Las Vegas Wash Coordination Committee

Las Vegas Wash Reptile Survey Summary Report, 2001-2003

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1.0 INTRODUCTION

Within Clark County, Nevada, lowland riparian zones (i.e., less than 4000 feet) are found along the Virgin, Muddy, and Colorado Rivers, and along the Las Vegas Wash (referred to herein as the Wash). These unique desert riparian ecosystems make up a small percentage of the total land area within the county and provide essential cover, water, food, migration, and breeding sites for a variety of wildlife species in this otherwise arid desert environment (Bradley and Niles 1973, USFWS 1995, BIO/WEST 2001, Mueller and Marsh 2002, Las Vegas Wash Coordination Committee 2003). For example, up to 70% of Southern Nevada's avifauna is found in these riparian communities (Bradley and Deacon 1965).

Beginning in the 1960's, the importance of the Wash to the Las Vegas watershed was recognized, and a variety of groups were formed and plans developed to address Wash related issues. The most recent attempt by the Las Vegas community to manage this resource began in 1998 with the formation of the Las Vegas Wash Coordination Committee (LVWCC), a 28-member group of Federal, State, and local agencies, citizen groups, stakeholders, and private businesses and organizations. By 2000 the LVWCC had developed the Las Vegas Wash Comprehensive Adaptive Management Plan that outlined 44 recommendations that would need to be accomplished to help manage the Wash. One of these recommendations was to develop a long-term fish and wildlife management plan. Herein, we provide a summary report on an inventory and monitoring program for reptile species (specifically designed for lizards and snakes) within the Wash area developed to support the wildlife plan. This report reflects three years of field efforts from 2001 through 2003.

The presence of riparian ecosystems within the Mojave Desert is advantageous for species inhabiting this otherwise dry landscape. A desert riparian ecosystem like the Wash introduces an ecotonal gradient that has the ability to support a greater diversity of animals than a monotonic ecosystem. The habitat gradient that exists in the Wash creates an uncertainty to the presence and abundance of desert-adapted species. For example, dispersing or wandering individuals from xeric habitats may explore interior riparian habitat in search of prey. If observed, these individuals may alter abundance and diversity measures in these areas. In a region where typical desert inhabitants would thrive, the competitive edge may lean towards those animals with the ability to use the permanent water supply or take advantage of resources available within, or because of, the riparian habitat. For example, insect populations that inhabit this aquatic/riparian area may provide a very abundant and diverse prey base for insectivores or the greater diversity and potentially longer growing seasons for flowering plants may provide a more abundant and diverse resource base for herbivorous species that specialize on succulent plant growth. These new resources may greatly alter the density and abundance of particular species or create niches for species that have otherwise been excluded from this area.

Reptiles are highly adaptive creatures that often comprise a significant portion of biotic assemblages within arid environments (Whitford 2002). The last known inventory of reptiles near the Wash occurred over 30 years ago (Bradley and Niles 1973). In that study, Bradley and Niles (1973) developed a general list of vertebrates and vascular plants in the Wash using both quantitative and qualitative data. Information on lizards and snakes was derived mainly through field observations. Much of the presence/absence and distribution information reported for the lizards and snakes in the Wash was identified based upon the earlier work of Bradley and Deacon (1965).

Population increase and urban development in the Las Vegas Valley over the past 30 years have led to dramatic alterations to Wash habitats and potentially to alterations of reptilian species diversity and population abundance. Because of the dynamic changes within the Wash region and because earlier information was lacking, our approach was to develop a qualitative baseline dataset for terrestrial reptiles focused on determining species diversity and relative measures of abundance. Only by monitoring the dynamics of lizard and snake populations in and around the Wash can the impacts of long-term habitat rehabilitation and enhancement efforts being implemented and planned within the Wash be evaluated on these taxa.

2.0 METHODS

Field efforts for reptile inventory and monitoring were initiated in May 2001. This report reflects data collected for three years of inventory (2001-2003). A previous report was prepared summarizing results from 2001 (SNWA 2002), however, 2001 data is included here in order to present a more thorough analysis of data collected from the entire period of study. The Las Vegas Wash Project Coordination Team (Project Team) primarily conducted fieldwork, but was assisted by staff from the Nevada Division of Wildlife. Because reptiles are ectothermic, they are physiologically restricted to seasonal activity patterns. As a result, the sampling periods were limited to spring, summer, and fall (May-September 2001, March-September 2002, March-October 2003).

A 'drift fence array' trapping methodology (e.g., Corn 1994) was used to collect animals. This method of reptile monitoring is similar to that reported by Fisher et al. (2002), with the design of the arrays specifically modified for use in this study (SNWA 2002, Appendix A). This type of monitoring program emphasizes sampling of the relatively more abundant species. In this study, the focus was on lizards and snakes, but other organisms (frogs, toads, salamanders, and small rodents) can be sampled using this methodology. Six drift fence arrays using both pitfall traps and funnel traps were established during 2001 within the Clark County Wetlands Park (Wetlands Park; Figure 1 and Figure 2). Four additional drift fence arrays were installed for 2003.

Drift fence arrays were installed in a variety of habitat types (Table 1 and Appendix B) to evaluate reptile presence and to develop rough estimates of their abundance in each area. Quantitative methods were not used for describing these vegetation types; instead qualitative descriptions were made. Vegetation types described in this study include scrub, wash, and riparian vegetation (Baldwin et. al. 2002). Scrub vegetation includes creosote (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*); wash vegetation includes mesquite (*Prosopis* spp.), saltbush (*Atriplex* spp.), catclaw (*Acacia greggii*), and salt cedar (*Tamarix ramosissima*); and riparian vegetation includes saltbush, salt cedar, willow (*Salix* spp.), and cottonwood (*Populus freemontii*). Two of the sampling sites (Sites 7 and 9) are within areas

Array Number	Habitat Type
1	Creosote-bursage
2	Mesquite-saltbush
3	Saltbush-salt cedar
4	Saltbush-salt cedar
5	Mixed saltbush
6	Saltbush-salt cedar
7	Mixed riparian
8	Saltbush-salt cedar
9	Mixed riparian
10	Salt cedar

Table 1: Description of array sites by habitat type.

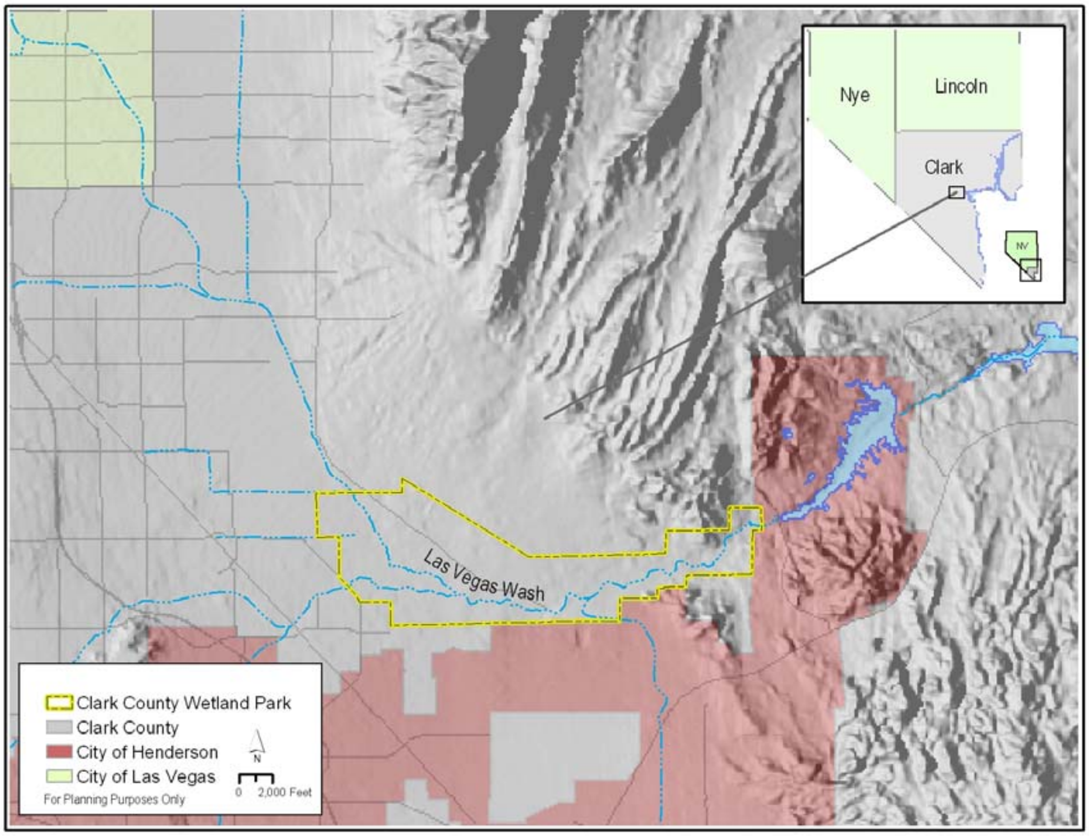


Figure 1: Study area location.

