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INCIDENCE OF GUNSHOT DEATHS IN DESERT TORTOISE POPULATIONS IN CALIFORNIA

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The State of California has protected the desert tortoise (*Gopherus agassizii*) from shooting and other vandalism since 1961 (Calif. Fish and Game Comm. Code 5000). Despite the regulation, remains of tortoises killed by gunshots are a frequent sight in parts of the California deserts (Ragsdale 1939, Boynton 1971, Olsen 1971, Bury and Marlow 1973, Switak 1973, Berry 1975, Nowak 1977). This paper reports the incidence of desert tortoise deaths attributable to firearms on U.S. Bureau of Land Management (BLM) study sites in the California deserts and records miscellaneous observations of shooting deaths near tortoise study sites.

METHODS

A sample of 635 carcasses collected between 1976 and 1982 (Berry 1984*a*) from 11 of 27 sites in the California deserts was examined for evidence of gunshots. The sample included all carcasses from study sites except those (1) from tortoises considered dead >4 years (Woodman and Berry 1984), (2) in a carcass deterioration study, and (3) from study sites with few shell-skeletal remains. Few carcasses consisted of the entire shell. Most soft parts were absent or mummified. The shells of many remains were disarticulated, fractured, or fragmented.

Frederic A. J. Tulleners, a criminalist with the California Department of Justice, examined 22 carcasses which appeared to have been shot. He provided information on whether the tortoises actually were shot, possible types of pellets or bullets, and suspected weapons. The 22 carcasses were used as a reference collection for analyzing the remaining 613 carcasses.

Tulleners used the presence of conchoidal fractures as presumptive evidence that a tortoise had been shot (Fig. 1). A conchoidal fracture has a series of shell-shaped fractures that leave the broken surfaces of bone marked with typical curved striations (Kirk 1974:261–263). When a bullet passes through thick bone, it leaves a characteristic pattern (Gonzales et al. 1954:419–420, Dixon 1984). The bullet produces a clean-cut opening at the point of entry on the outer table or exterior. As it passes through bone, it exerts both lateral and propulsive forces. Lateral forces chip away pieces of bone on the surface edges. When the bullet exits, it strikes the inner table or interior surface of bone first, leaving a punched-out opening, usually larger than the perforation at entrance. The exit point on the exterior surface leaves a larger opening because of increased expenditure of energy by the bullet. Perfect exit holes may not be evident if (1) the bullet encounters bone at an angle other than 90°; (2) several bullets (e.g., high-velocity bullets) penetrate the shell, fracturing and shattering bone; (3) the bullet is deformed during passage through the body; (4) the bullet hits bone or is otherwise deflected within the body; and (5) hydrostatic shock contributes to multiple fractures of the bone.

All carcasses with conchoidal fractures were treated as gunshot deaths. In addition a few carcasses without conchoidal fractures were considered gunshot deaths. These remains consisted of several sharp fragments of bones and scutes and appeared similar to shells known to have been shattered by high-velocity bullets. They had no punctures or gnawings typical of predators and scavengers. Some tortoises obviously were killed by gunshots, whereas others may have been shot after death. I believe that most, if not all, tortoises treated as gunshot deaths died of gunshot wounds. Other tortoises also may have died from shooting, but because parts of carcasses were missing or shattered into small fragments, the evidence was inconclusive.

For each of the 635 carcasses, the following data were recorded: name of site, date of collection, estimated year(s) since death, carapace length (mm), and evidence of conchoidal fractures and shooting. Carapace length was estimated for partial remains using 1 or more of 25 regression equations of scute size on carapace length (Berry and Woodman 1984). Regression equations were developed from measurements of 64 intact shells ranging in size from hatchling to large adult tortoises.

Tortoises were assigned to 4 size-age classes based on carapace length (mm): juvenile (<100), immature (100–179), subadult (180–207), and adult (≥208) (Berry 1980, Turner and Berry 1984*a*). Tortoise study sites were assigned to geographic regions according to location (Turner and Berry 1984*a*) (Fig. 2).

