THE ECOLOGICAL IMPORTANCE AND BIOLOGICAL UNIQUENESS OF THE SAN RAFAEL SWELL

Submitted to:

The Southern Utah Wilderness Alliance

Submitted by:

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THE ECOLOGICAL IMPORTANCE AND BIOLOGICAL UNIQUENESS OF THE SAN RAFAEL SWELL

1.0 Introduction

In order to write this overview, I obtained information on rare and sensitive species, communities, and their habitats from a variety of sources. One important source was GIS data from the Utah Natural Heritage Program. I also obtained numerous data and input from a variety of scientists and researchers at Utah's Universities and government research agencies such as the U.S. Geological Survey - Biological Resources Division. This particular information is perhaps the most important, because much of it is unpublished and it is possible that the Bureau of Land Management (BLM), the lead agency responsible for cataloguing the biological treasures of the San Rafael Swell, may be unaware of its existence. The numerous scientists who contributed to this unique knowledge are listed in Appendix A.

2.0 Rare and Endemic Plants

The plant species I focus on are those that are currently listed as federally threatened, endangered, or candidate species, or were formerly listed as Federal Category 2 candidate species.[1] Of Utah's 3000+ indigenous plants, about 170 (almost 6%) currently fall into one of the above "special status" categories (UDWR 1998). All of the species discussed in this paper are considered rare endemics.

The San Rafael Swell is located within the Colorado Plateau, where fully 50% of Utah's 240 rare and endemic plant species occur (Davidson et al. 1996). Indeed, this region possesses greater diversity than any other floristic region in Utah, with 85% of the total diversity of vascular plants in the state (Shultz 1997). The basis for high rates of endemism on the plateau are linked to many unique features of this province such as climate, position along migratory routes,[2] and distinctive geologic history (Welsh 1978). Conditions for growth on the unique substrates and stark formations of the plateau are often rigorous at best. Those species capable of establishment and reproduction are few, and competition is very limited. This results in very small populations[3] of unique plants that have evolved in relative isolation.

The local flora of the San Rafael Swell is largely considered to house one of the greatest percentages of rare endemics of anywhere in the state of Utah (Harris 1983, personal communication Stan Welsh, personal communication Mike Windham, personal communication Jim Harris). Although the total number of plant species per unit area is often greater in other

[1] It is this last category into which most of Utah's "State -Listed" plants fall.
[2] Over time, plants have migrated onto the plateau from the Great Plains, Rocky Mountains, Great Basin, and Mojave, Sonoran and Chihuahuan deserts.
[3] Though small population sizes may also be a product of the scattered and isolated nature of the unique outcrops/substrates that the plants are restricted to.

parts of the state, nowhere else in Utah will one find the flora comprised of such a large proportion of rare endemic species. Overall, there are 25 plants considered to be rare endemics in the Swell (Utah Natural Heritage Program database 2001), and half of these are considered to be globally imperiled, with a G1 or G2 ranking by the Heritage Program. Some of the Swell's rare plant species are strictly endemic to the Swell, and some are endemic to the Swell and nearby areas like Canyonlands National Park. Interestingly, there is also a whole suite of plants including Utah endemics and other natives that "jump" from the Uinta Basin to the middle of the San Rafael Swell (personal communication, Stan Welsh). Given this kind of distribution, it would not be too surprising if detailed study revealed the presence of additional species that are "hiding" within a traditional taxonomy. The rare and sensitive plant species tracked by Utah's Natural Heritage Program that occur in the San Rafael are shown in Figure 1. The plants depicted in Figure 1 are identified by a numbering code, which is described in Table 1, below.

It is the geology of the Swell, accompanied by a very dry climatic regime and access to strong migrational pathways that function in driving the evolutionary response of plants in the region generally and in the Swell particularly. As Welsh (1978) describes it: "Broad anticlines, synclines, [and] gentle to steeply plunging monoclines have been eroded to expose hogbacks or cuestas where vast statigraphies are exposed in relatively short distances." As these geologic substrates and formations were thrust to the surface as they rode on the uprising of a laccolithic dome and then eroded away through the eons, plants that could tolerate the specific conditions found on those outcrops migrated onto those substrates. Over time many of these early colonizers likely diverged and evolved *in situ* to produce the variety of rare endemic species found on the San Rafael today.

If one starts on the east side of the San Rafael Swell and works westward, they will first encounter the Summerville Formation where the Jones cycladenia (*Cycladenia humilis* var *jonesii*) is tightly restricted to the rare gypsiferous soils found there (personal communication, Jim Harris). The east side of the Swell experiences more natural erosion and decay of the formations and substrates, rendering abundant sandy soils. Here, one will find the Woodruff milkvetch (*Astragalus woodruffii*) and Ruth milkweed (*Asclepias ruthii*) (personal communication, Stan Welsh). As one travels towards the center of the Swell, one begins to encounter the Rush lomatium (*Lomatium junceum*) and a rare cryptanth (*Crypthantha paradoxa*, which is disjunct from the Paradox Basin in Colorado), both of which occur on the Moenkopi formation. In fact, many other rare endemics are particular to the Moenkopi; this formation is likely to be the most important of all in terms of the numbers of rare endemics it houses (personal communication Mike Windham). As one approaches the western edge of the Swell, new endemics start to pop up, such as the Johnston cryptanth (*Crypthantha johnstonii*) and the mussentuchit gilia (*Gilia tenuis*), the latter being confined to the outcrops of the Dakota and Curtis formations (Clark 2000 and 2001).

