive cooperative projects are those in which plants or plant materials are collected with the intent of returning the living material to a protected site. Such projects can truly close the circle between onsite and offsite conservation, resulting in a high degree of overall protection for the taxon. Various degrees of maintenance and monitoring may be required following the initial replanting. To be successfully carried out, projects in this group should always be undertaken in cooperation with the agency that manages the site on which the plants will ultimately be placed.

Damaged or degraded sites can be stabilized or enhanced by the use of propagules taken from the site itself. Dune erosion, mining, construction, and off-road-vehicle damage are among the causes that may require revegetation of a site (e.g. Diamond, 1985, Ferreira and Smith, 1987, Howald, 1987, Clark, personal communication). The most common practice is to take seeds or cuttings from remaining plants, propagate them in a botanical garden or commercial greenhouse, and then replant the rooted material on the site. This procedure has the advantage that the planted material is genetically similar to the remaining wild plants and well-adapted to local conditions.

Reintroduction

This term is perhaps best reserved for re-establishment of a taxon where it had previously occurred. If the causes for the population's original destruction have been corrected, it may be possible to reintroduce the plant. Reintroduction is still a relatively conservative option, especially if plant material can be found from a nearby population (Brack et al., 1987, Strahan and Wolley, 1987, U.S. Fish and Wildlife Service, 1987). In one current case in Oregon, Malheur wire-lettuce (*Stephanomeria malheurensis*) was completely extirpated in the wild, due to a combination of fire, grazing, and cheatgrass (*Bromus tectorum*) invasion (U.S. Fish and Wildlife Service, 1982). The taxon had been described by Dr. Leslie Gottlieb of the University of California, Davis in 1978. Gottlieb had collected seed, which was in storage and propagation at the time of the loss of the wild population. Seeds from propagated plants were germinated at the Berry Botanic Garden in Portland, Oregon and planted in spring 1987, at the original site, which was cleared and fenced by the managing agency, the Burns District of the Bureau of Land Management. The project also had the support of the U.S. Fish and Wildlife Service and crews of volunteers who helped clear and prepare the site. The Bureau of Land Management also installed exclosures in plots with four different dominant covers: cheatgrass, rabbitbrush (*Chrysothamnus* sp.), basin wild rye (*Elymus cinereus*), and big sagebrush (*Artemisia tridentata*). This will enable the agency to test whether there are significant allelopathic or other competitive effects and adds a controlled experimental dimension to the project.

Introduction

A number of projects involve introduction of a taxon to a

site where it was not previously found (this is often called "reintroduction" although there is nothing "re-" about it). Introduction may be appropriate when there are sites with a high degree of protection with suitable climate, soil, and surrounding plant community. This may be necessary if existing sites are threatened and/or poorly protected, or if recovery plans call for an increase in the number of sites (U.S. Fish and Wildlife Service, 1986, Brack et al., 1987, Havlik, 1987, S. Wallace, personal communication). While introduction may seem to violate a principle of attempting to maintain or restore existing natural communities, it may be an important technique when documented sites cannot be adequately protected. In these cases we may have to choose a route that is less pure than the ideal, but allows the species to be protected from extinction.

Restoration

The term "restoration" actually refers to a broad class of conservation work involving the creation or re-creation of whole plant communities. Restoration thus includes elements of revegetation, reintroduction, and introduction of particular species, woven together into an integrated whole (Jordan, 1986, 1987). The application to endangered species work is significant, for although the restoration effort may involve many common plants, the goal may be to create an environment in which naturalized populations of rare plants can be established (Reid and Walsh, 1987, Strahan and Wolley, 1987). If the first principle of conservation is "saving the pieces", as Aldo Leopold suggested, then perhaps ex situ programs are a way of making sure the pieces are saved and restoration a way of putting them back together.

Basic research

Many gardens and arboreta have the facilities and staff to conduct plant research. Such research may involve controlled, highly technical experimentation, for instance in plant tissue culture or physiology. The research may also be less formal and rigorous, but perhaps no less useful, as in the gradual discovery of optimal growing conditions for rare cultivated plants. Whatever its form, offsite research can contribute significantly to our scientific understanding of the plants we are trying to protect. Botanical gardens, arboreta, and other offsite facilities are optimal sites for certain kinds of basic research, including topics in systematics, genetics, physiology, pathology and developmental biology. The Desert Botanical Garden (Phoenix, Arizona), for example, is cultivating Arizona agave (*Agave arizonica*) as part of their overall plant protection program. The plant, which is grazed so heavily by cattle in the wild that it rarely reproduces sexually, is thought to be a naturally-occurring hybrid in the range overlap of *A. chrysantha* and *A. toumeyana* var. *bella*. Backcrossing against the two parent taxa and then testing for offspring viability may provide insight into the degree of reproductive isolation that has developed (Delamater and Hodgson, 1987). Another example of research activity is the work of the Arboretum at Flagstaff (Flagstaff, Arizona) on mycorrhizal associations in *Pediocactus knowltonii* to be described in Part 2 of this article.

Management research

Of all the areas of cooperative interaction, the most significant may be improving management practices for

wild populations by increasing our knowledge of species biology. Along with reintroduction and restoration, management-related research carries the greatest potential for development of integrated conservation strategies.

Offsite research can be useful in expanding our understanding of species autecology. For instance, many studies have focused on determining optimal conditions for seed germination. A classic example is a research study conducted by the Holden Arboretum (Mentor, Ohio) on cultural requirement of the spreading globeflower (*Trollius laxus* ssp. *laxus*) under contract to the Ohio Department of Natural Resources (ODNR). The arboretum conducted a series of trials aimed at providing propagation and growth requirement information, enabling the ODNR to improve its management of the last remaining Ohio site (Parsons and Yates 1983a, 1983b). Other agencies have indicated that research could be conducted on the effects of shading, soil type, drainage, herbivory, disturbance, and a variety of other factors that can be controlled by management practice (Dawson, 1987, Myatt, 1987, U.S. Fish and Wildlife Service, 1987, R. Cartica, personal communication).

Monitoring wild sites

Gardens and arboreta frequently are willing to assist land managing agencies with inventory and monitoring studies. Botanically trained and experienced staff are present at many institutions, often with considerable field experience in the region. Just as onsite agencies can undertake collecting on behalf of an ex situ program as part of their normal field work, so may garden staff be able to assist in monitoring projects as part of their planned field activities (Delamater and Hodgson, 1987, J. Borland, personal communication, W. Brumback, personal communication).

Conclusion: The movement toward more diverse plant protection strategies is not a new or isolated development. What is occurring now is the continuation of a long history of change in conservation philosophy, recognition of the complexity of endangerment, and the need to develop a corresponding diversity of protective strategies. The impetus has come from two forces: the growth in scientific understanding of natural systems and the rise of new institutions equipped to contribute new resources to these efforts. Viewed in this context, the growth of offsite protection programs is neither surprising nor against the grain. In fact, the integration of onsite and offsite approaches into an integrated whole looks suspiciously like an idea whose time has come.

