

## Temporary Captive Care of Mojave Desert Tortoises (*Gopherus agassizii*)

U.S. Fish and Wildlife Service  
Desert Tortoise Recovery Office



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## Document Preparation

(Listed alphabetically)

Kristina Drake, PhD  
U.S. Fish and Wildlife Service – Desert Tortoise Recovery Office

Kirsten Dutcher, PhD  
Ecocentric

Kimberleigh Field, MS  
U.S. Fish and Wildlife Service – Desert Tortoise Recovery Office

Jay Johnson, DVM  
Arizona Exotic Animal Hospital

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[www.fws.gov/program/desert-tortoise-recovery](http://www.fws.gov/program/desert-tortoise-recovery)

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## 1.0 Introduction

The information presented here was developed to promote the survival of Mojave desert tortoises (*Gopherus agassizii*; hereafter tortoise) temporarily placed in captive environments, a captive husbandry complex, research enclosures, or holding pens (hereafter enclosures). Prior to considering the containment of tortoises, project proponents will need to discuss the most appropriate disposition for the affected tortoises with the U.S. Fish and Wildlife Service (USFWS). If captive containment is deemed necessary and appropriate, the USFWS may require the proponent to move tortoises to an existing federally approved facility. If no such facility is available or if existing facilities do not meet specific project needs, the proponent will need to construct appropriate enclosures. Placement of enclosures will be coordinated with the USFWS. Outdoor enclosures will be placed in areas and habitats appropriate for tortoises (Bury 1982; Nussear and Tuberville 2014) and not scheduled for development or associated with activities that would interfere with the captive enclosure operation, required husbandry activities, or site security (USFWS 2020).

When possible, tortoises should not be removed from the wild or introduced to a captive environment during periods of reduced tortoise activity, especially October 15<sup>th</sup> – March 15<sup>th</sup>. Reduced activity is likely triggered by exogenous cues and decreased metabolic activity (Nussear *et al.* 2007). To minimize the potential effects of extreme temperatures, tortoises should not be introduced to a captive environment when daily temperatures fall below 10°C (50°F) or rise above 35°C (95°F) unless they will be monitored for at least 10 consecutive days to ensure proper use of shelter sites. This document aims to standardize and improve the care of tortoises held in captivity. Protocols may be adapted to address variable conditions, improve tortoise well-being, or minimize risks with modifications subject to approval by USFWS.

## 2.0 Husbandry Plan Guidelines

A detailed Husbandry Plan is required for all projects or entities (hereafter proponents) anticipating the placement of tortoises in captive enclosures. Proponents should expect to pay for all costs associated with captive enclosure construction (if required), site security and fencing, housing, care, treatment, veterinary consultation, and other husbandry related expenses. Proponents must maintain open communication with USFWS and associated land and site managers. Adopting a standardized approach to protocols and data collection will enhance husbandry practices for tortoises and support adaptive management. These husbandry guidelines are designed to minimize site security risks, disease transmission, and thermoregulatory stress, while safeguarding against malnutrition and dehydration. A detailed Husbandry Plan should follow the template guidance (APPENDIX 1: HUSBANDRY PLAN TEMPLATE) and address each requested topic and specific project need. The proponent's Husbandry Plan must be reviewed and approved by USFWS prior to placement of tortoises in captive enclosures and is effective for two years following approval date after which it must be reapproved by USFWS. Husbandry Plan submission and renewal requests should be provided to USFWS, allowing 30 days for review. USFWS will require access to the site for visits and inspections.

## **2.1 Regulations and Land Authorizations**

Proponents should coordinate with USFWS and related agencies early in the planning process to streamline regulatory actions and ensure all permits and authorizations are in place before placing tortoises in captive enclosures. Local, County, and State agencies or land managers, as well as public and private institutions, may require additional authorization prior to placing tortoises in captive enclosures. Additionally, Institutional Animal Care and Use Committee (IACUC) protocols and approvals should be included when applicable (ASIH 2004).

