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The Desert Tortoise Recovery Plan: An Ambitious Effort to Conserve Biodiversity in the Mojave and Colorado Deserts of the United States

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ABSTRACT. **In 1990 the U.S. Fish and Wildlife Service (USFWS) listed the desert tortoise, *Gopherus agassizii*, as "Threatened" over 30% of its geographic range and shortly thereafter selected a team to develop a plan for its recovery. The team developed a hypothesis-driven recovery plan, using population viability analyses and principles of reserve design. The *Desert Tortoise (Mojave Population) Recovery Plan* is designed to achieve a 50% probability of survival for the tortoise for 500 years.**

Drawing from concepts outlined in the federal Endangered Species Act, the recovery team used a strategy of protecting evolutionarily significant population units and their associated ecosystems. The six population units, called "recovery units," were identified using published and unpublished data on genetic variability, morphology, and behavior patterns of populations as well as ecosystem types. Boundaries of the six units closely approximate major ecosystem boundaries in the Mojave and Colorado deserts. The goal is to reach a target (where possible) of 50,000 breeding adult tortoises for each recovery unit.

Within the recovery units, the recovery team recommended the establishment of 14 reserves or Desert Wildlife Management Areas (DWMAs), ranging from 415 to 3,367 km^2 (with one exception, the Virgin River DWMA, which was very small). The USFWS followed by designating 26,087 km^2 as federally protected "Critical Habitat" in 1994. Additional habitat is also protected within Joshua Tree National Park (est. 2,574 km^2) and within the existing boundaries of the Desert Tortoise Research Natural Area (est. 100 km^2).

The recovery team attributed declines in tortoise populations to the result of human activities. To reduce and ultimately eliminate many sources of mortality that are driving the desert tortoise toward extinction, they recommended prohibition of several activities in the reserves. Within each DWMA, they also recommended that <10% of habitat be designated as "experimental management areas," where intrusive and experimental research can occur.

Governments at the federal, state, county, and city levels have begun to implement the *Recovery Plan* through development of regional land-use plans (habitat conservation plans, coordinated resource plans, and multi-species plans). While tortoise recovery considerations are the driving force for land-use planning, agencies are taking a more comprehensive ecosystems approach. If implementation of the *Recovery Plan* and land-use plans are successful, the reserve system for the desert tortoise will not only conserve its genetic diversity, but also the biodiversity of several major ecosystems in the Mojave and Colorado deserts.

The U.S. Fish and Wildlife Service (USFWS) placed the desert tortoise, *Gopherus agassizii*, on the list* of "Threatened" species in 1990 (Figure 1; USFWS, 1990a) and shortly thereafter selected a recovery team to develop a plan for its recovery. This paper describes (1) the resulting *Desert Tortoise (Mojave Population) Recovery Plan* (hereafter called the *Recovery Plan*), (2) the system of reserves that are being established to protect the desert tortoise and the ecosystems in which it lives, (3) the threats facing desert ecosystems and measures being taken to reduce the threats, and (4) the government land-use plans that are being created to ensure long-term protection of the ecosystems.

* In the United States, Congress has delegated the authority to determine the status of species to the USFWS, a federal agency under the Department of the Interior. Species may be placed on federal lists as "Threatened" or "Endangered" under the Endangered Species Act of 1973, as amended, and the lists are published by the government in the *Federal Register*. The process is known as federal listing. Each state may also develop separate lists of "Rare," "Threatened," or "Endangered" species, using its own criteria and standards, and the lists are known as state lists. The term *listing* is used to refer to the lengthy process involved in candidacy for listing, proposals for listing, and the ultimate action—formal or legal listing as "Threatened" or "Endangered."

Early Efforts to Protect the Desert Tortoise

The desert tortoise, *Gopherus agassizii*, is a widespread species of the arid southwestern United States and northwestern Mexico. It occupies a wide variety of habitat types in the Mojave and Sonoran deserts (including the California subsection of the Sonoran Desert known as the Colorado Desert) and occurs in four states in the U.S. and two states in Mexico (Figure 1).

The organized effort to protect significant populations and habitat of the desert tortoise from numerous human and land uses in the U.S. has spanned more than 20 years. The U.S. Department of the Interior's Bureau of Land Management (USBLM), the agency that administers approximately 75% of the remaining high-quality desert tortoise habitat, identified the tortoise as a valued component of the deserts and as a sensitive species in the 1970s (see USBLM, 1980). At that time the USBLM and state fish and wildlife agencies selected the tortoise as one of several indicator species for long-term monitoring of environmental conditions using criteria similar to those later described by the National Research Council's Committee on the Applications of Ecological Theory to Environmental Problems (1986). The selection was based in part on the tortoise's longevity, low reproductive potential, and sensitivity to environmental perturbations.

