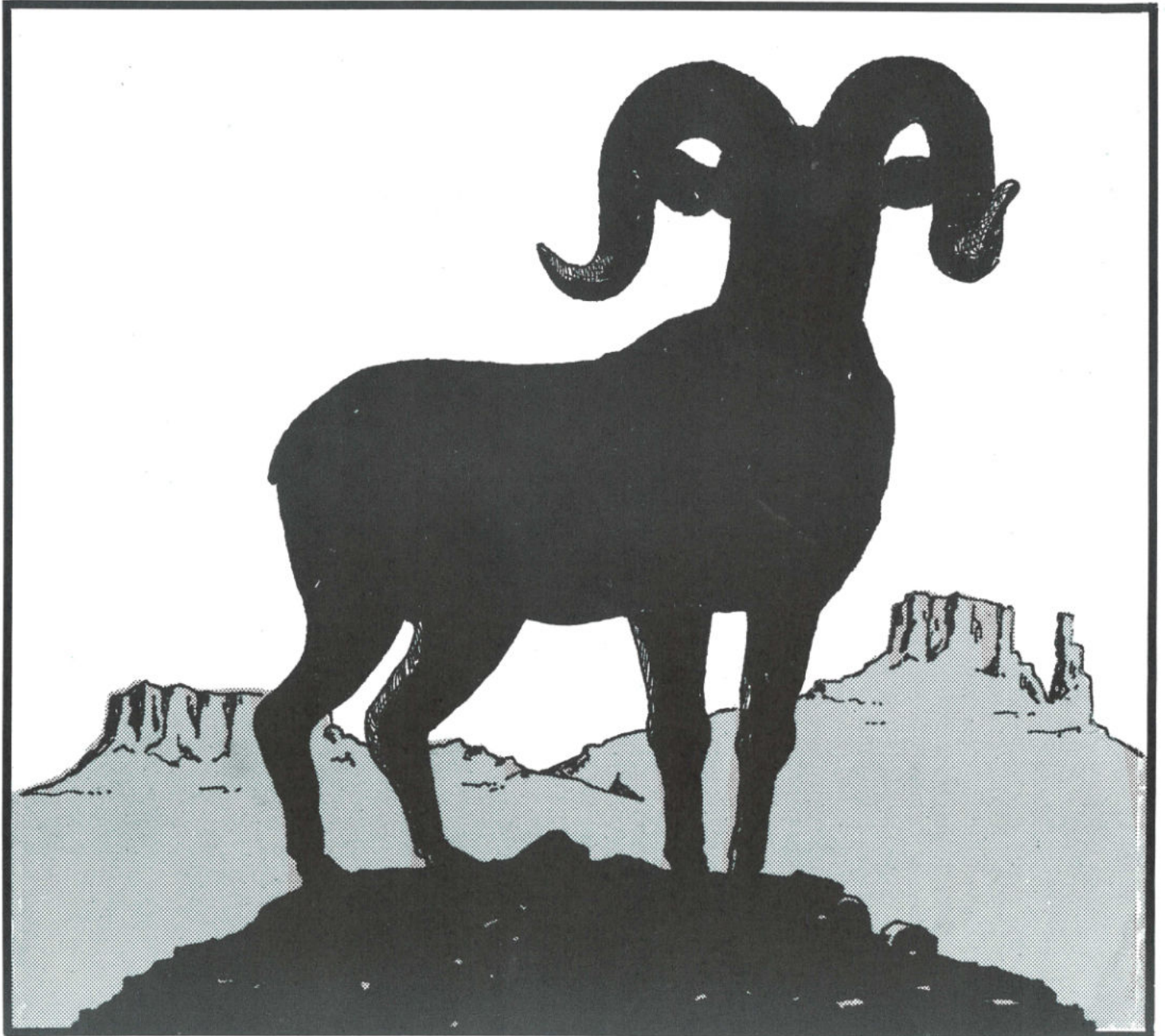


# Canyon Legacy

*A Journal of the Dan O'Laurie Museum - Moab, Utah*

#4

\$6.00



**Canyon Country Natural History**



The Dan O'Laurie Museum

# Canyon Legacy

The Journal of the  
Southeastern Utah Society of Arts & Sciences, Inc.

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# Canyon Legacy

Number 4

Contents .....	1
Within .....	2
Maligned or Malignant; Tamarisk: The Plant We Love to Hate by Dave May .....	3
The Return of the Desert Bighorn by Jean Akens .....	8
Sensitive Resources of the Colorado Plateau: Peregrine Falcons .....	15
Endangered fish .....	17
"Radioed" Rattlesnakes .....	18
The Black Footed Ferret and The Prairie Dog .....	20
Cryptogamic Soils .....	22
the above by Jean Akens and Dave May and Cisco Desert Antelope .....	23
by Joe Cresto .....	
QUATERNARY CORNER: A Brief Look at the Recent Past by Saxon Sharpe .....	24
and Mammoths on the Colorado Plateau by Larry Agenbroad .....	27
Books of Interest .....	30
Museum News .....	31
Next Issue .....	32

This issue is dedicated to past president of the Dan O'Laurie Museum Board of Directors, Pete Plastow. Pete, an accomplished western artist, recently resigned to allow more time for his career. His three-plus years as president saw many important changes, including a new museum building, the inception of this journal, and the design and creation of an entire new exhibit system. Thank you, Pete, for your vision and dedication, and we wish you well.

Cover design by Jim Stiles

WITHIN...

The Colorado Plateau,  
A place of vast open spaces  
rugged landscape,  
harsh, extreme climate.

Where the bare bones of the earth are exposed,  
only slightly blanketed by shallow rock soils and sands,  
dotted by plants adapted to eking out survival from rain to rain:  
inhabited by reclusive animals whose lives revolve around sparse springs,  
seeps,  
and potholes.

The canyon country is a place where the spirit soars  
with the wind  
like a golden eagle.

This is a land of contrasts.  
What appears rugged and indestructible at first glance  
is among the most fragile of all ecosystems.

This land of contrasts and paradox.  
Rugged lands of rock  
and  
marginal ecological balance.

by Kate Kitchell

The above is partial text from the script for the National Park Service video, GUEST IN THE DESERT: TREADING LIGHTLY ON THE COLORADO PLATEAU. I could find no better way to introduce the Winter Natural History issue of *Canyon Legacy* than through Kate's evocative description.

Reprinted by permission of Canyonlands National Park.

*Jean Akens*



Photo by F.A. Barnes

## Maligned or Malignant;

### *Tamarisk:*

## *The Plant We Love to Hate*

by Dave May

There probably are more people who detest goatheads than who despise tamarisk, but tamarisk-haters have developed their dislike to such a fine degree that their emotion far outweighs that of goathead (or even crabgrass) haters. That is as it should be, too, for tamarisk richly deserves every dollop of malice accorded it. Unfortunately, one of the primary reasons for disliking tamarisk is not justified; the dislike is justified, but not the reason.

Tamarisk, *Tamarix pentandrans*, is that lovely shrub or small tree one finds crowding the banks of the rivers and sprouting from every wet site in Southeastern Utah. With feathery light green branches waving in the canyon breezes, and clouds of soft pink to nearly white blossoms in the spring, tamarisk is a joy to behold. For many miles along the rivers, however, dense thickets of the stuff keep river travelers from getting to the rivers. That lovely, soft, colorful, and graceful plant becomes an industrial-strength nuisance if one wants to get from any "Point A" to any "Point C" when tamarisk occupies "Point B".

The river-running fraternity finds tamarisk to be especially obnoxious. Dense thickets occupy hundreds of sites which, but for the plants, would be ideal campsites. Impenetrable walls of vegetation prohibit access to side canyons and other points of interest. Within a few years, it can - and does - transform idyllic places like Jasper Canyon into rasping, scratching, poking, and in all other ways hurtful and insulting jungles. In short, "tammies" are despicable plants and ought to be prohibited by an Amendment to the Constitution. Bad as it is, tamarisk is innocent of the crime most often attributed to it.

Tamarisk is an exotic species, a plant native to another part of the world and introduced here by humans. That places it in a class with dandelions, cheatgrass, tumbleweeds, and Siberian elms, none of which is among most people's favorite plants. The reason most often given

for disliking the plant is none of the valid points outlined in previous paragraphs; the basic excuse for hating tamarisk is that it overwhelms our native species. Tamarisk stands accused of invading stands of native riverside vegetation and destroying them; crowding out and replacing native plants. By destroying our good native plants, the exotic becomes evil. Its other characteristics just make it rotten, a massive pain in the ... well, neck.

Now, this writer does genuinely despise tamarisk. He has wriggled through thickets of it on his tummy while his naked back was ripped and torn by the stuff. His clothes have been shredded and sensitive parts of his body assaulted by protruding sharp branches, and gallons of his blood have been consumed by mosquitoes that harbor in it, only to come swarming out when a tender, tasty body approaches. In nearly 20 years of river travel, however, and despite conscious efforts to find evidence of tamarisk invasion of native vegetation for more than half that time, this author has been unable to find any evidence that the plant is guilty of the crime most often charged to it. Indeed, a careful observer can find thousands of examples of tamarisk encouraging the spread of native plants, but not one case of native plant suppression by the exotic along the rivers.

Tamarisk is a "pioneer species", a plant which establishes itself on surfaces devoid of other plants. Mature specimens produce millions of seeds each year, seeds which are widely distributed by air movements. If those seeds are to germinate and grow, they must land on a moist surface exposed to full sunlight; they will not germinate on a dry surface nor in the shade of other plants. Entirely by coincidence, tamarisk happens to produce most of its seeds at the same time southwestern river water levels are dropping from spring highs. As the rivers dwindle, they expose large areas of wet sand and silt which are ideal seed-beds for tamarisk.

It is the usual practice of the rivers to form those deposits we call sandbars and beaches each year and to rip them out during peak flow the following year. The deposition of sediments is controlled by flow patterns within the rivers, and those patterns (in turn) are dictated by the shape of the canyons in which the rivers flow. Thus, beaches and sandbars are destroyed during high water and then rebuilt in the same locations every year, although it may appear to us that they remain in place from year to year.

