Best Management Practices
Reducing Impacts of Roads

Networks of roads and off-road vehicle trails have expanded dramatically in southwestern deserts since the 1800s. Roads directly affect desert tortoises by being sources of mortality from vehicular traffic and subsidizing prey of common ravens, which are predators of desert tortoises. Roads further affect habitat quality by being areas denuded of vegetation, altering patterns of surface water flow (dramatically affecting plant productivity), limiting dispersal and migration of desert tortoises, and facilitating access for additional human disturbances.

Best-management practices for reducing impacts of roads to desert tortoises and habitat include:

- **Include the total footprint of impact when planning new roads or expanding existing roads.** The zone of depleted tortoise populations surrounding roads generally increases in width with increasing size and traffic volume of roads. The mortality zone around highways can extend several thousand meters from the roadside into surrounding desert. A footprint of impact larger than the footprint of the road itself should be included in projections of habitat loss for new projects within desert tortoise habitat.

- **Constructing tortoise exclusion fencing along roadsides can reduce evidence of desert tortoise mortality.** Effects of roads can be partly, but not completely, mitigated through proper construction of tortoise exclusion fencing. Tortoise exclusion fencing may also reduce roadkills of small mammals, potentially decreasing predation of tortoises by ravens. To allow movement of tortoises across the landscape, well-maintained culverts or other structures could allow passage of tortoises through roads. The 2011 Fish and Wildlife Service Recovery Plan provides guidelines for constructing tortoise fencing.

- **Decommissioning un-needed backcountry, dirt roads is likely to improve habitat quality.** Closing roads to vehicular traffic, accompanied by restoration and enforcement against trespasses where appropriate, can reduce chance of tortoise mortality by vehicles (Fig. 1). It also can help reduce vectors for non-native plant invasions.

Fig. 1. Examples of road and trail closure techniques: a) strategic use of outplanting perennial plants near a road entry point; b,d) vertical mulch ("planting" dead plant material) to camouflage closed road; and c) creating walking trail using fencing and rock placement after damage by off-road vehicles. Photo credits: a) S.R. Abella; b,d) H. Weckesser; and c) E. LaRue.

- **Installing barriers or camouflaging entry points of decommissioned roads and trails can help limit trespasses.** Barriers such as fencing or rock can help reduce unauthorized incursions to closed roads. Strategically placing vertical mulch ("planting" dead plant material) or revegetating areas near road entry points can help blend closed roads into the surrounding landscape (Fig. 1).

- **Treating surfaces of closed dirt roads can increase water infiltration and plant establishment.** Treatments such as ripping, imprinting (creating a pattern of indentations), and mulching have potential for decompacting soil and promoting plant establishment. For ripping, it may be important to focus on surface soil (upper ~ 15 cm [6 inches]) to avoid disrupting soil layering and bringing subsoil to the surface (Fig. 2).