RESULTS

Gunshot Incidence

Ninety-one (14.3%) of the 635 carcasses showed evidence of gunshots. Tulleners (pers. commun.) identified the following firearms as probable weapons: .177 caliber pellet or BB guns; shotguns, e.g., with No. 7½ or 8 shot; .22 caliber rifles or pistols; .22 caliber Winchester magnum rifles or pistols; .223 caliber assault

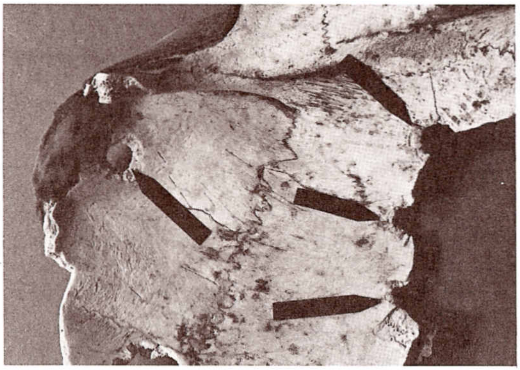

Fig. 1. Four conchoidal fractures (black arrows) on the interior shell of a desert tortoise. Photo by B. Steveson.

rifles, e.g., AR-15, M-16; .30 caliber weapons; and .38 caliber weapons, e.g., .38 special, .357 magnum, and 9-mm pistols.

Nine of the 11 sites had sample sizes of more than 25 carcasses; 0–28.9% of the carcasses from these sites showed signs of gunshots (Table 1). In the western Mojave Desert 20.7% of carcasses had gunshot wounds, whereas in the eastern Mojave and Colorado deserts the figures were 1.5 and 2.0%, respectively. Frequencies of gunshot deaths differed among the 3 desert regions ($\chi^2 = 35.0$, 2 df, $P < 0.005$).

Table 1. Frequency of gunshot vs. other deaths of desert tortoises on 11 sites in the California deserts, 1972–1982.

Desert region Site—name	Gunshot deaths	Other deaths	Percent gunshot deaths
Western Mojave			
2—Fremont Valley	26	64	28.9
3—Desert Tortoise Natural Area, Sec. 11	24	100	19.6
5/6[a]—Fremont Peak	16	80	16.7
7—Kramer Hills	6	35	14.6
9—Stoddard Valley	9	28	24.3
10—Lucerne Valley	3	9	
11—Johnson Valley	3	18	
Eastern Mojave			
14—Ivanpah Valley	1	31	3.1
15—Goffs	0	34	0.0
Colorado			
20—Chemehuevi Valley	1	35	2.8
23—Chuckwalla Bench	2	110	1.8

[a] Data for Sites 5 and 6 were combined because of close proximity.

Tortoises killed by firearms were 57–267 mm in length and represented all size classes (Table 2). From 7.8 to 19.9% of tortoises in each size class were killed with firearms. Among all tortoises killed by gunshots, 39.8% were subadults and adults and 60.2% were in juvenile and immature size classes.

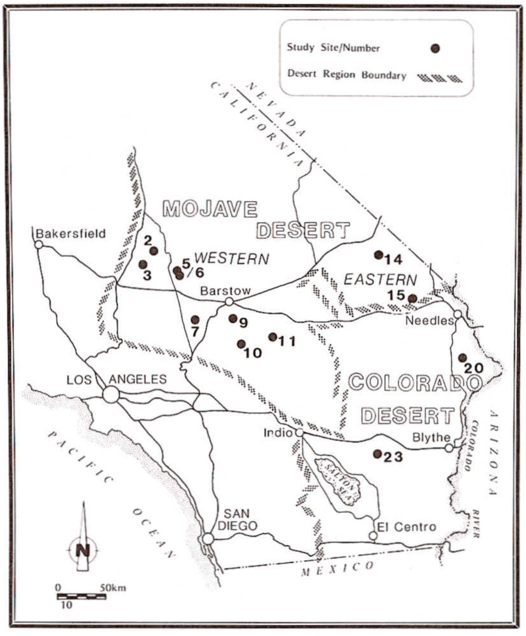

Fig. 2. Locations of desert tortoise study sites and the Mojave and Colorado desert regions in California.

Miscellaneous Observations

In the western Mojave Desert, California Department of Fish and Game wardens Carl McCammon and Frank Tharp (pers. commun.) occasionally found tortoises dead from gunshots near roads in eastern Kern and northwestern San Bernardino counties during the 1960s and 1970s. Campbell (1982) collected carcasses of 2 recently shot tortoises on the perimeter of the Desert Tortoise Natural Area (DTNA) (Site 3 [Fig. 2] includes about 3% of

Table 2. Frequency of gunshot vs. other deaths by size-age class of desert tortoises in the California deserts, 1972–1982.