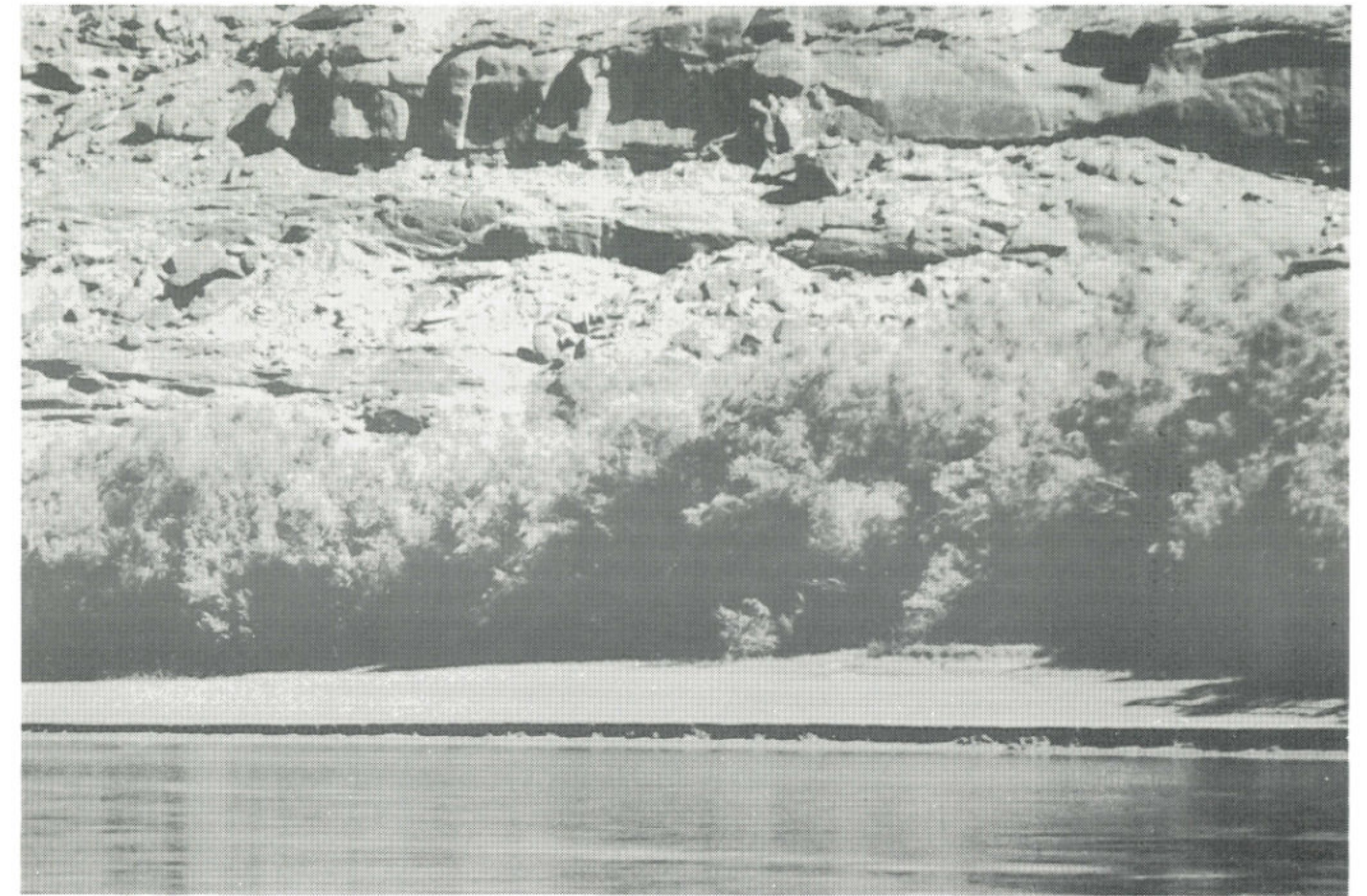
Native plants are well adapted to local conditions. They tend to establish themselves on more stable soils along the very edge of the rivers' flood plains and to stay out of the zone subject to frequent destruction and replacement. Prior to the arrival of tamarisk about 50 years ago, Canyon Country rivers were bordered by wide expanses of bare sand. Early photographs, such as those taken on the second Powell expedition in 1872, show little or no vegetation between the water's edge and the natural levee on which cottonwood and other native plants grow. That levee is still there and it still supports cottonwood trees - many of them the same trees Powell observed. Now, however, there often is a dense thicket of tamarisk extending from near the water's edge to the levee.



*Roots and lower stems buried in sediments allow rapid re-growth after fire has destroyed the upper parts of tamarisk.*  
by Dave May

As the river level drops in late spring and summer each year, a band of wet sand and mud is exposed along each bank. Depending upon soil type (sand dries out more quickly than mud), slope, and other factors, the surface may remain moist for a week or more. Tamarisk seeds can travel great distances on the wind, but eventually fall to the ground. If they land upon the wet, newly exposed surface near the rivers, they quickly germinate and produce a few small leaves above a rapidly growing root. By the time the surface dries the seedling has a root extending several inches into the moist soil beneath the surface.

Top growth of the seedling is not very impressive during the first year, but the root heads straight for the center of the Earth. This writer has pulled up 6 inch tall tamarisk seedlings with roots more than 3 feet long in late summer. If the beach on which the seedlings sprouted is not swept away the following spring (because of lower water levels, for example), the plantlets really take off. The root extends more deeply into the soil and branches profusely, while the top grows to a height of as much as three or four feet. Once the plants have achieved that second season's growth, only the extremely high water level of the biggest floods is likely to dislodge them.



*Tamarisk typically develop in even-aged stands of limited extent: "lawn" of seedlings on newly exposed beach (foreground) adjoins older stands embedded in sediment trapped by older plants.*  
by Dave May

In years of moderately high run-off, the soil on which the tamarisk first germinated may be under water, but the plants can tolerate inundation for weeks without harm. Also, the tangled stems of the tamarisks slows the water's rate of flow. As the flow rate drops, the water loses much of its ability to carry sediment so a layer of sand or mud is deposited around the plants. Each time a few more inches of soil is added, the plants become more securely established. As the plants grow taller and branch more profusely, the thicket is more effective at slowing the water; more and more soil is deposited around the plants. Within a few years, the seedlings which sprouted in a narrow band along the riverside have become a stand of shrubs growing in a low ridge of soil they have trapped and stabilized.

Meanwhile, in subsequent years, additional strips of wet sand are colonized by tamarisk. Those plants proceed in the same fashion as described above, and the wide, bare beaches which were originally present are covered by narrow, curving bands of tamarisk. Along each band, all the trees are of the same age, but adjacent bands may be of very different ages. In many cases, each band is located on a separate ridge of trapped soils. In a few cases the entire area is evenly filled.

Viewed from above, the banded nature of tamarisk groups is clearly visible, with trees of the same age forming long, curving bands that parallel the course of the river. Viewed from the water level in mid-July, the tamarisk seem to be growing on a soil surface many feet above the water level. In fact, those plants began their lives on a surface very near the present water level; the high banks (up to 10 feet or more) consist of sediments trapped and stabilized by the trees. One of the reasons that fire is totally ineffective in controlling older tamarisk is that the roots and portions of the stems of the plants are deeply buried and well insulated by several feet of soil. Heat from the fire cannot penetrate far below the surface, so the roots are undamaged and buds on the stems are available to produce new top growth.

Tamarisk controlled sedimentary deposits under older stands of the pest (such as those near the confluence of the Green and Colorado rivers in Canyonlands National Park) now are so deep that they rarely are covered by water. Mud and sand deposited on them during the extreme high water years of 1983 and '84 will not be inundated until equally high water levels occur again. That could happen next spring, but it is more likely to be 50 or 100 years from now



Cottonwood (center) growing on old levee marks pre-tamarisk limit of native vegetation. Tamarisk thickets now occupy previously bare sand between levee and water's edge.  
by Dave May

- or considering changes in water flow caused by humans, never.

Older, relatively stable soil surfaces are being invaded by native species of plants. Young cottonwood trees are not numerous, but can be found in scattered locations. *Forestiera* and other shrubs are abundant and spreading very rapidly. Those native plants are growing in soils provided and enriched by tamarisk and others will follow: hackberry, redbud, and others surely will appear. Peachleaf willow will become established along the water's edge (the only place it grows) and sandbar willows will form thickets nearby. In other words, the same plant associations that once were found along the natural levee will extend themselves to the "new" river bank as long as tamarisk is present to stabilize the soil.

Tamarisk's ability to stabilize soils is the plant's most notable attribute. Seedlings often occur in very dense stands of several hundred plants per square feet. Their roots penetrate deeply into the earth and branch vigorously. Although competition eventually reduces the number of plants to a tiny fraction of the original density, the survivors' root systems hold the soil so well that the plant ex-

erts a high degree of control over the size and shape of river channels. In the 1970s, a study of the effects of tamarisk found that portions of the Green River's channel in Canyonlands National Park had been reduced to 25% of their former width by the plant. The extraordinarily high run-offs of 1983 and '84, in both the Green and Colorado rivers, ripped out a few parts of established stands of tamarisk but had little overall effect. At Cataract (or Spanish) Bottom in Cataract Canyon, an arc of cottonwood trees marks the former edge of the river's flood channel. Those trees now are about 100 years from the water's edge; neither the floods of the early 80s nor an intense fire in 1988 have impaired the tamarisk's ability to maintain the new river bank.

As native plants invade areas stabilized by tamarisk, the natives replace the exotics. Some natives, such as *Forestiera*, are increasing rapidly from year to year and in some places have nearly replaced tamarisk. The seeds of at least some native plants apparently are capable, unlike those of tamarisk, of germinating in the shade. Seeds of some natives also may be capable of lying dormant for long periods of time until optimum conditions for germination occur; tamarisk seeds appear to remain viable for

only a very short time after being produced. Whatever the reasons, they work - and are working. Native plants are invading tamarisk stands and are spreading. What, then, will the future bring? Will native vegetation overwhelm the exotics and gradually eliminate them? Can the "home team" whip the bejagers out of the visitors?

Regrettably, it seems unlikely. If the native species were capable of maintaining stabilized surfaces within the historic flood channel of the rivers, they would have done so long ago. Tamarisk have demonstrated that they can withstand the ravages of the rivers, but not the inroads of native plants. Thus, it seems likely that native plants will replace tamarisk until the exotics no longer protect the natives, at which time the rivers will scour large areas of riverbank down to the old pre-tamarisk beach level.

Then, as the receding waters expose a band of wet soil on both sides of the rivers, tamarisk seeds will germinate and begin to grow...

#### ABOUT THE AUTHOR

*Dave May is an avid river runner and retired chief interpreter of Canyonlands National Park. He provides interpretive training for commercial river guides, in the course of which he teaches the "truth" about tamarisk. May insists that his non-traditional explanation of tamarisk's role will be accepted "...by anyone who actually looks at what is going on rather than just parroting the 'accepted wisdom.'"*

#### Tamarisk? Tamarack? Salt Cedar?

In addition to the number of unprintable names cheerfully assigned the plant, *Tamarix pentandrans* has several common names. If there is "right and wrong" among common names, then "tamarisk" is the correct term.

"Salt Cedar" is derived from the fact that the plant is fairly tolerant of saline soils and has foliage somewhat like that of junipers (which in North America often are called cedars). Tamarisk is neither a cedar nor a juniper, however, and is not closely related to either.

"Tamarack" is not a near relative of tamarisk, either; in fact, tamarack is more closely related to cedars and junipers than to tamarisk! The similarity of the two names, presumably, is the source of the confusion. Tamarack is a North American larch, *Larix laricina*. Tamarack is a conifer that, unlike most of its relatives (pines, yews, junipers, hemlock, etc.), sheds its leaves (needles) in autumn and grows a new set each spring.

The other common names, those which cannot be printed in a family oriented magazine, are numerous, varied, imaginative, colorful, and entirely appropriate.



Young porcupine.  
by F.A. Barnes

# The Return of the Desert Bighorn

by Jean Akens

More than any other creature, Desert Bighorn have become the symbol of desert wilderness in the southwestern United States. Their close relatives in other habitats (Dall Sheep, Rocky Mountain Sheep, and others) have similar status in their respective areas. The popularity of bighorn as symbols, however, is not just a modern fad, for Desert Bighorn apparently were highly regarded by the prehistoric occupants of the Southwest. Images of the sheep are among the most numerous figures painted on and carved into canyon walls by members of Anasazi, Fremont, Archaic, and other cultures. Prehistoric peoples also saw a lot more bighorn than we do!

Estimates of wildlife population numbers prior to the arrival of Europeans in North America are only guesses, but some estimate that as many as two million Desert Bighorn were present. That number may be due more to excessive enthusiasm than hard data, but there were "at least" several hundred thousand during historic times. Father Silvestre de Escalante, in 1776, observed bighorn in what now is Glen Canyon and reported, "Through here wild sheep live in such abundance that their tracks are like those of great bands of domestic sheep. They are larger than the domestic breed, of the same form, but much swifter."