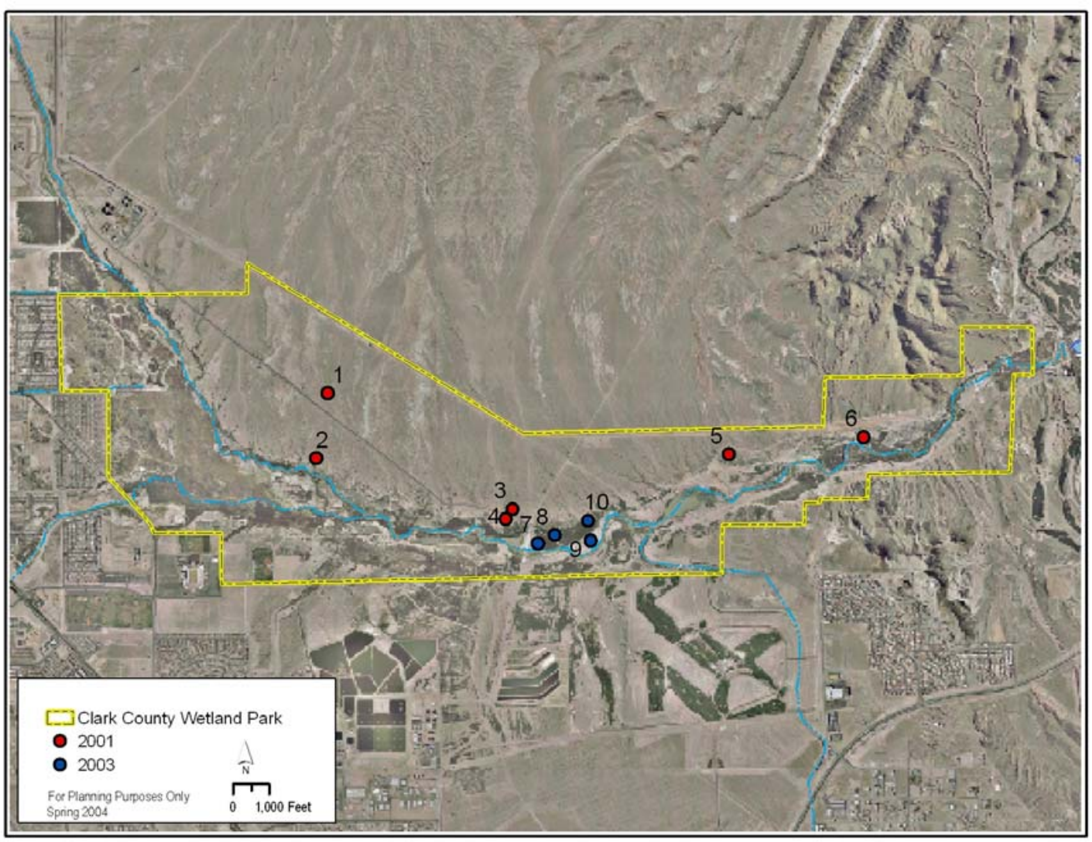


Figure 2: Array site locations and installation dates.

that have been cleared and revegetated with native riparian taxa as part of wetland mitigation activities in association with the construction of erosion control structures.

Traps within the arrays were opened on a Tuesday and were sampled between 0600 and 1200 hours for three consecutive days, then closed and reopened two weeks later. Individual reptiles were identified to species according to Stebbins (2003). Although we focused on collecting reptiles, small mammals and occasionally toads were incidentally captured. The toads were identified to species according to Stebbins (2003), and the mammals were identified to species, when possible, according to Hall (1946) and Zeveloff (1988). Where species names have changed, taxonomy follows that of the Integrated Taxonomic Information System database (http://www.itis.usda.gov). Captured lizards were examined to determine age, length, weight, gender, parasite load, and tail regeneration. This information was recorded on a field data sheet (Appendix C). Snakes were identified to species. Before release, lizards were marked by toe clipping (Appendix D). Toe clipping provides a unique identifier for each lizard so that recaptures can be easily identified.

Environmental measurements, including temperature and precipitation, were monitored during the study. Temperature was recorded at approximately 1.5 m and 0.05 m above the ground surface at each array for all sampling days. Precipitation data was gathered by rain gauges maintained by the Clark County Regional Flood Control District, U.S. Geological Survey, and the National Weather Service as part of the Flood Threat Recognition System.

Species diversity is a common variable of interest for biological communities. It incorporates two separate concepts, the number of species (i.e., species richness, often given as a species list or inventory) in a given community and the evenness (i.e, frequency of occurrence) of those species in the community. Evenness takes into account both the common and uncommon animals in a community. For example, a population of ten animals from the same species is less even than a population of ten animals equally divided among five different species (two animals per species). In order to determine species diversity measures a Shannon-Wiener index (H'), which is sensitive to the abundances of rare species in the community (Peet 1974), was calculated. It was then converted to MacArthur's (1965) number of equally common species (N_1) since this measure is more clearly understandable to ecologists (Hill 1973). MacArthur's N_1 describes the number of equally common species in a population and therefore high N_1 measures reflect high species richness and evenness values (equals greater species diversity). Species diversity as measured by MacArthur's N_1 is a useful tool for describing biotic assemblages or communities. High species diversity can often imply ecological value (if the diversity is not inflated by exotics and common species that specialize on disturbed habitats).

Relative capture frequency (relative frequency) values were calculated yearly for each species. Relative frequency was determined by dividing the number of individuals of a species by the total number of individuals for all species found over a period of time. Relative frequency values provide a measure of how often species were captured during the study. Changes in relative frequency values can provide a general indication of changes in abundance or activity. Capture rates were also calculated. They were calculated by dividing the number of individuals trapped by the number of array nights. Niche breadth is another value that ecologists measure. A niche is the particular area (i.e., resource state) within a habitat occupied by an organism and breadth estimates the spectrum of niches occupied by that organism (Colwell and Futuyma 1971). Simply, niche breadth values reflect the distribution of an organism in different habitats and thus the degree of specialization or generalization that an animal may have. Species that have high niche breadth values are generally found throughout the landscape whereas species with low niche breadth values may be confined to specific habitat types. Niche breadth estimates were calculated using Levins (1968) measure (B) and then standardized on a scale from 0 to 1.0 (B_A) as suggested by Hurlbert (1978).

Resource states (i.e., habitats) are defined botanically by the dominant/co-dominant vegetation type at drift fence array locations (Krebs 1999). Resource states can be described on many different spatial scales including large resource states (i.e., dominant/co-dominant vegetation within the area) or small resource states (i.e., the particular shrub that an organism was first observed on or near). Using the dominant/co-dominant vegetation type as the basis for describing niche breadth, we can than start to explore species-habitat models that may help with predicting the presence or absence of reptiles in many areas of the Wetlands Park.

3.0 RESULTS

A variety of lizards and snakes were captured in the drift fence arrays. A total of 14 species (10 lizards and 4 snakes) were captured during the three-year sampling period (Table 2 and Appendix E). The tracks of one additional snake, the Mojave Desert sidewinder (*Crotalus cerastes cerastes*), were observed at site 5 in 2001. The desert horned lizard (*Phrynosoma platyrhinos*) was observed in 2003 adjacent to site 5, but was not captured at any site that year. The number of species trapped differed annually, with the greatest number of species (12) occurring during 2001. Over all three years, most of the lizards were captured less than five times and all the snakes were captured only once.

		Year Observed		
Common Name	**Scientific Name**	**2001**	**2002**	**2003**
Zebra-tailed lizard	*Callisaurus draconoides*	x	x	x
Great basin whiptail lizard	*Cnemidophorus tigris tigris*	x	x	x
Western banded gecko	*Coleonyx variegatus*	x	x	x
Mojave desert sidewinder	*Crotalus cerastes cerastes*	x*		
Great basin collared lizard	*Crotaphytus bicinctores*			x
Desert iguana	*Dipsosaurus dorsalis*	x	x	x
Long-nosed leopard lizard	*Gambelia wislizenii*	x		x
Common kingsnake	*Lampropeltis getula*	x		
Western blind snake	*Leptotyphlops humilis*	x		x
Red racer	*Masticophis flagellum piceus*		x	x
Desert horned lizard	*Phrynosoma platyrhinos*	x	x	x*
Great basin gopher snake	*Pituophis catenifer deserticola*	x		
Desert spiny lizard	*Sceloporus magister*	x	x	x
Side-blotched lizard	*Uta stansburiana*	x	x	x
Yucca night lizard	*Xantusia vigilis vigilis*	x		x

* species not captured

Table 2: List of species captured.