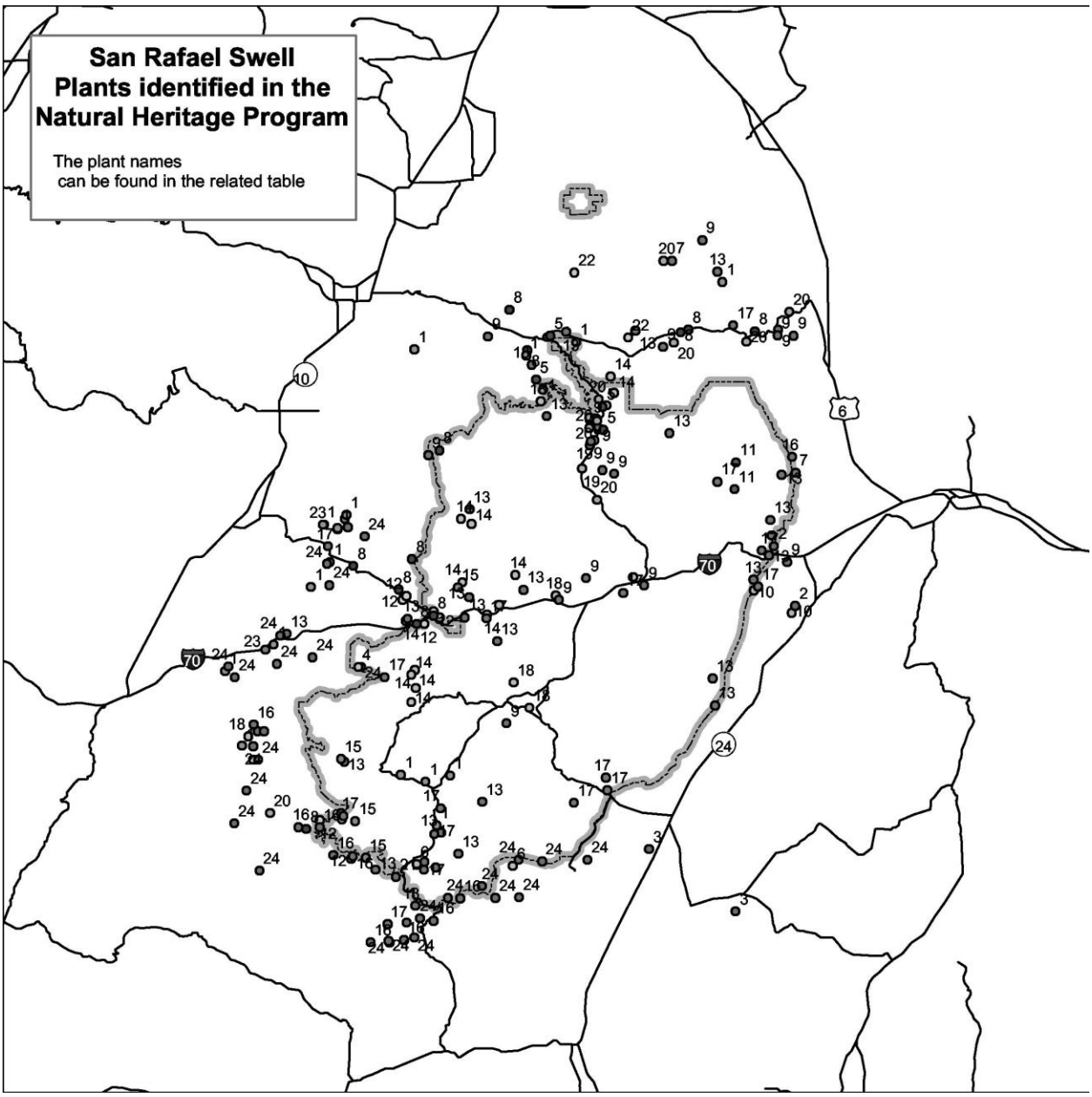

Figure 1. Rare and sensitive plant species tracked by Utah's Natural Heritage Program that occur in the San Rafael Swell.

Table 1. Plant species depicted in Figure 1

Plant ID number	Common Name	Global Rank	State Rank	Status
1	DESPAIN PINCUSHION CACTUS	G2	S2	Federally endangered
2	ENTRADA SKELETONPLANT	G1Q	S1	BLM Sensitive
3	FLAT TOP WILD BUCKWHEAT	G5T1	S1	BLM Sensitive
4	GUNNISON STICK-LEAF	G3Q	S1	BLM Sensitive
5	HARRIS SANDVERBENA	G4T1Q	S1	BLM Sensitive
6	HEIL'S BEAVERTAIL	G5T2T3	S2S3	BLM Sensitive
7	HOLE-IN-THE-ROCK PRAIRIE CLOVER	G5T1Q	S1	BLM Sensitive
8	JOHNSTON CATSEYE	G1G2	S1S2	BLM Sensitive
9	JONES CATSEYE	G2G3	S2S3	BLM Sensitive
10	JONES CYCLADENIA	G2	S2	Federally threatened
11	JONES INDIGO-BUSH	G5T1T2	S1S2	BLM Sensitive
12	LAST CHANCE TOWNSENDIA	G2	S2	Federally threatened
13	LOW WOOLLYBASE	G5T1T2	S1S2	BLM Sensitive
14	MAGUIRE DAISY	G2	S2	Federally threatened
15	MUSSENTUCHIT GILIA	G1	S1	BLM Sensitive
16	PSORALEA GLOBEMALLOW	G2	S2	BLM Sensitive
17	ROCKLOVING MILKVETCH	G5T3	S3	BLM Sensitive
18	RUSH DESERT-PARSLEY	G3	S3	BLM Sensitive
19	RUTH MILKWEED	G3?	S3	BLM Sensitive
20	SAN RAFAEL MILKVETCH	G3	S2S3	BLM Sensitive
21	SYE'S BUTTE PLAINSMUSTARD	G1	S1	State endangered (in Utah)
22	UTAH PINK FLAME-FLOWER	G1	S1	BLM Sensitive
23	WINKLER PINCUSHION CACTUS	G2	S2	Federally threatened
24	WRIGHT FISHHOOK CACTUS	G2	S2	Federally endangered

As a rule, outcrops of shale, mudstone and siltstone at all elevations within the Colorado Plateau should be considered suspect sources for endemics (Welsh 1978). Any portions of the San Rafael Swell that contain considerable outcrops of this type, or particular substrates such as lacustrine limestones, or any geologic formations that are particularly unique or under-represented in other existing protected areas, should be given high priority for inclusion within the boundaries of the new Monument because of the probable endemics they harbor.

As mentioned above, the rare and unique geology of the Swell drive the responses of the species that have evolved unique adaptations to survive on these unusual substrates and stark formations found on the San Rafael Swell. Mike Windham at the Utah Museum of Natural History is documenting what looks like evolution in progress in a rare variety of plant that occurs on the Swell. Currently, the species *Erigeron consimilous* can be found both on, and off, the San Rafael. Study of the species' morphology and phenotype indicate that the species seems to be undifferentiated throughout its range. But closer inspection at the genetic level reveals that

Erigeron consimilous plants on the Swell may be starting to diverge from *Erigeron consimilous* outside of the Swell. The ongoing genetic work shows that all individuals on the Swell have a chromosomal number of n=18, and all those off the Swell have a chromosomal number of n=9. Additionally, all individuals that occur on the San Rafael occur solely on the Moenkopi formation; those off the Swell do not (personal communication, Mike Windham).

Also worth mentioning is the fact that many of the plants in Utah that are currently listed under the federal Endangered Species Act (ESA) can be found on the San Rafael Swell. This line-up includes the Jones cycladenia (*Cycladenia humilis* var *Jonesii*), Maguire's daisy (*Erigeron maguirei*), Barneby thelypody, (*Schoencrambe barnebyi*), Despain footcactus (*Pediocactus despainii*), Wright's fishhook cactus (*Sclerocactus wrightii*), and Last chance townsendia (*Townsendia aprica*).

Numerous areas of additional conservation and protection in this part of Utah are essential to protect in perpetuity these rare, often listed, endemic plants. As described above, many rare endemics in this part of Utah exist as very small populations adapted to specific habitats. With ranges as narrow as these, it is conceivable that an entire population of a rare species could be decimated by a single Off Road Vehicle (ORV). By maximizing the area included in the new Monument and providing strong language on use and recreation, these threats could be reduced. Additionally, an increased amount of habitat protection in the San Rafael Swell may help reduce the threat of collection of Utah's cactus species, many of which are rare endemics. However, it is also imperative that the draft Management Plan for the new Monument contains language that allows scientific researchers access to all parts of the Swell, as the flora of the San Rafael, though one of the most diverse, is also one of the least studied in the State (personal communication, Duane Atwood).

