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Research Brief for Resource Managers

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Synthesizing Best-Management Practices for Desert Tortoise Habitats

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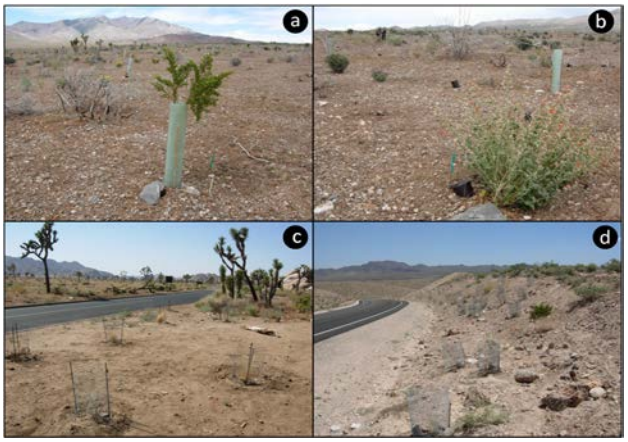
Persistence of natural populations of the federally listed desert tortoise (*Gopherus agassizii*) in the Mojave and western Sonoran Desert partly depends on habitat quality. Tortoises must obtain protection (provided by native shrubs offering cover and shade), soil microsites free from harmful contaminants for digging burrows, digestible and nutritionally rich forage (typically provided by certain annual and perennial forbs), and drinking water provided by habitats.

During the last 150 years, habitat has likely changed unfavorably for desert tortoises, which is potentially related to observed long-term declines in desert tortoise populations. Two of the major changes are widespread invasion by non-native annual grasses (e.g., red brome [*Bromus rubens*] and *Schismus* spp.), which are generally poor-quality forage compared to native forbs; and wildfires, in part fueled by non-native grasses, that alter forage quality and remove the mature shrublands that provide cover for tortoises.

In a collaborative project funded by the non-profit Desert Tortoise Council with Natural Resource Conservation LLC, we synthesized published literature and practitioner's experiences to develop best-management practices for habitats of desert tortoises. Our review included two parts: 1) relationships of desert tortoises with habitat features, such as forage preferences displayed by tortoises; and 2) best practices for enhancing and restoring perennial plants as cover or forage, improving forage quality and quantity, and restoring and conserving soil health.

Management Implications

- Desert tortoises are selective foragers, often preferring certain native forbs, and avoiding non-native annual grasses that also create hazardous fuels.
- Our review synthesizes best-management practices for reducing non-native grasses while increasing native species and desirable features in desert tortoise habitats of the Mojave and western Sonoran Desert.
- A priority need is implementing multiple habitat improvements at protected sites.



Post-burn restoration on BLM land in southern Nevada (top) and revegetating roadsides on NPS land in Joshua Tree National Park (bottom left) and Lake Mead Natl. Recreation Area (bottom right). Photos by S.R. Abella.

Restoring Shrub Cover
Based on 18 published studies in the Mojave Desert, outplanting greenhouse-grown seedlings for tortoise cover has more reliably restored native perennial plants than has seeding. Several perennial species have achieved ≥ 50% survival through outplanting, such as creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*). Furthermore, using creative planting arrangements, such as establishing patches of plants to serve as seed sources, warrant consideration for enlarging the area able to be revegetated via outplanting.

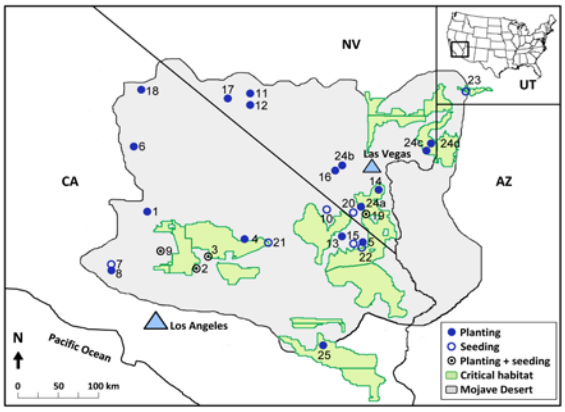
Reducing non-native grass fuels
In addition to conserving the mature shrublands that offer tortoises cover, fire management (via reducing non-native grass fuels) is important to tortoise forage quality. Our review provides example studies that have identified treatments for reducing non-native annual grasses, such as timing herbicide applications early in the growing season. Tortoises may also be inactive at this time and thus avoid direct exposure to herbicide. Further references for minimizing non-target effects of herbicides are provided in the review. When non-native grasses have been reduced, many native annual forb species have increased, including those that supply forage preferred by tortoises. Non-native grasses are a top threat to tortoise habitat, and working to develop further treatments that reduce non-native grasses should be prioritized. Furthermore, potential unintended impacts of grass treatments must be balanced against impacts of unabated invasion and wildfires.

Improving Forage
Several additional strategies for improving tortoise forage quality are also discussed, such as providing protection from grazing by non-native animals (e.g., burros, cattle). At the Desert Tortoise Research Natural Area in California, biomass of tortoise forage plants was sharply higher inside fenced areas than outside during a three-year study. Augmenting soil seed banks using pelletized seed also increased a favored native annual forb (desert plantain [*Plantago ovata*]) during a 2013-2014 study.

Restoring Soil
Salvaging topsoil if large soil disturbances are planned, detecting and remediating soil toxic to tortoises, and techniques for decommissioning certain backcountry roads are among best practices for conserving or restoring soil in tortoise habitat. These techniques are additional to the revegetation and fire management practices discussed in other sections.

Future Research and Management
A priority research and management need is implementing comprehensive suites of habitat enhancements at selected sites. Most tortoise habitat management activities to date have occurred on a one-at-a-time basis, such as just fencing an area. Integrating several of the activities discussed in the review – such as treating non-native plants while also establishing preferred forage plants and restoring hydrology – is an action that warrants evaluation for slowing or even reversing the decline in tortoise populations. It is unclear whether this strategy would work, and both short- (e.g., juvenile survival, shell characteristics) and long-term (e.g., population size) indicators of success could be monitored for this long-lived (~50 years) species.

Further Reading
In addition to the published journal article, five fact sheets outlining best practices for tortoise habitat management activities were produced jointly by the Desert Tortoise Council and Natural Resource Conservation LLC, available here: http://www.deserttortoise.org/bmp_docs.html



Distribution of designated critical habitat units for the desert tortoise in the Mojave Desert and locations of revegetation studies (circles).