A century after Escalante's historic journey, the number of Desert Bighorn had begun a general decline that would continue for nearly a hundred more years. Settlement of the West brought habitat changes to which the sheep could not adapt. The introduction of domestic grazing animals and fencing of western grasslands had major negative effects. Some experts contend that bighorn exhibit "social intolerance" for cattle and domestic sheep, claiming the bighorn - aside from the effect of actual competition for food, water, and other necessities of life - cannot tolerate the presence of large herds of other grazing animals. Whether that is true or not, bighorn did prove susceptible

to the ectoparasites and diseases of domestic sheep, to which they had little or no natural immunity. Desert Bighorn populations dwindled to a few small herds in isolated pockets of wilderness.

One of those surviving herds was located in the land between the Green and Colorado rivers. The area occupied by this herd was near the center of the lands that were set aside as Canyonlands National Park in 1964. Domestic stock grazing continued in the park for several years but, as it declined and finally ended in the mid 1970s, Desert Bighorn populations grew. As their numbers increased, the animals moved back into areas from which they had been excluded earlier.

By 1980, it was becoming obvious that bighorn had reached the land's carrying capacity or soon would. Standard policy of the National Park Service (NPS) is to allow native wildlife to exist under natural conditions without human intervention, but the possibility of transplanting sheep to other areas came under consideration. Bighorn

"The trapping and transfer program was justified with the understanding that the trapping would be discontinued once the sheep were back into these good habitats and more than one population was remaining stable, or increasing."

Jeff Conner and Larry Thomas, *FROM THE CANYONS*, April 1986

existed in the Needles District but were thought to have been eliminated entirely from the Maze District. Park administrators wanted to transfer sheep into this area. Utah's Division of Wildlife Resources (DWR) and the Bureau of Land Management (BLM) also wished to reintroduce sheep to a number of areas from which bighorn had been eliminated.

The NPS and DWR entered into an agreement whereby bighorn from the Island in the Sky District of Canyonlands would be relocated to areas administered by both NPS and BLM. The State of Utah agreed to provide major funding and personnel for the project while the Federal government would provide additional personnel and, most importantly, the sheep. Approximately 50% of the relocated bighorn would go to areas chosen by each agency. The first transplant, in 1981, resulted in 26 sheep being moved to the Maze and 30 to the Bureau of Land Management-administered San Rafael Swell region. By 1986, 126 bighorn had been removed from the Island in the Sky herd and thriving populations were developing in other areas.

"Historical sightings, as well as sheep remains and numerous petroglyphs in the area, helped us to determine that bighorn had indeed once occupied the San Rafael Reef. This information, along with our habitat suitability studies, indicated that sheep would do well in the area."

Jeff Carroll, San Rafael Wildlife Biologist,  
*FROM THE CANYONS*, August 1984



courtesy of Bureau of Land Management

At first, bighorn to be transplanted were located by helicopter, then driven into a box canyon. A net was spread across the canyon mouth and the sheep were chased into it, again using the helicopter. They could then be immobilized and transported by truck or flown to their "new homes".

More recently, helicopters are used to carry a "net gun," which launches a net over a single sheep. Netting the sheep one at a time is both more efficient (more animals can be captured each day) and less stressful to the sheep because no long chases are required.

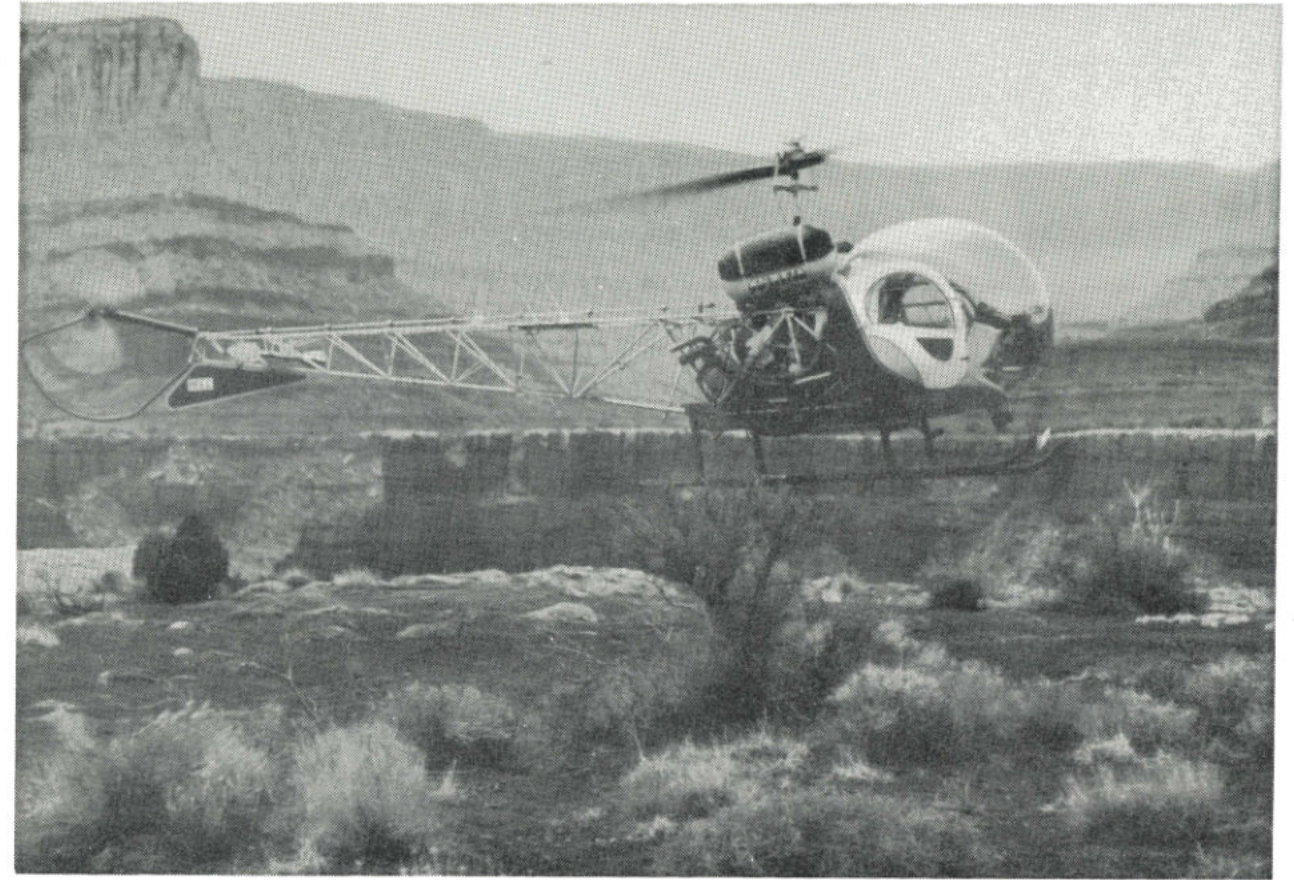
Although the herds in the Island and Maze Districts are either increasing or remaining static, those in the San Juan Herd, in and near the Needles District, are on the decline. For the past five years spring lambs die within about six weeks of birth. A DWR aerial count on BLM land in 1983 totaled 325 bighorns in the North and South San Juan herds. By 1988, this number had dropped to 69 sheep in the south herd and 8 in the north. No lambs are currently surviving in the north San Juan herd unit, and only 14 were counted in the south San Juan herd unit in 1988. As yet, no conclusions have been reached concerning the cause of the bighorn decline.

Despite the above dismaying figures, desert Bighorn herds established on most of the lands administered by the BLM have increased to the point where the State of Utah allows carefully controlled hunts for trophy rams. The state sells approximately 10-15 permits each season. Avid hunters pay premium prices for such permits (bids usually go for no less than \$20,000, and in some states bighorn permits have been auctioned for as high as \$109,000)! The removal of older rams benefits the rest of the population, while funds derived from the high bid trophy-ram permit help pay the costs of bighorn transplant programs, and for aerial counts conducted by the DWR.

From August 1980 through November 1988, the BLM funded a study through Utah State University, whereby the movements of bighorn fitted with radio transmitter collars were monitored. This was accomplished by air and from the ground. Study objectives were to collect forage utilization data, determine the influence of livestock grazing on bighorn habitat, gather physiological and disease information on all captured bighorn, and to monitor lambing success. A total of 22 bighorn were captured and fitted with radio collars. Much useful information was obtained from this study, such as bighorn home-range preference, and the fidelity of rams to certain breeding areas and of ewes to



*Bighorn equipped with radio transmitter collar.  
courtesy of Bureau of Land Management*



*Helicopter transporting equipment for water catchment installation.  
courtesy of Bureau of Land Management*

favorite lambing areas. The complete results of this eight year study are available at the Moab District BLM office.

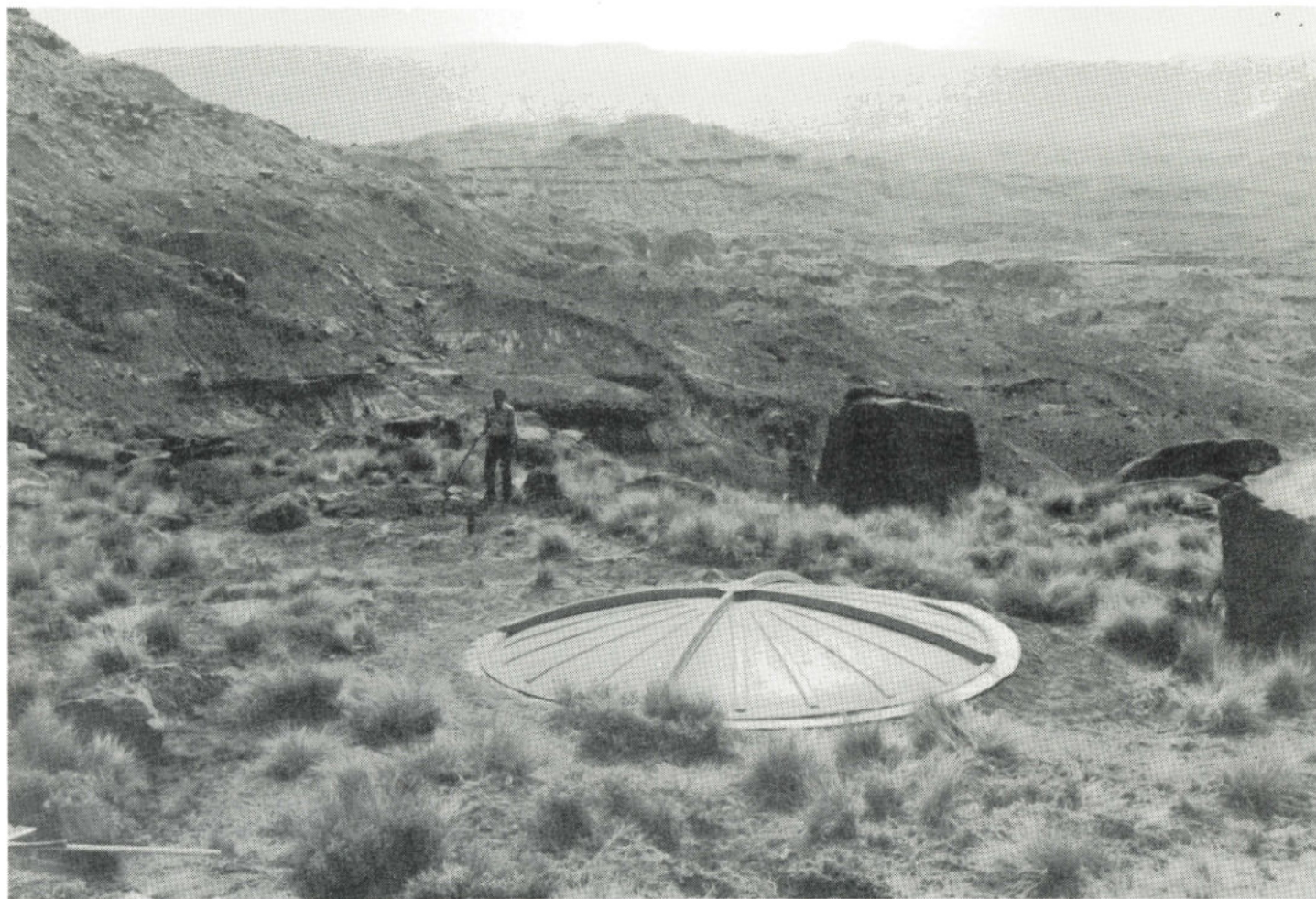
Accompanied by a group of Blanding Varsity Scouts, the BLM recently installed water catchment basins, often called "guzzlers", at Paiute Pass and on Found Mesa in the White Canyon-Red Canyon area. The project was directed by Geoff Walsh from the Monticello BLM office. Linda Seibert, the Moab District biologist, assisted, as well as David Lloyd of the Division of Wildlife Resources and Arden Taylor and the Utah Power and Light Crew, the latter by repairing the access road to Found Mesa. The most valuable assistance for the project, however, came from the Foundation for North American Wild Sheep, who provided funding for the purchase of the fiberglass catchments and paid for the helicopter flight time to transport volunteers and construction materials to the installation sites. The Foundation consists of a group of national and international sportsmen, who are dedicated to the well-being of the bighorn.