A 10(a)(1)(A) recovery permit (obtained through the USFWS's ePermits website; <http://fwsepermits.servicenow.com/fws>) will be required prior to placing tortoises in captive enclosures. This recovery permit will cover all activities for tortoises while in captivity. Husbandry Plans must specify details and include a copy of all documentation (*e.g.*, recovery permit and related biological opinion, incidental take permit, or authorization letter). Projects should coordinate early with USFWS to ensure recovery permits are issued prior to placing tortoises in captive enclosures.

## **2.2 Authorized Personnel**

All personnel involved with placing tortoises in captive environments and providing tortoise husbandry must be approved and listed as an authorized individual under the associated recovery permit prior to beginning work. Modifications to staff, contractors, and volunteers associated with the recovery permit can be made by requesting permit 'Authorized Individual' changes (include name, associated proponent (if applicable), and qualifications) via email to the USFWS Desert Tortoise Recovery Coordinator and documented within the Husbandry Plan. Recovery permit holders and authorized individuals will be held responsible for husbandry outcomes and tortoise survival.

## **3.0 Captive Enclosure Information**

### **3.1 Project Site/Resident Habitat Information**

Descriptions of the project site, habitat information for tortoises placed in captivity (if there is no associated project), and captive husbandry enclosures are required. Proponents should inquire early with USFWS to determine if USFWS approved captive husbandry enclosures are available for use in the area; however, opportunities may be limited. Proponents would be required to repair existing structures (*e.g.*, fences, cinder block including mortar, flashing, netting, access points) and ensure sufficient vegetative cover prior to placing animals in captive enclosures. Captive husbandry enclosures must be single species; they cannot house any vertebrate species other than the Mojave desert tortoise in the previous 12 months. Under no circumstances can any species, other than Mojave desert tortoise, be purposefully brought into the complex. Extenuating circumstances for injured or confiscated tortoises should be coordinated with the USFWS.

### **3.2 Location of Captive Enclosures**

The location of the project site and captive enclosures must be specified in the Husbandry Plan. If available, the address, city, county, and state for all related areas should be included in the Husbandry Plan. If an address is not available, Universe Transverse Mercator (UTM) coordinates (Map Datum NAD83) for the project site and captive husbandry complex location should be included. Additionally, a detailed map identifying the location of the captive enclosures relative to the project site, the perimeter fence, predator exclusion fencing, other enclosure locations, access locations (*e.g.*, gates), or other related details should be included (for additional information see 3.0 CAPTIVE ENCLOSURE INFORMATION and 4.0 CAPTIVE ENCLOSURE SECURITY AND PERIMETER FENCING sections). If new enclosure construction is required, enclosures must be included within the project footprint or as part of the disturbance area.

### **3.3 Construction Practices to Minimize Disturbance to Vegetation**

Sites where enclosures will be constructed should have native vegetation that will be minimally disturbed during construction and soil that is appropriate for tortoises to construct burrows.

### **3.4 Resident Tortoises**

Captive enclosures should be sited in locations that avoid confining or displacing resident tortoises. Resident tortoises found within the enclosure boundaries are animals affected by the project and require translocation following guidelines described in the most recent translocation guidance (USFWS 2020) in accordance with the biological opinion, incidental take permit, or coordination with the USFWS. All tortoises moved because of the project or found within the enclosure are considered project take and must be included as part of the proposed action for the project.

### **3.5 Final Disposition of Captive Enclosures**

Immediately following a proponent's use of the captive enclosures, the related infrastructure must be decommissioned or transferred to another proponent for later use. The proponent will be responsible for all associated costs to decommission the site. All structures and materials must be removed from the area. Access roads may require removal of asphalt, soil decompaction, and restoration with native plants. Additional habitat disturbance may necessitate landscape recontouring, further soil decompaction, and vegetation restoration with native plants. Following revegetation, plants should be monitored and cared for by regular watering until they become established. Invasive non-native vegetation must be removed and monitored. Should the captive husbandry complex remain in place for later use, all artificial tortoise burrows must be removed and disinfected (see 5.0 DISINFECTION AND SANITATION section) unless it is suspected that hatchlings may be present. If a gravid female occupied an enclosure or hatchlings are suspected, burrows should remain intact over winter. All materials (*e.g.*, dishes) must be removed from enclosures. Structures are to be adequately repaired and left ready for use (*e.g.*, perimeter fence, enclosures). Enclosures must be searched thoroughly for tortoises to ensure no tortoises, including juveniles or hatchlings, remain. Searches are to be repeated until no tortoises are found and then conducted again the following spring. All proponents must describe site decommissioning within the

Husbandry Plan and coordinate with USFWS to determine appropriate actions following project completion or transfer. Site decommissioning must be included as part of the proposed action for the project.