3.0 Insect Pollinators in the San Rafael

The San Rafael Swell is likely to be a large hotspot of pollinators, as recent research in the adjacent San Rafael Desert found 68 endemic species of bees (most of them new to science) as well as disjuncts from both the Great Plains and the Mojave and Sonoran deserts (Griswold et al. 1997). In fact, researchers at the Utah State University bee lab have found that one third of Utah's bee species live in an area (centered on the San Rafael desert) that covers only 2% of the State (Jones 1999a). Indeed, the numbers of bee genera in the San Rafael Desert is more than in all of New England (Griswold et al. 1997). In addition to describing 48 new species previously unknown to science in the San Rafael Desert, the USU researchers have also documented extraordinarily unique bee nesting behavior, such as nests 12 feet deep, nests in honey-comb like holes in sandstone, and 20-foot long nests (Jones 1999a).

The diversity of bees in the San Rafael Desert is partly the result of floral specialization; at least one third of the bee species in the San Rafael desert specialize on plants at the family or generic level (Griswold et al. 1997). The USU bee researchers, in many cases, have determined which rare plants on which the newly described species of bees are specializing (e.g. Griswold 1993). When one observes the impressive diversity of endemic plants in the San Rafael Desert (Harris

1983, Coroinquist et al. 1972), it not surprising that there would also be an impressive diversity of bees and wasps here as well. Since the San Rafael Desert is adjacent to the San Rafael Swell, it should be expected that an impressive and diverse bee fauna awaits discovery there.

Insect pollinators merit study and preservation efforts because 67% of extant flowering plants rely (to varying extents) on pollinators for reproduction (Tepedino 1979). Because Utah has such a large number of rare and imperiled endemic plants, efforts must be made to conserve habitat of their pollinators, as well as habitat for the plants themselves. Indeed, it has already been postulated that perceived problems with reproduction in the federally listed Jones cycladenia is the result of dissociation of the original pollinator from the cycladenia (Sipes and Tepedino, unpublished manuscript). Additionally, insects perform important pollinating services for Utah farmers that grow crops such as fruit, nuts, alfalfa and clover. In general, insect pollinators may be more susceptible than one might think to anthropogenic influences; because pollinators are highly specialized and have co-evolved with one or two key plant hosts, they have been thought to be less adaptable to changing conditions and therefore vulnerable to extinction.

Bees are particularly key insect pollinators to focus on, because only bees depend exclusively on pollen and nectar for food throughout their life cycle (Tepedino 1979). Bees are also significantly impacted by a variety of human activities. Most bees nest in the ground. Nests are often shallow and can be crushed or exposed by ORV activity. Additional negative effects of ORVs are destruction of nest entrances and manipulation/destruction of visual landmarks bees use to locate nests when they return from foraging (personal communication, Terry Griswold). In terms of agricultural spraying, there are indications that bees may be more susceptible than other insects to this practice. Bees have lower fecundity than most insects, because they produce relatively few offspring and expend considerable effort to insure their survival. This results in slightly less genetic variability than most other insects, who produce prodigious numbers of offspring (resulting in slightly higher number of mutations being expressed - etc., Tepedino 1979). This leaves bees less able to eventually develop adaptations to pesticides, as most other insects are known to do. Indeed, resistance to pesticides is unknown in bees (Tepedino 1979).

4.0 Other Invertebrates in the Swell

Richard Baumann and Riley Nelson of Brigham Young University conduct surveys for new arthropod species in southern Utah. Because there are very few living experts available that can identify most newly discovered arthropods to species, Dr. Baumann and his team have spent countless hours convincing these experts to study their specimens of undescribed species from Utah. Almost without exception, those that have accepted the challenge have been surprised at the diversity that exists in what is commonly thought to be a part of the world depauperate in arthropod diversity, and even more surprised at the many "new" or undescribed species that Baumann's team have found (personal communication, Richard Baumann).

Dr. Baumann is convinced that the San Rafael Reef and Swell also contain many special species that have been hitherto not known or studied. For example, during a recent study of the Quitchupah Creek drainage a peculiar male of caddisfly (in the genus *Hydropsysche*) was

collected in the creek near Emery and an equally interesting female was found in a light trap collection at Goblin Valley State Park. In addition, along the Price River on Highway 6 at what has been called Woodside, a rare cicada, *Okanagana tanneri* Davis, was recently discovered and named. And, an extremely large and interesting fauna of tiger beetles has been found in the same region - perhaps one of the most interesting tiger beetles assemblages in the country (personal communication, Richard Baumann). Tiger beetles are under-appreciated as an important indicator species; the type found in the Swell prefer sandy washes and riparian zones, and because their habitat preferences are extremely narrow, a surprising number of different species can occur in one riparian area.

Tim Graham with the U.S. Geological Survey - Biological Resources Division has also documented unusual invertebrates in the vicinity of the Swell. One is a very rare species of grasshopper (*Acrolophitus nevadensis*) that Dr. Graham discovered east of Mt. Ellsworth and west of Lake Powell. There were only two records of this grasshopper in Utah (Otte 1981) before the one Dr. Graham collected south of the Swell (personal communication, Tim Graham). The other rare and unusual species of grasshopper discovered by Dr. Graham near the San Rafael is an unidentified Monkey grasshopper (possibly in the genus *Psychomastax*). There is very little known about monkey grasshoppers, especially in North America (it is primarily a tropical group). Dr. Graham has collected individuals from many areas adjacent to the Swell, including sites near Moab, east of Mt. Ellsworth, and a site south of the Needles District in Canyonlands National Park (personal communication, Tim Graham). Thus, it is at least possible and perhaps likely that one or both of these rare and interesting grasshoppers also inhabit the San Rafael Swell.

Of the invertebrate discoveries in the Swell, perhaps most exciting is a new species of mite (*Aquanothrus* spp.) recently found in Navajo and Kayenta slick rock east of the San Rafael Swell at the mouth of the Dirty Devil River, with other locations in the swell probable (personal communication, Tim Graham). What is perhaps most remarkable about this (still unnamed) species is that it belongs to a genus that is the only genus in its family, and the only other member of the genus *Aquanothrus* is this species' sister species, which is found only in South Africa (Graham and Norton 1997). The *Aquanothrus* of the Swell region resides in potholes in small depressions in the slick rock, where it can live in a liter or less of water (Graham and Norton 1997). When the potholes are close to drying up, this mite engages a "tupperware strategy" where it seals itself up to retain its moisture through the dry spells. It is believed that this undescribed mite may serve as a good indicator species of human impacts, as its presence and abundance have been negatively correlated with the degree mountain bike activity in an area (personal communication, Tim Graham).

The bottom line is that we know very little about most invertebrate animals that live in many wild places in Utah. The San Rafael Swell area is one of these places and to preserve it we need to know and understand even the arthropods that are such a major part of this type of desert ecosystem. Now is the time to enlist the scientists that have the expertise and experience before it is too late.

