THE COACHELLA VALLEY, AN ENDANGERED ECOSYSTEM
PROGRESS REPORT ON CONSERVATION AND MANAGEMENT EFFORTS

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ABSTRACT

The Coachella Valley is a desert ecosystem dominated by strong winds and sandy soils. These winds transport sand from the Whitewater River and the Indio Hills to the Coachella Valley. Many species of plants and animals are dependent upon habitats of wind-blown sand. Among these are the Coachella Valley fringe-toed lizard (Uma inornata), a federally and State-listed endangered species; at least two endemic invertebrates; and four taxa of plants under status review by the U.S. Fish and Wildlife Service. Large areas of natural habitat have been destroyed by urban and agricultural developments. Only 48% of the suitable fringe-toed lizard habitat available prior to human settlement of the valley existed in December, 1982. Wind obstructions and off-road vehicle use have caused declines in habitat quality in many areas. Future projects with potential negative impacts on the Coachella Valley ecosystem include oil and gas developments and continued agricultural and urban growth. Wind energy facilities are being developed on a large scale at the northern end of the valley, but potential effects on wind and sand transport patterns are not known. Human population levels in the valley are expected to double between 1980 and 2000. At current rates of loss, remaining aeolian sand habitat in the valley will be completely eliminated in 50-80 years. Nearly all wind-blown sand habitat in the Coachella Valley is privately owned. A coalition of concerned citizens and government agencies are working to preserve a portion of this vanishing system. To date (January 1983) the California Department of Fish and Game has purchased 180 acres for establishment of a preserve and is negotiating for the acquisition of another 240 acres.

INTRODUCTION

During the 1970s, the efforts of many biologists and conservationists were focused on the biological resources of the California deserts and the land uses affecting them. One area receiving special attention was the Coachella Valley. This region has been of interest because several sand-loving taxa are either endemic to the aeolian sands of the valley or occur in a limited number of sandy areas elsewhere. Also, the valley has undergone rapid agricultural and urban development with concomitant habitat losses. The species receiving the most attention has been the Coachella Valley fringe-toed lizard (CVFTL), Uma inornata. Several government agencies and conservation groups have been working to preserve a portion of the Coachella Valley ecosystem and the organisms it supports.

My goals in this paper are 1) to increase awareness of biologists and the public that conservation and management of the Coachella Valley ecosystem is required for taxa other than CVFTL, 2) to provide an update on the amount and rates of habitat loss and deterioration based on new data and the works of other researchers, and 3) to report on the results of conservation efforts by public and private organizations. Throughout the paper I will use CVFTL habitat as an indicator of conditions for other taxa and sandy habitats throughout the entire Coachella Valley ecosystem.

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THE COACHELLA VALLEY ECOSYSTEM

Physical Attributes -- The Coachella Valley is in the extreme northwest corner of the dry, hot Colorado Desert. The Santa Rosa and San Jacinto Mountains lie along the western edge of the valley and create a strong rainshadow effect. Mean annual precipitation values typical of the valley are 15.95 cm (6.28 in) at Palm Springs and 7.80 cm (3.07 in) at Mecca. Rainfall is erratic; one year in twenty may have either less than 1.27 cm (0.5 in) or greater than 20.32 cm (8.0 in) of rain. Temperatures are mild in winter but are frequently hot in summer. Daily maximum temperatures in July exceed 38 degrees C (100 degrees F) and highs over 4 C (115 degrees F) are regular. (U.S. Soil Conservation Service 1980).

The uniqueness and fragility of the Coachella Valley ecosystem are products of sandy soils and a strong wind regime. Understanding potential negative impacts to organisms found in the valley and developing effective management plans require knowledge of the interaction between sand and wind.

Sand originates during storms in the San Jacinto, San Bernardino, and Little San Bernardino Mountains and in the Indio Hills. Floodwaters along the Whitewater River and its tributaries transport sand to the San Gorgonio Pass and through Thousand Palms Canyon in the Indio Hills in the northern and western periphery of the valley. Cool marine air typically is pulled inland toward warmer air over the deserts. This pattern can be enhanced by the combination of an offshore high pressure air mass and an inland low pressure cell. Air moving toward the Coachella Valley is channeled through San Gorgonio Pass; the resulting Venturi effect creates high velocity winds in the northern and western portions of the valley. Sand is transported by these winds from the periphery of the valley in a southeasterly direction towards Indio. However, the winds dissipate as they leave the pass and sand is deposited in the southeastern portion of the valley. The exact location of sand deposition varies with wind velocity. (For detailed description of aeolian sand transport, see Weaver 1979.)