In the early 1970s biologists realized that desert tortoise populations were declining in the U.S. (USFWS, 1994a). By 1980 very small segments of three populations had received substantial legal protection: the Beaver Dam Slope population in Utah (which occupied an est. 101 km^2) was federally listed as "Threatened" under the Endangered Species Act (ESA) of 1973, as amended (USFWS, 1980); and parts of two populations were protected within small reserves, the Desert Tortoise Research Natural Area (est. 100 km^2) and the Chuckwalla Bench Area of Critical Environmental Concern (213 km^2) (USBLM, 1980). In 1984 three conservation organizations—Environmental Defense Fund, Natural Resources Defense Council, and Defenders of Wildlife—proposed federal listing for the remaining populations within the U.S. The USFWS (1985) responded by issuing a finding that federal listing was warranted but precluded by other, higher priority actions, thus briefly tabling conservation actions under the ESA.

Recognizing that tortoise populations were continuing to decline, the USBLM developed two plans to offset threats to tortoise populations and their habitats in 1988 (USBLM, 1988a, 1988b). One plan, *Desert Tortoise Habitat Management on the Public Lands: A Rangewide Plan*, contained a directive to ". . . manage tortoise habitats using an ecosystem management approach with emphasis on maintaining or restoring natural biological diversity" (USBLM, 1988a). The three aforementioned conservation groups also observed the continued population and habitat declines; they served notice of pending court action to the USFWS in mid-1989. Shortly thereafter (August 1989), the USFWS took emergency action to federally list approximately 30% of the tortoise populations within the geographic range (USFWS, 1989a, 1990a). Tortoise populations listed as "Threatened" occur in the Mojave and Colorado deserts; for administrative reasons, the USFWS refers to these populations as the *Mojave Population* (Figure 1).

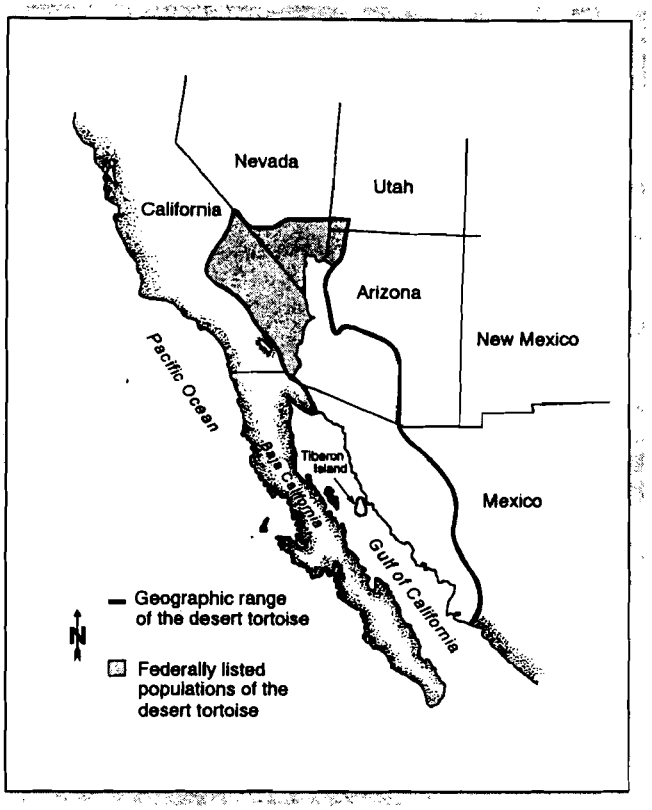

Figure 1. The geographic range of the desert tortoise, *Gopherus agassizii*, from Stebbins (1985). The portion of the geographic range where populations are federally listed is shaded.

Preparing the Desert Tortoise *Recovery Plan*

The Desert Tortoise Recovery Team

The USFWS has prepared several recovery plans for chelonians, such as the St. Croix population of the leatherback turtle (*Dermochelys coriacea*), the ringed sawback turtle (*Graptemys oculifera*), the Alabama red-bellied turtle (*Pseudemys alabamensis*), and the flattened musk turtle (*Sternotherus depressus*) (USFWS, 1981, 1988, 1989b, 1990b). In each of these cases, a single person prepared a short plan using traditional USFWS guidelines. In 1990 the USFWS took a different approach to draft a recovery plan for the desert tortoise, selecting a recovery team composed of nationally recognized scientists with expertise in genetics, plant and animal ecology, physiology, biogeography, veterinary medicine, and conservation biology. The recovery

team, which was chaired by Peter F. Brussard, included Kristin H. Berry, Michael E. Gilpin, Elliott R. Jacobson, David J. Morafka, Cecil R. Schwalbe, C. Richard Tracy, and Frank C. Vasek. Judy Hohman of the USFWS was Executive Secretary. Six of the eight team members were academicians and two were government research scientists. The team met 17 times over a period of four years to develop the *Recovery Plan*.