A total of 376 individuals were captured over 304 array nights during the three-year period (Table 3). More than half were trapped in 2003 while the least number of captures was observed in 2002. Capture rates fluctuated annually with the greatest rates observed in 2001. After a period of low capture rates in 2002, a rebound occurred the following year. The proportion of recaptured animals was too low to employ mark-recapture population estimates. However, relative capture frequency was determined annually. The most frequently captured species for all years was the Great Basin whiptail lizard (*Cnemidophorus tigris tigris*), which comprised

Common Name	Scientific Name	2001	2002	2003	Total	Total Relative Frequency (%)	2001 Relative Frequency (%)	2002 Relative Frequency (%)	2003 Relative Frequency (%)
Zebra-tailed lizard	*Callisaurus draconoides*	1	1	1	3	0.80	0.90	1.39	0.52
Great basin whiptail lizard	*Cnemidophorus tigris tigris*	67	37	111	215	57.18	60.36	51.39	57.51
Western banded gecko	*Coleonyx variegatus*	1	5	16	22	5.85	0.9	6.94	8.29
Great basin collared lizard	*Crotaphytus bicinctores*			2	2	0.53			1.04
Desert iguana	*Dipsosaurus dorsalis*	5	8	2	15	3.99	4.50	11.11	1.04
Long-nosed leopard lizard	*Gambelia wislizenii*	1		1	2	0.53	0.90		0.52
Common kingsnake	*Lampropeltis getula*	1			1	0.27	0.90		
Western blind snake	*Leptotyphlops humilis*	1		1	2	0.53	0.90		0.52
Red racer	*Masticophis flagellum piceus*		1	2	3	0.80		1.39	1.04
Desert horned lizard	*Phrynosoma platyrhinos*	3	1		4	1.06	2.70	1.39	
Great basin gopher snake	*Pituophis catenifer deserticola*	1			1	0.27	0.90		
Desert spiny lizard	*Sceloporus magister*	5	3	13	21	5.59	4.50	4.17	6.74
Side-blotched lizard	*Uta stansburiana*	24	16	43	83	22.07	21.62	22.22	22.28
Yucca night lizard	*Xantusia vigilis vigilis*	1		1	2	0.53	0.90		0.52
	Total Individual Captures	111	72	193	376				
	Total Species	12	8	11	14				
	Array Nights	54	90	160	304				
	Capture Rate (captures/array night)	2.06	0.80	1.21	1.24				

Table 3: Number of individuals trapped, relative frequency, and capture rate data for the 3-year sampling period.

more than 50% of all captures each year (relative frequency 60.36% for 2001, 51.39% for 2002, and 57.51% for 2003). The second most frequently captured species for each of the years for the survey was the side-blotched lizard (*Uta stansburiana*) (relative frequency 21.62% for 2001, 22.22% for 2002, and 22.28% for 2003). Other species observed in decreasing order of average relative frequency for all years combined include the western banded gecko (*Coleonyx variegates*; 5.85% across all years), desert spiny lizard (*Sceloporus magister*; 5.59% across all years), desert iguana (*Dipsosaurus dorsalis*; 3.99% across all years), and the desert horned lizard (*Phrynosoma platyrhinos*; 1.06% across all years). All the remaining species were only trapped 1-3 times (≤ 1% across all years). Individuals were trapped in all months sampled but relative frequency was seasonally stratified. Typically, the highest relative frequency values occurred in April, May, or June for all years. Relative frequency was also spatially variable. The saltbush-salt cedar and mesquite-saltbush vegetation types had the highest relative frequency, while the creosote-bursage and mixed saltbush vegetation types had the lowest relative frequency for all years of the study.

Species richness (i.e., the total number of species observed) fluctuated among years (2001 = 12 species, 2002 = 8 species, 2003 = 11; Table 2). Species diversity, measured as N_1 (the number of equally common species), varied temporally. Cumulative species diversity for all arrays for 2001, 2002, and 2003 was $N_1 = 3.71$, $N_1 = 4.12$, and $N_1 = 3.64$, respectively. These data indicates that 2002 was the most diverse year even though species richness values were the lowest for the period of study. This apparent inconsistency can be explained partly since species diversity incorporates both richness and evenness data. The number of individuals that were trapped of each species in 2002 was more even than in the other years. The basic concept that drives the species diversity measure reported here is illustrated by the following: a population with 99 lizards and 1 snake is not as “diverse” as a population of 50 lizards and 50 snakes.

Species diversity also varied seasonally (Figure 3) and by habitat type (Figure 4) among years. Diversity was typically greatest in August and September, however, there does appear to be a slight trend towards a bimodal distribution in some years where diversity can also be relatively high in May and June. The saltbush-salt cedar (Array 6 in 2001, Array 4 in 2003) and mixed saltbush (Array 5 in 2002) vegetation types had the least diversity for all years of the study. In

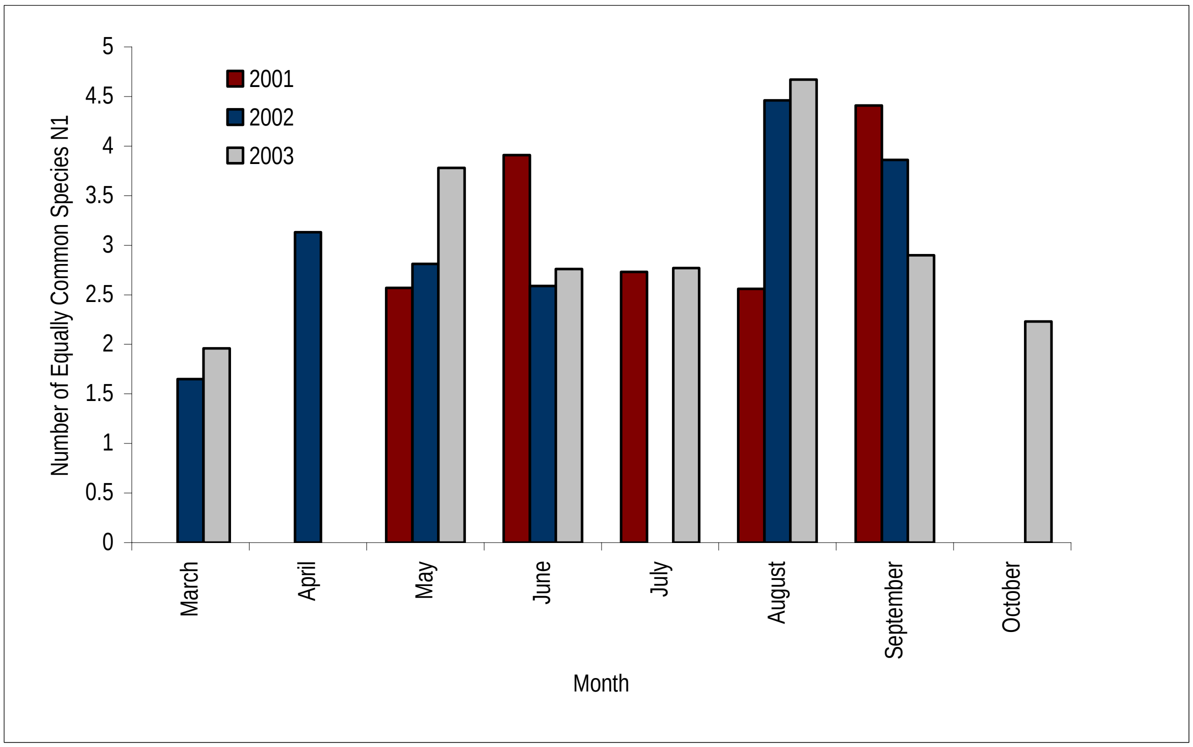


Figure 3: Monthly species diversity.

contrast, the creosote-bursage site (Array 1) had the greatest diversity in 2001 and a different saltbush-salt cedar site (Array 3) had the greatest diversity in 2002. In 2003, four additional arrays were installed in new habitat types. One of those new habitat types, the mixed riparian vegetation type, had the greatest diversity for 2003. Of the six original sites that were sampled, the mixed saltbush community had the greatest diversity in 2003. There were no clear trends in site diversity over the period of study; however, diversity values at each site were greatest during 2003 (Figure 4). This is in contrast to the cumulative diversity value that indicates 2002 as the most diverse year on record.