From this brief description of aeolian sand transport, a picture emerges of a habitat with a soil surface that is constantly changing. In the sand source areas new sand is brought in by water and moved out by strong winds. In the intermediate portions of the valley, sand can be either deposited or moved by winds. In the southeastern portion of the valley, sand is constantly deposited. The net result is that under natural conditions new sand always is avilable to replace that moved out by winds. Few places ever become stabilized.

Critical Biological Resources -- The Coachella Valley supports a fauna capable of surviving a harsh desert climate in wind-blown sands. Several taxa are endemic to the valley, others can be found elsewhere. The CVFTL is the most widely known and most studied of these organisms. It is endemic to the Coachella Valley and has a variety of behavioral and morphological adaptations for life in aeolian sands (Stebbins 1943, 1944; Pough 1970). Concern by many herpetologists and work by England and Nelson (1976) led, in 1980, to official listing of CVFTL as endangered by the State of California and threatened by the U.S. Fish and Wildlife Service (FWS). The primary cause for concern at that time was habitat loss to urban and agricultural development.

The flat-tailed horned lizard (Phrynosoma m'calli) occurs in the Coachella Valley, as well as in sandy regions of Imperial and eastern San Diego counties, southwestern Arizona, and northwestern Mexico. Turner and Medica (1982) found the original range of this species in California had been reduced and, in some areas where it still occurs, its abundance lowered. They believe human activities caused these declines. The flat-tailed horned lizard is now under status review by the FWS Office of Endangered Species.

At least two invertebrates are endemic to the Coachella Valley. The giant red velvet mite (Dinothrombium pandorae) is largely restricted to fine sands in the valley and emerges from burrows as adults only after winter rains to prey on termites (Tevis and Newall 1962). Larvae are parasites on grasshoppers (Tevis and Newall 1962). The desert cockroach (Arenivaga investigata) also is found in fine sands. Adults and immatures burrow just below the soil surface and feed on plant and animal detritus (Friauf and Edney 1969, Edney et al. 1974). Neither endemic invertebrate has been officially recognized as rare, threatened, or endangered.

The FWS includes four plant taxa found in sandy soils of the valley on the Category 1 list of candidate species (Table 1). Plants under this classification are biologically appropriate for listing as threatened or endangered, but no official action has been taken (U.S. Fish and Wildlife Service 1980). All four species are recognized as either rare and endangered by the California Native Plan Society (Smith et al. 1980), sensitive by the Bureau of Land Management (U.S. Bureau of Land Management 1982a), or both (Table 1).

Table 1. Rare or Endangered Sand-Loving Plants Found in the Coachella Valley

Scientific Name[a]	U.S. Fish and Wildlife Service Candidate Species[b]	Bureau of Land Management Sensitive Species[c]	California Native Plant Society Rare and Endangered Plants[d]
Euphorbia platysperma	Yes	Yes	Yes
Astragalus lentigenosus var. coachellae	Yes	Yes	No
Linanthus maculatus	Yes	Yes	Yes
Ditaxis californica	Yes	Yes	Yes

a Munz 1974.

b "Taxa for which the (U.S. Fish and Wildlife) Service presently has sufficient information on hand to support the biological appropriateness of their being listed as Endangered or Threatened Species." U.S. Fish and Wildlife Service 1980.

c U.S. Bureau of Land Management 1982a.

d Smith et al. 1980.

Astragalus lentigenosus var. coachellae is a winter annual or short-lived perennial endemic to sandy soils of the Coachella Valley. Euphorbia platysperma is a winter annual found only in dry, sandy soils. It has been recorded near Thousand Palms in the Coachella Valley and near Yuma, Arizona. Linanthus maculatus is a minute winter annual that occurs only in San Gorgonio Pass and the Little San Bernardino Mountains. Ditaxis californica occurs on gravelly alluvium adjacent to sandy washes at scattered locations from La Quinta in the Coachella Valley to near the Colorado River in Imperial County.

CAUSES OF HABITAT LOSS AND DEGRADATION

Urban and Agricultural Development -- The most obvious threat to natural habitat in the Coachella Valley is rapid urban and agricultural development. Large habitat losses in the 1960s and '70s created concern among herpetologists about the status of the CVFTL. Other important organisms may be affected similarly, and the habitat of the CVFTL can be used as a preliminary indicator for monitoring other species found in aeolian sands of the valley.