The review process for the *Recovery Plan* was extensive. Comments received during the review process not only improved the *Recovery Plan* and associated documents, but also ultimately contributed to the acceptance of the concepts contained in the documents. Government agencies, the public, and the scientific community played important roles. Prior to release to the public, two drafts of the plan were prepared for government review, including review by a four-state, multi-government agency committee, the Desert Tortoise Management Oversight Group (MOG). The MOG, formed in 1989 after publication of the USBLM's *Desert Tortoise Habitat Management on the Public Lands: A Rangewide Plan* (USBLM, 1988a), coordinates research, management, conservation, and recovery efforts for the desert tortoise in the U.S. Government review of the *Recovery Plan* was followed by an official draft, published for a 90-day public comment period in 1993. Public hearings were held, and the USFWS received a total of 143 letters. The draft *Recovery Plan* was modified to reflect the additional information and criticisms, and the final *Recovery Plan* was distributed in 1994. During the same year, the government determined the boundaries of Critical Habitat and published the decision in the Federal Register (see footnote, page 430). The four-year time span* from the initial federal listing of the Mojave population as "Threatened" and selection of the recovery team to publication of the final *Recovery Plan* and determination of Critical Habitat is in large part a reflection of the complexity of the task, the disparate nature of the available data bases, and the large amounts of land involved. Much of what follows is taken directly or paraphrased from the *Recovery Plan* (USFWS, 1994a) and is, in part, an enlarged abstract of the plan.

The Approach: Using the Principles of Conservation Biology

The recovery team recognized that the tortoise is a widespread species and exhibits substantial variation in genetic, morphological, ecological, physiological, and behavioral characteristics throughout its geographic range (USFWS, 1994a). Drawing from the ESA and the works of Ryder (1986) and Waples (1991), the recovery team decided to use evolutionarily significant units, which they termed "population segments" or "recovery units," to encompass the genetic and environmental variation present in the species. Six recovery units were identified: Western Mojave, Eastern Mojave, and Northeastern Mojave; Northern Colorado and Eastern Colorado; and Upper Virgin River (Figure 2 and Table 1).

The six recovery units vary considerably in climate and vegetation (USFWS, 1994a). The mean number of freezing days annually (which affects length of tortoise burrows and amount of seasonal activity above ground) varies from as low as 2–16 days in the two Colorado Desert recovery units to 46–127 days in the Northeastern Mojave Desert recovery unit. The mean annual precipitation and distribution of precipitation within the year differ considerably from the western to the eastern portions of the geographic range and are important factors that affect amount and timing of vegetation available to tortoises for forage. The Western Mojave recovery unit, for example, is in a region where annual precipitation primarily occurs in winter and produces ephemeral vegetation in late winter and spring, but little precipitation (6–10%) and forage occur in summer. In contrast, the other five recovery units are in eastern or southern regions that receive two periods of precipitation per year, which in turn can result in two distinct seasonal floras that may be utilized for food.

Within each recovery unit, from one to four reserves or Desert Wildlife Management Areas (DWMAs) were identified as locations where desert tortoise populations could be managed to achieve recovery (USFWS, 1994a; Brussard et al., 1994). A total of 14 DWMAs were identified (Figure 2 and Table 1).

Genetic factors, minimum viable population size, sizes of reserves (DWMAs), and the probability of long-term persistence are critical elements in the strategy to recover the "Mojave Population" of desert tortoises (USFWS, 1994a). From a genetic standpoint, the recovery team concluded that a minimally viable population should probably contain at least 2,000–5,000 adult animals (USFWS, 1994a). Three population viability analyses were prepared, and predictions were developed based on the probabilities that tortoise populations would persist for 500 years. Using these analyses, the recovery team concluded that (1) tortoise populations at minimum densities (3.9 adults/km²) require reserves of at least 518–1,295 km² to be genetically viable; (2) where the discrete population growth rate (lambda) is slightly below 1.0 but varies over a range of approximately 25%, extremely large reserves (12,950 km² to support 50,000 adults at minimal density) are necessary to support populations that would be relatively resistant to extinction within the next half-century; and (3) if lambdas fall below 0.975 on average, no population size is sufficient to persist for 500 years.

* However, four years is considerably less than the average 9.4 years reported by Tear et al. (1995) for completion of recovery plans for threatened and endangered vertebrates in general.