## **4.0 Captive Enclosure Security and Perimeter Fencing**

All captive enclosures housing tortoises must include enhanced security for both predators and humans. All proponents must include a detailed description of security measures and perimeter fencing within the Husbandry Plan. Adjustments in security and fencing may be approved in coordination with the USFWS.

### **4.1 Perimeter Fence Specifications**

A perimeter fence that is impermeable to tortoises (tortoise exclusion fencing), canids, felids, and humans is required around the entirety of the captive enclosure and should contain all enclosures housing tortoises. The perimeter fence may be constructed of chain-link and must be sufficiently high to prevent unauthorized human intrusion (generally 2.4 m (8 ft.) high). The fence may also be retrofitted with 2.5 x 5 cm (1 x 2 in.) tortoise exclusion fencing (USFWS 2005) along the bottom and buried into the ground at least 30 cm (12 in.) with the bottom flared outward to prevent digging by wildlife. Perimeter fencing materials (*e.g.*, galvanized metal) should be selected to increase longevity, reduce maintenance, and be resistant to degradation and corrosion. For captive husbandry complex security, the fence can be topped with two to three rows of barbed or razor wire (Figure 1). Tortoise enclosure access locations should be gated and secured with locks.

### **4.2 Additional Security Measures**

Additional security measures such as access road security and 24-hour staff at or near the complex may be required. Potential night security issues may require the installation of motion sensor cameras with night vision in key locations or areas prone to unauthorized access. Because artificial light can disturb wildlife, motion lights and security cameras with lights are not recommended outside of perimeter fencing.





Figure 1. Example perimeter and security fencing for Mojave desert tortoise captive enclosures. Perimeter fencing is buried in the ground at least 30 cm (1 ft.) with the bottom flared outward to reduce wildlife digging. (Left) Chain-link fencing roughly 2.4 m (8 ft.) high with razor wire or strands of barbed wire at the top for additional security. (Right) Tortoise exclusion fencing attached to the bottom of chain-link fencing. Photos courtesy of the Ivanpah Desert Tortoise Research Facility.

## 5.0 Disinfection and Sanitation

Because knowledge of tortoise health hazards is limited, there are possible significant disease risks that are unknown and unpredictable (Rideout 2015). Additionally, there can be a significant lag in the onset of clinical signs and physiological markers relative to time of infection, potentially obscuring diagnosis (Aiello *et al.* 2018; Drake *et al.* 2019). Extreme care must be taken to prevent the introduction or transmission of fomites or infectious agents (such as pathogenic bacteria, viruses, or fungi) that can transfer disease to tortoises in captivity and to likewise limit transfer from captive tortoises to populations outside husbandry facilities. Development of a rigorous disinfection and sanitation protocol must be included in each Husbandry Plan and implemented throughout the use of captive enclosures. The following guidelines have been adapted from USFWS 2019; adjustments may be approved as necessary by USFWS.

### 5.1 Personnel Exposed to Other Herpetofauna Species

Inadvertent exposure to pet tortoises or other species can increase the probability of novel pathogen introduction (Rideout 2015). All personnel working with or caring for captive herpetofauna in any context (*e.g.*, another workplace, at home) must declare this exposure and must follow one of the following options: 1) individual is not permitted into the complex or 2) individual entering complex is required to sanitize hands and wear clean clothes and shoes that have not been exposed to pet tortoises or other species of herpetofauna.

## **5.2 Entering Husbandry Complex**

All staff and visitors must be aware of and fully implement strict biosecurity measures to ensure that they do not aid in the unintended transmission of fomites and pathogens among tortoises.