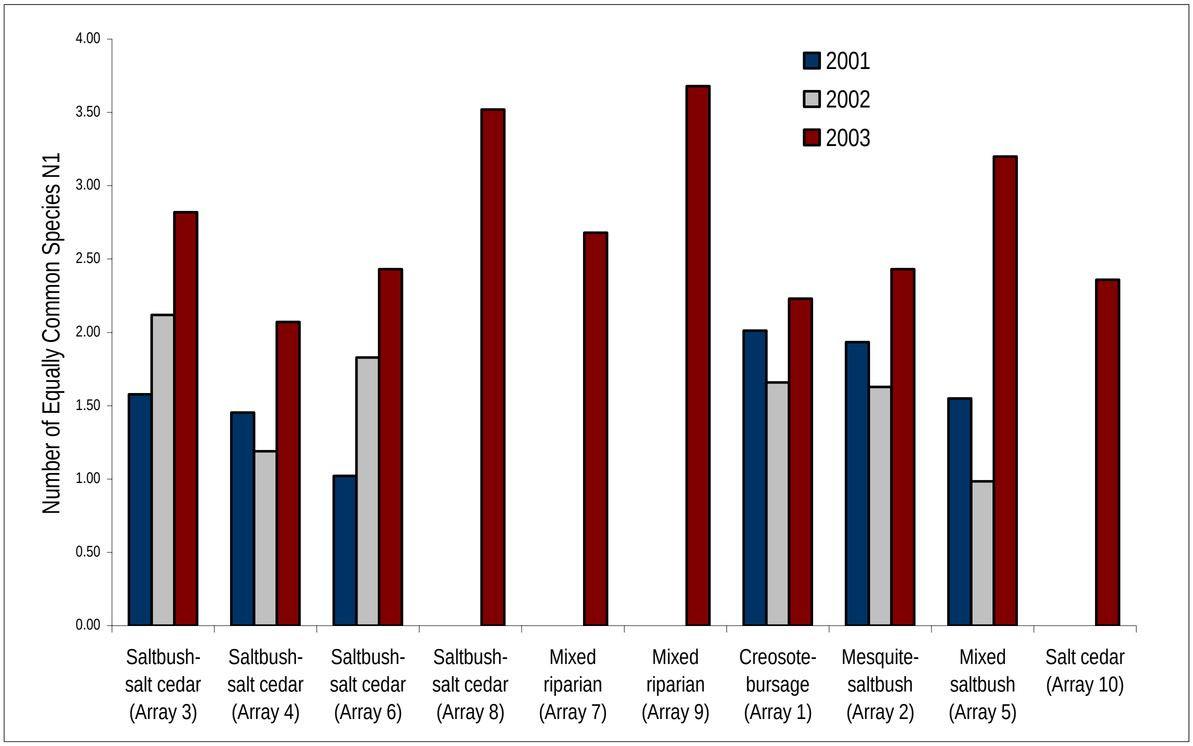


Figure 4: Species diversity for each array.

Standardized niche breadth measures (B_A) range from 0 to 1.0; species with high values generally are distributed widely across the sampled resource states (i.e., habitat types). Although some array sites have similar habitat conditions that would allow them to be lumped into inclusive resource states, the decision was made to consider an individual array site as a resource state so that niche breadth measures would not only evaluate the relative use of species by particular habitat types but also the use of those habitat types in different regions of the Wetlands Park (Table 4). The Great Basin whiptail lizard and the side-blotched lizard had similarly high weighted mean niche breadth values. This indicates that they are the most ubiquitous species found in the Wetlands Park. The Great Basin whiptail and side-blotched lizards were trapped at all array sites for all years with one exception; side-blotched lizard was not captured in the salt

	Levin's Standardized Niche Breadth (B_A)			
Species	**2001**	**2002**	**2003**	**Weighted Mean**
Callisaurus draconoides	0	0	0	0
Cnemidophorus tigris tigris	0.89	0.78	0.75	0.80
Coleonyx variegatus	0	0.25	0.35	0.31
Crotaphytus bicinctores			0	0
Dipsosaurus dorsalis	0.36	0.27	0.11	0.28
Gambelia wislizenii	0		0	0
Lampropeltis getula	0			0
Leptotyphlops humilis	0		0	0
Masticophis flagellum piceus		0	0.11	0.07
Phrynosoma platyrhinos	0.40	0		0.30
Pituophis catenifer deserticola	0			0
Sceloporus magister	0.51	0.40	0.29	0.36
Uta stansburiana	0.73	0.83	0.74	0.75
Xantusia vigilis vigilis	0		0	0

Table 4: Standardized niche breadth values for all species.

cedar dominated habitat type (Array 10) in 2003. Other species that had relatively high niche breadth measures, therefore representing common species, include the desert spiny lizard, desert iguana, and the western banded gecko. Since many of the other species were minimally captured, niche breadth values of 0 indicate that they are relatively uncommon in the landscape.

In addition to the lizards and snakes that were captured, a total of 125 small mammals of 9 genera were trapped during the study period (2001-2003). They include the cactus mouse (*Peromyscus eremicus*), desert shrew (*Notiosorex crawfordi*), desert wood rat (*Neotoma lepida*), house mouse (*Mus musculus*), pocket mouse (*Chaetodipus* spp.), antelope ground squirrel (*Ammospermophilus leucurus*), round-tailed ground squirrel (*Citellus tereticaudus*), Merriam's kangaroo rat (*Dipodomys merriami*), long-tailed pocket mouse (*Perognathus longimembris*), and an animal from the genus *Peromyscus* (possibly *Peromyscus maniculatus*) that we could not identified to species. Because our sampling methodology was not set up to document small mammal captures in 2001, most of the small mammals that were trapped during that sampling season were not identified to species. Of the mammals that were trapped during 2001, three species were identified including the desert shrew, round-tailed ground squirrel, and the pocket mouse.

4.0 DISCUSSION

A variety of reptile (and small mammal) species were trapped in drift fence arrays over the course of the study. Generally, many of the lizards found along the Wash are rarely trapped and only a few are commonly trapped. The most abundant reptile species that were found for each year were the Great Basin whiptail lizard and the side-blotched lizard, which is consistent with other studies of reptile abundance in the southwestern U.S. and in reference texts (Hirsch et al. 2002, Stebbins 2003, Szaro and Belfit 1986). Our surveys provide an initial species inventory and insight on relative abundance measures for reptiles within the project area. A dramatic difference in species composition was observed from year to year, with many of the species observed in 2001 and 2003 not observed in 2002. Yearly variation in numbers and abundance of species is a characteristic of arid ecosystems (Jones 1986), and spatial and temporal variability of primary productivity, particularly of annual vegetation, is a characteristic of the Mojave Desert (Beatley 1974; Smith et al. 1997). Primary productivity is likely a major factor in insect populations, which likely influences the abundance of the reptiles (mostly lizards) that prey upon these insects. Rainfall patterns may also have influenced the spatio-temporal abundance of reptiles in the study area. Above ground plant productivity (vegetative growth, flowering, and fruit production) responds significantly to late fall and spring rains in the desert. Rainfall data, collected at two Clark County Regional Flood Control District rainfall gauges near the array sites (Pabco Road and Three Kids Wash sites, see map in Appendix F), indicate a dramatic difference in precipitation for each of the study years (Figure 5 and 6). Total rainfall from October (of previous year) to March averaged 0.43 and 0.52 inches, in 2001 and 2003 respectively, while rainfall in 2002 for the same period averaged only 0.03 inches. The negligible rainfall that was observed in 2002 probably led to minimal primary productivity, which lead to low capture rates and species diversity measures for that year. We are unsure if these values actually represent changes in population numbers or simply a reduction in activity associated with drought conditions. Wilson (1991) observed that side-blotched lizard activity was reduced as a consequence of drought and other species may be similarly affected.