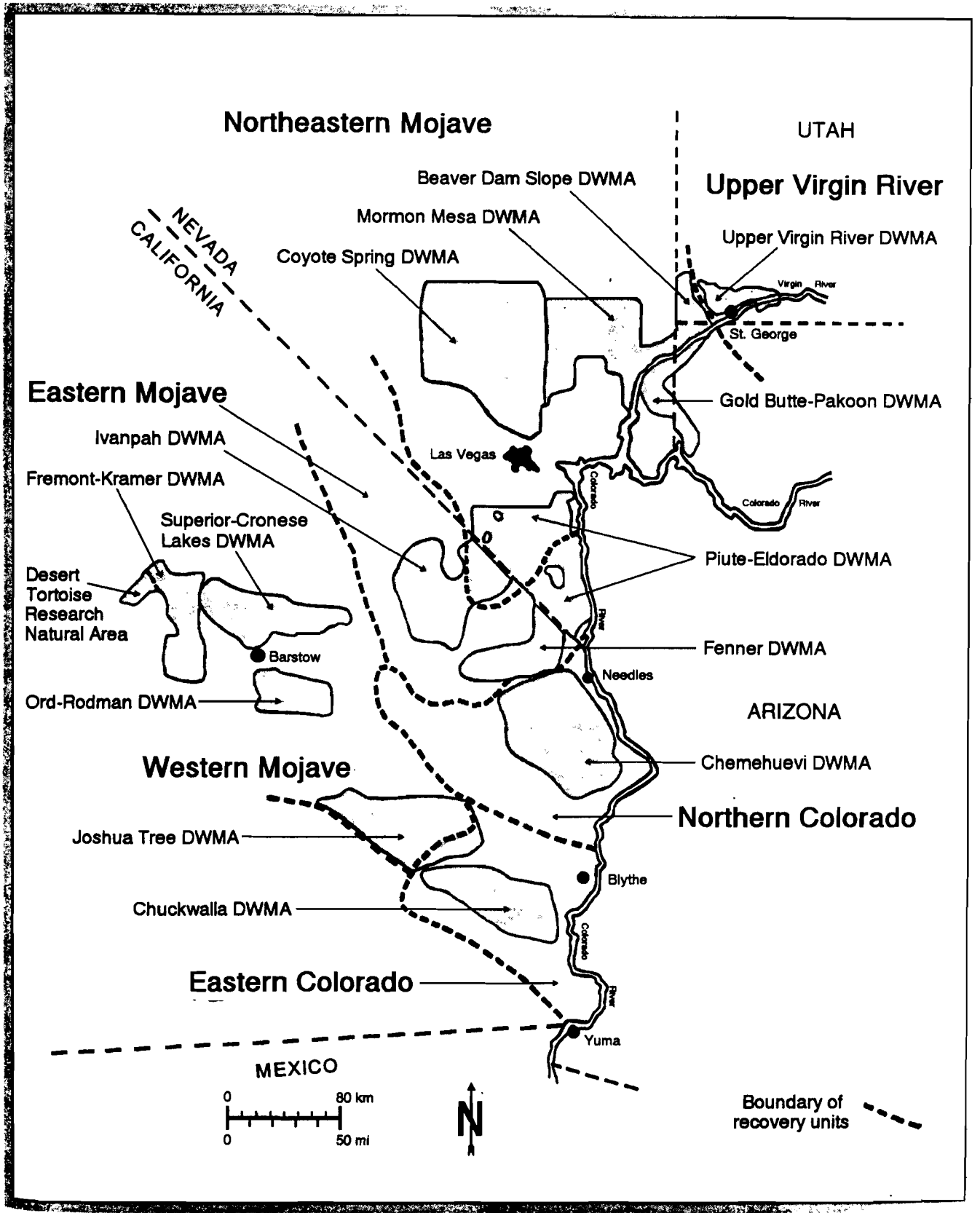

Figure 2. The portion of the desert tortoise population (Mojave population) that is federally listed as "Threatened." The six recovery units and 14 Desert Wildlife Management Areas (DWMAs) described in the *Desert Tortoise (Mojave Population) Recovery Plan* (USFWS, 1994a; Brussard et al., 1994) are shown.

The recovery team recommended a target size of >2,590 km² for DWMAs because reserves of this size would be likely to provide sufficient buffering from demographic stochasticity and genetic problems and would be sufficiently large to support recovered populations with a reasonable probability of persistence.

The shape and arrangement of DWMAs are essential to their success (USFWS, 1994a). The recovery team recommended the use of current theory and practice of reserve design (e.g., Thomas et al., 1990; Noss, 1991). Seven guidelines were followed in recommending DWMA boundaries (USFWS, 1994a):

TABLE 1

A comparison of sizes of Desert Wildlife Management Areas (DWMAs) recommended for protecting desert tortoises (Brussard et al., 1994) and the names and sizes of Critical Habitats ultimately designated by the federal government in February 1994 (USFWS, 1994b).