## **5.3 Tortoise Handling**

To prevent the transfer of pathogens or infectious agents, disposable gloves (*e.g.*, latex, nitrile, KVP BetterGloves™) must be worn when handling tortoises, carcasses, or tortoise excretions. Disposable gloves must be changed and disposed of between enclosures. All items (*e.g.*, gloves, clothing, shoes, clipboards, equipment, phones, watch) touched by a tortoise or in contact with soil within captive enclosures must be sanitized. Contaminated gloves are to be removed prior to the disinfection process.

## **5.4 Sanitizing Skin, Clothing, and Shoes**

Skin must be sanitized between enclosures or tortoises within larger enclosures (> 4046 m<sup>2</sup> or 1 acre) if it comes into contact with a tortoise, tortoise excretions, or soil from enclosures. This commonly occurs when disposable gloves rip. Because organic debris can interfere with proper sanitation, rinsing the affected area with water prior to applying a sanitizing solution is most effective. Acceptable sanitizing solutions include soap with water or hospital grade ethyl alcohol hand wash with a minimum alcohol concentration of 60%. Alcohol hand washes should be rubbed vigorously into the skin to distribute the product appropriately and then allowed to air dry. Follow the manufacturers' recommended contact times for all sanitizing products.

Staff should prevent tortoises from coming into contact with clothing. All clothing that contacts a tortoise should be changed immediately or cleaned using an acceptable sanitizing solution (soap with water or hospital grade ethyl alcohol hand wash) or disinfectant. Clothing may be sanitized *in situ* by first removing organic debris, then applying the sanitizing solution. All personnel must strictly adhere to the manufacturers' directions and warnings.

All employees and guests are required to disinfect their shoes upon entering the facility and entering and exiting an enclosure. Organic matter should be removed first with a brush or a mat. It is particularly important to remove dirt and debris prior to disinfecting as organic matter may inactivate or reduce the effectiveness of some disinfectant solutions. Following the removal of organic matter from shoes, disinfectant spray or a footbath (*i.e.*, a mat that is filled with disinfectant) should be used. Ensure footbaths are regularly maintained and refilled to adequately moisten shoes. Disinfectant spray or footbaths must be appropriately located in the captive husbandry complex or carried to ensure proper disinfection of shoes upon entering and exiting each captive enclosure.

## **5.5 Disinfecting Equipment and Work Stations**

All equipment and work surfaces (if not natural ground) must be thoroughly cleaned and disinfected before and after use. Any item that comes into contact with a tortoise or is touched with a contaminated glove must be disinfected. Organic debris should be removed by brushing,

wiping, or rinsing with water. Disinfectant spray should be used to thoroughly moisten equipment and the work surface, allowing for the appropriate contact time, and air dried. Exposure to sunlight and heat improves the disinfection process; therefore, placing equipment in direct sunlight is recommended whenever possible.

### **5.6 Protective Containers for Tortoises**

Tortoises are to be soaked for rehydration or transported in well-ventilated protective containers. Disposable containers may be used; however, they are to be strictly single use. Reusable containers must be thoroughly cleaned before and after use, by first washing with water or soap and water to remove all organic matter. Following washing, reusable containers should be sprayed with an appropriate disinfectant (see below) to cover all interior surfaces and allowed to sit for the appropriate contact time. Containers should then be rinsed with water to remove any chemical residue and allowed to air dry, preferably in direct sunlight.