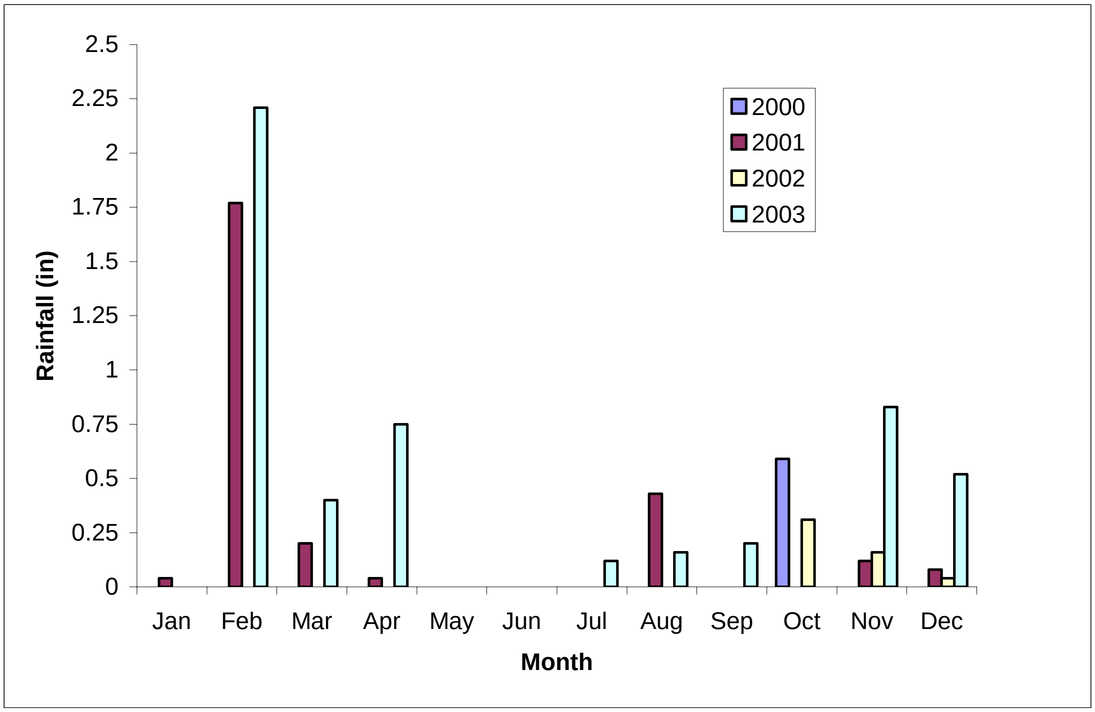


Figure 5: Rainfall data for 2000-2003 at the Pabco Road rainfall gauge.

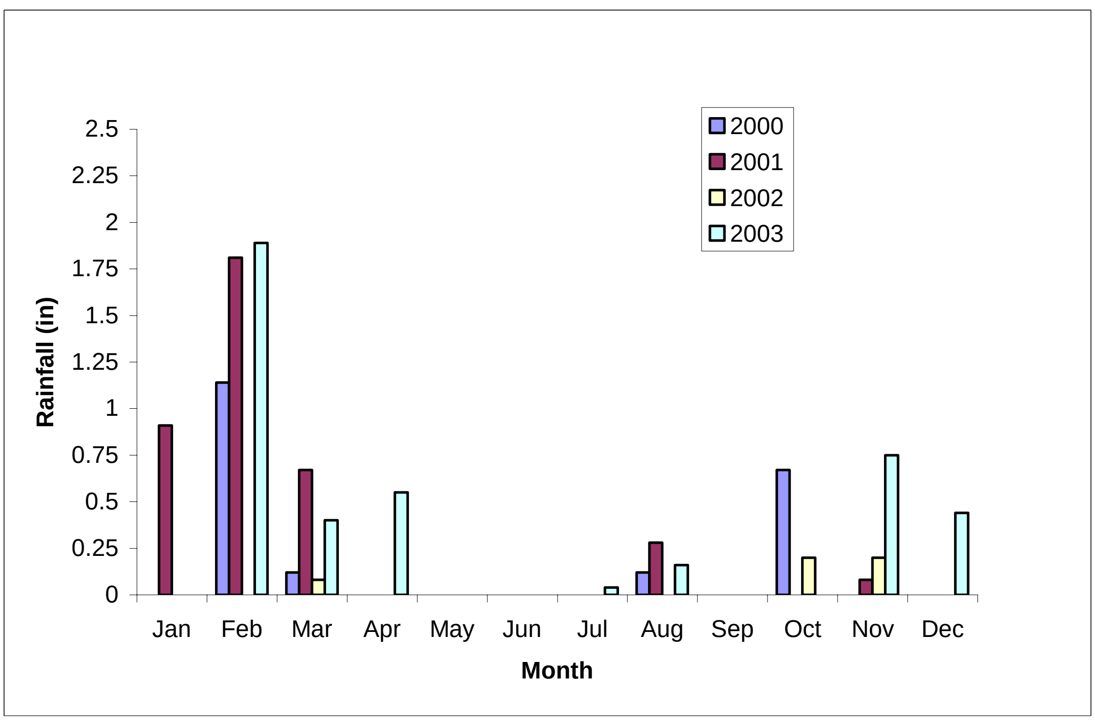


Figure 6: Rainfall data for 2000-2003 at the Three Kids Wash rainfall gauge.

Importantly for future monitoring efforts, the temporal variability of the data recorded here strongly argues for longer-term monitoring strategies, and for some recognition and measurement of environmental conditions that could influence results. If our monitoring program was only conducted for one year (e.g., 2002) than we would have missed many of the species found in 2001 and 2003.

Although capture rates substantially declined from 2001 to 2002, despite an increase in trapping effort, cumulative species diversity measures slightly increased. The decline in capture rates could be a reflection of reduced food resources available to reptiles possibly caused by low precipitation conditions. Alternatively, the decline could be a derivation of not focusing trapping effort during seasonal periods of reduced activity (i.e., the months of March, April, and a few weeks in July were not sampled in 2001). It is important to recognize data collection differences for each of the study years. In 2003, cumulative species diversity values decreased slightly from the previous year while capture rates declined as well. Species diversity, which is often considered a good indicator of ecological health and benefit (e.g., see Tilman 2001), changed seasonally and from site to site. There were, however, no obviously distinct trends in the data other than a suggested importance to observed diversity of late summer to early fall sampling. Reptile activity (as measured by the number of animals trapped per month) seems to be focused around the period from late spring to early summer, but this mostly reflects activity of the two abundant lizards, the Great Basin whiptail and side-blotched. In addition to being active lizards, these species also appear to use a broader set of resources at the arrays than other species with niche breadth measures often twice as much as other lizards and snakes. Observed patterns may be related to habitat components (i.e., vegetation, soils, prey items, etc.) or to individual species resiliencies or adaptations. Since habitat parameters have not yet been analyzed, it is difficult to draw specific conclusions from the data set.

An interesting result from this study was the documentation of a dramatic increase in western banded gecko captures in 2003. This result was an artifact of the inclusion of new array sites that were installed for the 2003 sampling season. More than 80% of the individual geckos trapped that year were captured at these new array sites. A total of 22 individual western banded geckos were captured during the period of study. More than 85% of those captures were in two habitat types, saltbush-salt cedar and mixed riparian (i.e., restoration sites). Salt cedar has typically been regarded as sub-sufficient habitat for a variety of animals; however, it has been shown here that it supports a greater abundance of western banded geckos than do the more xeric upland sites. The removal of salt cedar in restoration efforts, however, may not be a negative factor for this species, since the restoration sites appear to be just as good or better habitat types. Half of the western banded geckos trapped in 2003 were at these sites. As restoration progresses, it may contribute to an increase in the abundance of western banded geckos. Riparian corridors, like the Wash, may provide habitat conditions, including prey bases, that appear to be favorable to the western banded gecko. An analysis of habitat variables and prey item selection may need to be conducted in successive years to identify more precisely the species-habitat relationships involved in gecko abundance.

Another interesting observation from this study is the documentation of two small mammal species, the round-tailed ground squirrel and the desert shrew, that were trapped in drift fence arrays but have not been observed in the more intensive small mammal survey program being conducted separately from this study (Gerstenberger et al. 2004). These animals should be included on formal species inventory lists for the Wash. Of the 14 desert shrews captured, all were trapped at array sites six (saltbush-salt cedar vegetation) and ten (salt cedar vegetation). These sites share the salt-cedar vegetation component, which may provide specific habitat or micro-climatic features that this shrew has been associated with (e.g., increased humidity, downed debris, and the presence of woodrat burrows; Armstrong and Jones 1972). Woodrat burrows have not been observed at these sites, but small mammal inventories being conducted near the Wash indicate that desert woodrats are an abundant species in salt cedar dominated habitats. The array method being used to collect reptiles appears to be a viable addition to conventional snap trapping for mammal surveys and monitoring, especially for cryptic, snap-trap avoidant animals like the desert shrew.