Recovery units DWMAs	Size (km^2)	Names of corresponding Critical Habitat(s)	Size (km^2)
Northern Colorado			
Chemehuevi	2,590.0–3,367.0	Chemehuevi	3,793.54
Eastern Colorado			
Chuckwalla	1,942.5–2,460.5	Chuckwalla [a]	4,130.24
Joshua Tree [a]	see Western Mojave	Pinto Mountains [a]	———
Western Mojave			
Fremont-Kramer	1,489.25–1,748.25	Fremont-Kramer	2,096.28
Ord-Rodman	1,165.5–1,424.5	Ord-Rodman	1,024.67
Superior-Cronese	2,331.0–2,849.0	Superior-Cronese	3,103.55
Joshua Tree [a]	2,136.75–2,913.75	Pinto Mountains	694.85
Eastern Mojave			
Fenner, California [b]	1,372.7–1,631.7	Piute-Eldorado, California	1,836.47
Piute-Eldorado, Nevada	1,740.16 [c]	Piute-Eldorado, Nevada	2,091.43
Northeastern Mojave			
Ivanpah Valley [d]	2,201.5–2,719.5	Ivanpah Valley	2,559.24
Coyote Spring	2,460.5–2,719.5	see Mormon Mesa	
Mormon Mesa	2,072.0–2,590.0	Mormon Mesa	1,731.66
Gold Butte-Pakoon	699.3–802.9	Gold Butte-Pakoon, Nevada	778.21
		Gold Butte-Pakoon, Arizona	1,197.88
Beaver Dam Slope in Utah, Nevada, Arizona	414.4–440.3	See below, by state	
		Beaver Dam Slope, Nevada	353.70
		Beaver Dam Slope, Arizona	172.80
		Beaver Dam Slope, Utah	301.49
Upper Virgin River			
Upper Virgin River	No number given	Upper Virgin River	220.96
Totals	22,615.56–27,407.06		26,086.97

[a] The Joshua Tree DWMA was located primarily in Joshua Tree National Park, with the vast majority of habitat in the Western Mojave recovery unit; only the southeastern part of the DWMA was in the Eastern Colorado recovery unit. When Critical Habitat was formally designated, the portions of the DWMA within the park were excluded. The northern part of the DWMA (in the Western Mojave recovery unit) became the Pinto Mountain Critical Habitat unit, and the southeastern portion of the DWMA outside the park was designated as part of the Chuckwalla unit of Critical Habitat.

[b] Located primarily in the Eastern Mojave recovery unit, with a small portion in the Northern Colorado recovery unit. When the habitat within the Fenner DWMA was designated as Critical Habitat, the name was changed to Piute-Eldorado, California.

[c] An estimate of the size, using 430,000 acres described in a proposed management plan (see Brussard et al., 1994).

[d] Located in both the Eastern Mojave and Northeastern Mojave recovery units.

1. Reserves that are well distributed across a species' native range will be more successful in preventing extinction than reserves confined to small portions of a species' range.
2. Large reserves (>2,590 km²) containing large populations of the target species are superior to small blocks of habitat containing small populations.
3. Blocks of habitat that are close together are better than blocks far apart.
4. Habitat that occurs in less fragmented, contiguous blocks is preferable to habitat that is fragmented.
5. Habitat patches that minimize edge-to-area ratios are superior to those that do not.
6. Interconnected blocks of habitat are better than isolated blocks, and linkages function better when the habitat within them is represented by protected preferred habitat for the target species.
7. Blocks of habitat that are roadless or otherwise inaccessible to humans are better than blocks containing roads and blocks easily accessible to humans.

The recovery team emphasized three related points: the desirability of redundancy, or more than one reserve per recovery unit, a strategy likely to increase the probability of recovery of populations within the recovery units; the importance of connecting small reserves with corridors containing functional habitat; and intensive management into perpetuity where small reserves are the only option. The recovery team also recognized the role of small, isolated populations, in the event that epidemic disease (such as upper respiratory tract disease) contributes to near extirpation in DWMAs.

The USFWS (1994b) used the guidelines to establish Critical Habitat in February 1994 (Table 2). Of the original 22,616–27,407 km² recommended for protection in 14 DWMAs (Brussard et al., 1994), the USFWS designated 26,087 km² as Critical Habitat (USFWS, 1994b). The USFWS (1994b) recognized that additional habitat was already adequately protected within Joshua Tree National Park (est. at 2,574 km², C. Collins, pers. comm.) and the Desert Tortoise Research Natural Area (est. 100 km²) and did not require designation as Critical Habitat. Thus, the overall total of protected habitats for the desert tortoise is 28,761 km².