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Center for Plant Conservation, 1986. Recommendations for the collection and ex situ management of germplasm resources from wild plants. Center for Plant Conservation, Jamaica Plain, Mass

Primula maguirei:

Primulaceae: Maguire primrose. FS/FWS plan to initiate monitoring studies in the Logan area. The UNPS Cache Valley Chapter combined a field trip and *Primula* survey in Logan Canyon on May 14. (See following field trip report by Andrew Boyack.)

Sclerocactus glaucus:

Cactaceae: Uinta Basin hookless cactus. BLM/FWS plan to initiate monitoring studies. This plant and the following one, *S. wrightiae*, are under serious threat from commercial cactus collectors.

Sclerocactus wrightiae:

Cactaceae: Wright fishhook cactus. A NPS/FWS monitoring study is continuing and FWS plans to initiate joint monitoring studies with BLM on other populations.

Townsendia aprica:

Asteraceae: "last chance townsendia" (Ed. - no I didn't make that one up. It appears in the Illustrated Manual of Proposed Endangered and Threatened Plants of Utah, U.S. Fish and Wildlife Service, 1979.) As of 1979, one of the two known populations of this species had been exterminated by a gypsum mining operation. The remaining population was threatened by livestock. The FS, BLM and FWS plan to initiate monitoring studies.

Gilia caespitosa:

Polemoniaceae: Rabbit Valley gilia. An ecosystem listing package and an endangered proposal will be submitted in 1988.

Pediocactus winkleri:

Cactaceae. A threatened species proposal and ecosystem listing package will be submitted in 1988.

Schoenocrombe barnebyi:

An ecosystem listing package and threatened proposal will be submitted in 1988.

Lepidium barnebyanum:

A listing package will be prepared for this species in 1988.

Ranunculus acriflorus var. *aestivalis*:

Ranunculaceae: autumn buttercup. This late flowering *Ranunculus* was initially collected in 1894 near Panguitch, Utah. It was located again by L. Benson in 1948. Benson recommended that the only known population should not be "unduly collected as it was barely holding its own". As of 1979, the plant had not been recently collected and was thought to be possibly extinct. In 1983, a single population of the species was located in a pasture and numbered approximately 400 individuals. The most recent survey located only 10 to 20 individuals in an area still subject to grazing. The Nature Conservancy is attempting to acquire the land where the population is located.

Editor's Note:

The extinction or possible extinction of a species is deplorable for too many reasons to discuss in less than a massive book. But as a follow up to the Status Summary I would like to reprint the following brief article from the

"Threatened Plants Could Harm Medicine"

As many as 60,000 plants with valuable medical properties are likely to become extinct by 2050, according to organizers of a recent conference sponsored by the World Wildlife Fund and the World Health Organization, says the New York Times. "This means one in every four of the world's medicinal plants is threatened," said British biologist Hugh Synge. He said that 80 percent of the world's people rely on medicinal plants, which are important in industrial countries as well as developing nations. Peter P. Principe, a researcher, said, "In the United States, 25 percent of the prescriptions that are being filled are filled by drugs derived from plants." Synge said, "These shortages are intimately linked with the decline of forests and vegetation."



Bearclaw Poppy Filmstrip Popular in St. George

Andrew Boyack

Janet Williams sent eight copies of the Bearclaw Poppy film strip and cassette produced by her with UNPS funding to the schools in St. George this spring, hoping they would be used in classrooms to help increase awareness of the plant. The film strip combines photographs of the plant and its habitat with information on the species' endangered status.

On May 9, we received a call from Marilyn Matthews, a teacher at the Hurricane, Utah Middle School, asking if we could send her a copy of the film strip. She told us she had tried to borrow a copy from the schools in St. George, but found that the film strips were so popular that all eight of them were booked solid to the end of the school year. We did not have a copy available in Salt Lake, but Janet immediately set about having several slide sets and cassettes made from the original materials. One of these sets was sent to Ms. Matthews in Hurricane within the week.

UNPS now has one film strip and several slide sets available for loan. If you would like to show the program or know someone who would, contact Andrew Boyack (278-8596) or Dave Wallace (466-2719).

Janet Williams and Debbie Noel deserve a fervent thank you and congratulations for producing a film strip that has been so well received. Getting information of such value to the widest possible audience helps in UNPS efforts to preserve and protect the dwarf bearclaw poppy (*Arctomecon humilis*).



Primula Maguirei Shows Its Splendor

Andrew Boyack

The endangered *Primula maguirei* presented a beautiful show for the hardy Cache Valley Chapter members and others who climbed to its cliff edge habitat in Logan Canyon on May 14. Field trip participants estimated as many as 400 to 500 plants in full bloom on the Wood Camp site. This plant is of particular interest to UNPS members as it is listed as an endangered species. The only known populations of the species are in Logan Canyon.

Another plant species, *Musineon lineare*, family - Apiaceae, grows in much the same area as *Primula maguirei*. *M. lineare* or Cache musineon is being considered for listing as threatened. To obtain more information about this plant, UNPS members from the Cache Valley and Salt Lake chapters divided into groups and under the direction of Wayne Padgett searched all the known *P. maguirei* sites in an effort to find *M. lineare*. The group I accompanied found nearly a hundred plants in a quarter mile stretch along the base of the cliffs on one of the sites.

UNPS has recently entered into an agreement with the U.S. Forest Service to obtain and report field data on three rare plants growing in the Logan Canyon area. The three species are *Primula maguirei*, *Musineon lineare* and *Erigeron cronquistii*. *E. cronquistii*, family - Asteraceae, is a small perennial aster that grows in rock crevices in cliffs on the north side of canyons in the fir and spruce community. It is potentially a threatened plant due to its ecologically and geographically restricted habitat.



Threatened and Endangered Species Conference

Andrew Boyack

The annual conference on threatened and endangered plant species was held May 6 and 7 at Bullfrog Basin on Lake Powell in the Glen Canyon National Recreation Area. Representatives from many federal and state agencies, state colleges, universities and conservation organizations attended as did a number of officers and members of the UNPS. The meeting was organized by Duane Atwood, regional botanist for the U.S. Forest Service. Jim Holland, of the Glen Canyon National Recreation Area hosted the meeting and served as moderator.

Much of the conference was devoted to discussion of the ongoing efforts of federal agencies to map and classify the vegetation of Utah, particularly areas within the National Parks. Dr. Kimball Harper, botanist from BYU, described his work in mapping the vegetation in Zion National Park. Detailed data is being obtained from one twentieth acre plots established at section corners. Additional sampling sites are selected to represent hanging garden and seep communities. Where necessary, the study section is offset to avoid extreme terrain. The information gathered is being used to establish a computerized data base at BYU. The data will be accessible for further study.