### **5.7 Disinfecting Tortoise Enclosures**

Tortoises must not be moved among enclosures or placed into an enclosure previously occupied by another tortoise without first disinfecting the enclosure and associated materials (*e.g.*, burrow, water dishes). Enclosures should be disinfected by removing all tortoises and scat, materials used for artificial burrows, and artificial items from the enclosure. Soil within and around burrows should be exposed to direct sunlight and raked to decompact soil and expedite drying. All soil associated with a burrow (natural or artificial) with visible moisture should be raked daily until dry. All burrows previously occupied by adult female tortoises should be carefully excavated to determine if nests and/or hatchlings are present. Once the burrow soil has dried and all associated materials have been removed, the enclosure must remain unoccupied for a minimum of five days without moisture from precipitation or irrigation. Any enclosures with observable moisture during this 5-day disinfection period must be exposed to direct sunlight for an additional 5 days and repeated as necessary. All porous or organic materials (*e.g.*, wood) artificially added to the enclosure should be disposed of after use and are considered strictly single use. All non-porous artificial materials (*e.g.*, PVC pipes, sealed water dishes) should be thoroughly cleaned within the enclosure when possible to remove all dirt and debris by brushing, wiping, and/or washing with water or soap, sprayed on all sides with disinfectant, and exposed to direct sunlight without rain or moisture for a minimum of 5 days (10 days for both sides). New artificial burrows may be constructed once the enclosure, burrow, and all reusable materials have been disinfected and have passed the 5-day sunlight exposure period without moisture.

Any enclosure with a tortoise classified as clinically abnormal or presenting with clinical signs of disease should be visited only at the end of the day or on days on which other tortoise enclosures will not be entered. Disinfection and sanitization protocols are to be followed rigorously, including for the last enclosure and tortoise of the day. Consult with USFWS prior to reusing the enclosure for a new tortoise if the previous tortoise was clinically abnormal or presented with clinical signs of disease.

## **5.8 Disinfectant(s) To Be Used, Preparation Instructions, Contact Time, Expiration**

Clothing, reusable aprons, shoes, footbaths, equipment, work surfaces (if not natural ground), reusable containers that hold tortoises, artificial burrows, dishes, and any other item that comes into contact with a tortoise, a tortoise enclosure, or a gloved hand must be disinfected or sanitized. Organic matter must be removed prior to disinfection or sanitization. Solutions should be made and stored according to the manufacturer's instructions and used following manufacturers' contact time recommendations. Unused disinfectants should not be exposed to direct sunlight or prolonged heat. Local and state regulations should be followed for transport and disposal of solutions, and they should be kept away from skin and out of eyes. While several products are available for disinfection and additional protocols may be approved by USFWS, currently accepted disinfectants, listed in order of preference, include:

### **Rescue™ Ready to Use**

This product is sold as a broad spectrum ready to use liquid disinfectant. The expiration date is listed on the bottle. Contact time (the amount of time a disinfectant needs to remain on a surface to be effective) is 1 minute. It is effective against viruses, bacteria (including *Mycoplasma spp.*), fungi, and tuberculoids. This product uses hydrogen peroxide as the active ingredient, breaking down into water and oxygen and reducing environmental impact. Note: The wipes and concentrated solution have different contact times and are not recommended in the desert environment.

### **Trifectant™**

This product is sold as a powder or tablet and a 1 - 2% solution should be prepared according to the instructions. The prepared solution is stable for seven days. Contact time is 5 - 10 minutes. It is effective against viruses, bacteria (including *Mycoplasma spp.*), and fungi. It has low toxicity and is biodegradable.

### **Chlorhexidine diacetate (e.g., Nolvasan™)**

This product is sold as liquid and should be prepared according to the instructions. The prepared solution can be stable for up to 1 year, provided it is stored correctly. Contact time is 10 minutes. It is effective against viruses, bacteria, and fungi. This product is highly toxic to aquatic organisms.

### **Bleach**

This product is no longer a preferred option as it is readily inactivated by sunlight and organic material. If used, additional care should be taken to thoroughly wash items and remove all organic material before use. It is sold as a liquid and a standard bleach solution should be prepared (1:20 dilution of 5% household bleach in water). The prepared solution is stable for 24 hours; therefore, it needs to be made daily. Contact time is at least 1 minute. This product requires good ventilation, and manufacturers' instructions should be followed carefully. Bleach should not be used within enclosures occupied by tortoises.

## **6.0 Tortoise Enclosures**

Tortoise enclosures must be approved by USFWS prior to transferring tortoises to captive environments. Proponents may need to coordinate with USFWS on enclosure assignments. Husbandry Plans should address native and invasive/non-native vegetation present in the enclosure. Changes to these guidelines may be appropriate in response to environmental conditions, tortoise welfare, or project goals as approved by USFWS.