Causes of Tortoise Population Declines and Recommended Regulations for DWMAs to Reduce Threats

Government agencies and the recovery team recognized that declines in desert tortoise populations as well as losses to their habitats were primarily due to human activities (USFWS, 1994a). The list of threats and factors contributing to declines is lengthy and is similar to the list of threats to tortoises worldwide (Swingland and Klemens, 1989). To reduce the factors contributing to tortoise mortalities and reverse population declines, the recovery team identified the human activities considered to be incompatible with recovery of the tortoise and recommended that the following activities be prohibited:

- all vehicle activity off of designated roads; all competitive and organized commercial and recreation events (associated with vehicles) on designated roads;

TABLE 2
Critical Habitat for the Mojave Population of the desert tortoise and ownership of land, as of February 1994 (USFWS, 1994b).

Land owner or administrator	Size (sq. km)	Percent
U.S. Dept. of the Interior, Bureau of Land Management	19,386.96[a]	74.32[a]
Dept. of Defense	980.15	3.76
U.S. Dept. of the Interior, National Park Service	595.70[a]	2.28[a]
State lands	672.59	2.58
Tribal lands	6.48	0.02
Private lands	4,445.09[b]	17.04[b]
Total	26,086.97	100.00

[a] On 31 October 1994 (eight months after designation of Critical Habitat), a substantial amount of public land under the jurisdiction of the Bureau of Land Management was transferred to the National Park Service for the Mojave National Preserve (California) and for additions to Joshua Tree National Park and Death Valley National Park (California). The transfer of land was part of the California Desert Protection Act of 1994, which was created by the 103rd Congress (Public Law 103-433, 108 STAT. 4471). Therefore, the figures shown in the above table are no longer accurate.

[b] A significant portion (no figures available) of private lands are owned by Catellus Corporation, formerly Southern Pacific Railroad lands.

TABLE 3

The relationships between desert tortoise recovery units and the existing and proposed multi-species, ecosystem, and bioregional plans.

Recovery units Name of management plan	Size of area (km^2)	Proposed year of completion
Western Mojave		
Draft West Mojave Coordinated Management Plan (draft)[1]	37,969	est. 1997
Eastern Mojave		
California:		
Northern and Eastern Mojave Desert Ecosystem/Coordinated Management Plan (proposed[a])[2]	31,239	est. 1999
Nevada:		
Short-term Habitat Conservation Plan for the Desert Tortoise in Las Vegas Valley, Clark County, Nevada[3]	89,121	1991
Clark County Desert Conservation Plan[4] and *Final Environmental Impact Statement: Issuance of a Permit to Allow Incidental Take of Desert Tortoises, Clark County, Nevada*[5]	56	1995
Stateline Resource Management Plan (amendments and revisions)[6]	14,973	1992, 1994
Northeastern Mojave		
California:		
(same as Eastern Mojave recovery unit, combined into one plan[a])[2]	no data available	est. 1999
Nevada:		
(same as Eastern Mojave recovery unit, may be combined into one plan[a])[2] will also include parts of *Stateline Resource Management Plan* and *Caliente Resource Management Plan*[6]	no data available	est. 1997
Utah:		
Dixie Resource Management Plan[7]	no data available	no date
Arizona:		
Arizona Strip Resource Management Plan[8]	12,140	1992
Upper Virgin River		
Proposed Habitat Conservation Plan, Washington County, Utah (draft)[9]	226	June 1995
Northern Colorado		
Northern and Eastern Colorado Desert Coordinated Management Plan[10]	22,391	est. 1999
Eastern Colorado		
Planning effort combined with Northern Colorado recovery unit[10]	no data available	est. 1999

[a] May combine California and Nevada regions, crossing state jurisdictions.

References:

1. USBLM, 1995
2. U.S. National Park Service and USBLM (in prep.)
3. Regional Environmental Consultants, 1991
4. Clark County, Nevada, 1995
5. USFWS, 1995
6. USBLM, 1992a; supplement in 1994 (must be amended)
7. USBLM (in prep., 1985–1995; incomplete, may be amended)
8. USBLM, 1992b (must be amended)
9. Washington County Habitat Conservation Plan Steering Committee and SWCA, Inc., Environmental Consultants, 1995
10. USBLM and others (in prep.)

- habitat-destructive military maneuvers, clearing for agriculture, landfills, and other surface disturbances that diminish the capacity of the land to support desert tortoises, other wildlife, and native vegetation;
- domestic livestock grazing and grazing by feral burros and horses;
- vegetation harvest, except by permit (issued by the county for private land, by the USBLM for public land);
- collection of biological specimens, except by permit;
- dumping and littering;
- deposition of captive or displaced desert tortoises or other animals, except under authorized translocation research projects (guidelines established within the *Recovery Plan*);
- uncontrolled dogs out of vehicles; and
- discharge of firearms, except for hunting of big game or upland game birds from September through February.