Ken Heil spoke on the mapping and classification of

vegetation communities of Capitol Reef National Park and accompanied the information with slides. Areas in the park are being classified by dominant communities such as bristle cone pine, black brush, pinion/juniper, salt bush and riparian and by geographic/geological features including elevation, exposure and substrate. Populations of sensitive plants; *Townsendia aprica*, *Gilia caespitosa*, *Astragalus araneosus*, *Astragalus barnebyi* and *Pediocactus winkleri*, are being inventoried.

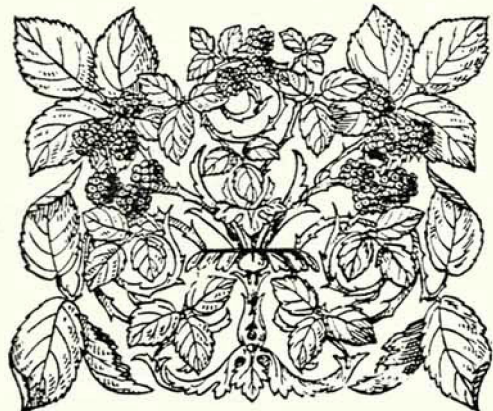
Joel Tuhy, from the Nature Conservancy described helicopter access to pristine and relict mesas along the Colorado River. The relict areas were grazed by sheep and cattle prior to the filling of Lake Powell behind Glen Canyon Dam but are now inaccessible. Information gained should provide interesting comparisons with areas which have been continuously grazed during the same period. Questions were raised during the meeting about the "lake effect" of Lake Powell on the climate and vegetation of areas bordering the lake.

Ken Holland showed slides of several rare plants growing in the Glen Canyon National Recreation Area. He expressed concern for the *Dalea epica* var. *flavescens* which grows on the site of a proposed airplane landing strip at Hall's Crossing on Lake Powell.

The purpose and work of the Center for Plant Conservation (CPC) was described by Donald Falk, executive director of CPC and by Pam Poulson of the Utah State Arboretum, an affiliate of CPC. Located in Massachusetts, CPC coordinates the work of arboreta and botanical gardens in the United States in preserving threatened and endangered plant species. The Utah State Arboretum, located on the University of Utah campus in Salt Lake City, is collaborating with CPC on preservation of several plant species at present. The species involved are *Arctomecon humilis*, *Phacelia argillacea*, *Primula maguirei*, *Pediocactus despainii* and *Townsendia aprica*.

Threatened and endangered plants, federally listed or proposed for listing in 1988, were discussed by Larry England of the FWS with input from a number of the other meeting participants. See the Status Summary in this issue of *Sego Lily*.

(Ed. Note: Additional articles will appear in this and subsequent issues of *Sego Lily* as the information is forwarded from the presenters. If the presenter fails to submit a summary of the presentation given I'll take my best shot at reporting the presentations from my notes. Presenters, please send summary material or related articles as soon as possible.)



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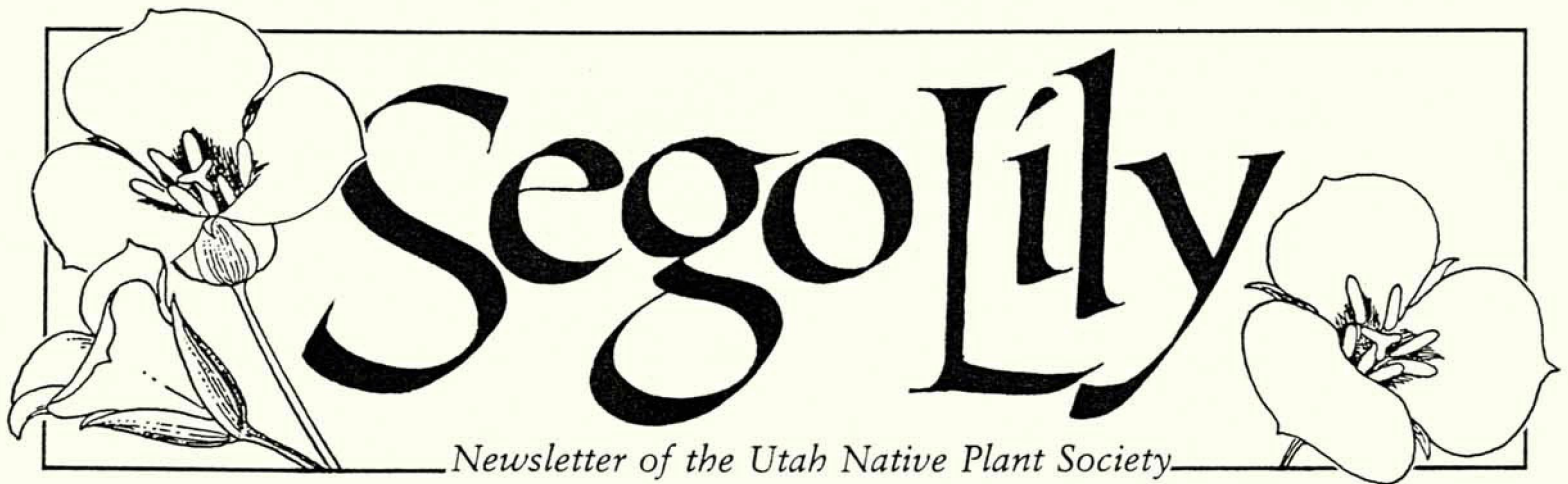
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Sego Lily

Newsletter of the Utah Native Plant Society

Vol. 11 No. 3 August 1988

When, Where, What

August 25
Thursday
Cancelled

Salt Lake Chapter Meeting
Loud sighs and lamentations are in order, the summer's drought can be blamed for cancellation of the pre-mushroom hunt meeting and the mushroom hunt as well. Dr. Anderson reports no sign of quarry for the mushroom hunt and little chance of mushrooms even if August is quite rainy. So the As-Nearly-Annual-As-Possible Mushroom Hunt won't be held this year.

September 10
Saturday
9:00 a.m. to
2:00 p.m.

UNPS Plant Sale
Now for some good news, the annual native plant sale will take place on the second Saturday in September. Millcreek Gardens Nursery is again graciously providing space for the sale. Millcreek Gardens is located at 3500 South 900 East, on the west side of the street.

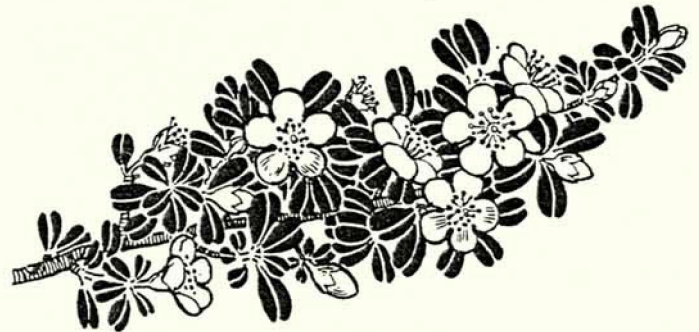
September is an excellent time to plant natives and let them settle in. We will have an extensive selection of native trees, shrubs and flowers, mostly well established plants in gallon cans.