Using all accessible CVFTL locality records, I have reconstructed an approximation of "suitable" habitat distribution prior to settlement of the valley by humans. "Suitable" habitat includes any undeveloped areas with sandy soil. Therefore, habitats of various qualities are not distinguished. Different techniques were used to determine habitat boundaries to the east and west of the Coachella Canal. West of the canal, field reconnaissance, aerial photographs, and locality records were used to determine approximate pre-settlement distribution limits. Records in isolated sandy washes at a distance from the central area of continuous sand were not included. East of the Coachella Canal, agricultural development was so extensive that habitat boundaries had been obscured completely. Soil descriptions in a 1927 soil survey (Kocher and Harper 1928) of the lower Coachella Valley were used to classify areas as suitable or unsuitable CVFTL habitat. Locality records were compared to the resulting map; 35 of 38 sitings occurred within the habitat boundary determined by this technique. Two of the three records outside the boundary had extremely vague locality information (e.g., near Indio). The result was an estimated 518 km^2 (200 mi^2) of suitable habitat prior to human settlement (Table 2). Of this, 373 km^2 (144 mi^2) occurred west of the canal and 145 km (56 mi^2) occurred to the east of the canal (Table 2).

Table 2. Estimates of "Suitable" Coachella Valley Fringe-toed Lizard Habitat and Rates of Loss km^2 (mi^2)

West of Coachella Canal

Time	Remaining Habitat	Habitat Lost	Rate of Habitat Loss Units - km^2 (mi^2)/year
Pre-settlement	373 (144)	--	--
1955	316 (122)	57 (22)	--
August 1978	262 (101)	54 (21)	2.3 (0.9)
August 1979	257.4 (99.4)	4.6 (1.6)	4.6 (1.6)
August 1982	248.4 (95.9)	9.0 (3.5)	3.0 (1.2)
December 1982	245.5 (94.8)	2.9 (1.1)	8.7 (3.3)

East of Coachella Canal

Time	Remaining Habitat	Habitat Lost	Rate of Habitat Loss Units - km^2 (mi^2)/year
Pre-settlement	145 (56)	--	--
August 1979	26 (10)	119 (46)	--
August 1982	14 (5.5)	12 (4.5)	4.0 (1.5)

Aerial photography was used to estimate amount and rate of habitat loss. Photographs were available from the following sources: U.S. Army Corps of Engineers 1955 and 1979, California Department of Fish and Game 1978, and Coachella Valley Water District 1982. The area south of Interstate 10 and west of Indio was checked on the ground for new developments on December 18, 1982.

Since 1955, approximately 90% of the suitable CVFTL habitat east of the Coachella Canal has been lost (Table 2). The remaining areas east of the canal are fragmented into numerous small parcels and are not considered viable as long-term habitat for the lizard (U.S. Fish and Wildlife Service 1982). Large areas of suitable habitat also have been lost west of the canal. Pre-settlement habitat has declined 34%. Rates of loss from August 1978 to August 1982 were 3.0 to 4.6 km^2 per year. If similar rates continue, suitable CVFTL habitat, and thus the habitat of all sand-loving species in the Coachella Valley, will be totally developed in 50-80 years. Field reconnaissance in December 1982 suggests a higher rate of loss from August 1982 to August 1983 than during the previous four years. The

Riverside County Planning Department projects continued rapid growth in the valley through the year 2000 (Table 3). Permanent population is expected to more than double between 1980 and 2000. Seasonal residents can increase the human population size by an additional 40%. The Coachella Valley Association of Governments (1978) estimates a peak (permanent and seasonal) population of approximately 384,557 in the year 2000.

Table 3. Permanent Human Population of the Coachella Valley

Year	Population Size	Source
1940	12,000	US Census[1]
1950	26,832	"
1960	53,241	"
1970	86,999	"
1980	128,478	"
1985	159,699	County of Riverside[2]
1990	183,466	" "
1995	207,665	" "
2000	266,575	" "

1 Provided by Riverside County Planning Department.

2 County of Riverside, 1982. SCAG Population Forecasts. Riverside County Planning Department, Riverside, California.

Windbreaks -- A more subtle negative impact to the flora and fauna of the Coachella Valley than urban and agricultural development is alteration of sand movement patterns. Changes can result from planting tamarisk (Tamarix aphylla) windbreaks around developments or creation of any obstruction that reduces wind velocity. As the wind slows, transported material is deposited around the obstruction. Since winds may no longer transport sand after crossing a windbreak, sand transport may be halted into downwind areas and stabilization may occur. Winds may regain velocity after passing a windbreak, and fine sands may be transported out of former deposition areas causing sand depletion.