5.0 The Fishes of the San Rafael

Stream and associated riparian and water resources are critical lifeblood of southwestern fish species. Unfortunately the number and kind of native fish species that live in the San Rafael and Muddy Rivers has changed pretty drastically over the last 150 years, as the result of profound, human-caused alterations to the flow and hydrology of the Colorado River and all of its tributaries. For example, profound changes in flow regimes due to irrigation have influenced the amount and seasonality of flows. Introduced exotic fish species have out-competed native fish, diminishing their numbers (Sigler and Sigler 1996, Marsh and Douglas 1997, Osmundson et al. 1997).

Four federally listed endangered fish species use the lower reaches of the San Rafael River (personal communication, Bill Bates). These include the Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*). A state listed sensitive species, the roundtail chub (*Gila robusta*) also lives in the upper reaches of the San Rafael River. Other native fish species in the San Rafael include the bluehead (*Catostomus discobolus*) and flannelmouth (*Catostomus latipinnus*) suckers (personal communication, Bill Bates), which are both on the State Sensitive Species List.

While all four of the endangered Colorado River fish have evolved to flourish in the fast, deep muddy waters of the Green and Colorado Rivers (Sigler and Sigler 1996), numerous researchers have found that these species seek out eddies and pools (Woodling 1985, Karp and Tyus 1990), often for spawning activities (Sigler and Sigler 1996). Young are found in the quiet, shallow backwater and shallow shorelines (Woodling 1985, Sigler and Sigler 1996). As an offshoot of the Green River, the San Rafael River should be considered important habitat for resting, breeding, depositing eggs and larval development for the endangered Colorado River fish.

Ideally, the boundaries of the new San Rafael National Monument will incorporate as completely as possible entire watersheds. If the waterways through the new Monument are managed properly, Monument designation could protect fish living in headwater streams that may currently be protected from invasions by exotic fish species by existing downstream barriers. These already isolated species need to be carefully protected from additional habitat alterations brought about by roads, recreation, and water diversions and dams, as well as introductions of non-native fish for sportfishing.

6.0 Herpetofauna of the Swell

Seventeen species of reptiles are known to exist in the San Rafael Swell, as well as seven species of amphibians (personal communication, Bill Bates; Appendix B). While most of the herpetofauna is fairly widely distributed, one lizard and two toads that inhabit the Swell are at the periphery or margins of their total geographic ranges. These species are the desert spiny lizard (*Sceloporus magister cephaloflavus*), the Great Plains toad (*Bufo cognatus*) and the red-spotted

toad (*Bufo punctatus*) (personal communication, Jack Sites). All three of these species reach their northern distribution in the intermountain west in the San Rafael Swell region.

The fact that these three species reach the edge of their range in the San Rafael is significant because individuals at the edge of their range often possess slight genetic variation, or are more susceptible to conditions that can induce slight variation, in comparison to those at the core of the species' distribution (Frey 1993, Lesica and Allendorf 1995, Garcia-Ramos and Kirkpatrick 1997). This makes this outreaching segment of the population a dynamic focus of evolutionary change, in which those individuals may be more likely to survive and adapt to regional perturbations, or climate shifts. From both an evolutionary perspective, and from the perspective of conservation all of Utah's native herpetofauna, populations at their distributional limits become extremely important (personal communication, Jack Sites).

In general, designation of a new Monument in the San Rafael Swell will tend to benefit herpetofauna because it will limit construction of new roads. Many studies show that all reptiles suffer from the deleterious effects of roads (Busack and Bury 1974, Bury et al. 1977, Gaddy and Kohlsaat 1987, Finlay and Houlahan 1997). A properly managed Monument will also limit ORV use, another activity known to be harmful to reptiles and amphibians (personal communication Howard Wilshire, Volmer et al. 1976).

7.0 Raptors in the Swell

The San Rafael region includes some of the best habitat for raptors in southeast Utah, and the State's largest concentration of nesting raptors is very close by to the San Rafael Swell (Utah Natural Heritage Program 2001). Major river corridors through the Swell (i.e. the San Rafael) that have deep canyons serve as prime areas of nesting and foraging habitat for all raptors that occur in the area (personal communication, Frank Howe). Any areas with cliffs are particularly important habitats for raptors because they offer nesting sites for some species, as well as significant habitat diversity with habitats at the base of the cliffs often very different from habitats at the tops of the cliffs. And riparian zones with particularly rich structural diversity provide excellent habitat for the federally threatened Mexican spotted owl (*Strix occidentalis lucida*). In fact, areas that are suspected to contain the owls because they are prime examples of good spotted owl habitat include Buckhorn Wash (personal communication, Frank Howe) and Eagle Canyon (personal communication Bill Bates). In general, all riparian areas in the San Rafael Swell are important to raptors, because these areas usually contain high densities of small mammals, which are very important prey items for most raptors (personal communication Chris Colt).

Currently, the Utah Division of Wildlife Resources is monitoring over 400 nests of golden eagles, peregrine falcons and various hawks from the Book Cliffs near Price and down along the cliff faces of the east side of the Manti's to the town of Emery (personal communication Chris Colt). In a typical survey year there are about 40 active golden eagle territories (*Aquila chrysaetos*), making this area likely one of the densest golden eagle populations in the West (personal communication Chris Colt). All of the raptors monitored in this area are likely using

the San Rafael Swell for a foraging ground - feeding on black-tailed jackrabbits (*Lepus californicus*) and white tailed prairie dogs (*Cynomys leucurus*) (personal communication Bill Bates, personal communication Jerran Flinders).

Currently, there are three known active peregrine falcon (*Falco peregrinus*) eyries in the San Rafael region (personal communication Bill Bates, personal communication Frank Howe). There are perhaps three times as many active prairie falcon (*Falco mexicanus*) eyries in the Swell. Though the number of peregines in the Swell is lower than in other areas of suitable habitat in southern and southeast Utah, there are indications that peregine numbers in the San Rafael are steadily on the rise, as birds slowly and consistently expand out of the Colorado River corridor - their biggest stronghold in the state (personal communication Chris Colt). The San Rafael Swell appears to be a critical "stepping stone" for peregrines as they slowly increase their numbers and distribution throughout the state.

It is not inconceivable that the federally endangered California condor (*Gymnogyps californicus*) could occasionally occur in the San Rafael Swell. The area south of Interstate 70 is included in the experimental/non-essential range for this endangered species, which was originally released along the Vermillion Cliffs near the Arizona/Utah State line. Several sightings of condors have been reported in Arches National Park and at Flaming Gorge Reservoir, and thus it is not inconceivable that condors could pass through the proposed San Rafael Monument in these long distance forays (personal communication Bill Bates).

In general, most raptors that exist on Utah's BLM lands are likely to benefit from increased protection within these lands. The BLM acknowledges that birds of prey are sensitive to human encroachment on their habitat (BLM 1995). Furthermore, disturbance resulting from ORV use can cause nest abandonment and chick mortality (personal communication, Kirk Gardiner). Most of the chief causes of mortality in raptors (trauma, shooting, electrocution, poisoning and trapping) are probably least likely to occur in a strictly protected area such as a properly managed National Monument (Jones 1999b).