P.S. If you could help with the plant sale, even for an hour or two, call Dave Okelberry (968-6190). It's an opportunity to meet other native plant enthusiasts and you don't need to be an expert to help out.

October 8
Saturday
8:00 a.m.
to 6:30 p.m.

**Utah Geological Association
Central Wasatch Range Field Trip**
The trip is geared for naturalists and non-geologists. It begins with a short overview of the geology of the central Wasatch Range by Frank DeCourten. Travel by bus will take participants to stops along the Wasatch Fault and up Big and Little Cottonwood Canyons. The trip includes a ride up the tram at Snowbird and concludes with the activities of the Grand Octoberfest at Snowbird prior to returning to Salt Lake. Cost of the trip is \$14.00 per person and

advance registration is required.
To make reservations or for more information, call 581-6831 - days or 363-1412 - evenings.



Wild Bunch Captivates Utah

While too early to predict a second printing, the wildflower poster is selling faster than even the poster committee had foreseen. The combination of botanical accuracy and eye-pleasing artistry has made the poster popular with wildflower enthusiasts and art lovers. Many, having received a first poster, have ordered more.

It's gratifying to those of us who took part in draining the society's funds for this venture that the sales are going well. Natural history associations at two of Utah's national parks have quadrupled the number of posters ordered with their second purchases. A couple of framing shops have sought us out after framing our poster for their clients. And, while such sales are extremely pleasing and even complimentary, wholesale distribution does not produce as much revenue for UNPS projects as do retail sales to individuals.

Reticently, last May, I approached friends and co-workers about buying a poster. The posters were enthusiastically received. Before seeing the poster many contacts were lukewarm, after seeing the poster these individuals often bought two. One friend whose father made a frame for her poster lost the whole works to her mother and had to buy another copy. Walking down a hallway at work with a framed poster in hand, I was accosted by a stranger wanting to know where to buy the poster. They are not hard to sell. Other UNPS members have had the same sort of experience but there are too few members involved in selling posters, and those few have nearly exhausted their contacts.

How can you help? First, if you haven't bought one, do, if not for yourself then as a gift for a flower-loving friend. Secondly, approach every friend, teacher and co-worker who has ever admired a wildflower in your presence. If you are too shy for the direct approach, hang your poster at home or at work and let people ask where you got it.

Our goal is 600 retail poster sales this year. We are a third of the way there, but our best season (summer) is passing quickly. Posters can be ordered by mail, by sending \$10.00 plus \$1.50 for postage and handling to:

Utah Native Plant Society
P.O. Box 520041
Salt Lake City, UT
84152-0041

Posters are also available through the State Arboretum of Utah on the University of Utah campus.



Albion Basin Field Trip

The mountain meadows of Utah present changing floral scenes throughout their growing season. Glacier lilies, spring beauties and marsh marigolds predominate in spring (May and June), sky pilot, columbine, bluebells, indian paintbrush and hackelia in midseason, shading to fleabanes and senecios at the end of the season.

Our July 16 field trip found the Albion Basin in full midseason bloom. With the able direction of Beverly Albee, Pam Poulson and Dave Wallace, we traversed the Secret Lake trail studying the vegetation of diverse habitats found in the area. Along the streams were brook saxifrage, shooting star, *Mimulus guttatus* and *Mimulus lewisii*. On the moist tree shaded slopes were a variety of plants including polemonium, columbine, hackelia, indian paintbrush, bluebells, penstemons, lupines and delphinium. On the rocky slopes higher up the train were *Ivesia*, sulphur flower, owl clover, white gilia, pussytoes and pennycress. All told, our botanists identified more than seventy species of plants in bloom.

We wanted to find the *Primula parryi* but it seemed to be missing from its usual locations. Howard Albee finally located a few plants in the cliffs adjacent to the Secret Lake approach. The plant, as Dave Wallace pointed out, looks somewhat like a larger edition of the *Primula maguirei* which UNPS has been studying in Logan Canyon. It has a similar red-lavender flower and basal leaves though the leaves are much larger.

Alpine Flora Subject of June Meeting

Andrew Boyack

Dr. Shaw, professor emeritus of Utah State University, spoke of alpine flora at our June 23 meeting. The alpine environment, according to Dr. Shaw, is characterized by special conditions, among them, low temperature, short

growing seasons and harsh winters which shape the growing habits of alpine plants. Alpine conditions exist at high elevations in the tropics and at successively lower elevations at higher latitudes, 10,000 feet in Utah, 7,000 feet at the Canadian border and at sea level in the arctic. "Alpine" is often thought of as the ecosystem above timberline.

Plants adapt to the alpine conditions in a fascinating variety of ways which Dr. Shaw described and demonstrated with slides. To conserve heat, plants are small and grow close to the ground, often in tight bunches. Plants develop rapidly to take advantage of the short growing season. The krumholtz form of alpine fir is an example of adaptation to cold, wind and snow. The bristlecone pines of Wheeler Peak are another example of adaptation.

Alpine plants are versatile and tough but the ecosystem in which they exist is fragile. Quoting Dr. Shaw, "We have received a most marvellous gift from the alpine flora and it is now a challenge to preserve this gift."

Uintas Explored on Field Trip

Andrew Boyack

Flora along Highway 150 in the Uintas was explored on a leisurely field trip, June 25, led by Dave Gardner, Pam Poulson and Dave Wallace. The geological formations along the route offered an interesting contrast as described by Pam Poulson. From Kamas eastward the road passes through Pennsylvanian sandstone and Mississippian limestone where the soil is basic. Here are found the open stands of ponderosa pine (*Pinus ponderosa*) with snowbush (*Ceanothus velutinus*) understory. Beyond milepost 18, the rock formation changes to Precambrian granite of the Laramide uplift, typical of the high Uintas. The soil is more acidic. Ponderosa pine gives way to dense stands of lodgepole pine (*Pinus contorta*). Above 8,000 feet the forest becomes predominantly subalpine fir (*Abies lasiocarpa*).

Flowers in bloom in the meadows below Bald Mountain were primarily marsh marigold (*Caltha leptosepala*), glacier lily (*Erythronium grandiflorum*) and spring beauty (*Claytonia lanceolata*) interspersed with shooting star (*Dodecatheon pauciflorum*), elephant's head (*Pedicularis groenlandica*) and mountain bluebells (*Mertensia ciliata*). It is noteworthy that *Polemonium foliosissimum*, so abundant at higher elevations in the Wasatch, is strangely lacking in this area of the Uintas.

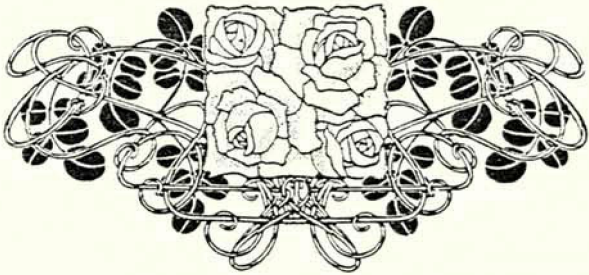


Welcome New Members

I don't have a list that separates new members from renewals this time around so I'll just extend our sincere appreciation to all dues paying members. Your continued interest in UNPS enables us to work actively for the preservation and propagation of native plants in Utah.