Turner et al. (1981) and Weaver (1981) conducted the first studies to determine the effect of blowsand reduction on CVFTL populations. By comparing sand characteristics and lizard densities on plots immediately upwind and downwind from tamarisk windbreaks, they found that upwind plots supported 11 to 45 CVFTL per hectare while CVFTL were essentially absent on downwind plots (Turner et al. 1981). Alteration of sand movement patterns can be detected for several kilometers downwind from an obstruction (Weaver 1979, 1981). Models being developed by Weaver (pers. comm.) indicate lizard populations also may suffer deleterious effects long distances downwind from obstructions. In a June 1980 analysis of sand movement patterns from San Gorgonio Pass to Indio on the south side of the Indio Hills, Weaver (pers. comm.) estimated that 65% of remaining undeveloped land on the valley floor was shielded by an upwind obstruction.

These findings suggest the status of the CVFTL may be much worse than previously thought by considering only habitat loss due to agricultural and urban developments. The quality of large areas of remaining suitable CVFTL habitat may be severely degraded in areas shielded by windbreaks. It is not known how changes in sand movement patterns may affect other taxa found in sandy habitats of the Coachella Valley. Since these organisms also require blowsand, they may be suffering similar negative impacts.

Energy Development -- The Coachella Valley recently has become the focus of considerable energy development activity. During 1982, the Bureau of Land Management (BLM) leased approximately one-half of all Public Lands (1,160 hectares/2,900 acres) within suitable CVFTL habitat for oil and gas exploration and development. Parcels were not leased if suitable CVFTL habitat could not be avoided by proper placement of facilities. No drilling has occurred in

the valley and the leases are considered speculative. However, if either oil or gas is discovered in the region, deleterious impacts to the CVFTL and other species found in and adjacent to the valley could be substantial.

Of more immediate concern is wind energy development in the northern end of the valley. The Bureau of Land Management (1982b) completed an environmental impact statement and leased 640 hectares (1,600 acres) of scattered public lands for wind energy development. Construction has begun on one parcel, will begin on others during 1983, and should be completed on all parcels by 1986 (Mark Hatchel, BLM Realty Specialist, personal communication). The County of Riverside is considering wind energy development on an additional 865 hectares (2,164 acres) of private lands in the same portion of the valley (Wagstaff and Brady 1982). Only a portion of the potentially developable private and public parcels contain sand habitats.

Potential impacts of wind energy developments could come from construction of facilities and alteration of the valley's wind regime. Mitigation measures during construction and operation call for minimizing habitat destruction by avoiding CVFTL habitat. However, some marginal habitat may be lost. These parcels are among the few in public ownership that could be protected.

Potential changes in wind and sand movement patterns and subsequent effects on downwind habitat are not known. One model shows that maximal development with 25,000 turbines could reduce wind velocity significantly (Don Weaver, pers. comm.). As a result, sands may not be transported as far downwind as before development; this change potentially could have either negative or positive impacts to sandy habitats in the valley. Current plans call for construction of about 2,500 turbines or only 1/10 the number in this model. Researchers at Southern California Edison (R.M. Rutledge, letter to BLM, 11/22/82) suggest that this level of development will have no effect on wind velocities in the valley. Most sand is transported near the ground below the air mass being utilized by most wind turbines. Local aeolian sand transport will be modified around each tower. However, regional sand movement patterns may not be significantly affected.

Off-Road Vehicle Use -- Motorcycle and dune buggy (ORV) use has caused severe habitat degradation at Windy Point near the confluence of the Whitewater and San Gorgonio Rivers and in the vicinity of Flat Top Mountain and Edom Hill. These two areas total approximately 7.8 km^2 (3.0 mi^2) of relatively intense ORV use. ORV activities also occur at several smaller sites in the valley, especially on and near large mesquite-covered dunes. Although negative impacts of ORV use on sand-loving species have not been documented in the valley, numerous studies on other desert species strongly suggest such a relationship (e.g. Busack and Bury 1977, Vollmer et al. 1977).