In 1985, the Potash-Confluence Management Plan was written for BLM-administered lands adjacent to the Island in the Sky District. As a result, five additional "guzzlers" have been placed in that area, also. The labor for the in-

stallation of two of the catchments was provided by the Canyonlands Wildlife Federation, which consists of a group of dedicated Moab Sportsmen. The Foundation For North American Wild Sheep also donated \$10,000.00 toward the purchase of the "guzzlers." The water catchments should aid in better distribution of the herds, increase lamb survival and improve the general health and well-being of the bighorn throughout the area.

The Moab District Bighorn Management Plan, written by Joe Cresto, Wildlife Biologist and Desert Bighorn Coordinator, was completed in 1987. The BLM is also in the process of adding an amendment to their 1985 Resource Management Plan (RMP) that would highlight Desert Bighorn management. When completed it will allow for the re-introduction of the sheep to Professor Valley, north of the Colorado River.

Another recent change in the status of BLM land on Elliott Mountain, north of the town of Green River, should have an impact on the bighorn population. Livestock grazing permits were relinquished on a total of 105,000 acres and a planning amendment is being prepared to include that area. This is an important habitat for bighorn sheep; there is a large undisturbed area that was



*Installation of "guzzler" in Red Canyon area, San Juan County, courtesy of Bureau of Land Management*

historic range for the animals. With the absence of domestic sheep, the native bighorn should again thrive in that region.

Bighorn studies continue on topics such as genetic diversity, the carrying capacity of the land, nutritional requirements, nutritive content of the plants they feed on, and stress and the interaction of sheep with different types of recreational use of an area. Even though the Desert Bighorn are recovering from earlier declines, problems still exist for them. These include a lack of habitat continuum because of the isolation of some herds, predation of small herds, forage competition with domestic livestock and deer, interactions with livestock and wild burros that transmit disease, and human intrusion.

Each year, counts from both the air and ground are taken by Canyonlands National Park to arrive at an approximate census of sheep within NPS boundaries. The 1988 figures were: 189 estimated sheep in the Island District, 21 in the Needles, 90 in the Maze and 30 in Arches National Park. The 1988 count conducted by the DWR for BLM lands resulted in a figure of 60 bighorn in the Potash Herd, with a ratio of 73 lambs per 100 ewes.

When visiting any area of Canyonlands National Park, those who sight bighorn are requested to fill out an observation form, available from rangers or at any of the visitor centers. Questions to be answered include the location of the bighorn, in what type of terrain they were seen, or whether they were near the river. The approximate distance between the observer and the animal is asked, as well as the number of sheep seen, their sex and approximate age, the reaction of the animals to human or vehicle contact, and comments concerning their apparent health. Any other useful information is also appreciated.

An extensive research program is proposed for 1991, to study the bighorn throughout the region. The National Park Service has money already committed for this multi-year project, which will also involve other government agencies. Several groups such as the Desert Bighorn Council, which consists of professional biologists, as well as state game agencies and conservation and sportsmens groups also work toward restoring the animal. Much has and will be done to see that this remarkable species will continue to thrive in the deserts of southeastern Utah.

...

### Desert Bighorn Statistics

**SIZE:** Bighorn can be as much as three feet at the shoulder and achieve 200 pounds in weight, but are usually smaller and much lighter.

**COLOR:** The usual colors are various shades of creamy gray or tan, with a distinctively lighter (often nearly white) rump.

**HORNS:** Both sexes have horns, which in young males and mature females are slim and slightly curved. As the males age their horns develop the graceful spiral form and massive bases from which the name "bighorn" is derived. Horns exhibit surface features related to annual growth patterns, allowing accurate gauging of the animal's age. Rams may be ten to twelve years old before their horns describe a full curl; they seldom extend much beyond that point because the rams abrade the tips.

**HABITAT:** Escape terrain is perhaps the most significant factor for bighorn. They prefer to live in steep, rugged terrain, where visibility is far, although they have been known to cross large expanses of flat country. They generally prefer habitat that is sparsely vegetated and show a liking for overhangs or shallow caves. These provide shelter, shade, and protection from avian predators like eagles who sometimes prey on newborn lambs. Bighorn habitat must also be sufficient in size if the animals are to sustain themselves over any period of time.

**FOOD:** Bighorn are grazing animals, subsisting primarily on grasses, but Desert Bighorn are somewhat more opportunistic feeders than other varieties. They utilize grasses when available, but also eat blackbrush, singleleaf ash, Mormom tea, and other shrubby plants.

**WATER:** Although there are reports of bighorn going for months without drinking, water is very important for lactating ewes. When water is available, it is also readily used by the entire population.

**BREEDING:** Bighorn mate in the fall (October, November) and lambs are born in mid to late spring (May, June), although there are many records of earlier and later births. Ewes usually have a single lamb, occasionally twins. If food and water supplies are ample, ewes may produce lambs every year, but lambing is typically less frequent.

**MORTALITY:** Bighorn are subject to predation by the larger carnivores (coyotes, cougars) and (not surprisingly, considering the rugged terrain they inhabit) to accidents. Mature bighorn in poor condition due to disease or parasites are more susceptible to both predation and accidental falls, as are lambs. Desert Bighorn have a potential life span of twenty years or more, but few achieve that potential.





courtesy of Bureau of Land Management

# Sensitive Resources of the Colorado Plateau:

by Jean Akens and Dave May

*The desert is far more fragile than first appearance would indicate. There is a delicate balance to the ecosystems that make up the natural environment. Numerous studies are currently being conducted in canyon country, some of which will be discussed in the following articles.*

## PEREGRINE FALCONS

Peregrine falcons show promise of becoming one of the success stories in recent efforts to protect and assist wildlife species that have become endangered due to human activities. Indeed, it seems possible that peregrines may be *removed* from the endangered species list in the foreseeable future, if present trends continue.

Falcons are one of the major divisions, or families, of hawks. Typically, falcons have long narrow wings, rapid wing beats, a notched bill, and a relatively long tail that narrows at the tip. With their streamlined bones, their heads appear larger in relationship to the rest of their bodies than those of other hawks. Falcons rarely soar, but can achieve extraordinary speed in flight. Peregrines diving in pursuit of prey have been estimated to move at speeds approaching 200 miles per hour.

The prey they pursue is usually another bird, a habit that led indirectly to the sharp decline in peregrine numbers. Most of the birds that the falcons prey upon are insect-eaters. For two decades after World War II, such birds were ingesting significant amounts of the pesticide DDT. DDT-laced meals concentrated the insecticide and its

chemical derivatives in peregrines and other native birds. One effect of the poison was to inhibit the secretion of sufficient calcium during egg-laying, resulting in thin-shelled eggs, which may be crushed by the weight of the incubating parents and are subject to other losses. Although pesticide levels might not be sufficient to kill individual adult birds, greatly reduced levels of reproduction appeared to doom the species. By the time DDT use was banned in the United States, peregrine populations had declined to very dangerously low levels.

Massive efforts to assist the birds were launched, including added protection from humans and a captive breeding program. Injured peregrines that could not be released into the wild became a nucleus of a caged population that produced offspring available for release. Eggs also were removed from the nests of some wild peregrines, hatched in incubators, and the young raised for release. The wild birds, meanwhile, would lay a second clutch of eggs and perhaps raise young on their own. Captive breeding programs have been highly successful and, as DDT levels in the U.S. have dropped, wild birds have enjoyed greater reproductive success, too.



*Peregrine falcon in flight.  
courtesy of Bureau of Land Management*

These successes have been encouraging, but peregrine falcons are not yet secure. Mexico and countries in South America still use DDT (most of which is manufactured in the United States). Peregrines and many of their prey species migrate south each winter, where they pick up a fresh load of DDT. Thin shelled eggs remain a problem for peregrines and other predatory birds, but the severity of the problem is much reduced.

Inter-agency research of peregrine falcons is an on-going effort, including the National Park Service, Bureau of Land Management, and Utah Division of Wildlife Resources. Continued study of breeding habits, prey/predator relationships, and other aspects of peregrine life improves our ability to encourage the recovery of the species.

An interesting aspect of peregrines is their unusual ability to achieve peaceful coexistence with humans. Peregrines find the "canyons" of great cities much to their liking and the local "wildlife" (pigeons, starlings, English sparrows, etc.) well suited to their palates. Most major North American cities, such as Baltimore, New York, Chicago,

Seattle, and Salt Lake City, now boast one or more pairs of peregrines in residence in the downtown areas.

A major part of peregrine research consists of monitoring their aeries (nests). Locally, seven pairs are known to reside in Canyonlands National Park and one in Arches. On land administered by the Bureau of Land Management, there are four pairs along the Colorado River, three along the Green, three in the San Rafael Swell region, and one on the Dolores River. Janet Ross of the School of Outdoor Education in Monticello has organized trips and provided assistants for the BLM count in San Juan County, where at least three pairs are known to nest.

In Canyonlands and Arches last year, a total of nine baby peregrines survived. Nine fledglings may not seem like much to brag about but, if all survived, would amount to an increase of more than 50%. On BLM land the increase is about the same. Considering the fact that the species was in sharp decline only twenty years ago, a 50% increase is nothing short of phenomenally good news! Each year the figures will vary, but the overall picture of the future for peregrine falcons is encouraging.

## ENDANGERED FISH

Since 1974 an ongoing study has been conducted by the Colorado River Fishes Recovery Team on endangered species in Colorado Plateau waterways. Sponsored by the U.S. Fish and Wildlife Service, the goal of these biologists from Arizona, California, Colorado, Nevada and Utah, is to restore to healthy populations those fish that are vanishing from the Colorado River and its tributaries. Species placed on, or nominated for, the endangered list are the Colorado Squawfish, the Humpback Chub, the Bonytail Chub and the Razorback or Humpback Sucker.