Size-age classes	Gunshot deaths	Other deaths	Percent gunshot deaths
Juvenile	18	213	7.8
Immature	30	121	19.9
Subadult	12	59	16.9
Adult	31	151	17.0

this area), and found a third nearby during a 6-month study in 1980–1981. Other carcass sightings and collections by BLM personnel and others between 1981 and 1984 include: 2 from the DTNA interpretive center, 1 from the El Paso Mountains, 4 in a pile south of Fremont Peak, and 3 in Stoddard Valley.

In the eastern Mojave Desert, a BLM ranger reported that a tortoise was shot and then run over with a vehicle in Ivanpah Valley during 1977. In the Colorado Desert, BLM personnel found 8–9 tortoises shot near Site 23, the Chuckwalla Bench, between 1979 and 1981.

DISCUSSION

The percentages of tortoises shot vs. those dying of other causes may be higher throughout the California deserts than indicated by my data, particularly in the western Mojave Desert. My study sites have experienced less human traffic and vandalism than most surrounding valleys and bajadas (Berry 1984*a*).

People who shoot tortoises probably are not licensed game hunters. With the exception of shotguns and .22 caliber rifles, the firearms used to kill tortoises were not weapons generally carried by hunters of upland game birds, desert cottontails (*Sylvilagus audubonii*), and black-tailed jack rabbits (*Lepus californicus*), the available game species in tortoise habitat. Hunters of upland game are unlikely to see tortoises, because upland game seasons coincide with tortoise hibernation. Furthermore, tortoise study plots were not in prime hunting habitats (J. Scull, unpubl. rep., U.S. Bur. Land Manage., Riverside, Calif., 1978).

Field Research Corporation (1977) took opinion polls of California residents about the California deserts in 1975 and 1977. In 1975, 20% of respondents said they were target shooting or would like to do so. In 1977, 12% of desert visitors reported that they engaged in some form of target shooting in the past year, 1% said it was their primary activity, and 4% said they would like to do so. Target shooters or "plinkers" may be responsible for the vandalism of tortoises. Scull (1978:16) noted that "game wardens were nearly unanimous in stating that casual plinkers tend to shoot anything that moves. This includes songbirds, ground squirrels, raptors, lizards, and other illegal targets of opportunity." Campbell (1982) reported seeing people fire at small animals in and near the DTNA. He also found 3 raptors which had been shot. Tortoise field workers (L. Nicholson, K. Bohuski, and K. H. Berry, U.S. Bur. Land Manage., unpubl. data) have seen people shooting at small animals from vehicles and on foot at tortoise study sites.

The higher percentage of tortoises killed by firearms in the western Mojave Desert probably is attributable to higher numbers of human visitors, greater vehicular access, and closer proximity to urban centers. In the mid-1970s, the BLM identified many concentrated recreational use zones in the California deserts (U.S. Bur. Land Manage., unpubl. rep., Riverside, Calif., 1979). Recreational activities were identified within the concentrated use zones, and number of visitor-use-days (VUDs) was measured. Human use was much higher in tortoise habitat in the western Mojave Desert than in the eastern Mojave and Colorado deserts. For example, figures for the DTNA and the adjacent Fremont Valley were 100 and 1,100 VUDs/km^2 per year, respectively. The Fremont Peak, Stoddard Valley, Kramer Hills, Lucerne Valley, and Johnson Valley sites, while not in concentrated recreational use zones, were within a few kilometers of areas with up to 29,600 VUDs/km^2 per year. No concentrated recreational use zones were near tortoise study sites in the eastern Mojave Desert. In the Colorado Desert, 1 concentrated use zone with 1,050 VUDs/km^2 per year was within a few kilometers of the Chuckwalla Bench study site.

