THE STATUS OF UTAH'S STATE-LISTED SENSITIVE HERPETOFAUNA, AND IMPLICATIONS OF NEW WILDERNESS DESIGNATION WITHIN THEIR RANGE

Submitted to:

The Southern Utah Wilderness Alliance

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1.0 INTRODUCTION

The state of Utah currently has 6 amphibians and 25 reptiles on state and federal sensitive, threatened, and candidate species lists. However, details on the current status, occupied range, and even natural history of many of Utah's state-listed[1] herpetofauna are largely unknown. This is because there has not been sufficient of research on these animals, and because they are not receiving the conservation attention they deserve (and these two issues are clearly hand-in-hand). This issue is troubling to Utah's herpetologists, who agree that the lack of research is related to many factors including shortage of funds, difficulty in getting permits, and trends in biological research towards sophisticated genetic analyses and evolutionary biology, rather than simple research on range, distribution, and population dynamics (personal communication with Edmund Brodie, George Oliver, Jane Perkins, Terry Schwaner, and Jack Sites).

Because we really know so little about the current status of Utah's rare and sensitive herpetofauna, it is important that we work to protect those areas where we know, or suspect, they live. Most of Utah's reptiles exist in the lower-elevation, drier regions of the state such as the Great Basin desert and Colorado Plateau. An impressive amount of acreage in both of these ecoregions (almost 2.5 million acres in the Great Basin, and 7.3 million acres in the Colorado Plateau) are either already Wilderness Study Areas or have been recommended by the Utah Wilderness Coalition (UWC) for wilderness. Below, the implications of new wilderness for Utah's state-listed herpetofauna are discussed, overlap between the ranges of these species and the UWC wilderness proposal are analyzed.[2]

In preparing this manuscript, I consulted field guides, scientific literature, and Division of Wildlife Resources reports. I also had discussions with several Utah herpetologists, including curators of museum collections.

2.0 HOW WILDERNESS CAN BENEFIT RETPILES AND AMPHIBIANS

There are many reasons why increased wilderness designation within the range of Utah's sensitive herpetofauna would tend to benefit these species. Principally, these reasons involve prohibition of harmful activities that currently occur on non-protected BLM lands in arid areas of Utah.

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[1] Because there are very few federally listed herpetofauna in Utah, this manuscript primarily addresses the state-listed sensitive herpetofauna. When a species is also federally listed, this is mentioned in the text.

[2] Throughout this manuscript, when the terms "proposed wilderness area" or "proposed wilderness unit" are used, it is referring to the UWC citizen's wilderness proposal on BLM lands.

Importance of wilderness for amphibians

Wilderness can offer more comprehensive and ecologically sound protection for riparian zones and other wetlands, which are where amphibians live and breed. Generally, **all** aquatic and riparian areas should be considered crucial for amphibians; even for those which at present appear to be widespread in Utah.

Any possible implications of additional wilderness designation on native amphibian populations in Utah must be viewed within the larger context of global and regional declines, because there is strong evidence that local declines may often be due to a synergism of more than one effect (Carey 1993, Kiesecker and Blaustein 1995, 1998, Long et al. 1995). The recent attention given to global declines of amphibians stems from the fact that many of these declines have been noticed in relatively pristine, protected environments, and seem to have occurred in parallel on different continents, including Australia (Richards et al. 1993, Laurance et al. 1996), Central and South America (La Marca and Reinthaler 1991, Lips 1998), and extensive areas of the western United States (Carey 1993, Fellers and Drost 1993, Sherman and Morton 1993, Ross et al. 1995). The most troubling aspect of these particular declines is that they are not due to obvious habitat destruction, which is often considered a strong correlate of regional amphibian population declines (Hayes and Jennings 1988, Jennings and Hayes 1994, Fisher and Shaffer 1996). These large-scale declines and extinctions in protected environments have been attributed to climatic variability (Pounds and Crump 1994, Stewart 1995), increased UV radiation associated with thinning of the ozone layer (Blaustein et al. 1994a, 1995, 1996), and pathogens (Blaustein et al. 1994b, Laurance et al. 1996, Berger et al. 1998). One constraint of many of these studies is the need for long-term monitoring, within a sampling framework robust enough to distinguish annual population fluctuations (which may be large) from real long-term declines (Blaustein 1994, Pechman and Wilbur 1994, Reed and Blaustein 1995). Amphibian conservation and management issues on Utah BLM lands must be considered as a regional issue within this larger context.

In connection to the global problems amphibians are experiencing (some of which are as of yet unexplained by science), there are intrinsic traits of amphibians that may render them more susceptible than other organisms to extirpation. Physiological constraints, low vagility, and high site fidelity characterize many amphibian species, which imposes an extremely subdivided spatial structure characterized by frequent extinction of local demes, and difficulties in recolonizing post-extinction habitats (Blaustein et al 1994c). This kind of spatial structure means that individual demes often differ in vital rates (Gill, 1978, Cuellar 1994, Berven,1995), which may lead to extinction of many local populations due to stochastic demographic events (Corn and Fogleman 1984). Beyond the demographic issues, population genetic studies of temperate zone populations of ranid frogs (*R. pipiens* in the southwestern US; Kimberling et al., 1996; and *R. temporaria* in Europe, Hitchings and Beebee 1997) reveal that populations in close proximity are often genetically isolated from each other, despite absence of obvious barriers to gene flow. In these cases, the `effective size' of each breeding group may be only a tiny fraction of its actual census size (as demonstrated for *R. pipiens* by Merrell, 1968), and therefore vulnerable to extinction due to inbreeding depression (Saccheri et al. 1998). Minimizing these demographic

extinctions may be contingent upon protection of even very small, isolated wetlands because these appear to provide temporary 'stepping stone' habitats for dispersing individuals that are crucial for maintenance of metapopulation dynamics (Semlitsch and Bodie 1998). Future wilderness designation in Utah, especially if connected across the landscape, offers an opportunity to protect these kinds of isolated wetlands across Utah's desert lands.

There are many indications that Utah's rare, and often highly sensitive amphibian species, may benefit from additional wilderness. Protected areas will generally not be subjected to pesticides or other chemical vegetation treatments. Tadpoles of both hylid and ranid frogs have been shown to manifest increased developmental anomalies (Rowe et al. 1998) or loss of performance in selected fitness correlates (Jung and Jagoe,1995) when exposed to aquatic contaminants. Also, larval tiger salamanders (*Ambystoma tigrinum*) are susceptible to mass mortality when changes in water quality result in mass bacterial blooms (Worthylake and Hovingh 1989).