CONSERVATION AND MANAGEMENT EFFORTS

Protection and management of sandy habitat and sand source ares is needed to ensure survival of part of the Coachella Valley ecosystem. Unfortunately, nearly the entire valley is privately owned. The BLM administers several small scattered parcels of suitable habitat in the central and western portion of the valley. At least one of these tracts, Windy Point, is a favorite area for ORV enthusiasts. Prior to official listing of the CVFTL in 1980, these areas were the only publicly held lands that potentially could be protected.

When the FWS listed the CVFTL as threatened, 48.2 km^2 (18 5/8 mi^2) of Critical Habitat were identified in an area north of Interstate 10, east of Thousand Palms, west of Washington Street, and south of the Indio Hills. This region was selected for several reasons. It was one of few relatively large undeveloped areas remaining in the valley and contained a variety of vegetation types. Most of the valley received sand from San Gorgonio Pass; however, the sand source areas for the Critical Habitat were the Indio Hills and Thousand Palms Canyon. These source areas were immediately adjacent to suitable habitat and could be included within a relatively compact Critical Habitat. Thus, approximately half the Critical Habitat did not support CVFTL, but was needed to maintain areas that did. Few obstructions existed between sand sources and CVFTL habitat. Development north of Interstate 10 traditionally had been slower than other parts of the valley. Therefore, land prices were lower and more time could be expected for habitat acquisition before significant development occurred.

Since official listing of the CVFTL in 1980, the primary effort of the FWS has been preparation of a species recovery plan. A draft has been written, and technical review by interested biologists and other experts was completed in July 1982. Public and agency review should take place soon. The draft recovery plan calls for protection either through acquisition or management control of existing Critical Habitat and a second area to be identified later. If implemented, CVFTL populations would be actively managed within Critical Habitat and habitat conditions would be maintained throughout the valley.

Listing the CVFTL has stimulated the interest of the public and government agencies other than the FWS. All recognize that habitat acquisition is essential to preserve a sample of the Coachella Valley ecosystem and the organisms it supports. The most active and successful group has been the California Department of Fish and Game (CDFG). They have identified a 2,560 hectare (6,400 acre) reserve within CVFTL Critical Habitat and have acquired 72 hectares (180 acres) with funds from their Environmental Protection Program. In December 1982, CDFG was granted permission by the Wildlife Conservation Board to begin escrow on another 96 hectares (240 acres) of CVFTL habitat available from willing sellers. A proposal currently before the California Fish and Game Commission would officially designate these lands as the Coachella Valley Ecological Reserve.

A private organization closely affiliated with the CDFG is the Coachella Valley Ecological Reserve Foundation (CVERF). Founded in 1980, CVERF's goal is to establish the same habitat reserve as identifed by the CDFG. All lands acquired by the Foundation will be transferred to CDFG for addition to the Coachella Valley Ecological Reserve. No lands have been acquired by CVERF, but the group is led by several valley residents who monitor local events and pass information on to others. CVERF also is building support for a mitigation program under which developers working elsewhere in the valley could compensate for losses by purchasing lands within the Coachella Valley Ecological Reserve.

Land acquisition by CDFG and CVERF are important actions, but much suitable CVFTL habitat and a significant portion of the sand source area within Critical Habitat are under control of a single private land owner. Protection of this parcel is needed for the ultimate success of all efforts. During 1980-81, the BLM began a land exchange that would have placed this large holding in public ownership. However, disagreement between the Bureau and the owner on appraised land values caused the project to fail.

The Nature Conservancy is now interested in the Coachella Valley project and has been in contact with the landowner. Potential exists for acquiring the land, and The Nature Conservancy will prepare a preserve design study and a financial analysis in the near future. However, the project would be extremely costly, and assistance from other sources might be needed. One possibility would be reinvolvement of the BLM in a smaller exchange. However, priorities of the current administration in Washington make this unlikely.

It remains to be seen whether an adequate portion of the Coachella Valley ecosystem can be preserved. If it is, the area problably would be within CVFTL Critical Habitat and would serve as a representative sample of the Coachella Valley ecosystem and the organisms it supports. People with different backgrounds and with several organizations are working toward this common goal. These efforts are encouraging, but the project is large, and land prices are high throughout the valley. Urban and agricultural growth has been rapid even during the current recession, and population growth is expected to continue. The eventual success or failure of efforts to preserve part of the Coachella Valley ecosystem probably will be decided by the end of this century.

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