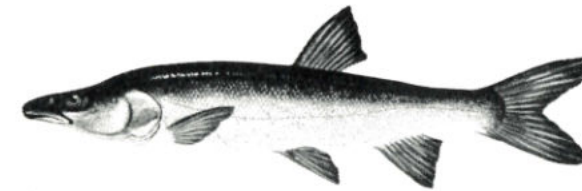
The Colorado Squawfish is the largest minnow in North America; at its population peak, some weighed between 50 to 80 pounds. It has all but disappeared from most of the river system. The Humpback Chub is now found only occasionally in the canyon country. It seldom weighs more than two pounds or exceeds 13 inches in length. The Bonytail population experienced the most rapid decline; once common in the Yampa and Green Rivers, it is virtually nonexistent today. The Razorback Sucker is one of the largest of its kind in the United States and may weigh 12 pounds. At present it is proposed for Federal protection as a threatened species.

The decline in the population of the fish is attributed to the same causes in each instance. Twenty-seven species of non-native fish have been introduced to western waterways

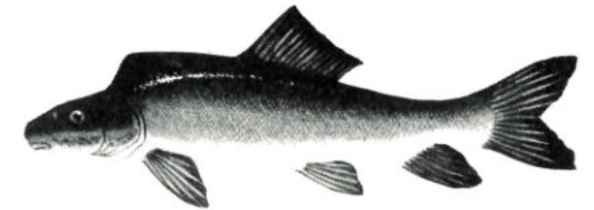
in historic times. These include catfish and pike, which are natural predators of the native fish; they also out-compete them for available food. The tamarisk is also causing plateau waterways to "channelize," therefore eliminating natural backwater areas necessary for spawning. The major problem, however, involves the habitat of the endangered species. Most need warm, flowing water to spawn in, and upstream dams have caused unnatural temperature and flow fluctuations, which the fish have not been able to adapt to.

Some measures are being taken to reverse the process. Flaming Gorge Reservoir in northeastern Utah has begun to regulate its water flow, so the amount released is more natural for the fish downstream. The water temperature has also been returned to more natural figures by pumping water from nearer the top where it is not as cold as that taken from the bottom, as was done in the past.

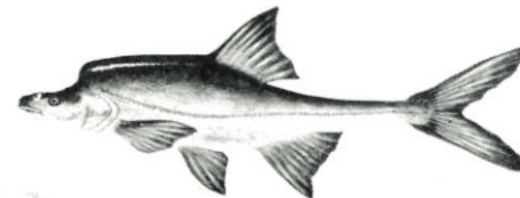
Also of benefit, the habits of the endangered species are being studied. Colorado Squawfish have been caught and tagged or had radios implanted in them. It has been discovered that this species travels far. For example, one fish tagged near the Green/Colorado confluence, was later tracked to near Grand Junction--a distance of about 100 miles!



*Colorado Squawfish*



*Razorback Sucker*



*Humpback Chub*



*Bonytail Chub*

*Paintings by K. Pendleton, courtesy of Colorado Division of Wildlife.*

Studying the habitat for spawning is also of considerable importance to understanding the fish. It is necessary to identify favorite areas, such as certain gravel beds, and to protect those sites. The fear is that some or all of these species may become extinct before their biology and needs are identified.

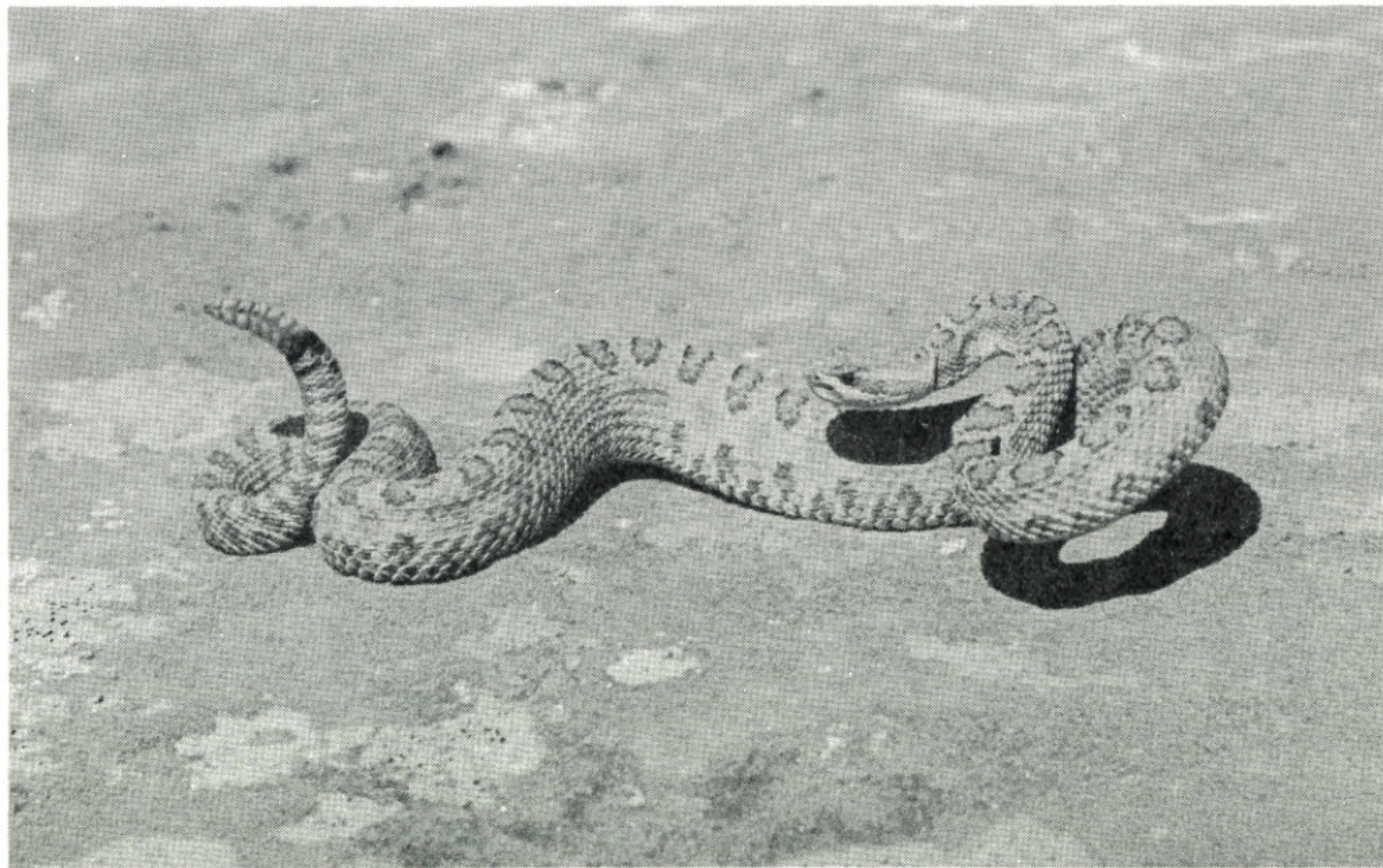
#### "RADIOED" RATTLESNAKES

One of the very few drawbacks to working at Natural Bridges Natural Monument has been the rather unusual number of midget faded rattlesnakes appearing in the employee housing area. There seemed to be more of the reptiles in the residence area than anywhere else in the monument, but no obvious explanation of why this was so. Some suspected the housing area was built on or near the snakes' hibernation den, while others thought it was on a regular travel route. At least one cynic thought it just *seemed* like there were more snakes present because there were more people there to see them. In 1988, it was decided that a small research project was in order.

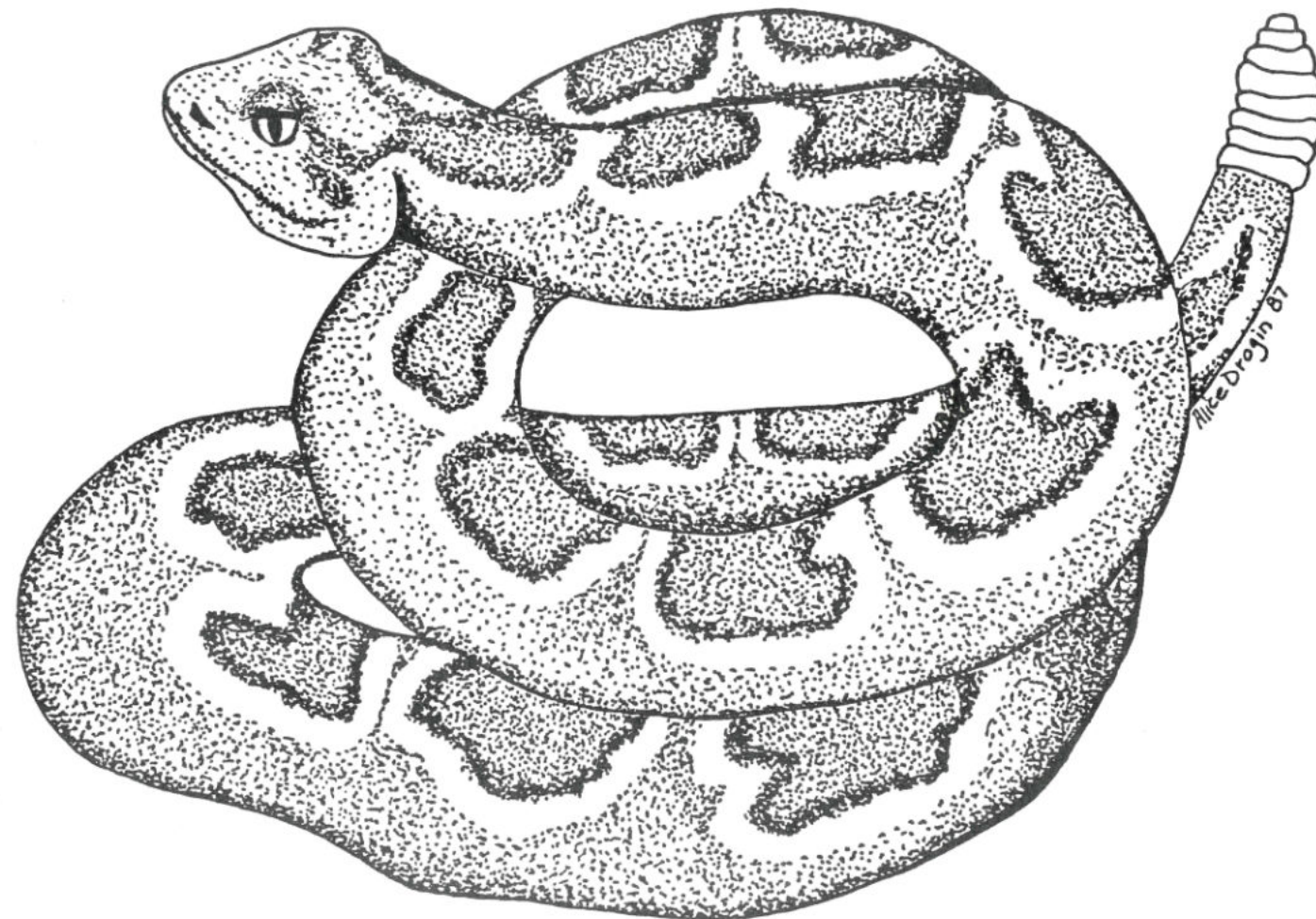
Fishermen can obtain a brochure from the U.S. Fish and Wildlife Service, which pictures and describes each endangered species, as well as those similar fish that are legal catches. Anyone fishing the Colorado or its tributaries should study the pamphlet, before these fish, too, have gone the way of other species lost forever.