8.0 Bats of the San Rafael

Most of what we know about bats in the San Rafael region can be extrapolated from the knowledge that has resulted from intensive bat surveys in Capitol Reef National Park, due south of the Swell. 16 different species (both migratory and local) have been found in the National Park, which is an unusually large number of bats for this part of Utah (personal communication, Mike Bogan). It is likely that most, if not all, of these same bat species exist in the San Rafael Swell as well. Of note are two species - Allen's big-eared bat (*Idionycteris phyllotis*) - which reaches its northern distribution in the San Rafael, and another species - big free-tailed bat (*Nyctinomops macrotis*) - which reaches the northernmost extent of its breeding territory in this region.

The San Rafael Swell has many habitat features important to bats. Certain bats, such as Allen's big-eared and the big free-tailed bat, prefer to roost in cracks and crevices in high cliffs and

natural bridges, of which the Swell has ample amounts. Other bats, such as the western pipistrelle (*Pipistrellus hesperus*) and California myotis (*Myotis californicus*), have specialized kidneys that enable these bats to subsist in especially dry areas (personal communication, Mike Bogan). All sources of water in the Swell, whether rivers, streams, large seeps and springs, stock tanks or water filled pockets or tinajas are critical for bats in the region.

The State of Utah does not have any federally listed species of bats. However, two species (the spotted bat - *Euderma maculatum*- and, Townsend's big-eared bat - *Corynorhinus townsendii*-) are designated Sensitive by the BLM and are known to occur in the San Rafael Swell (personal communication Bill Bates). The spotted bat is thought to be dependent upon cliffs and cliff-like features (Leonard and Fenton, 1983), while Townsend's big-eared bat is highly associated with lower elevation habitats that contain a juniper (*Juniperus* sp.) vegetative component (Sherwin et al. 2000). Both of these features occur in abundance in the Swell.

Potential impacts from which a new Monument with sound management may insulate these species include: de-watering of streams and lowering of water tables, loss of riparian vegetative structure (through road construction etc. - Sherwin et al. 2000), pesticide use (which has been shown to negatively impact bats, Geluso et al. 1976, Henny et al. 1982), the reduction in insect densities as a result of pesticide use (Utah bats are insectivorous), water contamination (often associated with mining activities), blasting (usually from road construction/maintenance), and impacts at roost sites.

All of the bats that are definitely known from the San Rafael Swell are listed in Appendix B (provided by Bill Bates, Utah Division of Wildlife Resources). All of the locations of listed, sensitive and rare animals tracked by Utah's Natural Heritage Program that are known to occur in the San Rafael Swell are depicted in Figure 2.

9.0 Small mammals of the San Rafael Swell

Overall, there is a high diversity of mammals, both large and small, that are known to occupy the San Rafael Swell (personal communication, Mike Bogan). Of particular interest to the BLM as they designate a new monument in the San Rafael region is the numbers and densities of white tailed prairie dog, a species very recently petitioned for listing under the Endangered Species Act (Robertson 2002). In addition, white tailed prairie dogs play a particularly important role in all systems where they exist, as they are considered a keystone species and thus have a beneficial effect on their local systems and faunal communities that are disproportional to their abundance. Currently, the Utah Division of Wildlife Resources is monitoring and surveying white tailed prairie dogs in the Swell so they can get an idea of numbers of individuals and numbers of acres occupied by this important species (personal communication Bill Bates).

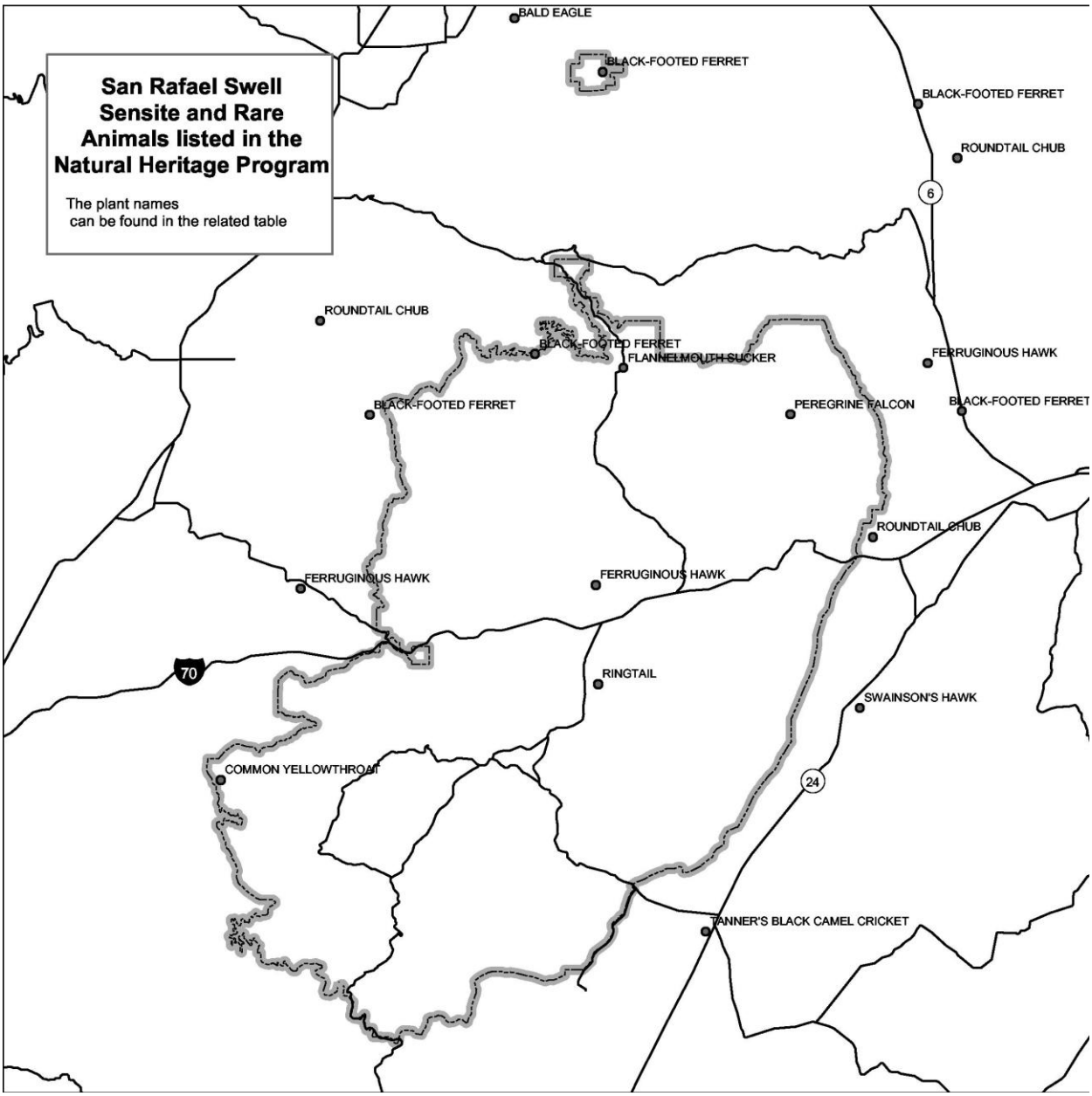

Figure 2. Sensitive and rare animals tracked by Utah's Natural Heritage Program that are known to occur in the San Rafael Swell.