Another substantial threat to amphibian habitat in non-wilderness BLM lands is the capping of springs, and diversion and impoundment of water away from riparian zones and other wetland areas. Water extraction for activities such as livestock grazing and mineral exploration leads to reduced wetland acreage and overall productivity of the associated wetlands. 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 some amphibians. Also, dams and impoundments provide habitat for non-native fish and frogs, which can adversely affect many native amphibians through both competition and predation (Lannoo 1998).

Lastly, roads and off-road vehicles (ORVs), which are not permitted in wilderness areas, have proven to be deleterious to many amphibians. For example, ORVs that cross creeks crush frogs and toads, as well as their eggs which are buried in the sand (Phillips 1994). ORV use has also been shown to alter the behavior of some anurans, with extremely damaging results. For example the Couch's spadefoot toad (*Scaphiopus couchi*) will typically emerge from its burrow with the first summer thunderstorms and gather at pools where mating occurs. The timing of emergence during thunderstorms is of critical importance to reproductive success, because the supply of body moisture is insufficient for the animals to return to deep burrows in the absence of rainwater. The trigger that identifies approaching rain apparently is the sound of thunder, a sound simulated closely by dune buggies. Studies show that this sound will encourage emergence of the spadefoot toad, and thus, certain death (Brattstrom and Bondello 1983).

Roads can similarly have insidious effects on amphibians. Roads can prove fatal when they separate different habitats that are required by amphibians. Because most amphibians need to use more than one kind of habitat to meet foraging/wintering/breeding needs, they often move seasonally between habitats juxtapositioned differentially in the landscape (Laan and Verboom 1990). When these movements occur across roads, mortality can be substantial (Van Gelder 1973). For example, Seitz (1990) estimated that travel rates of 24-40 cars/hour on a road could kill 50% of migrating toads in an area. Other road-related factors such as exhaust emissions, vibrations and noise, and pollution in road runoff (oil, salt, etc.) may also affect frog and toad densities, either by causing direct mortality or interrupting behavior (Buchanan 1993).

In general, wilderness designation in areas with appreciable wetland areas would tend to benefit amphibians because it would restrict the sorts of human activities (largely outlined above) that tend to negatively impact these sensitive animals.

Importance of wilderness to reptiles

Again, the potential benefits of wilderness for reptiles are best measured by looking at harmful activities or developments that are not allowed in wilderness areas. Roads are one development that has been particularly harmful to reptiles, especially snakes, which can be drawn to the warmth of pavement on a sunny day. It has been estimated that perhaps tens to hundreds of millions of snakes have been killed by automobiles in the U.S. alone (Fahrig et al. 1995). In an example closer to home, Rosen and Lowe (1994) computed that 4000 snakes were killed during a 4-year period along state route 85 between Why and Lukeville in Arizona.

While roads seem to be a more serious threat to snakes, studies show that all reptiles suffer from the deleterious effects of roads. This includes decreased species diversity of reptiles in areas near roads (Busack and Bury 1974, Vollmer et al. 1976, Finlay and Houlahan 1997), and decreased reptile abundance associated with roaded areas (Vollmer et al. 1976, Bury et al. 1977, Gaddy and Kohlsaat 1987).

Reptile susceptibility to road mortality is related to factors such as habitat type, prey base, and road location. For example, reptiles whose ranges fall partly or completely within forested areas will be attracted to roads even more than desert reptiles, because roads will represent more open, and therefore warmer, conditions than most other parts of their range (Reinert and Zappalarti1988). Furthermore, roads bordered by berms will often have increased numbers of berm-burrowing rodents, who take advantage of the loosened soil. Snakes will tend to utilize this increased source of prey, and after the mice are removed by the snakes, lizards will move into the abandoned burrows (personal communication with Terry Schwaner). However, neither the snakes nor lizards will benefit from traveling vehicles on the road, especially if travel is moderate or heavy. Also, susceptibility of reptiles to roads can be affected by road placement. If a road is cutting across a habitat corridor that connects prime snake hibernation areas to good foraging habitat, snake mortality along that particular stretch of road will tend to be high (personal communication with Jane Perkins).

One of the most insidious threats to reptiles in non-wilderness areas is ORV activity. During winter and daytime hours in hot weather most desert reptiles seek shelter below ground or beneath or within objects resting on the surface. At such times, the biomass of all these sequestered reptiles, including eggs in developmental stages, might approach 80 to 90 percent of the total reptile biomass in an area, and perhaps 75 percent of this biomass is located between the surface and a depth of one foot (personal communication with Howard Wilshire). Their shelters and burrows are fragile. How much life expires beneath the wheels of ORVs is not known, but the figure must be staggering. We already know from studies in the Mojave desert that lizard densities are significantly reduced in areas with ORV activity (Volmer et al. 1976). Also, some species of rattlesnakes are particularly fidelic to their dens, and even if disturbed by continuous ORV use, they may be more inclined to stay out all

winter in the vicinity of their den, rather than travel any distance to find a new one (personal communication with Jane Perkins).

ORV use can also lead to reduced density and diversity of a chief snake prey item: small mammals (Bury 1977, BLM 1978, CEQ 1979, Liddle 1997). Often this effect on small mammals can be attributed to a reduction in plant diversity, simplification of plant structure, and reduction in ground cover, all of which are results of ORV activity (CEQ 1979).

Lastly, wilderness protection may benefit those reptiles that are particularly susceptible to collection. Most reptile collecting is at the hands of amateur (hobby) collectors and dealers in the pet trade. Roads and ORV use offer better access to these collectors, and there are indications that collectors who don't care whether the specimen is alive or dead will purposely kill the animal with a vehicle if its seen on a road (Berish and Diemer 1998). Besides the collection threat, several snakes - especially rattlesnakes and the harmless species that resemble them - are often persecuted out of unfounded fear, and they will benefit from roadless areas simply because fewer roads mean fewer encounters with people.

Additional wilderness designation in Utah, especially on the Colorado Plateau, would probably positively affect reptiles because it would restrict the sorts of human activities and uses (such as roads and ORVs) that tend to negatively impact these species.