Rattlesnakes were trapped and, with volunteer help from a veterinarian, were implanted with tiny radio transmitters. For perhaps the first time ever, the habits of radio-equipped rattlesnakes are being studied.

Like most "cold-blooded" creatures (reptiles, amphibians, insects, etc.) rattlesnakes operate efficiently within a fairly narrow range of temperatures. Unlike mammals and birds, which expend well over half their energy intake just to maintain body temperature, snakes neither generate much internal heat nor are effective in radiating excess heat. High temperatures can be fatal, so snakes generally shelter in a protected site during periods of intense heat.



*Midget faded rattlesnake.  
photo by F.A. Barnes*



*Drawing by Alice Drogin, for Reptile and Amphibian List,  
available from Canyonlands Natural History Association.*

Rattlesnakes are members of a group of snakes called "pit vipers." The word "viper" is applied to many snakes, but the "pit" part is a lot more interesting. Rattlesnakes, their close relatives, and certain other snakes have a small hole or pit on either side of their nostrils. Inside the pit are cells sensitive to infrared radiation. All warm bodies radiate energy in the infrared part of the spectrum and pit vipers eat warm-blooded animals such as rodents and birds. Thus, the snakes can locate and capture prey even when they cannot see it with their eyes because they can "see" the heat emitted by other animals. Housed in absolute darkness with their eyes covered, rattlesnakes exhibit unimpaired ability to capture prey. Those with their

infrared receptors covered are unable to locate and capture dinner.

The rattlesnakes in the Natural Bridges housing area have not yet demonstrated what exactly they are doing, but it appears that a nearby hibernation den is not involved. The snakes are monitored daily to determine how far and in what direction they move and if they have a "home" area in which they stay. Aside from the immediate interest in what the snakes are doing in the residential area, much new information about rattlesnake habits is being collected. Many questions have yet to be answered, however, before final analysis of this intriguing study can be made.

**CRISIS IN THE CISCO DESERT:  
The Black Footed Ferret  
and the Prairie Dog**

In recent years there have been several as yet unconfirmed sightings of the endangered black-footed ferret in the Cisco Desert region, between Crescent Junction and the Colorado border. The Bureau of Land Management was directed to conserve ecosystems essential for the survival of the ferrets, by acquisition and maintenance of potential habitat.

The Cisco Desert's approximately 100,000 acres had become a favorite of the white-tailed prairie dog, which is the primary prey of black-footed ferrets. This resulted in more attention being placed on the widely scattered prairie dog colonies, which are generally found near roads, railroads, pipelines and utility corridors where burrowing is easy due to past vegetation disturbance.

In 1989, there was a sudden and dramatic decrease in the prairie dog population. It is speculated that this may be the result of drought conditions. Whatever the cause, the problem can have a significant affect on other species of wildlife in the area, especially predators such as ferrets.



*courtesy of Bureau of Land Management*

The unique set of conditions suited to one animal, that species' ecological niche, exists in delicate balance with conditions suited to other species. The ferrets may not be much concerned about the amount of succulent vegetation present in an area, but prairie dogs are. Prairie dogs may not care if it snows during the winter, and might even prefer sunny days to rainy ones in summer. But if moisture is lacking, the vegetation is not very succulent, for grasses and forbs produce little and become dormant early. Lacking a good food supply, prairie dogs produce few offspring to offset the constant predation upon them, and their colonies dwindle. Alternate food sources for predators (other rodents and rabbits, for example) may be subjected to heavier than usual predation, but their numbers may also have been reduced by the absence of a generous food supply. As prey species decline, predators may encounter more difficulty obtaining ample food supplies so they also produce fewer young.

Prairie dogs are limited in distribution throughout the West by the availability of succulent plants. They can sur-



*Black footed ferret.  
courtesy of Bureau of Land Management*

vive on dried plants for extended periods, but must have access to moisture-containing plants at least part of the time, especially during the breeding season. Prairie dog colonies at Cisco and near the I-70/U.S. 191 intersection, occupy areas where the average annual precipitation is near the lowest tolerable amount. That is, they do reasonably well under average conditions, barely survive the occasional dry periods, and "explode" in wet years.

It may not be the total amount of moisture received in a twelve month period, but the timing of it, that is most important. Generous amounts of precipitation in late winter and spring will stimulate relatively lush stands of grasses and forbs when those are most beneficial to breeding vegetarians. As go the vegetarians, so go the carnivores; therefore the meat eaters benefit greatly from lush grasses. One naturally thinks of predators as "controlling" the populations of prey species. In fact, simplistically, the opposite is nearer the truth: prey species control predators.

Predator populations usually rise and fall in response to

fluctuations in prey species. The ferrets do not enjoy great reproductive success until after their food supply booms. They and other predators continue to do well as long as the bountiful food supply continues, but they crash soon after it fails. If there are indeed black-footed ferrets in the Cisco Desert, it is imperative to keep the prairie dogs alive and well.

The above describes parts of a "food chain," the biodynamics of an area. The description is grossly simplified, failing to touch upon critically important matters such as soil types, plant species present, and numerous other factors affecting the success or failure of the species named. Nevertheless, it outlines the salient facts.

1990 may be another dry year; so may the entire decade. Sooner or later, however, precipitation will increase, the grasses will grow, and prairie dogs will again pump out large numbers of offspring. When they do so, the predators dependent upon them should again increase.



*Cryptogamic soil at the edge of slickrock, where a plant community of prickly pear and claret cup cactus has begun to develop.*  
by Jean Akens

#### CRYPTOGAMIC SOILS

One of the most fascinating studies in recent years may prove to be of prime importance to the future of the fragile canyon country environment. The study involves cryptogamic soils, a basic component of the Colorado Plateau ecosystem.

Cryptogams, *Kryptos* (hidden) and *Gamis* (marriage), consist of several species of algae, mosses, fungi, and lichen, all "lower" forms of plant life that reproduce by spores. They make up the dark green and blue-green crust, (usually dark brown to black in appearance) that covers most sandy areas in canyon country. Cryptogams also protect the soil from erosion while providing nitrogen and other nutrients for plant growth. In fact, cryptogamic crusts are the predominant source of fixed nitrogen for desert ecosystems, since it is also utilized by surrounding vascular plants. The cryptogams, of which algae is the major component, form a spongy surface that absorbs moisture, thus "binding" sand together. When it freezes, the spongy mass uplifts and cracks form, which also retain moisture. Eventually the soil is stabilized, seeds are deposited and plant communities are able to develop.

Jayne Belnap, then a biological technician, was working

as a seasonal ranger for Canyonlands National Park at the time NPS biologist, Kate Kitchell, initiated the cryptogamic soil study. Kitchell, Belnap and others were concerned because so little was known about cryptogamic soil and particularly about the crusts' response to pollutants. Because it is composed of microscopic plant life similar to other pollution indicators, the NPS Air Quality Division in Denver quickly became interested in the project, providing funding. The research proposal was written to determine the effects of both wet and dry pollutants on the physiology and elemental accumulation in cryptogamic crusts. One purpose of the study was to establish crustal sensitivity to pollutants such as those from fossil-fuel power plant emissions.

Preliminary results indicate that cryptogamic soils are showing the effect of acid deposition (a dry form of acid rain), which is important to the nitrogen fixation in soils. Important questions have been raised through Belnap's research. Does pollution cause cryptogams to shut down? If so, will this pass on up the ecological chain to grasses and other higher plant life forms?

Much work remains before final analysis is complete.

#### CISCO DESERT ANTELOPE by Joe Cresto

Many years ago, pronghorn antelope roamed freely over much of the high prairie region of the Colorado Plateau. The introduction of domestic livestock by early settlers, combined with heavy predation, resulted in a gradual decline in antelope numbers. Competition for forage, water and space became extreme in some cases, and the antelope were gradually forced out. The severe drought of the 1930s added to the existing stress, and by 1940 the pronghorn antelope were completely eliminated from the Cisco Desert.

In 1948 an unsuccessful attempt was made by the Colorado Division of Wildlife to re-establish the pronghorn between the Utah-Colorado state line and Grand Junction, Colorado. The Colorado Division of Wildlife again released 48 pronghorn at two different locations in Colorado in 1968. The antelope migrated back and forth across the state line, with their population fluctuating between 100 and 150 animals over the next several years.

A huntable population had become established in Utah by 1976. The Bureau of Land Management, along with the Utah Division of Wildlife Resources (UDWR), saw a need to provide the expanding pronghorn antelope herd with some essential habitat improvements. The BLM then wrote

the Cisco Habitat Management Plan.

150 pronghorn were reintroduced on the Utah side of the Cisco Desert in 1983 by the UDWR. The Colorado Division released another 90 head near the state line in January of 1988. These pronghorn also migrate back and forth across the state line.

Since completion of the Cisco HMP, nine water projects and a 10 acre vegetation study plot have been completed. Future project plans include 10 additional water developments, modification of the Colorado-Utah state line fence to allow for unrestricted pronghorn movement, and re-vegetation of 1200 acres recently destroyed by fire.

The Cisco antelope herd is currently increasing as indicated by aerial trend counts, and fawn/doe ratio studies conducted by the UDWR. The herd is gradually expanding its range west, and sightings near Thompson, Utah are not uncommon.

According to Brad Palmer, Area Manager for BLM Grand Resource Area in Moab, "Managing wildlife habitat is one part of BLM's multiple use mission."



*courtesy of Bureau of Land Management*

## QUATERNARY CORNER

With this issue, *Canyon Legacy* introduces a feature that will become a frequent and welcome addition to the magazine. The "Quaternary Corner" will offer articles provided by scientists in the Quaternary Studies Program at Northern Arizona University (NAU).

The Quaternary Period is our time. Beginning 1.7 million years ago, it is the most recent geologic period. It includes the Pleistocene Epoch (which ended about 10,000 years ago) and the Holocene, which continues today.

Participants in NAU's Quaternary Studies Program will provide information on current research relating to the Colorado Plateau, near the center of which is Moab. As Saxon Sharpe points out in this introductory article, Quaternary studies involve a multi-disciplinary approach. For example, the investigation of packrat habits leads to information about climatic change, which in turn provides insight into geologic evolution and human prehistory. There are few other areas in which the inter-relationship of the various sciences is so clearly demonstrated.

As a continuing discussion of current research, "Quaternary Corner" should be a sterling addition to *Canyon Legacy*.

## A Brief Look at the Recent Past

by Saxon Sharpe

Twenty thousand years ago North America was in the midst of the Wisconsin Ice Age. Vast continental glaciers, which consisted of sheets of ice up to a mile thick in places, covered much of the northern portion of our continent. To the south, the upper elevations of many of the mountain ranges, such as Utah's Uintas and La Sals and the San Francisco Peaks in Arizona, were blanketed by alpine glacier systems that originated in the high country and flowed into the valleys below.

In many regions the climate was very different at that time, but was not necessarily as frigid as the name "Ice Age" may imply. In fact, late Pleistocene winters on the Colorado Plateau may not have been a great deal colder than winters of today. There was also more "effective moisture": a combination of cooler weather, less evaporation and/or increased precipitation, resulted in more perennial streams, drainages and lakes. During this time Lake Bonneville, ancestor to the Great Salt Lake, covered the entire northwestern quarter of Utah.