At present, the reptile community found near the Wash shares many of the same lizard species as other desert riparian ecosystems in Clark County (e.g., Virgin River, BIO/WEST 2001). This may be attributed to regional similarities in large desert riparian ecosystems that provide for a diversity of microhabitats. A wildlife inventory of the lower Virgin River riparian corridor reported the presence of five lizards and seven snakes, however, most of the inventory was completed during the day and therefore many of the lizards and snakes that were observed are diurnal species. They did, however, conduct some nighttime searches, which likely increased the chances of observing snakes. All of the lizards that were observed during the Virgin River inventory were reported in this study. Three species of snakes, the desert glossy snake (*Arizona elegans eburnata*), Mojave shovel-nosed snake (*Chionactis occipitalis occipitalis*), and night snake (*Hypsiglena torquata*) were found along the Virgin River but were not found in the Wash. Since snakes may be better at avoiding or escaping pitfall traps, direct observation (searches) techniques may be more appropriate for these species. Side-blotched and Great Basin whiptail lizards were the most commonly observed species along the Virgin River. This study also found these species to be relatively common.

The historical reptile assemblage found in the Wash as described by Bradley and Niles (1973) is different than the species currently documented in this study (Table 5). A direct comparison of these studies is subjective, however, since the data collection methodologies differ substantially. Bradley and Niles did not use quantitative data collection methods; rather they described the community through general observations and interpreted occurrence data from regional field studies. Nonetheless, the historical account reflects the best information available describing the general composition of reptiles found near the Wash 30 years ago. The most noticeable difference between these studies is in the snake species reported. Bradley and Niles reported 15 snakes while only five were found during the current study. There are a variety of reasons for this apparent difference in historical and current accounts. Two of these reasons may be artifacts of the differences in sampling methods. Snakes may not have been effectively sampled with the current array/pitfall trap methods. Alternatively, historical interpretations of species presence within the area of the Wash may have been over estimated based on the more regional approach of the earlier investigators. The reduced species count of snakes, however, may reflect real population extirpations or declines within the study area, which shows substantial indications of

		Year Observed			
Common Name	**Scientific Name**	**1973**	**2001**	**2002**	**2003**
Glossy Snake*	*Arizona elegans*	x			
Zebra-tailed lizard	*Callisaurus draconoides*		x	x	x
Western shovel-nosed snake*	*Chionactis occipitalis*	x			
Great Basin whiptail lizard	*Cnemidophorus tigris tigris*	x	x	x	x
Western banded gecko	*Coleonyx variegatus*		x	x	x
Great Basin collared lizard	*Crotaphytus bicinctores*				x
Mojave desert sidewinder	*Crotalus cerastes cerastes*	x	x		
Speckled rattlesnake*	Crotalus mitchelli	x			
Mojave rattlesnake*	Crotalus scutulatus	x			
Desert iguana	*Dipsosaurus dorsalis*		x	x	x
Long-nosed leopard lizard	*Gambelia wislizenii*		x		x
Gila monster*	*Heloderma suspectum*	x			
Spotted night snake*	*Hypsiglena torquata*	x			
Common kingsnake*	*Lampropeltis getula*	x	x		
Western blind snake	*Leptotyphlops humilis*	x	x		x
Red racer	*Masticophis flagellum piceus*	x		x	x
Spotted leaf-nosed snake	*Phyllorhynchus decurtatus*	x			
Desert horned lizard	*Phyrnosoma platyrhinos*		x	x	x
Great Basin gopher snake	*Pituophis catenifer deserticola*	x	x		
Long-nosed snake*	*Rhinocheilus lecontei*	x			
Western patch nosed snake*	*Salvadora hexalepis*	x			
Chuckwalla*	*Sauromalus obesis*	x			
Desert spiny lizard	*Sceloporus magister*	x	x	x	x
Western ground snake*	*Sonora semiannualata*	x			
Arizona lyre snake*	*Trimorphodon lambda*	x			
Long-tailed brush lizard	*Uta graciosa*	x			
Side-blotched lizard	*Uta stansburiana*	x	x	x	x
Yucca night lizard	*Xantusia vigilis vigilis*	x	x		x

* Represent species not well sampled in 2001-2003 inventory because of experimental design

Table 5: List of species observed by Bradley and Niles (1973) as compared to current inventory.

habitat degradation caused by human activities over the last three decades. Current sampling methodologies likely were the primary factor in limiting snake captures. All of the snakes, however, that were trapped during our study were reported in 1973. Unfortunately, abundance data was not collected in 1973 and therefore minimal trend information can be reported.

The current survey, however, documented five lizard species that were not inventoried in the 1973 study. All of these species, zebra-tailed lizard, western banded gecko, desert iguana, long-nosed leopard lizard, and the desert horned lizard, were all relatively rare across the study area. While these data might suggest that changes in habitat found around the Wash have improved local reptile diversity, a more parsimonious explanation is that the array methodology was simply better at documenting these less common species than the observations made by the earlier researchers.

5.0 RECOMMENDATIONS

This report summarizes data collected from three years of monitoring lizards and snakes adjacent to the Wash. Species diversity, activity, and composition are markedly different both spatially and temporally. Importantly biological organisms dynamically respond to environmental conditions, particularly in arid environments, and as such community measures will change over time. This is particularly true in years when the Mojave Desert receives above average precipitation (an El Nino event) and substantial primary productivity ensues. Reptile monitoring programs necessitate a considerable effort, particularly of time. Nevertheless, a baseline dataset for reptiles has been established and will prove useful in further defining biological resource management strategies for the Wash.

As rehabilitation and enhancement activities continue in the Wash (and as part of invasive species control strategies), traditionally viewed poor-quality habitat (salt cedar) will be replaced by native vegetation (willows and cottonwoods). This will alter large acreages of habitat that may be used by certain species. It has been reported here that salt cedar may be an important habitat for the locally uncommon western banded gecko. Recently cleared restoration sites which were reported as having greater western banded gecko abundance may also be important habitat. Although the western banded gecko is not listed as a threatened or endangered species, regional demographic information suggests that it could be listed in the future. For this reason, it was listed as "covered" under the Clark County Multiple Species Habitat Conservation Plan. Information gathered on its occurrence and abundance in Clark County would be valuable to managers that are charged with promoting species conservation efforts. In the case of salt cedar, it is a highly invasive weed that now dominates many riparian drainages in Southern Nevada. Interestingly, the traditional view that salt cedar is an under-used resource for many biological organisms is slowly being replaced as more information is collected to support the belief that salt cedar does provide some habitat values.

Finally, the following is recommended: (1) To capture the full spectrum of potential environmental variation, the pitfall arrays should be initiated for another 2-3 year period starting during the spring of the next substantial El Nino. This would allow for the likely documentation of species not currently observed and provide some insight into changes in species captures caused by high precipitation. (2) Vegetation, as the basis for habitat, has not been quantified at array sites and this needs to be completed. There may be a variety of habitat relationships that could possibly be explained with further analysis. Basic habitat models should be explored to determine species-habitat relationships. (3) To focus efforts on areas that are part of the active riparian enhancement along the Wash, two of the current trap arrays that appear redundant of the upland habitat should be closed and several new arrays should be installed in salt cedar habitat and adjacent, newly rehabilitated habitat. These should be installed in a paired sample design (adjacent salt cedar and revegetated areas) to determine changes in reptile diversity and abundance as rehabilitation and enhancement activities are conducted. These arrays could target habitat that is planned for future rehabilitation, thus allowing for a "before and after" evaluation to determine potential changes resulting from our activities. (4) A more intense study to investigate the relationship between western banded gecko populations, salt cedar habitat, and restoration efforts should be part of any future efforts. This effort should include research on the prey densities of geckos within the different habitats. This information could be of importance to the long-term conservation of the gecko. (5) Snakes should be surveyed using direct search techniques. Because pitfall arrays did not trap many snakes, direct searches (pedestrian transects or other) could be used to inventory these animals.

6.0 LITERATURE CITED

Armstrong, D.M., and J.K. Jones, Jr. *1972. Notiosorex crawfordi.* Mammalian Species, no. 17, 5 pp.

Baldwin, B.G., and S. Boyd, B.J. Ertter, R.W. Patterson, T.J. Rosatti, D.H. Wilken, and M. Wetherwax, eds. 2002. The Jepson desert manual. University of California Press, Berkeley, CA.

Beatley J.C. 1974. Phenological events and their environmental triggers in the Mojave Desert ecosystems. Ecology 55:856-863.

BIO/WEST. 2001. An Ecological Evaluation of the Lower Virgin River Riparian Corridor, Final Report to the Southern Nevada Water Authority. Submitted by BIO/WEST, Inc. Logan, Utah.

Bradley W.G. and J.E. Deacon. 1965. The biotic communities of Southern Nevada. Desert Research Institute, University of Nevada. Reprint No. 9. Reno, NV.

Bradley W.G. and W.E. Niles. 1973. Study of the impact on the ecology of Las Vegas Wash under alternative actions in water quality management. Final report to the Las Vegas Valley Water District.