Wilderness and desert tortoise: special considerations

Additional wilderness tracts within the range of the desert tortoise (*Gopherus agassizii*) should eventually contribute to the recovery of this federally threatened species. As identified by the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994), current threats to the tortoise include collection by people for pets/trade, vandalism (crushing and shooting), release of captive tortoises (which introduce disease), urbanization, agriculture, garbage, roads and utility corridors, mining projects, military operations, ORVs, exotic species, and noise and vibration. While all of these impacts and activities will be reduced or removed in wilderness areas, it is the reduced ORV impact that will have one of the most beneficial effects on tortoise habitat. ORV activities are among the most destructive, widespread, and best documented of threats to the survival of the desert tortoise, as well as to the integrity of their habitats (USFWS 1994). In addition to compacting soil and damaging vegetation that is important to the tortoise for both forage and cover, ORVs encourage problems such as shooting and tortoise collection due to greater public access (Toffoli 1980). Tortoises are susceptible to collection as it is, because they are slow moving, nonaggressive, and diurnal.

Also, wilderness areas protected from future road building (and in which infrequently traveled roads are closed) will harbor more robust tortoise populations. Not only are numbers of juvenile tortoise significantly lower in areas adjacent to well-used dirt and paved roads (Berry and Turner 1984), but population densities of tortoise can be depressed in areas with dirt roads that see relatively low vehicle use (Berry et al. 1986). Furthermore, vehicles crush a number of vertebrates, resulting in an increase in ravens which can be voracious predators of juvenile tortoise (personal communication with Ted Owens).

There is a special consideration involving the conservation of desert tortoise, and this relates to wildfires in the Mojave Desert. Wildfire can have significant short-term effects on tortoise populations, and may have long-term effects associated with habitat change in the Mojave Desert (USFWS 1994, Esque et al. 1994). In the short-term, tortoises die from exposure to excessive heat. Tortoise moralities due to wildfire have been recorded in the northeast Mojave Desert as early as the 1940's (Woodbury and Hardy 1948) and as recently as 1993 (Esque et al. In Preparation). Although the effects of fire on tortoises were observed decades ago, there is renewed concern about the role of fire in tortoise populations because of the relationship between wildfire and alien annual plants that have recently invaded the southwest deserts (Esque 1999, Brooks et al. 1999). The long-term effects of fires on desert tortoises are less understood, but certainly the habitat changes associated with wildfire alter food availability and the availability of plants for protection from thermal extremes and predators (Esque et al. 1997, Esque et al. In Preparation). Wildfires that occur in tortoise habitats should be suppressed as soon as possible (Brooks et al. 1999)[3].

3.0 STATUS AND RANGE OF KEY UTAH HERPETOFAUNA

Below, some key examples of Utah's sensitive and threatened herpetofauna are discussed, and areas where UWC proposed wilderness units overlap with these species' estimated ranges are analyzed. Based on the arguments presented above, it is generally assumed that wilderness designation is beneficial for most of these species. However, there are exceptions, such as instances where wilderness designation would tend to be inconsequential (neither positive nor negative) for certain species.

It is important to note that many of the roadless areas in Utah have not been surveyed for herpetofauna, even casually (often precisely because they are roadless). Therefore, for many of the species discussed in this manuscript, it cannot be said with certainty that taxon A occurs in proposed wilderness unit X, Y, and Z, etc. Instead, using estimations of both current and historic ranges provided by Utah scientists and field guides, it can be stated that Taxon A is **likely** to occur in proposed wilderness unit X, Y, and Z. On a related topic, the habitat requirements are poorly known for many species, so even within some regions, distributions may be very spotty or

[3] If fire occurs in a wilderness area that contains tortoise, the Endangered Species Act should "trump" the non-mechanical-use stipulation for wilderness. The Wilderness Act does permit aggressive fire fighting (including using mechanized vehicles and motorized equipment) where necessary to protect wilderness values (that includes endangered species). The IMP for Lands Under Wilderness Review states that BLM will use "Light-Hand-on-the-Land" fire suppression techniques, but it explicitly allows the use of motorized vehicles and equipment. In a situation involving fire in tortoise habitat, off-road vehicles can be used in tortoise habitats if hand crews on foot, or vehicles from roads, are insufficient to suppress fires, but special precautions should be used (Duck et al. 1995). There is no conflict between wilderness protection and fire suppression for endangered species management. The benefits of wilderness designation, such as protecting tortoise from new roads and ORV abuse far outweigh the inconvenience of fire fighting in wilderness.

disjunct. The range maps included in the following section are primarily based on historic distribution of the species, because this is usually the best data available.

Most of Utah's state-listed amphibian and reptile species are at the extreme limits of their respective ranges. For example, many of these species enter Utah in the southwestern or southeastern corner of the state, and extend only slightly into Utah. This 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 in Utah become extremely important. The same is true for a few species with populations isolated "internally" on mountaintops or in springs in the West Desert. For this reason, the discussion below on Utah's sensitive herpetofauna is organized according to geographic region.

North-western corner species

Pseudacris regilla - **Pacific Treefrog or Chorus Frog** (G5, S1)[4] This species barely occurs in Utah, yet is likely to be found in the extreme northwest corner of the state in aquatic habitats in and near the Little Goose Creek Proposed Wilderness Area. This proposed wilderness area is contained within the southern-most extent of the Columbia Plateau and as such is within a biologically unique portion of the state, with several species or subspecies of vertebrates occurring only in this region of Utah.

The pacific chorus frog is currently listed as a sensitive species by both the BLM and Utah Division of Wildlife Resources,[5] because of restricted or specialized habitat. It is known from only two or three localities in the region, and as such "practically nothing is known about the habits of this species in Utah" (Oliver 1998). However, elsewhere on the Columbia Plateau, it is known to use a fairly wide variety of habitats. Like most frogs, this species is sensitive to many human land-use practices that can occur in non protected (non-wilderness) areas. These include water extraction and diversion, which can diminish important wetland habitats for frogs.

[4] The Utah Natural Heritage Program rates species on both Global rarity (G) and State rarity (S). These are both based on a scale of 1 to 5, with 1 being the very rarest.

[5] The BLM sensitive species list is derived directly from the state's list. Therefore, when a Utah species is referred to as sensitive, it can be assumed that this designation pertains to both the Utah Division of Wildlife Resources list, as well as the BLM list (assuming it occurs on BLM lands, which all animals referred to in this manuscript do).