A number of researchers have surveyed the San Rafael region for rodents. What these scientists are finding is that populations of rodents have gradually been isolated from one another over evolutionary time due to the rivers (i.e. Price and San Rafael, personal communication, Mike Bogan) that bisect the San Rafael Swell, which itself is like an island among disparate adjacent desert floor and montane habitats. What results is a fascinating diversity of desert rodents; in fact there are four endemic subspecies of rodents unique to this region of Utah. These subspecies include: white-tailed Antelope ground squirrel (*Ammospermophilus leucurus notom*), southern pocket gopher (*Thomomys bottae osgoodi*), Great Basin pocket mouse (*Perognathus parvus*

bullatus) and desert woodrat (*Neotoma lepida sanrafaeli*). While all of these rodents have subspecies described that occur in the San Rafael Swell area, none of these subspecies are contained strictly within the swell (personal communication Duke Rogers).

It's also possible that the Swell offers important habitat for shrews (personal communication, Mike Bogan). However, knowledge of shrews in this part of Utah, and generally throughout the western U.S, is generally scant, as shrews are notoriously hard to find and survey for. However, limited records show that the rare desert shrew (*Notiosorex crawfordii*) occurs in nearby Capital Reef National Park, and its possible that the San Rafael Swell represents the edge of this species' northern distribution (personal communication, Mike Bogan). As mentioned earlier, this is noteworthy since individuals at the edge of their range often possess slight genetic variation in comparison to those at the core of the species' distribution (Frey 1993, Lesica and Allendorf 1995, Garcia-Ramos and Kirkpatrick 1997), and thus this portion of the population can be a dynamic focus of evolutionary change. Other rare shrews that may very well exist in the San Rafael region include water shrews (*Sorex palustris*) which have been found near the Fremont River in Capital Reef National Park, and dwarf shrews (*Sorex nanus*) which have been found in the Henry Mountains (personal communication, Mike Bogan).

All of the small mammals that are definitely known from the San Rafael Swell are listed in Appendix B (provided by Bill Bates, Utah Division of Wildlife Resources).

10.0 Large mammals of the San Rafael

The San Rafael Swell houses the largest and fastest-growing population of desert bighorn sheep (*Ovis canadensis nelsoni*) in the state of Utah. This population is the direct result of reintroduction and transplant activities carried out by the Utah Division of Wildlife Resources in the late 1970's and 1980's, and currently numbers over 900 animals (personal communication Bill Bates). The Swell provides areas of excellent habitat for bighorns, especially in areas such as Chimney Canyon. Wildlife officials are not sure why the historical population of bighorns disappeared, but there is no question that they once dwelled in the San Rafael Swell, as evidenced by rock art in the area that clearly depicts this species.

The San Rafael also offers good habitat for pronghorn antelope (*Antilocapra americana*), which historically occurred in very large numbers (personal communication Jerran Flinders). It is not clear why population numbers dwindled over the last 150 years, but numbers were boosted by transplant efforts by the Division of Wildlife Resources in the early 1970's, and today they number over a thousand in the Swell (personal communication Bill Bates).

Pumas, or mountain lions (*Puma concolor*), also inhabit the Swell (personal communication Bill Bates). All of the large mammals that are definitely known from the San Rafael Swell are listed in Appendix B (provided by Bill Bates, Utah Division of Wildlife Resources). Figure 3 depicts high quality and critical habitat for both pronghorns and bighorns, as well as important wildlife habitat considered by the Utah Division of Wildlife Resources to be at risk (GIS data provided by the Utah Division of Wildlife Resources, 2000). The Division defines critical habitat at risk as

"the habitat that Utah must maintain to meet the management objectives and the habitat conservation needs of all species of protected wildlife in the state."

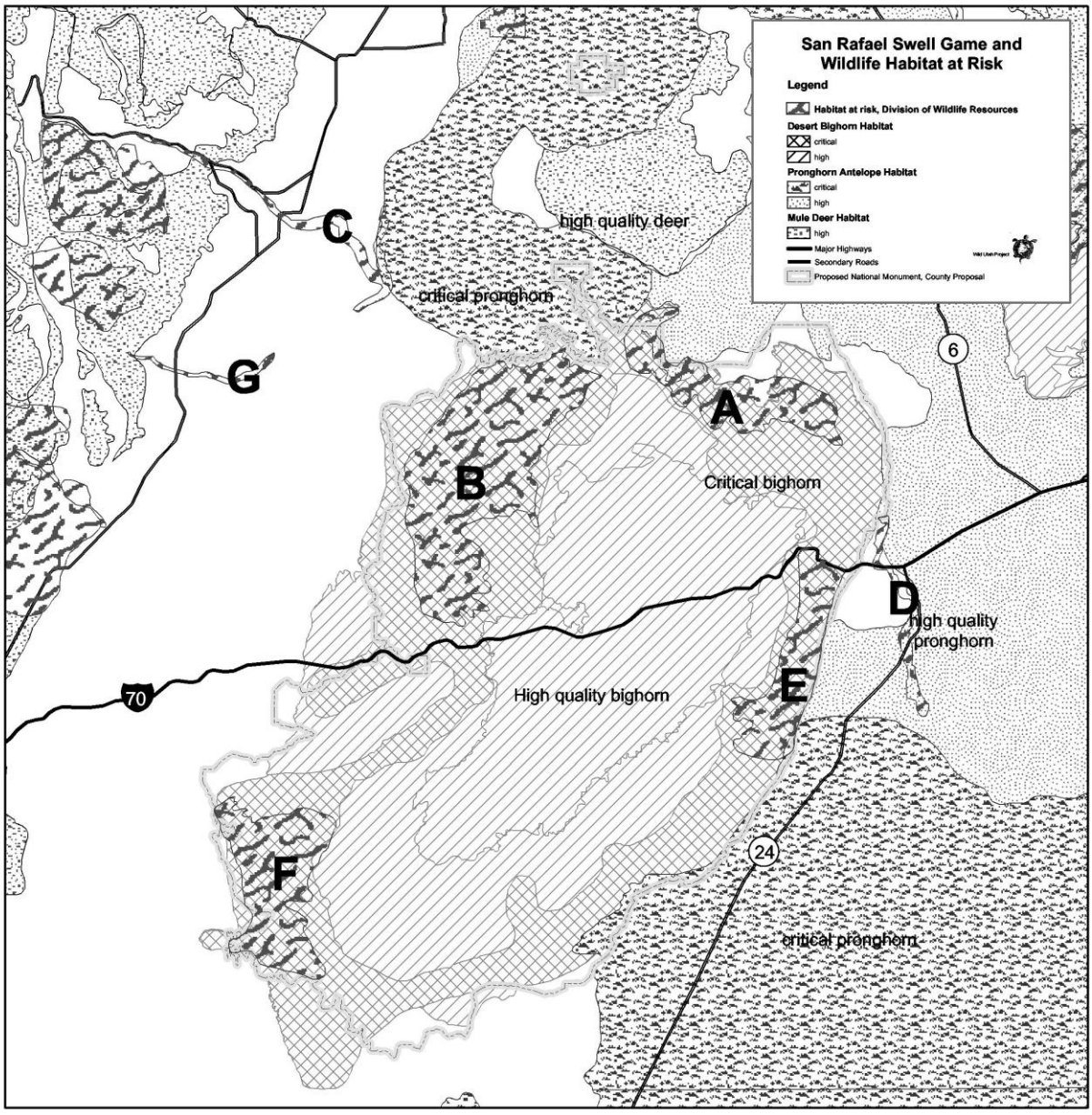

Figure 3. High quality and critical habitat for game, as well as important wildlife habitat considered by the Utah Division of Wildlife Resources to be at risk in the San Rafael Swell

The following table (Table 2) lists the comments that the Division of Wildlife Resource biologists have described for each lettered area in Figure 3.