The relationship between vehicle access, off-road vehicle (ORV) use, and frequency of gunshot deaths is circumstantial. ORV users frequently carry firearms and reach relatively remote parts of the desert through roads, trails, and cross-country travel. They congregate in several major ORV-use areas in the California deserts, often in the thousands (U.S. Bur. Land Manage. 1973, 1980). Between 1973 and 1980, 10 authorized ORV areas were in tortoise habitat in the western Mojave Desert. The ORV-use areas were used for unrestricted travel ("open areas") and competitive events. The 7 tortoise study sites in the western Mojave were in or adjacent to open areas and competitive event areas, whereas the 2 study sites in the eastern Mojave were not close to any ORV-use areas. In the southern Colorado Desert, 1 study site, Chuckwalla Bench, was several kilometers from 2 ORV-use areas.

Since 1980, ORV-use areas have changed somewhat (U.S. Bur. Land Manage. 1980). In the western Mojave, the Fremont Valley study site is still in an authorized ORV-use area, but traffic is permitted only on existing roads and trails. The Fremont Peak site is no longer within or near an ORV-use area. In the southern Colorado Desert, the 2 ORV-use areas near the Chuckwalla Bench study site were abandoned. Elsewhere, vehicle use is similar to the 1973–1980 levels.

Two tortoise study sites, Kramer Hills and Stoddard Valley, are close to urban centers. Kramer Hills is 8–30 km from several towns and cities with a combined total of about 40,000 people. Stoddard Valley is 9.6 km south of Barstow (population of 19,000).

The long-term effects of shooting on tortoise populations are unknown but are likely to be detrimental because tortoises (1) require 12–15 years to reach sexual maturity and (2) appear to have low recruitment of juveniles into adult age classes. Berry and Woodman (1984) estimated crude annual death rates for adult tortoises at 15 study sites over 4- to 9-year periods. Mean rates for the 11 sites discussed here (Fig. 2) were higher ($t = 2.17$, 8 df, $P < 0.1$) for sites in the western Mojave Desert ($\bar{x} = 6.2\%$, range 1.2–17.3%) than for the eastern Mojave and Colorado desert combined ($\bar{x} = 1.5\%$, range 0.4–3.1%). Near Goffs in the eastern Mojave Desert, Turner and Berry (1984*b*) estimated a 2% annualized mortality rate for adults. This site has little human use. Average annual mortality rates for adult tortoises in undisturbed populations probably are closer to 2% than the mean of 6.2% in the western Mojave Desert. Shooting may be a major contributor to the higher rates.

MANAGEMENT IMPLICATIONS

Desert tortoise populations are declining in California and elsewhere (Berry 1984*b*) to such an extent that the U.S. Fish and Wildlife Service decided in September 1985 that federal listing "is warranted, but precluded by other pending proposals of higher priority" (U.S. Fish and Wildl. Serv. 1985). Reduction in gunshot deaths, especially where responsible for or a contributing factor to unnaturally high death rates, should be a priority for wildlife and land-management agencies, as well as for local governments. Options for reducing gunshot deaths include (1) increasing numbers of law enforcement personnel in tortoise habitat with heavy human use, e.g., the western Mojave Desert; (2) seasonal closures (Mar–Sep) of tortoise habitat with high frequencies of gunshot deaths to users of firearms; (3) education through schools, signs, newspaper and magazine articles, gun clubs, and ORV associations; and (4) land-use planning and zoning. The key to reducing vandalism lies in reducing human densities in and near tortoise habitats. Even though vandals constitute only a fraction of land users, they can have significant impacts, particularly where human-use levels are high. Increased law enforcement, if coupled with seasonal closures, could be highly effective tools for reducing vandalism. Land-use planning at county, regional, state, and federal levels can exert important influences but is potentially most effective where human-use levels are still relatively low. Land managers and local governments can discourage moderate to high human use levels through zoning and long-term planning. Where human-use levels are already high, planning and zoning policies might be altered to reduce human numbers. However, many of the more heavily used areas already have irrevocable commitments.

SUMMARY

The incidence of gunshot deaths in desert tortoise populations was examined at 11 study sites in the California deserts using a sample of 635 carcasses. Of the carcasses, 14.3% had signs of gunshots. They were 57–267 mm in length and represented all size classes. In the western Mojave Desert 20.7% of carcasses had gunshot signs, whereas in the eastern Mojave and Colorado deserts the figures were only 1.5% and 2.0%, respectively. The higher ($P < 0.005$) incidence of gunshot deaths in the western Mojave Desert was probably associated with higher recreation use levels, greater vehicular access and off-road travel, and closer proximity to urban areas.

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