Eastern "edge" species[6]

Elaphe guttata emoryi - **Great Plains Rat Snake (**G5, S2) This species occurs in an isolated pocket that spans the Utah/Colorado border, and is considered to be very uncommon in Utah (Cox and Tanner 1995). Not only does this population represent the western-most extent of the species' range, the Utah/Colorado population is disjunct from the rest of the species, which is primarily east of the continental divide (Oliver 1998). Great plains rat snakes are suspected to occur in areas of suitable habitat extending for about 50 miles north and south of Moab (Sites 1998), including Hart's Point, Hatch Canyon, Behind the Rocks, Dome Plateau, and Diamond Canyon proposed wilderness areas (Figure 1). Recently, the great plains rat snake has been collected in Dinosaur National Monument, so it is possible that proposed wilderness units such as Diamond Mountain and Moonshine Draw would also contain this species (personal communication with Jack Sites).

The great plains rat snake is primarily found on rocky, wooded hillsides. It primarily feeds on rodents and birds, which it constricts before swallowing. Nocturnal in hotter seasons, these snakes will enter rodent burrows for cover during the day (Cox and Tanner 1995). For this reason, this species will benefit from the protection from ORVs provided by wilderness. ORVs can be particularly destructive to rodent burrows.

Southeastern corner species

Eumeces multivirgatus gaigeae - **Many-lined Skink** (G5, S2/3) This species is restricted to the southeast corner of Utah, and likely occurs in the San Juan River and Tabernacle proposed wilderness areas, and may extend as far north as the Grand Gulch and Nokai Dome units (Sites 1998), though its historic range extended even further north than that (Figure 2). It is one of the few state-listed reptiles that has been listed based upon both declining populations and limited distribution. However, scientists report that, because knowledge of the species in Utah is based on so few collection localities (about six), much more research is needed on this species. There is apparently conflicting evidence among researchers as to whether the many-lined skink is abundant or not in areas where it's known (Oliver 1998). Suitable habitat for the skink appears to be shrub/brush environments and mixed pine/deciduous forest (Maslin 1957).

Southern "edge" species

Xantusis vigilis - **Night Lizard** (G5, S2) This species occurs in the southern Utah, and may be found in some of the same proposed wilderness areas as the many-lined skink, or in the same

[6] In addition to specific listed species such as the Great Plains rat snake, the Book Cliffs/Uinta Basin region in the eastern part of the state possesses an impressive diversity of reptiles. Because this region lies essentially on the ecoregional border between the Uinta Mountains to the north, the high Colorado plateau grasslands to the east and the canyonland country to the south, many different kinds species reach their distributional limits in this zone. Examples include the Great Basin spadefoot toad, painted desert whiptail, northern leopard frog, eastern fence lizard, pale leopard lizard, yellow headed collared lizard, Great Basin and midget-faded rattlesnakes, and Utah milk snake (personal communication with Jane Perkins). The Desolation/Diamond Canyon proposed wilderness area likely contains all of these species.

units as the southwestern species, discussed below (Figure 3). The most appropriate habitat for this species appears to be gravel beds or alluvial deposits and rocky areas often containing woodrat middens (Schwinn and Minden 1979). The night lizard is extremely vulnerable to habitat disturbance because it is secretive and shows extremely high fidelity to a particular site; for example an individual may be found under the same decomposing Yucca log throughout its life (personal communication with Jack Sites). One mark-recapture study showed that, over a six year period, 91% of night lizard recaptures were at the original capture site (Zweifel and Lowe 1966).

Currently, two separate sub species of night lizard are listed on the state sensitive species list: the Utah night lizard (*X..v. utahensis*), and the desert night lizard (*X..v. vigilis*). However, recent analysis of DNA sequences for both groups have revealed that these two "subspecies" are genetically identical (personal communication with Jack Sites). Also, a recent study of *X. vigilis* throughout part of its range in the southwestern United States has unveiled a genetic signature characteristic of very deep divergences between populations, which are indicative of very long periods of isolation (Bezy and Sites 1987). Many of the populations currently recognized as *X. vigilis* may be a distinct species, and this may be the status of the Utah populations (Sites 1998). Genetic studies on populations of *X. vigilis* in Utah should be a high priority for future study.

Arizona elegans philipi - **Painted Desert Glossy Snake** (G5, S2). This subspecies of desert glossy snake would very likely be found in the San Juan River 202 Parcel and Tabernacle proposed wilderness area but could possibly be found in other proposed units closest to the border with Arizona (Figure 4). This species is nocturnal (Cox and Tanner 1995), and prefers sandy soils for easy burrowing (Tanner 1954, Oliver 1998). This is a bad combination in those areas where desert glossy snake populations overlap with ORV play areas. ORV users are often drawn to the challenge of sand riding, and sand is easily displaced under the tires of ORVs, resulting in certain burrow destruction. If the above proposed wilderness units become protected from future ORV use, it is likely to benefit this species. A study that documents the effects of ORVs on the desert glossy snake would be timely; currently little or nothing is known of populations trends for this snake in Utah.

Sauromalus obesus - **Chuckwalla** (G5, S2) The range of the chuckwalla in southern Utah extends up to at least St. George in the southwest corner of Utah and then extends north-northeast out of Arizona up the canyons on both sides of Lake Powell. This species would likely be found in any of the proposed wilderness units in the southern portion of the Grand Staircase Esclalante National Monument.

The chuckwalla is on the state sensitive list because of both declining populations, and because of its limited range in the state. It prefers basalt formations, layered sandstone shelves, limestone formations, and rocky habitat in general. Because it is such a habitat specialist, the chuckwalla has a fairly patchy distribution where ever it occurs (Oliver 1998). Since its historic distribution in Utah occurred along the Colorado River in the southern part of the state, the Utah population was probably largely reduced by the damming of the Colorado River (Lake Powell). In addition, the Chuckwalla is one of the reptiles most sought after by collectors. This probably continues to be a real threat to the species in Utah.

Southwestern corner species

The following list of reptiles represents an ecoregion that scarcely makes it into Utah: the Mojave desert. Many of the species that exist in this far southwest corner of the state exist no where else in Utah; if they vanish from this region due to lack of comprehensive protection, they will be effectively extirpated from the state. While the below discussion "showcases" a number of state-listed reptiles that are particularly rare or threatened, there are a number of listed and non-listed herpetofauna that are also found in southwest Utah, including the Arizona Toad, Lowland Leopard Frog, Mojave Zebra-tailed Lizard, Utah Banded Gecko, Chuckwalla, Plateau Striped Whiptail, California King Snake, Mojave Patch-nosed Snake, Utah Blind Snake, and Sonora Lyre Snake. All of these species are expected to occur within the Beaver Dam Wash and Joshua Tree proposed wilderness areas, and probably in the nearby Beaver Dam Mountains and Scarecrow Peak proposed wilderness areas as well. If the Beaver Dam Wash and Joshua Tree units are designated as wilderness, they could provide an important "stepping stone" for imperiled Mojave desert species in Utah, California and Arizona. A variety of sensitive species that currently reside in the DWMA Desert Tortoise Refuge in southwest Utah could then experience limited, protected movement between southwest Utah populations and those of existing protected areas immediately across the California and Arizona borders.