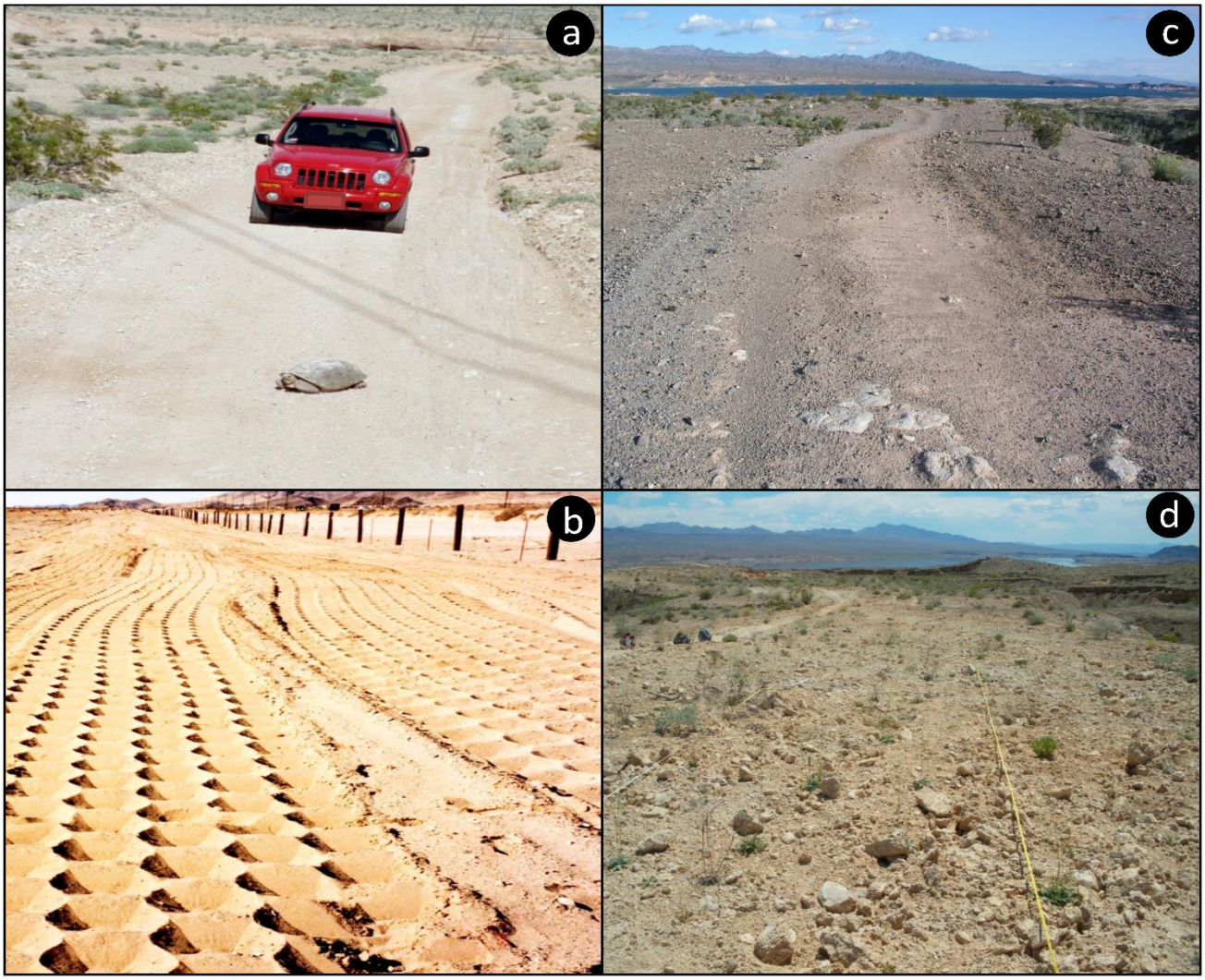

Fig. 2. Backcountry roads do pose risk to desert tortoises (a). Imprinting (b) to enhance water retention and plant establishment on a decommissioned road. Ripping road surfaces (d), compared to no ripping (c), can roughen compacted soil and promote plant recruitment. Photo credits: a) R.J. Abella; b) D.A. Bainbridge; and c,d) S.R. Abella.

- **Re-contouring road berms can be critical to re-connect washes and restore patterns of surface water flow.** Roads often alter and sever drainage networks, a problem especially severe for roads with large berms. Removing road berms and creating check dams on compacted road surfaces may prevent water from simply following a road as a flow path. Roads serving as artificial flow paths result in water draining off the landscape, without reaching natural soils.

Example References and Further Reading

Abella, S.R. 2010. Disturbance and plant succession in the Mojave and Sonoran Deserts of the American Southwest. International Journal of Environmental Research and Public Health 7:1248-1284.

Bainbridge, D.A. 2007. A guide for desert and dryland restoration. Island Press, Washington, D.C. 391 pp.

Boarman, W.I., and M. Sazaki. 2006. A highway's road-effect zone for desert tortoises (*Gopherus agassizii*). Journal of Arid Environments 65:94-101.

Brooks, M.L., and B.M. Lair. 2009. Ecological effects of vehicular routes in a desert ecosystem. Pp. 168-195 *in* Webb, R.H., L.F. Fenstermaker, J.S. Heaton, D.L. Hughson, E.V. McDonald, and D.M. Miller (eds.). The Mojave Desert: ecosystem processes and sustainability. University of Nevada Press, Reno, NV. 481 pp.

DeFalco, L.A., and S.J. Scoles-Sciulla. 2011. Protocol for documenting disturbances, prioritizing restoration, and evaluating restoration effectiveness for vehicle disturbances in Mojave Desert uplands. U.S. Geological Survey, Western Ecological Research Center, Henderson, NV. 69 pp.

LaRue, E.L. 1993. Distribution of desert tortoise sign adjacent to Highway 395, San Bernardino County, California. Proceedings of the Desert Tortoise Council Symposium 18:190-204.

Nafus, M.G., T.D. Tuberville, K.A. Buhlmann, and B.D. Todd. 2013. Relative abundance and demographic structure of Agassiz's desert tortoise (*Gopherus agassizii*) along roads of varying size and traffic volume. Biological Conservation 162:100-106.

Nichols, K.K., and P.R. Bierman. 2001. Fifty-four years of ephemeral channel response to two years of intense World War II military activity, Camp Iron Mountain, Mojave Desert, California. Reviews in Engineering Geology 14:123-136.

Weigand, J., and J. Rodgers. 2009. Active restoration for the Mojave Desert. Pp. 378-409 *in* Webb, R.H., L.F. Fenstermaker, J.S. Heaton, D.L. Hughson, E.V. McDonald, and D.M. Miller (eds.). The Mojave Desert: ecosystem processes and sustainability. University of Nevada Press, Reno, NV. 481 pp.