Melinda McIlwaine, Salt Lake
Dave Anderson, Salt Lake
Desma H. Galway, Salt Lake
Alair Griffin, Sandy
Danielle Paterson, Salt Lake
Shelly Julander, Layton
Paula Graham, Salt Lake
Debra Hand, South Jordan
Neil Frishknecht, Provo
Rose Marie Pendelton, Provo
Tom Roberts, Salt Lake
Jeanne Marie LeBer, Salt Lake
L.E. Horton, Pleasant View
Susan Crook, Logan
Donald Barr, Lake Oswego, Oregon
Connie Lundberg, Sandy
David Humphrey, Logan
Sharon Loomis, Layton
Debra Lynn Hanni, Salt Lake
Daniel F. Baker, Salt Lake
John Veranth, Salt Lake
Margaret McClelland, Park City
Ruth Dissel, Salt Lake
Patricia Lorenzo, Park City

Special thanks for commitment and generosity in the form of a donation in excess of regular dues go to Alice Stokes of Logan. Additional contributions go a long way in funding special projects such as the dwarf bearclaw poppy study.



Great Basin National Park Field Trip

Robert Fitts

The plant communities in the mountains seem very intimate after driving across the expanded valley floors of the Great Basin. The UNPS group camped near the 10,000 foot level on the flank of Wheeler Peak. Close to the alpine beauties, but not far from the dry areas of the lower slopes. The campground was filled with starwort, shooting star and arnica.

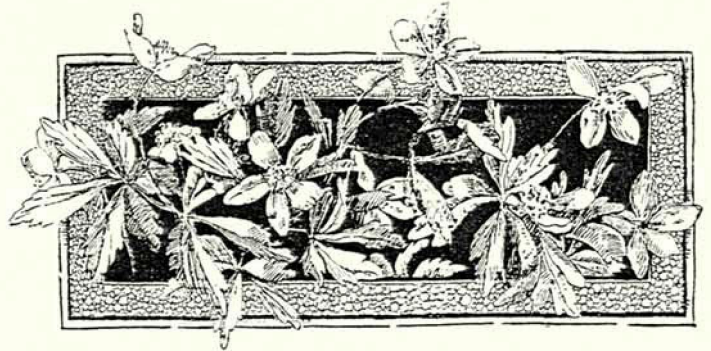
The trail to the top of Wheeler Peak offered sights of wet meadows, and spruce forest with a weasel, deer more curious than fearful, and many birds to liven the stage set with trees and flowers. A mat of alpine flowers welcomes you to the tundra of the peak. The wind blew so hard that the human guests had to adopt the ways of the ground-hugging alpine plants to keep from being blown away. This only brings you closer to the rich little carpets of moss campion, phlox and sky pilot.

Glacial morains around the peak are the setting of the ancient bristlecone pines. The excitement of seeing these photogenic trees was made somber by the visit to the oldest known tree, cut down as part of a scientific study. It seemed like a visit to the tomb of a fallen hero. We met a California couple whose personal cult also included a yearly pilgrimage to the ancient tree site.

Using plant keys proved exasperating to those who tried to learn all of the plant names, but rewarding when species characteristics were mastered.

Near Stella Lake was a meadow jeweled with red sedum and pygmy bitter root. What relaxation to be close to the ground with all the tiny plants.

Following the stream down from the campground really warmed up the group, going from the spruce forest to the gardens of cactus and sego lilies of the lower hills. The indian potatoes and wild onions were enjoyed by some, while others enjoyed the flowers visually, meadows of thermopsis and bog orchids, streamside views of monkshood and cardamine, and dry flats with indian paintbrush, penstemon and scarlet gilia. Dave Wallace had a watermelon waiting at the bottom for all, cooling off for a trip through Lehman Caves. Jo Stolhand stopped on the way home to find a pile of fossils, including her first trilobites. This was a trip we would have hated to miss.



Editor's Note: The following article is an extension of the remarks by Donald Falk at the Annual Threatened and Endangered Species Conference held earlier this year. It is reprinted by permission of the author from the *Natural Areas Journal*, April 1988; Volume 8, Number 2.

Endangered Plant Conservation Managing for Diversity

Donald A. Falk and Linda R. McMahan

Introduction: The past century is vivid evidence of the human tendency to "live as if tomorrow will never come." We are awakening from the pleasant dream of unlimited resources to find our wildlands disappearing along with the animals and plants inhabiting them. Only slowly are we making the necessary societal commitment to set aside natural areas and to learn how to manage them. At the species level the problem is no less formidable; about 3000 of the approximately 25,000 species, subspecies, or varieties of plants native to the United States are at risk of extinction in the wild. For an estimated 200 species, we are too late; they are already extinct. Other species survive in cultivation, but their native habitats are gone.

It is under these circumstances that botanic gardens find themselves becoming partners with those who conserve our natural heritage. Botanic gardens have many skills

to lend to the effort including knowledge of plant propagation and growth, research facilities, and dedicated staff. Techniques such as cryogenic seed storage, tissue culture micropropagation, and isoenzyme analysis may seem like methods of the future, but such tools will be an essential part of the conservation repertoire if we are to ensure the survival of rare plants and plant communities in the United States. As conservationist, we believe that tomorrow really will come.

An overview of cooperation between onsite and offsite natural resource management is given in an earlier article in the *Natural Areas Journal*. This article provides specific examples of how botanic gardens are helping to conserve rare plants, especially through the auspices of the Center for Plant Conservation (CPC). The CPC's program is aimed at encouraging botanic gardens to develop cohesive conservation projects. The program is part of an overall goal of integrated conservation strategies, which incorporate site protection, habitat management, and offsite backup and research. We believe that such integrated strategies are ultimately the most effective approach to preventing extinction.

The Center for Plant Conservation: Founded in 1984, the CPC is the first private conservation organization in the world dedicated to offsite germplasm conservation of the nation's rare flora. Its network includes nineteen regional botanical gardens and arboreta, each with a strong commitment to plant conservation. The CPC's objective is to create offsite germplasm collections (collections of seeds, living plants, tissue culture, pollen, and other plant material containing genetic information) of rare and endangered native plants in each region of the United States, so that there will be at least one site where any endangered species can be safely grown to ensure survival. Methods include collection and propagation, seed storage, maintenance of living plants in cultivation, and research on reproduction and growth. Collections are designed to represent the genetic composition of the wild populations to the greatest extent feasible. The collections thus act as a resource for the future, specifically for research into the plants' reproduction and biology or for carefully planned reintroductions into native habitats. Throughout the process the CPC works closely with other plant conservation professionals, both in identifying the highest priority taxa for offsite conservation and in developing strategy for offsite germplasm collection.