Gopherus agassizii - **Desert Tortoise** (G3, S1) A federally threatened species, the desert tortoise is currently the only Utah reptile on the FWS Endangered Species List. The Utah tortoises currently exist as semi-isolated to isolated populations in the Beaver Dam Mountains, the Beaver Dam Wash, and areas north of St. George. Collectively, the range of the species in Utah is about 80 $mi.^2$ The Utah population of about 800 individuals is down from about 2,000 a few decades ago, and is still experiencing unacceptably high mortality (Oliver 1998). Proposed wilderness areas that harbor the desert tortoise include the Beaver Dam Wash and Joshua Tree units, and probably the Beaver Dam Mountains as well (Figure 5). As mentioned above, its is critical that an adequate amount of tortoise habitat is properly preserved in extreme southwest Utah, so the species can have protected movement and connections between other protected areas across the border. A protected network such as this would compliment the Desert Tortoise Recovery Team's proposal for protected areas less than 500 mi^2 to be connected so as to maximize probabilities for tortoise persistence (USFWS 1994).

Most of the threats to desert tortoise, such as ORV use and roads which were outlined earlier, are general threats that occur across the range of the species in the Mojave desert. However, the populations in Utah face a specific threat - very rapid development in the popular resort town of St. George. In Utah, habitat loss (along with grazing) is considered the greatest threat to this species. Sprawling urban/suburban development in the desert can fragment desert tortoise habitat, thus threatening survival of the tortoise in those regions by creating artificial, potentially nonviable island populations from a previously contiguous population. Furthermore, urban development increases mortality of nearby tortoises through increased collection, road kills, vandalism, and predation by domestic animals (Campbell 1981). All of the threats faced by desert tortoise, whether occurring range-wide or in Utah specifically, are potentially even more damaging when one recalls the naturally low reproductive potential and recruitment rates which characterize these long-lived animals.

Heloderma suspectum - **Gila Monster** (G4, S1) The distribution of the Gila monster in Utah represents the northern-most extent of the species' range. It is only found in about a 30mi^2 area in southwestern Washington County, though its historical range probably included over 100mi^2 of suitable habitat in Utah (Oliver 1998). Similarly, the historic population of probably over 3,000 individuals has been estimated to now be around 400 (Oliver 1998). For these reasons, and because the gila monster is subjected to ongoing threats such as urban expansion and collecting, the state of Utah has listed this species as endangered.

The gila monster prefers red sand areas, rock shelves, Navajo sandstone, basalt flows, and creosote vegetation associations. It is known with certainty that the gila monster occurs in Beaver Dam Wash proposed wilderness unit (Davidson et al. 1996). Based on areas with prime habitat, it is possible that this species could be found within the Beaver Dam Wash, Johua Tree, Beaver Dam Mountain, Cottonwood, and Red Mountain proposed wilderness areas. However more research is needed, especially in the area between Beaver Dam Wash and the Nevada state line, where there is conflicting evidence as to whether the species is present.

Dipsosaurus dorsalis - **Desert Iguana** (G5, S1). This species has the most restricted distribution of any reptile in Utah. It is currently confined to about a <5 mi^2 area of habitat in the bottom of Beaver Dam Wash (Oliver 1998). The only estimate of population size for this area (~250) dates to the late 1970's (Coombs 1977?). Since the Beaver Dam Wash proposed wilderness unit is the only one in Utah known to contain desert iguanas, it is important that its designation as wilderness goes through.

The desert iguana, unlike most of Utah's reptiles, is strictly herbivorous. As such, there is an increased chance of competition with cattle for limited food resources at the bottom of Beaver Dam Wash. Additionally, cattle can be destructive to the already restricted and fragile habitat in the wash.

Crotalus mitchellii pyrrhus - **Southwestern Speckled Rattlesnake** (G5, S1) The Southwestern speckled rattlesnake is considered to be the rarest rattlesnake in Utah, with extremely few individuals (perhaps less than 10) ever discovered in the state (Oliver 1998). This species is restricted to the area southwest of the Beaver Dam Mountains. In other words, it does not extend up and over the "rim" of this small range and down onto the other side, as do some of the other Mojave desert species. The speckled rattlesnake is known with certainty from only the higher elevation Mojave sites, such as those contained within the Joshua Tree proposed wilderness area (Davidson et al. 1996). However, it is likely to also be found in the higher elevations in the Beaver Dam Wash unit (Figure 6), as well as the western slopes of the Beaver Dam Mountain proposed wilderness area (Sites 1998).

Crotalus cerastes - **Mojave Desert Sidewinder** (G5, S2). A Mojave desert endemic, this species is confined to sand dune areas; it would occur in any such microhabitats in the Beaver Dam Wash, Beaver Dam Mountain, and Joshua Tree proposed wilderness areas (Figure 6), while possibly extending into the Red Mountain and Cottonwood Canyon units (Sites 1998). This species is unique in that it has a particular locomotion adaptation that allows it to move

efficiently through the sandy habitats in which it has evolved.

One major threat to this species is urban development, primarily in the areas around St. George. The sidewinder is also likely to come into conflict with ORV users as well, especially those that seek the challenge of sand dunes. Sand dune assemblages are rare in Utah, and comprise ecologically distinctive landforms that support a unique and surprisingly diverse assemblage of species. Any proposed wilderness area with sand dune ecosystems should be made high priority for wilderness designation.

Great Basin (and range) species

Rana luteiventris - **Columbia Spotted Frog** (G3/4, S1) Wasatch Front populations of this species have been proposed for federal listing under the Endangered Species Act. As such, this species is under special management by BLM and Utah DWR (Conservation Species), and is being managed under a conservation agreement. A major impetus behind the proposed federal listing is the reduction and fragmentation of habitat associated with water development (e.g. alterations in hydrology), urbanization, introduction of non-native species, and outright habitat destruction (e.g. filling of wetlands). Since the Wasatch Front population are clearly in peril, it is important that the other areas of the state known to contain spotted frogs are carefully preserved. Spotted frogs occur in the Deep Creek Mountains, and the Tule and Snake valleys in the West Desert (Ross et al. 1993,UDWR 1994). Only a few areas containing spotted frogs in the West Desert currently overlap with the UWC proposal (Figure 7). However, since the springs and ponds that contain spotted frogs often depend on water sources in adjacent mountains and foothills, it is important that these areas receive adequate protection so these critical water sources can also be preserved.