### ***6.1 Enclosure Description***

A detailed description of captive tortoise enclosures (including protocols for associated construction, walkways, burrows, and shade structures) should be included in the Husbandry Plan. Along with housing tortoises individually (see exceptions below), enclosure construction will minimize the potential for disease transmission by allowing workers to access each enclosure without routinely entering. It is recommended that walkways be constructed between individual enclosures. Walkways should minimally be 1 m (3 ft.) wide, contained within the perimeter fence, and prevent unauthorized access at points of entry or exit (Figure 2). Barriers between enclosures are required to use materials and construction necessary to avoid tortoise contact.



Figure 2. Examples of walkways between Mojave desert tortoise enclosures and secure points of entry or egress. Walkways are at least 1 m (3 ft.) wide and allow access to each enclosure without entering. Walkways lead to secure access points that are predator-proof. Photos courtesy of Ecocentric and the Ivanpah Desert Tortoise Research Facility.

## **6.2 Construction by Tortoise Size**

Enclosures for adult and juvenile tortoises will likely differ. All tortoises must be measured for midline carapace length (MCL) from the longest anterior and posterior points on the carapace and recorded in millimeters (mm) prior to arriving at a husbandry complex. Tortoises with a MCL of at least 180 mm are considered adults. Regardless of size class, each enclosure must be within the captive husbandry complex perimeter fence, be predator-proof, and have appropriately sized

burrows for the assigned tortoise occupants. Each enclosure must allow for tortoises to thermoregulate and contain areas of shade, including native vegetation.

The probability of disease transmission increases with proximity to an infected individual and interaction time (Aiello *et al.* 2016). To minimize this risk, each adult tortoise must be housed individually in enclosures that prevent tortoises from contacting one another. Because the optimal environment for tortoises in captivity is their natural environment (Johnson *et al.* 2001), adult tortoises must be housed outdoors in escape-proof enclosures that are minimally 25 m<sup>2</sup> (269 ft.<sup>2</sup>; Figure 3). Escape-proof enclosures may be constructed using tortoise exclusion fencing (2.5 by 5 cm and 91 cm wide (1 in. by 2 in. and 36 in. wide) fence material), or other durable materials that resist desert environments, alkaline and acidic soils, wind, and erosion (USFWS 2009). Materials selected for enclosures may differ from tortoise exclusion fencing and should be specified in the Husbandry Plan along with construction details. Enclosures may be constructed by digging or cutting a trench with a blade on heavy equipment to allow 30 cm (12 in.) of enclosure material to be buried below the natural ground level. Enclosure height should be 61 cm (24 in.) above the natural level of the ground to prevent tortoises from climbing out. Special construction and engineering may be required to safely house tortoises temporarily within landscapes that preclude digging or are prone to washouts. All details of the enclosure design and construction techniques should be comprehensively documented in the Husbandry Plan to ensure safety and efficacy.



Figure 3. Enclosure examples for adult Mojave desert tortoises. Both example enclosures were constructed using tortoise exclusion fencing (2.5 by 5 cm and 91 cm wide (1 by 2 and 36 in. wide) buried in the ground at least 30 cm (1 ft.) with the bottom flared outward to reduce wildlife digging. The enclosures also contain artificial burrows and native vegetation. Photos courtesy of Ecocentric.

Tortoises <180 mm MCL must be housed individually unless housing as a cohort has been approved by USFWS. Tortoises housed as a cohort will be evaluated for translocation eligibility as a cohort; a single tortoise's health issues can disqualify its entire cohort. Small tortoises (<125 mm MCL) are to be housed outdoors in escape-proof enclosures that are minimally 1 m<sup>2</sup> (11 ft.<sup>2</sup>), although enclosure area may vary with tortoise size. Extra care must be taken to ensure that all

parts of each enclosure used for smaller tortoises are predator-proof. Enclosures are required to be covered and design may include a large walk-in enclosure with multiple pens inside (Figure 4). A combination of materials may be used, such as chain-link fence to create a walk-in enclosure, tortoise exclusion fencing along the bottom of walls, rodent-proof flashing, and a net cover. Enclosure material must be buried as described above. Note that walk-in enclosures have been constructed at USFWS approved head-starting and research facilities, and those captive husbandry complexes may be able to provide example designs and protocols.