Table 2: DWR's description of Critical Habitat at Risk, depicted in Figure 3

Map	Name	DWR Comments
A	North San Rafael Swell	Steep cliffs, talus slopes, and grassy bench tops. Excellent desert bighorn sheep habitat.
B	Sids Mountain	Desert bighorn sheep habitat
C	Cottonwood Creek	Lowland riparian habitat. High avian, small mammal and bat diversity.
D	San Rafael River, Hatt Ranch	Lowland riparian areas associated with agricultural habitat. High biodiversity, including neotropical migrants, upland game (quail, pheasants, and turkeys), waterfowl, and mule deer.
E	San Rafael Reef	Desert bighorn sheep habitat
F	Chimney & Poor Canyons	Desert bighorn sheep habitat
G	Ferron Creek	Lowland riparian habitat associated with agriculture field edges and ditch banks.

11.0 The importance of riparian zones and wetlands in deserts

The BLM acknowledges the value of many well-known and imperiled species within its holdings. Although these species use a large range of habitats, most are dependent on riparian and other wetland habitats during either seasonal migrations or seasons and years when surrounding habitats are dry and unproductive. Wetlands, including both riparian areas and springs/seeps, are key to the maintenance of biodiversity within desert regions. In addition to supporting rich endemic floras, they are the most productive communities in this arid landscape and are therefore crucial for much of Utah's wildlife.

Riparian corridors are natural attractants to recreational users and are easily disturbed by human activities. However, these riparian zones are essential to Utah's wildlife. This includes not only large vertebrates but also fishes and small terrestrial vertebrates, certain species of bats such as the Yuma myotis (*Myotis yumanensis*) and invertebrates that are distributionally restricted to these unique habitats. Riparian habitats in the arid west are among the most productive in western North America. The BLM has highlighted this same point in its recent draft management plan/DEIS for the Grand Staircase Escalante National Monument (BLM 1998), which noted that riparian areas total less than 1.0 % of the total lands within the Monument, but are used by up to 80% of all vertebrate species at some stage of their lives. Riparian ecosystems in Utah also act as important migration corridors for larger terrestrial species such as deer, mountain lions and bears (Belnap 1997).

When assessing the biological role of the very limited number of riparian corridors in the San Rafael Swell, it is important to consider the watershed that is associated with the main stream corridor. Temporary, or permanent, connections of streams to outlying wetland pockets renders these disjunct wetlands as important appendages to lotic systems (Davidson et al. 1996). Densities of aquatic invertebrates can be much higher in these outlying wetlands than in main

stream channels, in some cases having a 100-fold difference in invertebrate densities (Wolz and Shiozawa 1995). Floodplain wetlands can thus serve as auxiliary nurseries for larval and immature native fish.

One of the more critical qualities riparian zones offer in the deserts of the southwest are refuges and stopovers for migrating birds. The Management for Willow Flycatcher MigrantsManagement for Willow Flycatcher MigrantsManagement for Willow Flycatcher Migrantsrigors of migration often push birds to their physiological limits, and therefore a lack of suitable stopover habitat results in death and contributes to future population declines (Moore 1990). The ecological diversity of migratory species make an assessment of habitat requirements and the development of management strategies for migrants particularly difficult. However, the preservation and conservation of southwestern riparian habitats should be of major concern. There very well may be federally listed species of neotropical migrants that stopover in the San Rafael Swell, the prime candidate being the southwestern willow flycatcher. There are very large stands of suitable habitat for the southwestern willow flycatcher along the San Rafael River (personal communication, Bill Bates) that would primarily be used for migration, but not nesting, as this endangered subspecies is not known to nest as far north as the Swell (Behle 1985, personal communication with George Oliver).

Because of the relative isolation of riparian sites from other areas of similar habitat (i.e. riparian zones associated with a different drainage), their recovery from disturbance is likely to be hindered by the difficulty of recolonization from other drainages. This makes it all the more crucial that small, isolated, wetlands interspersed within the landscape, such as springs and small ponds, are also carefully protected because they may partially aid in limited recolonization and dispersal between disjunct riparian zones in desert lands.

Some of the rarest species in Utah and the most spectacular biotic assemblages are those associated with the springs and seeps that dot the landscape within the canyon country of southern and southeast Utah. Just as areas with distinctive soil types are inhabited by their own special floras, the uniqueness of spring and seep habitats usually translates into unusual species communities. Further, because these springs are generally isolated from other springs and seeps, their recovery from any form of disturbance is likely to be impeded markedly by the difficulty of recolonization from similar habitats that may be miles away. Isolation may also lead to genetic differentiation, in which particular sub-populations of plants and animals have adapted to local conditions in a given spring or seep. Because these communities are often one-of-a-kind and difficult or impossible to replace, they merit the strongest possible protection in the future.

Hanging gardens are geological oddities which result from the appearance of water on exposed sandstone surfaces (Rushforth et al. 1976, Rushforth et al. 1980). Under some circumstances on the Colorado Plateau, water seeps through porous sandstone layers until it contacts an impervious layer below. Water accumulates at these impervious layers until it is released by percolating laterally where it often forms a seep or spring. Some such hanging gardens are merely damp sandstone outcrops while others are moist or wet walls with an associated spring and/or stream (Johansen et al. 1980, 1983). Hanging garden habitats occur in areas of the Colorado Plateau where Navajo and Entrada Sandstone is exposed (Rushforth et al. 1976). They also occur

elsewhere, though less frequently.

Hanging garden habitats should be considered to be important biological libraries and should be carefully protected and studied. Examination of hanging gardens on the Colorado Plateau have demonstrated a rich and unique assemblage of organisms. For example, work done on hanging gardens in Zion National Park identified 27 Cyanobacteria, 11 Chlorophyta and nearly 80 diatoms (Johansen et al. 1983). Also, more than 50 diatom species, 2 euglenophytes, 17 Chlorophyta and 22 Cyanobacteria were collected and identified from two hanging gardens in southeastern Utah (Rushforth et al. 1976). Additional work done on hanging garden algal floras some years ago along Lake Powell determined a flora of approximately 7 Chlorophyta, 11 cyanobacteria, and more than 40 diatom species of which we believe at least 5 are new to science (Rushforth, personal observation).