Sea level was lower due to the lock-up of ocean moisture in glacial ice. The contrast between the cold, glaciated con-

continent and the comparatively warm ocean caused sea water to evaporate and fall as snow on the land, which enhanced glacial build-up. The lowered sea level exposed a "land bridge" from Siberia to Alaska, in an area now known as Beringia, thus allowing prehistoric peoples access into the New World.

Of this unique migration, Francois Bordes, author of *The Old Stone Age*, has said, "There can be no repetition of this until man lands on a (habitable) planet belonging to another star."

The timing of the land bridge crossings is unknown. Until indisputable evidence is found, one can only say that these early people, who we call Paleo-Indians, were on the northern part of the continent by at least 12,000-14,000 years ago. They were hunters and gatherers, killing game such as mammoth, bear, tapir, and rabbit, while gathering nuts, seeds and fruits to supplement their diet.

Animal communities at that time were different than those of today. Many of the animals would have been recognizable to us, but they were not the same as present-

day species. Bison and bear lived here but they were larger, now extinct, forms. Also present were mammoth, camel, sloth, shrub ox, horse and ancient mountain goat. The tapir, a North American native who later migrated south to the rain forest, is also found in the late Pleistocene record of the Plateau.

Plant communities also differed greatly from those of today. The amount and seasonal distribution of precipitation, the temperature, and the length of the growing season resulted in plant species growing together in communities where they can no longer do so. Desert plants such as yucca and cactus were growing beneath mountain trees such as Douglas fir and Ponderosa pine. This affected animal distribution and the humans who hunted them.

By approximately 14,000 years ago all of North America entered an interglacial stage. As the climate warmed, people, plants and animals were forced to alter their subsistence strategies. Plant communities began to change; for example, it was necessary for evergreen trees, which could not tolerate the new warmer, dryer conditions, to inhabit higher, cooler elevations.

Not all animals survived this transition period. Entire species such as the saber-tooth tiger, mammoth, camel, and ancient mountain goat perished. In fact, approximately 70% of the Pleistocene fauna weighing over 100 pounds were extinct by 11,000 years B.P. (before present). Scholars are actively debating the cause(s) of this extinction.

Temperatures on the Colorado Plateau continued to rise even though there were intermittent cold episodes and glacial advances in the Holocene or Recent Period (10,000 years B.P. to today). In general, the average temperature was warmer than it is now. Then, four thousand years ago, the temperature began to drop to its present mean.

About 3500 years ago another major event took place. Early Americans changed from a hunting/gathering lifeway to an agriculture-based subsistence, when they began to cultivate corn, then other crops such as beans and squash. During this period a more sedentary lifestyle replaced their roaming, hunting/gathering culture. Population increased and baskets, pottery and housing structures began to accumulate on the Plateau.

### PLEISTOCENE/HOLOCENE RESEARCH

The Pleistocene period was a time of spectacular, complex and tightly woven events. Quaternary scientists employ cross-disciplinary methods from geology, climatology, archaeology, and plant and animal remains to reconstruct the past environment (paleoenvironment). Plant pollen, packrat nests, tree rings, arctic ice cores, marine sediment cores, as well as glacial, lake, cave and arroyo deposits can all tell us about the past. Each bit of new information is like adding a piece to a three-dimensional jigsaw puzzle with height, depth and a time span of almost two million years.

Arroyos often contain layers of sediment that reflect

### MAJOR TIME PERIODS

ERA	PALEOZOIC (Age of Ancient Life)						MESOZOIC (Age of Medieval Life)			CENOZOIC (Age of Recent Life)			
	570*						230			63			
PERIOD	PRECAMBRIAN	CAMBRIAN	ORDOVICIAN	SILURIAN	DEVONIAN	MISSISSIPPIAN	PENNSYLVANIAN	PERMIAN	TRIASSIC	JURASSIC	CRETACEOUS	TERTIARY	QUATERNARY

\*Numbers indicate millions of years before present

cycles of erosion and deposition. By comparing arroyo sediment cut and fill cycles with archaeological information, patterns correlating climate and prehistoric occupation can be hypothesized. Dr. Larry D. Agenbroad of Northern Arizona University suggests that the erosion of the alluvium used for farming may have contributed to the final Anasazi abandonment in certain areas such as Grand Gulch, southwest of Blanding. By exploring the interrelationship of weather, climate variation and society, human subsistence patterns and population demography can be studied.

Animal remains are an important Quaternary tool, particularly in the arid Southwest. Bones, dung, and even hair of animals that died 40,000 years ago can be preserved in the sediments of dry caves. Dung of Pleistocene and Holocene animals can be used to determine some of the local plant community components, directly reconstruct diet and radiometrically date animals. With additional data, changes in diet composition through time can be used to determine the factors contributing to extinction and to identify environmental changes.

Plants and pollen are also useful tools in reconstructing paleoenvironment. Pollen from lake sediments and plant remains from packrat nests, also called middens, are often utilized. Determining which plants comprised Pleistocene communities can lead to information about minimum and maximum temperatures and seasonality of moisture (heavy

winter precipitation or summer monsoons). An ancient packrat midden at 5,200' elevation in the Abajo Mountains contained both yucca and cactus. Radiocarbon dates showed that these plants were incorporated into the packrat midden 12,000 years ago. Because we know the minimum temperatures of the area where these plants are found today, we can infer that winters were moderate at this site during the late Wisconsin Ice Age.

Packrat middens can also help determine human impact on the environment. Packrat midden analysis substantiated a major reduction of pinyon pine in the Chaco Canyon area between 1,230 and 520 years B.P. This reduction does not appear to be due to local or regional climatic change. It is highly probable that the Chacoan Anasazi population seriously depleted the woodland to use for housing and fuel.

Clearly, change in the plant and pollen record reflects climatic variation. Climatic change affects animal forage behavior and human utilization of both plant and animal resources. The Clovis (Paleoindian) people are known for their highly crafted stone tools associated with the hunting of large animals. With the extinction of these megafauna, stone tool (lithic) technology changed and tools became smaller and less well crafted.

Human social and technological adaptation to varying climatic episodes ties very closely to other aspects of

cultural evolution. How did the megafaunal extinction event affect the subsistence pattern of the hunters and gatherers? Was climatic change a factor in the adoption of agriculture by prehistoric people? Was climatic change indeed a factor in the abandonment of the Anasazi cliff dwellings? As our knowledge of the past increases, additional questions emerge. Quaternary scientists are seeking explanations of these enigmas. Each study has the potential of placing additional pieces to a very large puzzle. Someday perhaps, with all the interlocking pieces in place, the picture will be complete.

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#### ABOUT THE AUTHOR

*Saxon Sharpe is obtaining her graduate degree at Northern Arizona University, in the Quaternary Studies Program. Her specialty is the study of packrat middens. Saxon, who's home is in Castle Valley near Moab, formerly worked with the Canyonlands Natural History Association.*



Pack rat.

## RADIOMETRIC DATING

by Dave May

Radioactive materials in or associated with the remains of once-living organisms have proven to be a nearly indispensable tool in determining the age of those remains. Radioactive elements change, or "decay," into other elements at known, predictable rates. If one knew how much of a radioactive element was present in a plant or animal when it was living and could measure the amount today, the difference would indicate how long ago the plant or animal lived. A form of carbon, called "carbon-14," allows scientists to do just that.

Carbon-14 is present in the atmosphere in very small but unchanging amounts and is incorporated into all living tissue in known amounts. No additional carbon-14 is added to the remains of an organism after it dies and the presence of the radioactive carbon is unaffected by the digestive process, so animal dung can be used in the technique.

Many animals that once lived on the Colorado Plateau, including the mammoth, Shasta ground sloth, and Harrington's Mountain goat utilized dry caves and alcoves for shelter. Other mammals, such as the packrat, built nests in sheltered places. Numerous such sites still contain dung, and dozens of samples have been tested to determine their carbon-14 content. Uranium and other radioactive elements are utilized in a somewhat similar manner.

Radiometric dating methods do not yield absolute dates, like "12,363 years, 5 months, and 16 days before present." Averaging the results from several samples, however, does produce results of surprising precision.

Learning how long ago now-extinct animals lived is more than an academic exercise. If it appears that several species became extinct at about the same time, finding the cause of the mass extinction becomes an important part of understanding the ancient world - and the development of humans.

## Mammoths on the Colorado Plateau

Less than a decade ago, datable mammoth remains were almost unknown on the Colorado Plateau. Today, there are at least 41 sites, some of which were used by a sizable number of the large mammals. In Arizona there are 24 sites, with 12 in Utah, 3 in New Mexico, and 2 in Colorado. Of these sites, 13 have produced samples that have been accurately dated. Bone or dung samples from 10 of the Utah sites have been dated radiometrically, as have those from 3 Arizona sites. Averaging data from the two youngest Utah sites indicates that mammoths were present in southeastern Utah until at least 11,270 years ago. The single youngest date comes from Professor Valley, 20 miles east of Moab, where a mammoth tusk yielded an apparent age of only 10,230 +/- 110 years!

Mammoths were large elephant-like mammals which, judging from analysis of their dung, fed predominantly on grasses but also utilized large amounts of other plants. Sedges, reeds, saltbush, sagebrush, and many other plant remains favored by mammoths still grow near their prehistoric sites, while others are found today at only

substantially higher elevations.

Most known mammoth sites are along or close to major rivers and often are in sediments deposited by water. Others have been reported from caves and alcoves where extremely dry conditions have preserved dung and other remains exceptionally well. Bechan Cave, in Glen Canyon National Recreation Area, is such a site.

Bechan Cave is more than 90 feet wide, 150 feet deep, and up to about 25 feet high, providing space enough for a small herd of mammoths. Beneath a surface layer of sand and cultural remains is a layer of dung covering the entire floor of the cave. Most of the dung is that of mammoths, although other species also are represented. Dated samples from Bechan Cave range in age from 11,670 +/- 300 years to 13,505 +/- 580, suggesting the mammoths used the cave for about 2,000 years. Radiometrically dated samples from Bechan Cave represent more than half the total number of dated samples known from the Colorado Plateau.

Samples employed in the radiometric dating process have included mammoth bone, tusk, and dung, plant materials, and dung of other mammals. Dates from plant materials and dung of other species found in close association with mammoth remains imply that dates also apply to mammoth remains, but leave room for significant doubt. Bone and tusk samples that were leached by water may produce inaccurate results due to addition or removal of material from the skeletal remains. Radiocarbon dating of mammoth dung samples avoids both areas of concern, and thus provides the greatest potential for obtaining accurate results. Most of the plant remnants in dung were alive when the animal ate them and the animals were alive when they produced the dung (obviously!), so dung sample dates are excellent indicators of the time when the mammoths were living.