Corn, P.S. 1994. Straight-line drift fences and pitfall traps. *in* Heyer, W.R., M.A. Donnelly, R. W. McDiarmid, L.C. Hayek, and M.S. Foster, eds. Measuring and monitoring biological diversity, standard methods for amphibians. pp. 109-117. Smithsonian Institution Press.

Colwell, R.K., and D.J. Futuyma. 1971. On the measurement of niche breadth and overlap. Ecology, 52:567-576.

Fisher, R.N., Suarez, A.V. and T.J. Case. 2002. Spatial patterns in the abundance of the coastal horned lizard. Conservation Biology 16: 205-215.

Gerstenberger, S.L., C.L. Cross, and D. Divine. 2004. An investigation of small mammal diversity, population estimates and vegetative characteristics in the Las Vegas Wash. Final report to the Bureau of Reclamation.

Hall, E. R. 1946. Mammals of Nevada. University of California Press, Berkeley, California.

Hill, M.O. 1973. Diversity and evenness: a unifying notation and its consequences. Ecology 54: 427-432.

Hirsch, R., S. Hathaway, and R. Fisher. 2002. Herpetofauna and Small Mammal Surveys on the Marine Corps Air Ground Combat Center, Twentynine Palms, CA March 1999-October 2001.

Hurlbert, S.H. 1978. The measurement of niche overlap and some relatives. Ecology 59: 67-77.

Jones, K.B., 1986. Deserts. *in* Cooperrider, A.Y., R.J. Boyd, and H.R. Stuart, eds. Inventory and monitoring of wildlife habitat. pp. 123-147. U.S. Dept. Inter., Bur. Land Manage. Service Center. Denver, CO.

Krebs, C.J. 1999. Ecological Methodology. 2nd ed. Benjamin/Cummings. Menlo Park, CA.

Las Vegas Wash Coordination Committee. 2003. 2002 Year-End Report. Las Vegas, NV.

Levins, R. 1968. Evolution in Changing Environments: Some Theoretical explorations. Princeton University Press, Princeton, New Jersey.

MacArthur, R.H. 1965.Patterns of Species Diversity. Biological Reviews, 40: 510-533.

Mueller, G.A., and P.C. Marsh. 2002. Lost, a desert river and its native fishes: A historical perspective of the Lower Colorado River, Information Technology Report USGS/BRD/ITIR—2002—0010: U.S. Government Printing Office, Denver, CO, 69p.

Peet, R.K. 1974. The Measurement of Species Diversity. Annual Review of Ecology and Systematics, 5: 285-307.

Smith S.D., R.K. Monson, and J.E. Anderson. 1997. Physiological ecology of the North American deserts. Springer, New York, NY.

Southern Nevada Water Authority (SNWA). 2002. 2001 Las Vegas Wash Reptile Survey Summary Report. Prepared by the Southern Nevada Water Authority, Las Vegas, Nevada.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. 3rd ed. Houghton Mifflin Company, New York, NY.

Szaro, R.C. and S.C. Belfit. 1986. Herpetofaunal Use of a Desert Riparian Island and its Adjacent Scrub Habitat. J. Wildl. Manage. 50(4): 752-761

Tilman, D., P.B. Reich, J. Knops, D. Wedin, T. Mielke, and C.Lehman. 2001. Diversity and Productivity in a Long-Term Grassland Experiment. Science. Oct. 26, 2001: 843-845.

U.S. Fish and Wildlife Service (USFWS). 1995. Recovery Plan for the Rare Aquatic Species for the Muddy River Ecosystem. Portland Oregon. 60p.

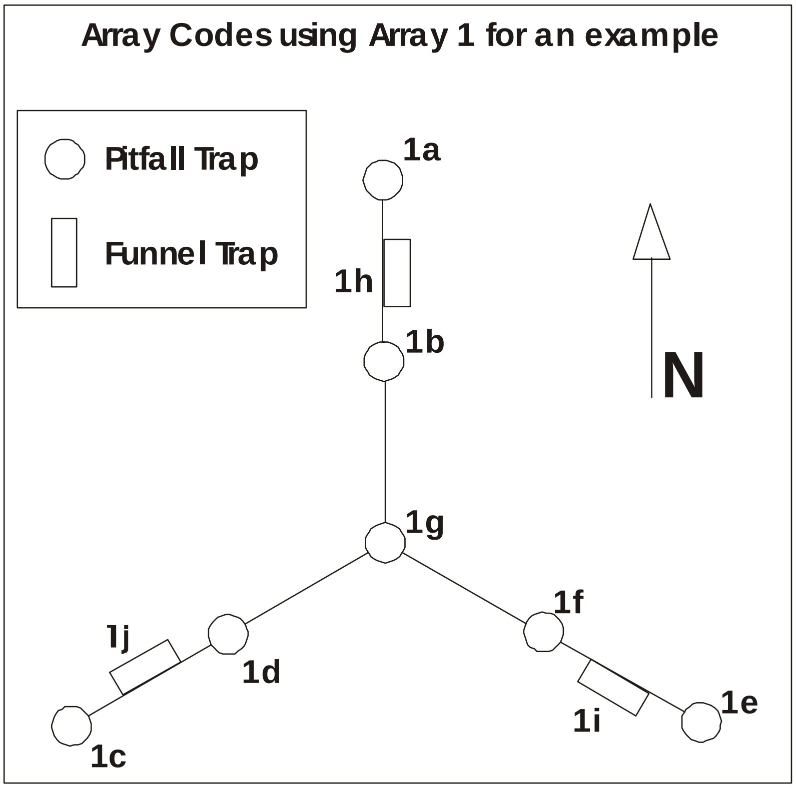
Zeveloff, S.I. 1988. Mammals of the Intermountain West. University of Utah Press, Salt Lake City, Utah.

Whitford, W.G. 2002. Ecology of Desert Systems. Academic Press, San Diego, CA.

Wilson, B.S. 1991. Latitudinal variation in activity season mortality rates of the lizard Uta stansburiana. Ecol. Mon. 61(4): 393-414.

Appendix A

Drift Fence Array Configuration



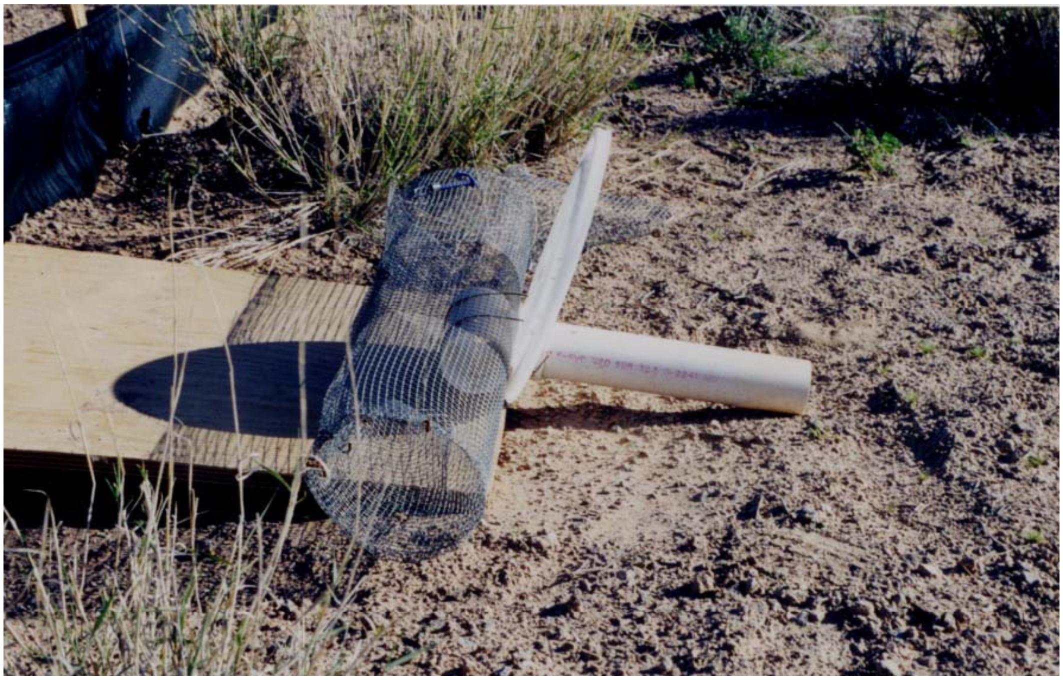
Drift fence array design schematic

Appendix B
Photographs of the Drift Fence Arrays

Drift fence array site three

Pitfall trap at end of drift fence arm

Pitfall trap at center of drift fence array



Funnel trap configuration

Funnel trap along drift fence arm with cover board shade structure

Pitfall trap (ground level view)