Spotted frogs are highly aquatic and tend to be more of a specialist than most ranids. They are found in small permanent ponds with little water movement and where deep silts and mucks collect on pond bottoms (Morris and Tanner 1969). Because these frogs are highly fidelic to specific sites, intra-population movement is very limited. Therefore, most known populations of spotted frog~~s~~ in Utah are already genetically isolated from one another (UDWR 1994). In fact, there is evidence that a split of *R. luteiventris* into two subspecies (a Wasatch Front and a West Desert subspecies) is warranted (Oliver 1998). It is also noteworthy that the range of the frog in Utah represents the southern-most tip of the species' range.

Lampropeltis pyromelana infralabialis- **Utah Mountain King Snake** (G5, S2/3) Populations of this sub-species primarily occur along the central mountain ranges in Utah, although it is considered uncommon throughout its range with only 12 collecting localities known (Oliver 1998). In fact, this is only one of two state-listed reptiles that are considered sensitive species solely because of indication of declining populations (rather than due to limited distribution, or because of both declining populations and limited distribution).

While the Utah Citizen's wilderness inventory primarily focuses on the lower-lying BLM lands, there are some proposed units that overlap with the suspected range of this species (Figure 8). Found up to 9,000 feet, the mountain king snake is usually found in moist, forested areas where

there is thick cover for protection (Cox and Tanner 1995). Additional wilderness designation in Utah's forested regions will be important to this species, whose desired habitat type is adversely affected by timber extraction.[7]

The Mountain kingsnake reaches its northernmost distribution in Utah (Sites 1998). Furthermore, records indicate its presence in the Wah-Wah Mountains (Cox and Tanner 1995, Oliver 1998). It is possibly present in other isolated West Desert mountain ranges as well (Sites 1998). It is very important that as much wilderness as possible be designated in Utah's isolated mountain ranges. For the most part, the biotic communities that occur in these isolated ranges have evolved in virtual isolation of other communities in distant ranges. If a population of Utah mountain kingsnake, or any other species for that matter, is extirpated from an isolated mountain range, chances of recolonization from another range are usually remote.

4.0 CONCLUSION

In this manuscript I have "showcased" only a few of Utah's sensitive species of herpetofauna that seem to be particularly rare or imperiled. However, it must be emphasized that scientists do not know enough about Utah's amphibians and reptiles to warrant concrete discussion of their current status, or predict with certainty which units of the UWC proposal capture their range. There is much more research that needs to be done.

Also, when elaborating on the many worthy aspects of increased wilderness designation in the Colorado Plateau and Great Basin in Utah, it is important to look beyond the benefits of wilderness for one guild (herpetofauna). In virtually all cases, increased acreage of land designated as wilderness in Utah will lead directly or indirectly to a greater chance for persistence for **all** of Utah's state and federally listed species. This scenario is in the best interest of the BLM and other land management agencies because it can lead to fewer regulatory headaches relating to management of imperiled species on federal lands. Importantly, the BLM will benefit from the avoidance of new listings of rare and candidate species that are positively affected by new wilderness designations. Most land management agencies already attempt to implement far-sighted policies to reduce chances of species listings[8] because they are aware of the increased management headaches and regulatory limitations that accompany new listings (i.e. consultation with the USFWS). In the long run, it will be cheaper and easier for the BLM to protect species in functioning, intact ecosystems now, rather than protecting them separately in imperiled and fragmented populations under the ESA.

[7]Other Utah wilderness groups are currently working on a Utah forest wilderness proposal.

[8] In fact, BLM Manual 6840.06D requires that state-listed species are afforded some modicum of protection to insure that they do not become federally listed.

5.0 LITERATURE CITED

Berish, J. and E. Diemer. 1998. Characterization of rattlesnake harvest in Florida. J. Herp. 32:551-557.

Berry, K. H., L.L. Nicholson, S. Juarez, and A.P. Woodman. 1986. Changes in desert tortoise populations at four study sites in California. Pp. 60-80, in: Proc. Desert Tort. Counc. Symp. 1986.

Berry, K.H., and F.B. Turner. 1984. Notes on the behavior and habitat preferences of juvenile desert tortoises (Gopherus agassizii). Pp. 111-130 in: Proc. Desert Tort. Counc. Symp. 1984.

Berven, K.A. 1995. Population regulation in the wood frog, *Rana sylvatica*, from three diverse geographic localities. Australian J. Ecol. 20:385-392.

Bezy, R.L., and J.W. Sites, Jr. 1987. A preliminary study of allozyme evolution in the lizard family Xantusiidae. Herpetologica 43:280-292

BLM (Bureau of Land Management). 1978. Evaluation report, 1974 Barstow-Las Vegas motorcycle race. US Dept. Interior, BLM, Riverside, CA.

Blaustein, A.R. 1994. Chicken Little or Nero's fiddle? A perspective on declining amphibia populations. Herpetologica 50:85-97.

Blaustein, A.R., P.D. Hoffman, D.G. Hokit, J.M. Kiesecker, S.C. Walls, and J.B. Hays. 1994a. UV repair and resistance to solar UV-B in amphibian eggs: A link to population declines? Proc. Nat. Acad. Sci. USA 91:1791-1795.

Blaustein, A.R., D.G. Hokit, R.K. O'Hara, and R.A. Holt. 1994b. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. Biol. Conserv. 67:251-254.

Blaustein, A.R., D.B. Wake, and W.P. Sousa. 1994c. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinctions. Conserv. Biol. 8:60-71.

Blaustein, A.R., B. Edmond, J.M. Kiesecker, J.J. Beatty, and D.G. Hokit. 1995. Ambient ultraviolet radiation causes mortality in salamander eggs. Ecol. Appl. 5:740-743.

Blaustein, A.R., P.D. Hoffman, J.M. Kiesecker, and J.B. Hays. 1996. DNA repair activity and resistance to solar UV-B radiation in eggs of the red-legged frog. Conserv. Biol. 10:1398-1402.

Brattstrom, B.H. and M.C. Bondello. 1983. Effects of off-road vehicle noise on desert vertebrates. Pp. 7-206 in: R.H. Webb and H.G. Wilshire (eds.), Environmental effects of off-road vehicles: impacts and management in arid regions. Springer-Verlag, New York.