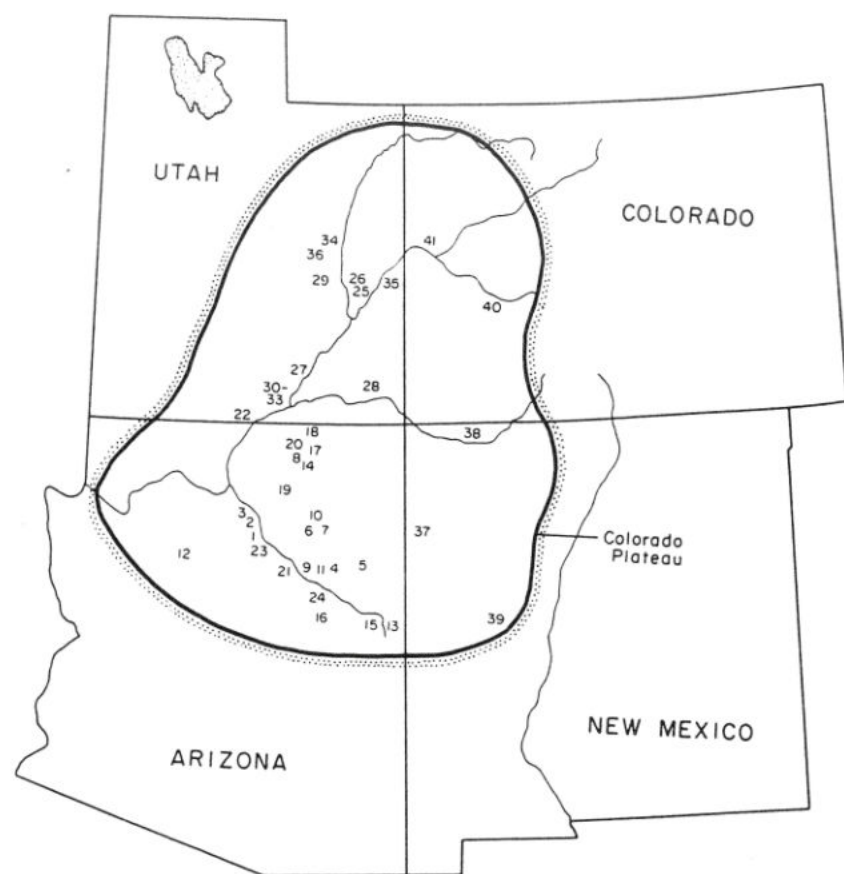
Few mammoth sites have been reported from Colorado or New Mexico. That may be due to there having been fewer mammoths in those areas, of course, but there is no known reason for that to be true. It seems more likely that portions of Colorado and New Mexico on the Colorado Plateau supported as many animals as did areas now in

Arizona and Utah. The dearth of reported mammoth site discoveries may simply be a result of fewer paleontological studies or of fewer studies in appropriate areas.

Does present knowledge allow us to pinpoint the time of extinction of mammoths? Perhaps...but there is always the possibility that continued study may provide still younger remains. Interestingly, averaged radiometric dates from two other extinct mammals, the Shasta ground sloth and Harrington's mountain goat, suggest they became extinct at about the same time as the youngest dates for mammoths. If the three herbivorous mammal species did become extinct at nearly the same time, that raises the obvious question: WHY?

The above information was derived from "Quaternary Geochronology and Distribution of *Mammuthus* on the Colorado Plateau" by Larry D. Agenbroad and Jim I. Mead, originally published in *Geology*, v. 17, pp. 861-864, September 1989 and used with permission of the authors (who I thank and to whom I apologize for any misrepresentations).

D. May



Map of Colorado Plateau. Numbers refer to localities.



## Books of Interest

### WESTERN EDIBLE WILD PLANTS

W.D. Harrington  
 Illus. by Y. Matsumura  
 University of New Mexico Press  
 Albuquerque, NM  
 1967, reprinted 1987; 153 pg.

Are you tired of the same old foods on your table every day? Of the complaint, "Not zucchini again!" or "Do I have to eat my broccoli?" or even "Can't we ever have anything different to eat?" Well, this book may be your answer!

Numerous western wild plants have been collected, prepared, and taste-tested by H.D. Harrington, Curator of the Herbarium at Colorado State University, (and fed with no ill effects to his friends and collaborators). In this book, Harrington suggests adding wild foods to jaded menus, such as root vegetables (like radishes, potatoes, or carrots), leaves and shoots (similar to spinach or asparagus), fruits and seeds (like apples and wheat) and teas and other miscellaneous and perhaps unknown delights.

Each plant is listed in the book under its scientific name, and also any known common names. Each is illustrated and described, including its typical habitat. Indian and Pioneer usage is given, and harvesting methods explained. Cooking procedures - including some recipes adapted to our modern tastes - and storage possibilities are quite complete and fascinating.

There is a chapter on poisonous plants, which should be required reading for anyone interested in using our native plants as a source of wilderness survival food, campfire meals, dinner "conversation" dishes, or just good additions to our daily meals.

WESTERN EDIBLE WILD PLANTS is available at the Dan O'Laurie Museum Gift Shop for \$7.95, plus tax.

by Marion Pierson

### A PRACTICAL GUIDE FOR THE AMATEUR NATURALIST

Gerald Durrell  
 Alfred A. Knopf, Inc.  
 New York, NY  
 1982 reprinted 1988; 320 pages  
 \$29.95

If you have an active curiosity about your natural surroundings, Durrell's guide will help you discover the intricate weave of life that abounds in our ecological world.

Durrell summarizes world environments from deserts and beaches to tropical forest and mountainlands. His vivid descriptions and easy-to-follow directions make backyard and exotic exploration an adventure. The author walks you through the steps of collection, preservation, categorization and experimentation of specimens. The techniques of discovery presented in the *Amateur Naturalist* will grant fascination of the outdoors for adults and children alike. Durrell's guide can accompany you into your backyard to beetle-watch, as well as into the forest to watch wildlife.

The complex ecological cycle is fast at work all around us. When your curiosity gets the best of you, *THE PRACTICAL GUIDE FOR THE AMATEUR NATURALIST* will give you timeless insight into discovering the rich secrets of the natural world.

by Angela Bautista

### FOR CHILDREN

Ages 3 and up:

### BIRDS AND THEIR ENVIRONMENT: A Stick and Learn Book

Frances Todd Stewart and Charles P. Stewart III  
 Harper, 1987  
 \$7.95

Five two-page spreads show vividly the many habitats in which birds live. A detailed, twenty-two page supplementary booklet describes the birds and their relationship with the environment.

Ages 3-7:

### THE WILDLIFE 1 2 3: A Nature Counting Book

Jan Thornbill  
 Simon and Schuster, 1986  
 \$14.95

This beginners number book cleverly blends the animal kingdom and natural wonders in a brilliantly colorful format for learning delights.



Ages 4-8:

### WILL'S MAMMOTH

Rage Marten and Stephen Gammell  
Philomel, 1988  
\$14.95

Here, woolly rhino's, saber-toothed tigers, wolves, bears, a cave family and wild ponies appear out of the swirling snow as Will rides astride his own woolly mammoth. Although rated for children 4-8, this book provides a full-color pictorial adventure for all ages.

Ages 5 and up:

### DONE IN THE SUN: Solar Projects for Children

Anne Hillerman and Mina Yamashita  
Sunstone Press, 1983  
\$6.95

Fully illustrated, this book provides a superb introduction to the sun for young people. By completing simple craft projects they become familiar with our neighboring star, the sun, and how its light and heat can be used—even in some unexpected ways.

Ages 8 and up:

### KENNETH LILY'S ANIMALS: A Portfolio of Paintings by Joyce Pope

Lothrop, Lee and Shepard, 1987  
\$16.95

A stunning, enduring resource book, in which both text and art invite young readers to understand, value and admire the animals that share our world.

### THE BOOK OF EAGLES

Helen Roney Sattler and Jean Day Zallinger

Morrow, 1988  
\$14.95

Renowned science writer Helen Roney Sattler offers a clear, accurate introduction to these majestic birds; body structure, flight and hunting, mating and nesting, and the hatching and growth of eaglets are all covered.

Ages 8-15:

### ANIMAL BABIES

Bobbie Kalman and Glen Loates  
Crabtree Publishing, 1987  
\$7.95

Through numerous paintings, this unique book gracefully shows, from birth, the amazing struggle of young animals and how they escape their predators in order to survive in an ever-changing environment.

(Also by the same authors: FOREST MAMMALS, BIRDS AT MY FEEDER, and OWLS.)

All Ages:

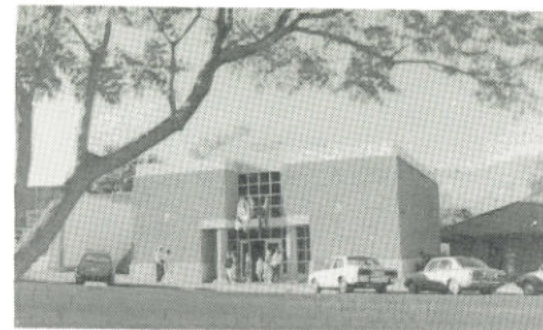
### HANDS-ON-NATURE: Information and Activities for Exploring the Environment with Children

Jenepher Lingelback, editor  
The Sewall Company, 1986  
\$16.95

Adults and children can share discoveries of wildflowers, trees, birds, bugs, animal life and more with this illustrated "how-to" manual. Local fields, woods, parks, and backyards can be utilized for fun activities that sharpen environmental awareness.

by Jacki Montgomery

ALL BOOKS AVAILABLE AT THE DAN O'LAURIE MUSEUM STORE



## Museum News

by Keith Montgomery

### RECENT HAPPENINGS...

The Dan O'Laurie Museum was privileged to host the Utah Museum Association annual conference this past September. The two day event assembled museumologists and interested participants from throughout the region. Seminars included topics on museum volunteer programs, archival computer systems, and museum funding. The keynote address was delivered by Michael J. Fox of the Heard Museum in Arizona.

A major focus of the conference was a panel discussion on Federal and State policies regarding the local preservation and exhibiting of donated antiquities, many of which may have originally been obtained from public land. One result of the discussion was the concurrence that new legislation is needed to discourage the looting and selling of cultural resources.

### EXHIBITS...

The newly-designed interim exhibits have met with enthusiasm and support from visitors and community members alike. These displays are the building blocks for the more elaborate exhibits now in the planning stage. Recent museum acquisitions include a dinosaur track and an unusual coral specimen, both on display in the geology section.

### MUSEUM STORE...

The museum store was recently remodeled to allow more space for its carefully selected gifts, books, and children's items. The book section was especially benefited by a new, larger display rack.

### TRAVELING EXHIBITS...

The traveling exhibit committee has scheduled the "Block Prints of Everett Ruess," provided by the Utah Endowment for the Humanities, which will open on December 7th. Other temporary exhibits planned include "Trails Through Time," "History of Extinction," and another on the Fremont Culture. The museum is currently seeking public support in sponsoring traveling exhibits in order to enhance the communities museum experience.

### NEW DIRECTOR; NEW PLANS...

Jean McDowell, an active member of the Museum Board of Directors recently accepted the part-time position of Director/Curator. She will help the museum organize a volunteer program for interested participants, who would learn and provide assistance in organizing and cataloging archival materials. Now in the planning stages, this training program will involve the public in the care and conservation of artifacts, museum curation, exhibit design, and research. Presently the museum is adopting the Automated National Card Cataloging System to organize its artifacts and documents.

NEXT ISSUE...

The history of the Colorado Plateau is intrinsically linked with the two great river systems, the Colorado and the Green, and with the first adventurous travelers who explored these oftentimes-dangerous waterways. In fact, before the John Wesley Powell expeditions surveyed the Green and Colorado Rivers starting in 1869, this part of the country was not even on the map!

The new John Wesley Powell Museum in Green River, Utah, is dedicated to preserving and presenting the river history of the region. In celebration of its Spring 1990 opening, the fifth issue of *Canyon Legacy* will focus on **River History of the Colorado Plateau**.



*The Green River near Buttes of the Cross. (on skyline, to right of center).  
photo by F.A. Barnes*

*"Off to the south we see a butte in the form of a fallen cross...many hundreds of feet high. We note its position on our map and name it The Butte of the Cross." Later, "We are surprised to find that our butte...is indeed two buttes, one so standing in front of the other that it gave the appearance of a cross."*

*J. Wesley Powell, The Exploration of the Colorado River and its Canyons.*

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