A basic part of the CPC's mission is to cooperate with agencies managing wild populations and their habitat. The old dichotomy of "in situ versus ex situ" is dissolving gradually as evidence accumulates that cooperative programs can be more successful than any single method applied alone. This trend toward integrated conservation strategies may represent one of the most significant developments in conservation methodology.

Current Cooperations in Endangered Species

Management: Following are examples of how botanic gardens and arboreta are carrying out plant conservation efforts in the United States today. Activities range from active management of natural areas to seeking information on conservation priorities. Many of the examples cited in this article predate the CPC or have proceeded independently of its efforts; no implication is made that all the cited projects are associated with CPC at the present time.

Management of Natural Areas: Botanical gardens often manage large tracts of land. It is not surprising, therefore, to learn that rare species have been identified on land owned by several botanical gardens. Other gardens have contracts to managelands or species not under their direct control.

Bok Tower Gardens in central Florida discovered two rare species on their 12-ha (30-acre) nature preserve while conducting a survey in 1985. The extremely rare clasping warea, *Warea amplexifolia*, occurs in only a few other locations. Additionally, botanists found nearly twenty scrub plums, *Prunus geniculata*. Both species are found only in central Florida's scrub pine habitats. As part of the CPC's program, Bok Tower collected seeds from the natural populations and is maintaining cultivated populations. The CPC's scientific Advisory Council approved the plans for maintaining separate collections but cautioned against growing plants from other populations of either species at Bok Tower so as not to affect the genetics of the wild populations found close by. In addition to land owned directly, Bok Tower Gardens manages the nearby Tiger Creek Preserve for the Florida Field Office of The Nature Conservancy, which is habitat to several rare Florida species.

Another example is the Pacific Tropical Botanical Garden in Kauai, Hawaii, which owns several natural areas on Kauai and other islands. One area near Kona on the island of Hawaii is home to several rare plants, including *Kokia drynarioides*, *Nothocestrum breviflorum*, *Dracaena hawaiiensis*, and *Colubrina oppositifolia*.

The Denver Botanic Gardens manages three off-site properties, including the 8-ha (20-acre) Walter S. Reed site in the montane zone of Upper Bear Creek Canyon in the Front Range, the 65-ha (160-acre) Mt. Goliath Alpine Unit on the slopes of Mount Evans, and the 283-ha (700-acre) Chatfield Arboretum in Jefferson County, southwest of Denver. Together these three sites provide opportunities for field research and education, in addition to being significant natural areas in their own right.

Recommending Target Species: Developing a program involves establishment of priorities. Since the CPC's program has a national scope, it is important to determine clear criteria for selecting target projects in any given year. The CPC's approach has been to integrate existing national endangerment rankings with other data collected specifically for and by the center. The published listings of the U.S. Fish and Wildlife Service in the Federal Register are a basic source, as are the global ranks assigned by The Nature Conservancy. The question is how to select the most important plants for collection and research in any given year from this data set of more than 5100 listings. To aid answering this question, the CPC has been conducting a national survey of 120 regional botanists, asking them to identify species that may be facing extinction in ten years or less. More than 200 plants have been identified as this close to extinction; these taxa naturally will have the highest priority for the CPC program in the coming years.

Conservation Collections : Several examples in this article describe conservation efforts that could proceed only because plants had been collected previously and established in a permanent living collection (see the descriptions of projects for *Kokia cookei*, and *Arctostaphylos uva-ursi* var. *leobreweri*). For this reason, the establishment of offsite conservation collections is the

primary focus of the CPC's efforts.

Conservation collections that provide some insurance against total extinction may now be found at botanic gardens in all parts of the United States. Extremely rare plants such as Peter's mountain mallow (*Iliamna corei*), running buffalo clover (*Trifolium stoloniferum*), Texas snowbells (*Styrax texana*), Knowlton's cactus (*Pediocactus knowltonii*), Tennessee purple coneflower (*Echinacea tennesseensis*), Florida torreya (*Torreya taxifolia*), and the blowout penstemon (*Penstemon haydenii*) are protected in permanent living collections or in seed banks. Such collections are most effective when they are maintained as part of a coordinated, comprehensive program such as that of the Center for Plant Conservation.

Endangered species can be maintained at botanic gardens or in seedbanks for long periods of time, although long-term maintenance can present formidable technical, scientific, and institutional difficulties. One of the basic roles of the Center for Plant Conservation is to encourage institutional commitment to conservation programs, along with providing technical and financial assistance.

The first instance of an American species saved from extinction through conservation collection was the Franklin tree, *Franklinia alatamaha*. The tree was extirpated from its only known wild location in Georgia in the late nineteenth century but exists today in many cultivated collections. One such collection is at The Arnold Arboretum of Harvard University; the large shrubs in the collection are probably genetically close to those once occurring in the wild.

Several plants face imminent extinction in the wild with little or no hope of saving their natural habitats. In such cases offsite conservation collections may offer the only hope for perpetuation of many species. Conserved germplasm will be available for reestablishment into the wild if and when suitable circumstances develop. Following are examples of three Hawaiian conservation collections.

A single tree in a degraded habitat is all that remains of the palm, *Pritchardia munroii*. Although the plant produces seeds prolifically, both the seeds and seedlings are consumed by domestic and wild animals, preventing seedling establishment. Seeds from this lone survivor have been collected and are being grown at the Waimea Arboretum and Botanical Garden.

Also grown at Waimea is a rare mallow, *Hibiscus brackenridgei* var. *mokuleina*. Most wild plants in this taxon already have disappeared from known sites. The one remaining population is in such poor condition that Waimea's director, Keith Woolliams, estimates that it will only survive for one or two more years. Botanists are searching for additional populations but so far have been unsuccessful. Meanwhile, Waimea has collected propagules from the current site and already has material from another location, now extirpated.

Another plant grown at Waimea is Cookei kokia, *Kokia cookei*. This tree, now extinct in the wild, bears beautiful large red flowers. Before the tree became extinct in the wild, Waimea collected cuttings and established a cultivated population. Only seven trees remain of the species, all in cultivation at the arboretum.

Rescue and Mitigation: When efforts to save a population in the wild fail, salvage of the plants is sometimes still possible. Few biologists feel that salvage efforts are likely to conserve a species in the wild, since specific habitat requirements may be lacking in the sites to which they are moved. The shock of transplantation and establishment can further threaten the survival of individual plants. Nonetheless, where extremely rare species are concerned it is better to retain living plants if at all possible. Several recent examples of salvage and transplantation will show how the process works.