Brooks, M. W., T. C. Esque, and C. R. Schwalbe. 1999. *Abstract*. Effects of exotic grasses via wildfire on desert tortoises and their habitat. Proceedings of the 24th Desert Tortoise Council Symposium.

Buchanan, B.W. 1993. Effects of enhanced lighting on the behaviour of nocturnal frogs. Anim. Behav. 43: 893-899.

Bury, R.B. 1977. Effects of off-road vehicles on vertebrates in the California desert. Washington, DC: Dept of the Interior: USFWS pub.

Busack, S.D. and R.B. Bury. 1974. Some effects of ORVs and sheep grazing in the Mojave desert. Biol. Conserv. 6:179-183.

Campbell, T. 1981. Some effects of recreational activitis at the Desert Tortoise Natursl Area. In: (Hashagen, K.A. and E. St.Amant, eds.) Proceedings of the Desert Tortoise Council, March 28-30, 1981, Riverside, CA. Pp. 121-127.

Carey, C. 1993. Hypothesis concerning causes of the disappearance of boreal toads from the mountains of Colorado. Conserv. Biol. 7:355-362.

CEQ (Council on Environmental Quality). 1979. Off-road vehicles on public land. Council on Env. Quality, Washington, DC. PrEX 14.2: V53.

Coombs, E. 1977? Wildlife observations of the hot desert region, Washington County, Utah, with emphasis on reptilian species and their habitat in relation to livestock grazing. A report to the Cedar City District, BLM, by the Utah Division of Wildlife Resources.

Corn, P.S., and J.C. Fogleman. 1984. Extinction of montane populations of the northern leopard frog (*Rana pipiens*) in Colorado. J. Herpetol. 18:147-152.

Cox, D.C. and W.W. Tanner. 1995. Snakes of Utah. Brigham Young University Press, Provo, UT.

Cuellar, O. 1994. Ecological observations on *Rana pretiosa* in western Utah. Alytes 12:109-121.

Duck, T. A., T. C. Esque, and T. J. Hughes. 1995. Fighting wildfire in desert tortoise habitat: considerations for land managers. Pp. 7-13, in: Proceedings – fire effects on rare and endangered species and habitats conference. Coeur d'Alene, Idaho.

Esque, T.C., T. Hughes, L.A. DeFalco, B.E. Hatfield, and R.B. Duncan. 1994. *Abstract*. Effects of wildfire on desert tortoises and their habitats. Pp. 153 - 154, in: Anne Fletcher, (editor), Proceedings of the 19th annual Desert Tortoise Council Symposium. Tucson, Arizona.

Esque, T. C. 1999. *Abstract*. Managing fire and invasive plants in the Mojave Desert: Defining an integrated research program to address knowledge gaps. Mojave Desert Science Symposium. Las Vegas, NV. 25 February 1999.

Esque, T. C. A. Burquez, and C. R. Schwalbe. 1997. *Abstract*. Effects of alien plant invasions, wildfire, and habitat change on the desert tortoise (*Gopherus agassizii*). Presented at the joint meetings of American Society of Ichthyologists and Herpetologists, Herpetologists' League, and Society for the Study of Amphibians and Reptiles. Seattle, Washington. Symposium proceedings.

Esque, T.C., Alberto Búrquez M., C.R. Schwalbe, T.R. Van Devender, Michelle J. Nijhuis, and P. Swantek. In Prep. Effects Of fire on desert tortoises and their habitats. Chapter ## in: T.R. VanDevender, C.R. Schwalbe, and H. Lawler, (eds.), Ecology and Natural History of Sonoran Desert Tortoises. University of Arizona Press. Tucson, Arizona.

Fahrig, L., Pedlar, J.H., Pope, S.E., Taylor, P.D. and J.F. Wegner. 1995. Effect of road traffic on amphibian density. Biol. Conserv. 73: 177-182.

Fellers, G.M. and C.A. Drost. 1993. Disappearance of the Cascades frog *Rana cascadae* at the southern end of its range, California. Biol. Conserv. 65:177-181.

Fisher, R.N., and H.B. Shaffer. 1996. The decline of amphibians in California's Great Central Valley. Conserv. Biol. 10:1387-1397.

Frey, J. 1993. Modes of peripheral isolate formation and speciation. Systematic Biology 42:373-381.

Gaddy, L.L. and T.L. Kohlsaat. 1987. Recreational impact on the natural vegetation, avifauna and herpetofauna of four South Carolina barrier islands. Nat. Areas Journal 7(2): 55-64.

Garcia-Ramos, G., and M. Kirkpatrick. 1997. Genetic models of adaptation and gene flow in peripheral populations. Evolution 51:21-28.

Gill, D.E. 1978. The metapopulation dynamics of the red-spotted newt, *Notophthalmus viridescens* (Rafinesque). Ecol. Monogr.48:145-166.

Hayes, M.P., and M.R. Jennings. 1988. Habitat correlates of distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylii*): implications for management. Pp. 144- 158, In:Management of amphibians, reptiles, and small mammals in North Americ: Proceedings of a symposium. R.C. Szaro, K.E. Severson, and D.R. Patton, technical coordinators, USDA Forest Service, General Technical Report RM-166.

Hitchings, S.P., and T.J.C. Beebee. 1997. Genetic substructuring as a result of barriers to gene flow in urban *Rana temporaria* (common frog) populations: implications for biodiversity conservation. Heredity 79:117-127.

Jennings, M.R., and M.P. Hayes. 1994. Decline of native ranid frogs in the desert southwest. Pp. 183-211, In: Herpetology of the North American Deserts. P.R. Brown and J.W. Wright (eds.). Southwest. Herp. Soc. Special Pub. No. 5.

Jung, R.E., and C.H. Jagoe. 1995. Effects of low pH and aluminum on body size, swimming performance, and susceptibility to predation of green tree frog (*Hyla cinerea*) tadpoles. Can. J. Zool. 73:2171-2183.

Kiesecker, J.M., and A.R. Blaustein. 1995. Synergism between UV-B radiation and a pathogen magnifies amphibian embryo mortality in nature. Proc. Nat. Acad. Sci. USA 92:11049-11052.

Kimberling, D.N., A.R. Ferreira, S.M. Shuster, and P. Keim. 1996. RAPD marker estimation of genetic structure among isolated northern leopard frog populations in the south-western USA. Mol. Ecol. 5:521-529.