Figure 4. Example hatchling/juvenile Mojave desert tortoise enclosures. All examples were constructed as walk-in enclosures using rodent-proof flashing and covered with predator-proof netting. The enclosures also contain artificial burrows and native vegetation. Photos courtesy of Ecocentric and the Ivanpah Desert Tortoise Research Facility.



### 6.3 Enclosure Labels

All enclosures must be visibly labeled to alert personnel if an enclosure is occupied without entering (Figure 5). Additionally, all tortoises must be assigned a unique identification number (ID) provided by USFWS (USFWS 2020) if not previously marked.



Figure 5. Examples of enclosure labeling schemes to identify occupied pens. Labels were placed in a visible location outside the enclosure and labelled with pen number and tortoise ID number(s). (Left) Tag clipped to enclosure fencing. (Right) Tile attached to a brick. Photos courtesy of Ecocentric and Turtle Survival Alliance.

### 6.4 Multiple Projects or Adjacent Complexes

Should multiple projects use the same captive husbandry complex or multiple complexes be directly adjacent to one another, a barrier must separate tortoises from different projects. Barriers can take the form of space between enclosures (at least 1 m (3 ft.) apart) or a set of enclosures that are left empty. Barriers must be conspicuous to alert personnel that there are multiple projects that use the same complex or multiple complexes that are directly adjacent. This can be accomplished by constructing visibly wider walkways or labeling captive husbandry complex areas using an obvious marking system, such as assigning different colors to tortoise enclosures. Additionally, effective communication and coordination among all project personnel working at the facility is required.

### 6.5 Predator-Proofing by Tortoise Size

Rates of depredation on tortoises can increase with proximity to human populations, at low elevations, and for smaller tortoises (Esque *et al.* 2010). Captive enclosures must be constructed to exclude predators. Proper construction of the perimeter fence is essential. Enclosures must also be predator-proof and routinely monitored to ensure the safety of all tortoises held in captivity.

Predator considerations differ by tortoise size class. Because tortoises <125 mm MCL are at greater risk of predation, they must be housed in enclosures that are inaccessible to animals, including ravens, ground squirrels, and other small mammals. All parts of the enclosure must be

predator-proof against potential predators that can squeeze through fencing. Note that fencing smaller than 1.3 cm (0.5 in.) should not be used as it can create too much uniform shade, blocking sunlight. It may also result in small animals (*e.g.*, lizards, snakes, rabbits) getting stuck in the fence and attracting predators. Tortoises <125 mm MCL must be housed in covered pens; netting over enclosures or walk-in structures may be used (Figure 4). Metal flashing can be used to keep rodents from climbing into enclosures (Figure 6). When applied to the bottom of an enclosure, rodent-proof flashing should be buried per the above specifications. Carefully consider enclosure design and construction to ensure that access points are completely predator-proof when they are in the closed position. See 7.5 ANTS AND ECTOPARASITES section for additional information.



Figure 6. Examples of predator-proof enclosures for Mojave desert tortoises. (Left) Rodent-proof flashing attached to the bottom of a chain-link fence walk-in enclosure. (Middle) Secure access door to a walk-in enclosure with rodent-proof flashing bordering the door and predator-proof netting above the structure. (Right) Predator-proof netting over a walk-in enclosure. Photos courtesy of the Ivanpah Desert Tortoise Research Facility.