Barrett's penstemon, *Penstemon barrettiae*, is a beautiful rare plant endemic to the Columbia River Gorge. One recently discovered population grew on a cliff near the Bonneville Dam. The Corps of Engineers (COE) had scheduled a new navigation lock before the plants were discovered, and no site alternative for the lock existed. Since the species is not listed under the U.S. Endangered Species Act, the COE was under no obligation to protect the site or the species. But the Corps of Engineers proposed that cuttings of the plants be taken for incorporation into garden beds on the dam property. The Berry Botanic Garden in Portland, Oregon, undertook the projects, which was paid for by the COE and aided by volunteers. In May 1987 and March 1988 the plants (progeny by cuttings from the original population) were transplanted into the prepared beds. Additionally, plants were reestablished on one natural rock face that had been spared blasting. Backup cuttings and seeds also are maintained at the Berry Garden to help preserve the gene pool of this particular population. Another example is the Florida goldenaster, *Chrysopsis floridana*. In 1987 Bok Tower Gardens in central Florida collected seed of this species from a site that was slated for residential development. The parks departments for several nearby counties were interested in the species. Bok Tower Gardens supplied more than a thousand seedlings of this attractive species for planting into natural sites not far from the original site. The plants are being monitored to determine the success of the program.

The plant rescue project at the North Carolina Botanical Garden in Chapel Hill has been operating for more than sixteen years and is probably the most established garden-based rescue program in the country. Using staff and volunteers, the garden has rescued plants on dozens of sites scheduled for destruction. Garden collectors obtain the permission and cooperation of the landowner, often removing blocks of soil or sod for replanting. Rescue projects have included the white wicky (*Kalmia cuneata*), least trillium (*Trillium pusillum*), and Oconee bells (*Shortia galacifolia*). One rescue of the latter species involved relocation of more than 2500 plants to a protected site at the garden. Ironically, the population was threatened by expansion of a recreational hiking trail by a local utility.

In a similar case, Holden Arboretum in Mentor, Ohio, recently undertook the rescue of plants from a doomed population of the lake iris, *Iris lacustris*. The population was being destroyed by a highway-widening project of the state of Michigan, and all efforts to protect the population had failed. With the help of the Michigan Department of Natural Resources, the arboretum obtained bulbs to establish a permanent germplasm collection.

Reintroduction: Reintroduction, as defined in part one of this series, refers to returning a taxon to a habitat where it was once known to occur but from which it has

been extirpated. One recent reintroduction for *Stephanomeria malheurensis* was described in the first article in this series.

The Center for Plant Conservation does not undertake reintroductions on its own but does provide material to natural resource agencies managing natural areas or restoring endangered plant species. Reintroduction to a documented site is unlikely to cause genetic contamination of wild populations if done correctly, although proper precautions need to be taken.

A striking example of the reintroduction of a species extinct in the wild is the work of Tilden Regional Botanical Garden in Berkeley, California, with *Arctostaphylos uva-ursi* var. *leobreweri*. The only remaining population of this species, on San Bruno Mountain south of San Francisco, was destroyed by fire in the 1960's. Fortunately the garden had collected material from the site previously and maintained it in cultivation, thus preventing total extinction. In 1987 the garden began propagating plants for reintroduction near the original site, in cooperation with the state/county park in which the plants originally were found. The project will continue as a cooperative effort until the population is reestablished and requires only ongoing monitoring by the land managing agency.

Introductions Introductions into new habitats are undertaken when there are only a few extant populations or individuals left in the wild. Botanists use introductions to increase the chances of the species' survival in the wild. All such introductions must be considered experimental at present; until we have completed many years of monitoring, we cannot declare them successful.

An introduction into a new habitat recently was undertaken for Texas snowbells, *Styrax texana*. The project was proposed and funded by the U.S. Fish and Wildlife Service, and much of the work was carried out by the San Antonio Botanical Gardens. Texas snowbells are one of Texas' rarest plants. The shrub, bearing attractive bell-shaped white flowers each spring, is known from fewer than thirty individual plants in the wild, which grow along cliffs of spring-fed streams of the Texas hill country. The existing populations, all on private land, are out of reach of the native and exotic herbivores that threaten their survival. In 1986 and 1987 staff at the San Antonio Botanical Gardens collected seed from wild plants. Germination proved to be extremely successful, and twenty-five plants were introduced into each of two new sites in fall 1987. These new populations, introduced into sites where the species was not known to occur previously, are being monitored closely by a botanist. Survival was high in the first few months after transplantation, but monitoring will continue for many years. In related efforts the landowner of the largest natural population of Texas snowbells recently agreed with The Nature Conservancy to allow fencing of the population to protect it from grazing herbivores.

An experimental introduction of the tiny endangered Knowlton's cactus, *Pediocactus knowltonii*, is showing marked success after two years. The species is now known from only one site in New Mexico, a location well-known to commercial and private collectors interested in the species. Since the land is under the management of The Nature Conservancy, the major threat at present is from collectors. In 1984 the U.S. Fish and Wildlife Service and the New Mexico Natural Resources Survey teamed up to

introduce the cactus into a new location with geography, soils, and climate nearly identical to the known habitat. Cuttings were taken from plants at the known locality and rooted in small pots. Although the propagation was done under contract with a private nursery, techniques were similar to those employed by botanic gardens. After a season in the greenhouse the plants were transplanted into the new site in a grid pattern set up to facilitate monitoring of the new population. After two years, survival is over 80 percent, leading to guarded optimism about the survival of the introduced population. Botanists will continue to monitor the population for survival and seedling production.

Revegetation and Enhancement of Existing

Populations: In many cases a conservation strategy focuses on enhancement of a population that has been damaged, often by grazing or off-road-vehicle use. Plants in naturally unstable environments such as dunes or talus slopes may be particularly prone to disruption. In such cases material (seeds or cuttings) may be taken from the site, propagated, and replanted onsite to help reestablish the population.

A case in point is the restoration of a Vermont population of *Hudsonia tomentosa*, a state endangered species found on land owned by The Nature Conservancy (TNC). Off-road-vehicles had nearly destroyed the population when TNC arranged for propagation of cuttings taken from the remaining plants. The rooted cuttings later were transplanted back to the original location, helping to reestablish the population. Such efforts are especially reliable because the propagated material is genetically consistent with the site's genome. This is an important consideration in cases where there is genetic variability between populations. Whenever possible, revegetation projects should use material taken from the site itself.

Population enhancement often relies on research to guide project design. A particularly cogent example is presented by the Catalina mahogany (*Cercocarpus traskiae*). The Catalina mahogany is known from only seven plants confined to a single canyon on the southwest side of Santa Catalina Island off the coast of southern California. Once consisting of forty trees, the population declined through overgrazing and soil loss caused by large herds of sheep and feral pigs. Active management of the seven remaining individuals began with fencing of two trees in the late 1970's by the Santa Catalina Conservancy. More extensive fencing was added in 1985. In 1987 the Rancho Santa Ana Botanic Garden began working closely with the Santa Catalina Conservancy to perpetuate the species. Using isoenzyme studies, they determined that only five of the seven trees were truly *C. traskiae*. The other two were hybrids with the more common mountain mahogany, *C. betuloides* ssp. *blanchae*. The chemical study confirmed what biologists had suspected from examining the trees morphologically. Armed with this knowledge of the trees' parentage, the Santa Catalina Conservancy will reintroduce rooted cuttings of the five true trees to help build back the population. If they had used cuttings from all seven trees, Rieseberg believes that "Catalina mahogany might be lost . . . and that our management efforts might actually be speeding up the loss."