Several factors associated with management of typical BLM lands represent potential threats to the welfare of its irreplaceable wetland resources. Some of the most direct threats come from roads, which are often constructed along streams and rivers. In addition, upgrading of roads grant easier access to both recreationists and plant collectors that are drawn to the lush plant communities found in riparian areas. However, it is the indirect threats of roads that are far more insidious. For example, upgrading and increased use of roads facilitate the spread of exotic wetland weeds. Another substantial threat to wetlands in the San Rafael Swell is the impoundment and diversion of water away from riparian areas, seeps, springs and other wetland areas. Diverting water away from these water sources reduces wetland acreage, and overall productivity of the site. Indirect effects similarly ensue in these areas; for example a reduction in surface water area caused by water diversion can lead to a decrease in insect populations, thereby decreasing the wetland's value as potential habitat for bats. Also, native aquatic biodiversity is threatened by dams and impoundments because they provide habitat for non-native fish and frogs, which adversely affect native aquatic species (Simms 1997). Water diversions that diminish or otherwise regulate natural flow of a stream will tend to halt or reduce the otherwise natural disturbance cycles upon which healthy riparian zones depend. Dams can upset regular seasonal fluctuations in flow rates, sediment loads and downstream temperatures. This in turn can depress densities of mayflies, which are highly sensitive to these types of habitat alterations (Davidson et al. 1996). This may not bode well for native fish, which feed on mayflies. Yet another significant impact to wetlands on BLM lands is the largely unregulated public use of many BLM lands. In short, people are drawn to shady riparian areas in deserts. Here one often finds make-shift camp sites and unauthorized staging sites for ORV "play areas." Indeed, many off-road enthusiasts find it easy to travel down desert washes, but depending on the annual flow and season, desert washes may have riparian species that can be severely impacted by these vehicles.

Wetland abundance is generally not characteristic of the San Rafael Swell. In fact, as rich wetland resources are generally rare in Utah's deserts, all rivers, tributaries, seeps and springs in the Swell should be included within the boundaries of the new Monument. The inclusion of a substantial amount of these precious wetland resources within the San Rafael Monument, assuming they are managed properly and really protected, should help stem the tide of wetland loss within our deserts. The severity of this loss, to date, on western arid lands cannot be

overstated. In 1990 the EPA concluded that riparian conditions throughout the west are the worst in American history (Chaney et al. 1990).

12.0 the protection of the ecological values of the San Rafael Swell in light of conservation science and ecosystem management

Wilderness and protected areas, such as properly managed National Monuments, linked across the state of Utah can lead to the realization of many fundamental goals and objectives proposed both by the science of conservation biology and the discipline of resource conservation. As I will illustrate, new Monument designation could be instrumental in achieving these goals. Further, these same conservation goals have already been adopted by the BLM, as evidenced in its published policy on Ecosystem Management.

The BLM should take a "big picture approach" when considering the boundaries for the new Monument, and when drafting language for management in the new Monument. In short, I believe that undeveloped and properly managed BLM lands could potentially play a key role in conserving Utah's biodiversity for the long term. It's important that the BLM look at the ecological potential of this new Monument in light of some of the basic goals of conservation biology, including viability and representation of all native species and ecosystem types on Utah's public lands, and maintenance of ecological and evolutionary processes throughout the San Rafael region. Additional WSAs/Wilderness and properly managed Monuments in Utah, as part of a linked, regional "conservation network," can be instrumental in achieving these primary goals.

Of key importance to land management agencies, wilderness and Monument designation can assist in maintaining viable populations of native species on Utah's public lands. In particular, wide-ranging species such as carnivores and ungulates stand to benefit from wilderness/WSA/ Monument designations that are linked to each other or to existing conserved land so as to achieve the largest possible contiguous acreage of preserved lands. Up to the present, the familiar strategy in this country of protecting small sites containing exceptional biological resources has worked well for plants and animals with small area requirements. However, it has been less successful in protecting wide-ranging animals (Noss 1987). Empirical evidence has demonstrated that these small reserves selected through a site-by-site approach are often heavily assaulted by external influences and fail to retain the full set of biological resources for which they were preserved (Newmark 1987, Noss 1992). As the BLM determines the final boundaries of the new San Rafael Monument, it should reflect on the fact that many terrestrial species, especially those that are wide-ranging and/or are negatively impacted by human activities, may be more likely to remain viable if large tracts of land are protected and these lands are linked to other protected areas.

Another way that the viability of terrestrial populations can be enhanced through Monument/ protected area designations is if special attention is paid to the specific habitat requirements of these organisms. For example, much attention should be given to obvious migratory pathways for vertebrates along natural corridors and canyons, as well as along pathways that are perhaps

not quite as obvious, such as elevation gradients that connect the lower-lying lands of the Swell to adjacent plateaus, mesas and mountain ranges (Davidson et al. 1996) such as the Manti's and the Wasatch Plateau. Many Utah bird, insect and mammal species migrate seasonally along these elevational gradients; an obvious example are large ungulates that migrate between low elevation winter ranges and high elevation summer ranges, or goshawks that come down from the Wasatch Plateau to winter on the San Rafael Swell (personal communication, Chris Colt).

Other habitat requirements that the BLM should consider are those needed by species that utilize separate communities, either during different life stages or in daily activity patterns. For example, desert bighorn ewes prefer to lamb on secluded rocky crags adjacent to riparian areas where they can go to forage while leaving their lambs in the relative safety of the cliffs (EDF 1995). It is important that the BLM consider needs of species for certain habitats, as well as migration corridors and space requirements for wide ranging species, as it determines the exact boundaries of the new Monument. As outlined above, these considerations can have profound implications for maintaining viable populations of Utah's native species on public lands.

A carefully managed National Monument can also provide an important refuge for rare, sensitive and critically imperiled species. In a BLM publication that describes Ecosystem Management on BLM lands ("Ecosystem management in the BLM: join the community") the BLM acknowledges the importance of its lands as a refuge for imperiled species:

> *"Public lands often provide the last remaining habitat for many vanishing species. For example, over 191 federally listed Threatened and Endangered plant and animal species and over 1,100 species considered candidates for listing under the Endangered Species Act are found on BLM lands"(BLM 1994b).*

As discussed above, some of these species exist on Utah BLM lands currently proposed for designation of a new National Monument in the San Rafael Swell. If the new Monument is managed properly and truly protects habitat for these species, it may help ensure that populations of Utah threatened and endangered species remain stable, and that other sensitive species avoid being listed.

Lastly, the BLM also acknowledges that it is changing the way that it has traditionally viewed its role in managing public lands: "traditional [BLM] management decisions were sometimes made on the basis of maximizing short-term productivity of the land…under Ecosystem Management, sustaining a healthy functioning ecosystem is the first priority" (BLM 1994). I hope that the BLM gives full effect to this statement as it writes the management plan for the new San Rafael National Monument. If it does this, it will give the BLM even greater credibility in the eyes of the conservation community. At that time, conservation biologists will certainly believe that the BLM has the ability to pass over short-term goals for the sake of long-term ecological integrity of its holdings, and the landscape they are imbedded within.

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