The above recommendations will be a challenge to implement quickly and effectively because much of the habitat (Table 2) for the Mojave Population of desert tortoises is on federal land administered by the USBLM (74.3%), where there is a long history of multiple-use activities (USFWS, 1994b). Tortoise habitats on the Department of Defense facilities (3.8%) and National Park Service properties (2.9%) also receive intensive use in some areas and are likely to require adjustments to land-use practices in the immediate future.

The recovery team expected that people would visit the DWMAS (USFWS, 1994a). They identified some limited human activities that are compatible with desert tortoise recovery efforts, including:

- non-intrusive monitoring of desert tortoise population dynamics and habitat;
- limited-speed travel on designated, signed roads and maintenance of these roads;
- non-consumptive recreation (e.g., hiking, birdwatching, casual horseback riding, and photography);
- parking and camping in designated areas;
- fire suppression that minimizes surface disturbance;
- permitted or otherwise controlled maintenance of existing utilities;
- surface disturbances that enhance the quality of habitat for wildlife, enhance watershed protection, or improve opportunities for non-motorized recreation (includes construction of visitor centers, wildlife guzzlers or drinkers, camping facilities, etc. where appropriate);
- population enhancement of native wildlife species, such as desert bighorn, Gambel's quail, etc.;
- mining on a case-by-case basis, provided that the cumulative impacts of these activities do not significantly impact desert tortoise habitats or populations, that any potential effects on desert tortoise populations are carefully mitigated during the operation, and that the land is restored to its pre-disturbance condition; and
- non-manipulative and non-intrusive biological or geological research, by permit.

An important element in the recovery strategy was the division of DWMAs into core areas where human activities would be restricted, and experimental management zones (EMZs) where certain prohibited activities may be permitted on an experimental basis during the recovery period (USFWS, 1994a). As envisioned by the recovery team, the EMZs would be composed of no more than 10% of tortoise habitat within a DWMA and would be located at the DWMA periphery. The types of research recommended for the EMZs include research on effects of cattle grazing on tortoises and their habitats and intrusive research on the tortoises themselves (e.g., affixing radio transmitters to shells, monitoring health profiles by drawing blood, etc.). The recovery team recommended that experimental translocations occur outside of DWMAs and that no desert tortoises be introduced into DWMAs, at least until relocation is much better understood (Appendix B *in* USFWS, 1994a).

Hypothesis Testing and Long-Term Monitoring

Recovery of desert tortoise populations is likely to require decades, if not centuries (USFWS, 1994a). The recovery team based the *Recovery Plan* on a series of hypotheses and models that can be tested as new data are acquired. The effectiveness of the recovery strategies (e.g., establishing recovery units, 14 DWMAs, and removing or reducing perceived threats from DWMAs) can be most appropriately tested by comparing changes in desert tortoise population densities inside and outside of DWMAs. The key to such comparisons is a reliable and economical method for estimating population densities of large immature and adult tortoises (>140 mm in carapace length) on a regional scale. No single method has yet to be embraced by government and the scientific community as "scientifically credible," an essential part of delisting criterion 1 (see following).

Hypothesis testing should also be a part of long-term research programs to evaluate threats to desert tortoise populations and habitat using the EMZs. Several subjects requiring attention are described in the *Recovery Plan*, e.g., research on the effects of cattle grazing and road density, the effectiveness of tortoise-proof barriers along freeways and highways, and feasibility of restoration of habitat.

Criteria that Must be Met for Tortoise Populations to be Considered "Recovered"

An essential part of the *Recovery Plan* is a description of recovery objectives and "delisting criteria," the threshold at which populations can be considered "recovered" and can be removed from the list of federally "Threatened" species. The USFWS (1994a) determined that desert tortoise populations could be delisted by recovery unit and that the Mojave Population could be delisted when populations in all six recovery units were considered to be recovered. Five criteria must be met for recovery to occur within a unit:*

1. The population must exhibit a statistically significant upward trend or remain stationary for at least 25 years (one tortoise generation); trends must be measured using a scientifically credible monitoring plan, with population estimates taken at five-year intervals.
2. Sufficient habitat must be protected within a recovery unit (at least one DWMA of >2,590 km²) or, in unusual circumstances, the tortoise populations must be managed intensively enough to ensure long-term population viability.
3. At each DWMA, population lambdas must be maintained at or above 1.0 into the future.
4. Regulatory mechanisms or land management commitments must be implemented to ensure long-term protection of tortoises and their habitats.
5. The population in the recovery unit should be unlikely to need protection under the ESA in the foreseeable future (as determined by detailed genetic, demographic, physiological, behavioral, and environmental analyses).