Enhancement projects also can involve transplanting common species to stabilize or revegetate a site, making it more hospitable for rare species. Such projects more correctly fall into the category of habitat restoration.

Restoration: The field of habitat restoration, or restoration ecology, is attaining increasing importance in plant protection efforts, for it is on a restored habitat that the survival of many rare species may depend. Restoration was recently the subject of a national conference and may represent one of the most synthetic conservation disciplines. Its original focus on severely degraded sites may find applications in endangered species preservation. For instance, a West Virginia site that had been destroyed by coal mining underwent a restoration that included establishment of the rare *Marshallia grandiflora*. Plants were collected, propagated in a greenhouse, and grown in a nursery to a size suitable for reintroduction.

Management Research: As important participants in integrated conservation strategies, botanic gardens have a responsibility to assist in the management and preservation of wild populations as well as maintain their own cultivated collections. One of the most useful contributions is to conduct rare plant research specifically designed to aid preserve managers.

An interesting current example involved the rare Peter's Mountain mallow (*Ilamna corei*), known from only one site with four plants in Giles County, Virginia. In cooperation with the Virginia Chapter of The Nature Conservancy, botanists at the Virginia Polytechnic Institute (Blacksburg, Virginia) and the North Carolina Botanic Garden (Chapel Hill, North Carolina) are studying seed germination, seedling establishment, flowering, and seed set in an effort to understand how the habitat should be managed to allow the population to regenerate naturally. The flowers presently abort before producing viable seed, indicating possible inbreeding sterility. In addition there are some indications that leaf litter at the site is inhibiting growth of the population, since there are substantial numbers of seeds in the duff layer that are not germinating.

The Plymouth gentian (*Sabatia kennedyana*) is another example being studied at the Garden in the Woods of the New England Wild Flower Society (Framingham, Massachusetts). The plant occurs naturally on pond edges in coastal Massachusetts, in what NEWFS propagator William Brumback describes as "alternating flood/bake conditions." Brumback found a way to germinate seeds in the garden and in so doing determined that the plant is monocarpic. This discovery has significant management implications because the soil seed bank therefore must constitute a large proportion of the species' total genome.

Management-related offsite research is being conducted on several other species such as *Lilium grayi* (North Carolina Botanical Garden), and *Aconitum noveboracense* (Cornell Plantations).

Basic Research: Botanic gardens and arboreta also conduct basic plant science research. Several United States gardens working with rare plants in the CPC's network are university-affiliated, including The Arnold Arboretum of Harvard University, the North Carolina Botanical Garden (University of North Carolina), the Rancho Santa Ana Botanic Garden (Claremont Colleges), the Nebraska Statewide Arboretum (University of Nebraska), the University of California Botanical Garden (University of California, Berkeley), and the Utah Statewide Arboretum (University of Utah). Others, such as the Missouri Botanical Garden and the New York

Botanical Garden, are independent but have a strong institutional tie to a university for teaching and research. And several gardens, notably the Fairchild Tropical Garden and the Pacific Tropical Botanical Garden, maintain research programs that are entirely internally managed. All of these have the potential to develop plant research programs that can significantly contribute to biologically sound conservation.

Research into the basic biology of rare plants includes studies in systematics, physiology, reproductive systems, and autecology, as well as horticulture. An excellent example is work carried out at The Arboretum at Flagstaff, Arizona, on mycorrhizal associations in several members of the genus *Pediocactus*. Arboretum staff have undertaken field collecting and propagation in cooperation with the regional office of the U.S. Fish and Wildlife Service, the state of New Mexico, The Nature Conservancy, and a private nursery. In 1985 the roots of Peeble's Navajo Cactus (*Pediocactus peeblesianus* var. *peeblesianus*) were observed to be heavily colonized by the fungus *Glomus deserticola*. Since then the arboretum has been conducting cultivation studies to determine the fungal symbiont's effect on the cactus' germination and growth rate. This previously undocumented symbiosis thus may have both basic and applied research interest. Related research by Barbara Phillips at the Museum of Northern Arizona with *P. peeblesianus* var. *peeblesianus* has demonstrated that the species is an obligate outcrosser, a formerly unrecognized characteristic.

From a conservation perspective, however, the most promising -- and vital -- realm of research concerns the distribution of genetic variation in populations of rare plants. For example, in species that typically self-fertilize it has been shown that genetic differences between populations are characteristically greater than for outcrossing taxa. Such patterns of genetic variation have enormous implications for the design of representative offsite germplasm collections, since they have a direct bearing on the number of sites that should be sampled and the size of the collections to be made. The problem in designing such strategies for rare plants is that, at the present time, so little data are available regarding genetic variation in rare plants that it is nearly impossible to construct a biologically sound program.

To address this need the Center for Plant Conservation is undertaking a one-year study program in genetic variation in rare plant species, to be concluded by a conference on the subject in March 1989. The purpose of the conference will be to bring the current state of knowledge in population biology and genetics to bear on conservation strategy and to advance the level of understanding in the conservation community.

Economic Research: Of the more than 1000 genera represented in the CPC's data base, more than two-thirds are congeners of plants with current or near-term economic potential. This includes crop genera (*Trifolium*, *Amaranthus*, *Zizania*); fruits, seeds, and nuts (*Vaccinium*, *Helianthus*, *Prunus*); forest products (*Pinus*, *Abies*, *Picea*, *Betula*, *Quercus*); and industrial products and pharmaceuticals (*Lesquerella*, *Linnanthes*, *Astragalus*). There are also hundreds of endangered plants in horticulturally popular genera (*Iris*, *Lilium*, *Rosa*, *Rhododendron*, *Penstemon*, *Magnolia*, *Fremontodendron*, *Carpenteria*) and families (*Cactaceae*, *Ochidaceae*). Botanic gardens can plan a key role by providing

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research-quality germplasm collections for screening programs.

In part to advance the systematic assessment of rare native plants for economic potential, the CPC has signed a cooperative agreement with the U.S. Department of Agriculture, National Plant Germplasm System (NPGS). Under this agreement the CPC and the NPGS will work jointly to store seeds of endangered native species and to develop material for USDA research in economic botany.

Conclusion: The conservation community is changing dramatically. Not only new institutions, but new kinds of institutions are becoming involved at a basic level. The entry of botanic gardens and arboreta into conservation in the mid-1980's has opened up new possibilities for cooperative projects in introduction, enhancement, restoration, and research into the dynamics of plant communities and endangerment.

Until recently such projects in botanical gardens were scattered, with no means to develop and apply consistent standards. As the Center for Plant Conservation and the botanical garden network gain experience in this area, they will become stronger allies in the fight against plant species extinction.

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