Drift fence array site five

Drift fence array site ten

Drift fence array site seven (restoration site)

Drift fence array site ten

Appendix C

Field Data Sheet

Date: **Last Capture #:**

Survey Day: **Tues Wed Thurs Fri**

Tues Only	**Time 1st Trap Opened:** **Time Last Trap Opened:**	Weather conditions: rain clear overcast
Fri Only	**Time 1st Trap Closed:** **Time Last Trap Closed:**	Flowering plants observed: yes no

Field Personnel: **SS KN TG NR TH DV LB KC NP**

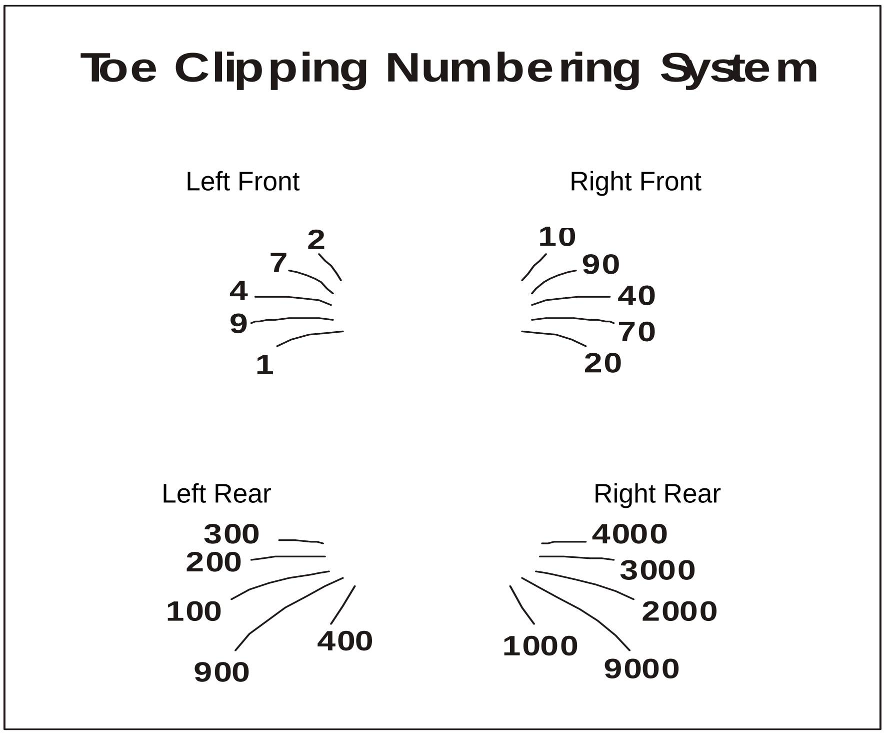
Array 1 Temp at CH (C): Array 1 Temp at GH (C):	Array 2 Temp at CH (C): Array 2 Temp at GH (C):	Array 3 Temp at CH (C): Array 3 Temp at GH (C):	Array 4 Temp at CH (C): Array 4 Temp at GH (C):	Array 7 Temp at CH (C): Array 7 Temp at GH (C):
Array 8 Temp at CH (C): Array 8 Temp at GH (C):	Array 9 Temp at CH (C): Array 9 Temp at GH (C):	Array 10 Temp at CH (C): Array 10 Temp at GH (C):	Array 5 Temp at CH (C): Array 5 Temp at GH (C):	Array 6 Temp at CH (C): Array 6 Temp at GH (C):

Trap ID	Reptile ID #	Time	Reptile Species	Recap? (Y/N)	SVL (mm)	TL (mm)	Mass (g)	Sex (M/F/U)	Age (J/A/N)	Regrown Tail? (Y/N)	Parasites (Y/N)	Non-target Species	Comments

Example of field data sheet

Appendix D

Toe Clipping Methodology



Toe clipping numbering system

Appendix E
Photographs of Species

Desert spiny lizard (*Sceloporus magister*) female in breeding condition

Desert iguana (*Dipsosaurus dorsalis*)

Red racer (*Masticophis flagellum piceus*)

Yucca night lizard (*Xantusia vigilis vigilis*)

Great Basin whiptail lizard (*Cnemidophorus tigris tigris*)

Zebra-tailed lizard (*Callisaurus draconoides*)

Desert horned lizard (*Phrynosoma platyrhinos*)

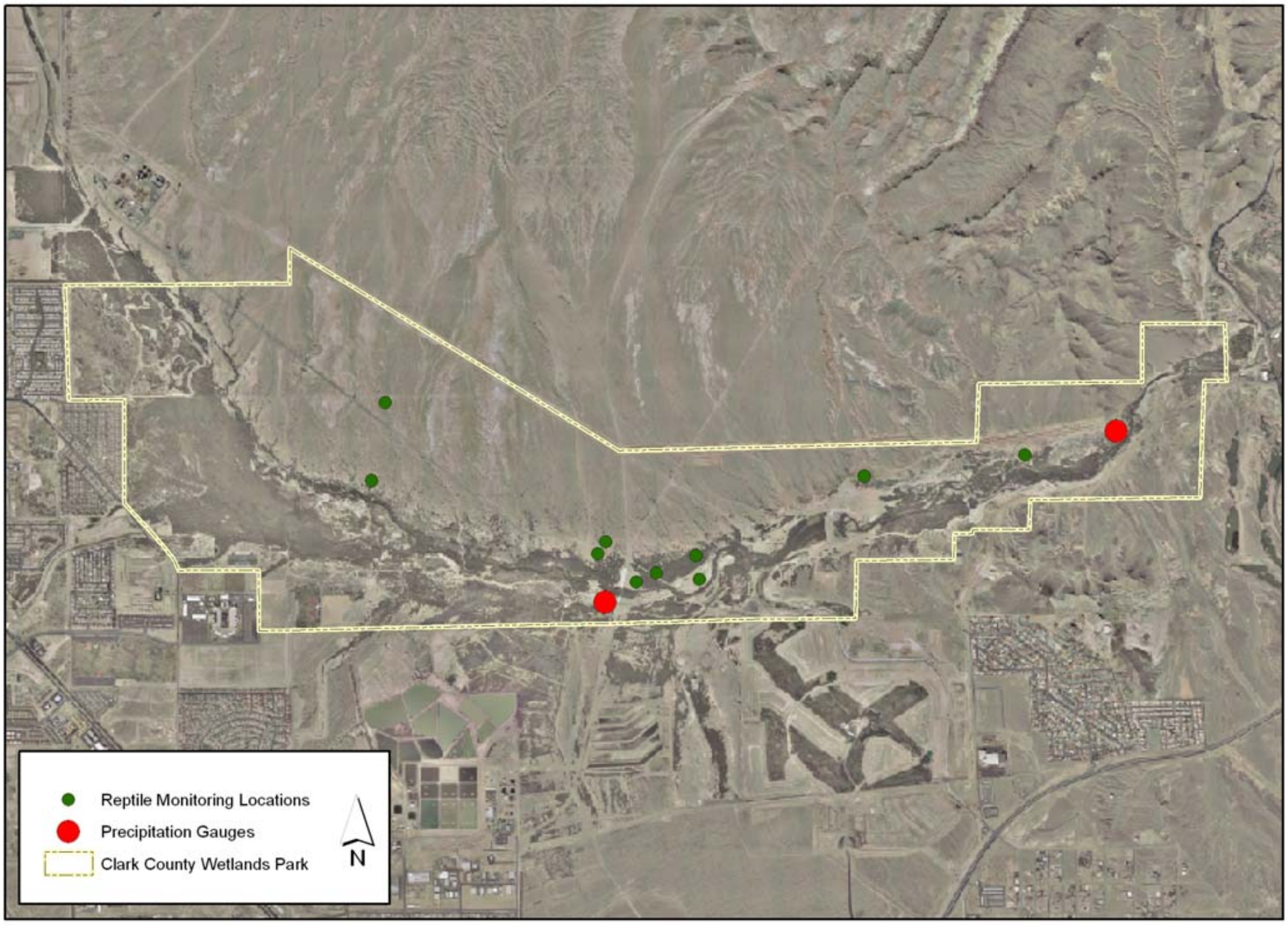
Long-nosed leopard lizard (*Gambelia wislizenii*)

Great basin collared lizard (*Crotaphytus bicinctores*)

Western banded gecko (*Coleonyx variegatus*)

Appendix F

Precipitation Gauge Location Map



Location of precipitation gauges and reptile monitoring locations along the Las Vegas Wash