Implementing the *Recovery Plan*: The Use of Multi-Species, Ecosystem, and Bioregional Plans

The *Recovery Plan* (USFWS, 1994a) is being implemented through preparation of up to six bioregional, multi-species, or ecosystem plans (Table 3). The plans, most of which are regional in nature, are delimited in part by state boundaries. Three of the plans—the *Western Mojave Coordinated Management Plan*, the *Clark County Desert Conservation Plan*, and the *Proposed Habitat Conservation Plan, Washington County, Utah*—will probably be completed between 1995 and 1997, at least as draft plans, whereas the others are still in early stages. With one exception, the Beaver Dam Slope of Arizona, plans are underway or proposed for all DWMAs and recovery units.

One group of plans belongs to a special subset, "habitat conservation plans" (HCPs). Habitat conservation plans are an option described in the ESA, as amended, for protection and management of "Threatened" and "Endangered" species, while at the same time allowing for "incidental take" of individual animals and losses to their habitats. The best-known of the desert tortoise HCPs is the three-year or short-term HCP developed for Clark County, Nevada (Regional Environmental Consultants, 1991; Beatley, 1994), which has been followed by a long-term HCP (Clark County, 1994; USFWS, 1995).

These management plans, whether developed by federal, state, or county governments, are "desert tortoise driven": they would not have been identified and scheduled for preparation and implementation if the desert tortoise had not been federally listed and the *Recovery Plan* had not been prepared. The desert tortoise, because of its widespread distribution, public interest and support, scientific value, and charisma, is being used as an umbrella or "flagship" species to represent many different plants and animals and their ecosystems.

The management protections required to recover the desert tortoise necessitate major changes in existing land-use plans, some of which are 16 years old (e.g., USBLM, 1980), thereby stimulating new land-use planning efforts on a large scale. In all cases, preparers of the new plans are fully aware of the importance of using the multi-species and ecosystems approaches. They are following mandates in the ESA, which provides for protecting the ecosystems on which "Threatened" and "Endangered" species depend; agency directives in the USBLM's 1988 *Desert Tortoise Habitat Management on the Public Lands: A Rangewide Plan* (USBLM, 1988a); and current scientific thinking in conservation biology.

The draft *Western Mojave Coordinated Management Plan* (USBLM, 1995) provides an example of the scope and the numbers of at-risk species that will benefit. Twenty species of plants and animals within the planning region are already federally listed as "Threatened" or "Endangered" or are proposed for listing, and another 46 species are candidates for listing. The area covered by the plan is 37,969 km², of which 18% is designated Critical Habitat for the tortoise. When the protected habitats at the Desert Tortoise Research Natural Area and Joshua Tree National Park are added to Critical Habitat, 25.3% of the planning area would be managed for long-term recovery and survival of desert

* The *Recovery Plan* states: "These recovery criteria were designed to provide a basis for consideration of delisting, but not for automatic delisting. Before delisting may occur, the Fish and Wildlife Service must determine that the following five listing factors are no longer present or continue to adversely affect the listed species: (1) the present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease and predation; (4) inadequacy of existing regulatory mechanisms [e.g., laws, existing land use]; and (5) other human-made or natural factors affecting the continued existence of the species . . ."

tortoise populations. Additional areas will be protected for at least some of the other species, potentially raising the percentage even higher.

A key point about the desert tortoise is its federal status under the ESA as a "Threatened" species. Because the tortoise is classified as "Threatened" and is not considered endangered, the government may still allow some multiple use of the land, and some time is still permitted to allow ecosystems to recover naturally. With many endangered species, such opportunities have been lost. Because the remaining ecosystem remnants have reached such severe states of perturbation, draconian measures are necessary. Some endangered species, such as the California condor, remain extant primarily through breeding programs. It is hoped that the recovery measures for the tortoise can be quickly implemented, thereby reversing declining population trends. Recovery is expected to require centuries for some desert tortoise populations.

In summary, the *Recovery Plan* for the desert tortoise follows a recent trend of recovery plans, e.g., the grizzly bear (USFWS, 1993) and the spotted owl (Thomas et al., 1990), which are regional in scope, are designed to improve management of troubled ecosystems, and are potentially controversial. Recovery plans for single species—especially when the species are widespread, large, showy, charismatic or well-known to the public—may serve to stimulate public support for large-scale, bioregional or ecosystem land use plans. In the case of the tortoise, over 26,000 km² in the Mojave and Colorado deserts may receive new and significant management and conservation efforts. Single umbrella species such as the desert tortoise also can assist immeasurably in educating the government and the public about conservation biology, biodiversity, and the need for reserves.

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