Laan, R. and B. Verboom. 1990. Effects of pool size and isolation on amphibian communities. Biol. Conserv. 54: 251-262.

La Marca, E., and H. Reinthaler. 1991. Population changes in *Atelopus* species in the Cordillera de

Merida, Venezuela. Herp. Rev. 22:125-128.

Lanoo, M.J. 1998. Status and conservation of midwestern amphibians. Univ. of Iowa Press, Iowa City, IA. 507 pp.

Laurance, W.F., K.R. McDonald, and R. Speare. 1996. Epidemic disease and the catastrophic decline of Australian rain forest frogs. Conserv. Biol. 10:406-413.

Lesica, P. and F.W. Allendorf. 1985. When are peripheral populations valuable for conservation? Conserv. Biol. 9:753-760.

Liddle, M. 1997. Recreation ecology. Chapman & Hall, London. 639 pp.

Lips, K.R 1998. Decline of a tropical montane amphibian fauna. Conserv. Biol. 12:106-117.

Long, L.E., L. Saylor, and M.E. Soulé. 1995. A ph/UV-B synergism in amphibians. Conserv. Biol. 9:1301-1303.

Maslin, T.P. 1957. Notes on the lizard *Eumeces multivirgatus gaigeae* from Colorado and Utah. Herpetologica 13:87-90.

Merrell, D.J. 1968. A comparison of the estimated size and the "effective size" of breeding populations of the leopard frog, *Rana pipiens*. Evolution 22:274-283.

Morris, R.L. and W.W. Tanner. 1969. The ecology of the western spotted frog (Rana pretiosa): a life history study. Great Basin Naturalist 29:45-81.

Oliver, G. 1998. Inventory of sensitive species and ecosystems in Utah. Utah Division of Wildlife Resources. Cooperative Agreement No. UC-95-0015.

Pechmann, J.H.K., and H.M. Wilbur. 1994. Putting amphibian decline populations in perspective: natural fluctuations and human impacts. Herpetologica 50:65-84.

Phillips, K. 1994. Tracking the vanishing frogs: an ecological mystery. New York: St. Martins Press.

Pounds, J.A., and M.L. Crump. 1994. Amphibian declines and climate disturbance: the case of the golden toad and the harlequin frog. Conserv. Biol. 8:72-85.

Reed, J.M., and A.R. Blaustein. 1995. Assessment of "nondeclining" amphibian populations using power analysis. Conserv. Biol. 9:1299-1300.

Reinert, H.K. and R.T. Zappalorti. 1988. Timber rattlesnakes of the pine barrens: movement patterns and habitat preference. Copeia. 1988(4): 964-978.

Richards, S.J., K.R. McDonald, and R.A. Alford. 1993. Declines in populations of Australia's endemic tropical rainforest frogs. Pacific Conserv. Biol. 1:66-77.

Rosen, P.C. and C.H. Lowe. 1994. Highway mortality of snakes in the Sonoran desert of southern Arizona. Biol. Conserv. 68:143-148.

Ross, D.A., Shirley, D.L.., White, P.A. and L.D. Lentsch. 1993. Distribution of the spotted frog along the Wasatch Front in Utah, 1991-1992. Utah Division of Wildlife Resources, Publication No. 93-4. Salt Lake City, UT. 25 pp.

Ross, D.A., T.C. Esque, R.A. Fridell, and P. Hovingh. 1995. Historical distribution, current status, and range extension of *Bufo boreas* in Utah. Herp. Rev. 26:187-189.

Rowe, C.L., O.M. Kinney, and J.D. Congdon. 1998. Oral deformities in tadpoles of the bullfrog (*Rana catesbeiana*) caused by conditions in a polluted habitat. Copeia 1998:244-246.

Saccheri, I., M. Kuussaari, M. Kankare, P. Vikman, W. Fortelius, and I. Hanski. 1998. Inbreeding and extinction in a butterfly metapopulation. Nature 392:491-494.

Schwinn, M.A. and L. Minden. 1979. Utah reptile and amphibian latilong distributions. Utah Division of Wildlife Resources, Publication No. 80-1. Salt Lake City, UT.

Semlitsch, R.D., and J.R. Bodie. 1998. Are small, isolated wetlands expendable? Conserv. Biol. 12:1129-1133.

Sherman, C.K., and M.L. Morton. 1993. Population declines of Yosemite toads in the eastern Sierra Nevada of California. J. Herpetol. 27:186-198.

Sites, J.W. 1998. Amphibian and reptile distributions in Utah, relative to BLM roadless areas identified by SUWA/wildlands volunteers. Unpublished MS. Brigham young University, Provo, UT.

Stewart, M.M. 1995. Climate driven population fluctuations in rain forest frogs. J. Herpetol. 29:437-446.

Tanner, W.W. 1954. Herpetological notes concerning some reptiles of Utah and Arizona. Herpetologica 10:92-96.

Toffoli, E.V. 1980. The desert tortoise - at the crossroads. In: (Hashagen, K.A., ed) Proceedings of the 1980 symposium of the Desert Tortoise Council, March 22-24, 1980, Riverside, CA. Pp 13-22.

UDWR (Utah Division of Wildlife Resources). 1994. Distribution, habitat use and relative abundance of spotted frogs in the West Desert, Utah, 1993. Native Wildlife Section, UDWR. Pub. No. 93-15. Salt Lake City, UT.

USFWS (U.S. Fish and Wildlife Service). 1994. Desert tortoise (Mojave population) recovery plan. U.S. Fish and Wildlife Service, Portland, OR. 73 pages plus appendices.

Van Gelder, J.J. 1973. A quanititative approach to the mortaility resulting from traffic in a population of *Bufo bufo*. Oecologia 13: 93-95.

Volmer, A.T., Maza, B.G., Medica, P.A., Turner, F.B., and S.A. Bamberg. 1976. The impact of ORVs on a desert ecosystem. Env. Manage. 1:115-129.

Woodbury, A.M., and R. Hardy. 1948. Studies of the desert tortoise, *Gopherus agassizii*. Ecological Monographs 18:146-200.

Worthylake, K.M., and P. Hovingh. 1989. Mass mortality of salamanders (*Ambystoma tigrinum*) by bacteria (*Acinetobacter*) in an oligotrophic seepage mountain lake. Great Basin Nat. 49:364-372.

Zweifel, R.G., and C.H. Lowe. 1966. The ecology of a population of Xantusia vigilis, the desert night lizard. American Museum Novitates 2247:1-57.