### **6.6 Burrows by Tortoise Size**

Burrows provide essential protection for tortoises from extreme environments and allow proper thermoregulation (Bury 1982; Germano *et al.* 1994; Spotilla *et al.* 2014; Sah *et al.* 2016). At least one artificial burrow is to be provided in each enclosure to fit each individual tortoise to ensure optimal environmental refugia. For juveniles, care must be taken to ensure artificial burrow's size is updated as the tortoise grows. The recommended burrow height is 3 - 5 cm (1 - 2 in.) taller than the highest point along the tortoise's shell to accommodate movement. The recommended burrow width is 5 - 8 cm (2 - 3 in.) larger than the MCL of the tortoise to ensure that the animal does not become stuck should it turn around in the burrow. Artificial burrows that are greater than 10 cm (4 in.) larger than the tortoise (MCL or height) should not be used, as the extra space may reduce the chamber humidity, which could increase shell abnormalities (Wiesner and Iben 2003). The increased airflow may also be detrimental in extreme temperatures. Tortoises with special needs, such as those with missing limbs or conditions that impair movement, may be more

likely to become stuck in what would normally be considered a properly sized burrow and may require different accommodations. Discuss any such individuals with USFWS.

Artificial burrows can be created out of PVC pipe or other materials (lighter colors preferred) upon approval by USFWS (Figure 7). To create a burrow from PVC pipe, cut the material in half lengthwise, using the half pipe as the burrow top. To construct a burrow, dig a trench downward at a 15 - 25° angle that is appropriately wide and long to fit the artificial burrow material. An adult tortoise artificial burrow should be approximately 2 m (6 - 7 ft.) long and dug to a depth of at least 61 cm (24 in.) at the chamber end. Juvenile burrows should be around 1 m (3 - 4 ft.) long. Do not place or leave any wood, tile, or other material at the back of a burrow and allow appropriate soil for tortoises to modify the back of the burrows. Lay the PVC half pipe in the trench to form the burrow top with the front end of the pipe resting 10 - 15 cm (4 - 6 in.) higher than the ground. It is important to raise the burrow entrance to redirect water flow and avoid flooding during rain events. You may need to add dirt to the mouth to fit the burrow. Cover the entire length of the artificial burrow with at least 30 cm (12 in.) of dirt. Once covered, it is optional to line the outer sides of the artificial burrow with cobble or small rocks (less than 8 cm (3 in.) in diameter) to help keep the dirt in place. However, for hatchling burrows do not use rocks; gravel is optional. Moisten the dirt daily for three to four days to promote compaction. It is essential that the artificial burrow remains completely covered with dirt at all times to provide adequate protection. Tortoises that have no option but to use a poorly constructed burrow are at a high risk for mortality.



Figure 7. Examples of artificial Mojave desert tortoise burrows. Example burrows were constructed using PVC pipe that was cut in half lengthwise and fit in a trench dug into the soil at a 15 - 25° angle. Although difficult to see, the burrow aprons are mounded to redirect water flow and avoid flooding. The entire length of each artificial burrow is completely covered with at least 30 cm (12 in.) of dirt. Photos courtesy of Ecocentric and the Ivanpah Desert Tortoise Research Facility.

Following burrow construction, ensure the entire path is clear of debris and ready for tortoise occupancy. Prior to placing a tortoise in the enclosure, check the temperature in the burrow chamber during the coolest and hottest parts of the day every four days for two weeks. Temperatures may be recorded using a thermometer placed far back into the burrow or a

thermometer gun that can measure the surface temperature of inaccessible areas, such as the back of a burrow. To be safely within tolerable limits for tortoises, the temperature should regularly fall within the range of 15 - 30°C (59 - 85°F); however, burrow temperatures as low as 7°C (45°F) in the winter or as high as 32°C (90°F) in the summer are likely acceptable for short periods.

### **6.7 Soil Conditions and Native Vegetation**

Soil conditions within enclosures should be appropriate for tortoises to dig their own burrows. Digging a burrow requires soils that allow excavation by animals without collapse (Anderson *et al.* 2000). The presence of native perennial vegetation that reinforces soil structure can provide favorable sites for natural burrow construction (Bury 1982). Additionally, tortoises prefer areas with perennial vegetation (Nussear and Tuberville 2014; Hromada *et al.* 2020).

Native vegetation can provide benefits in addition to shade and burrow construction, including serving as a food source for tortoises in captivity. Native plants such as creosote bush (*Larrea tridentata*), bursage (*Ambrosia dumosa*), yuccas (*Yucca spp.*), ephedra (*Ephedra spp.*), indigo bush (*Psoralea argophylla*), and wolfberry (*Lycium andersonii*) can provide thermoregulatory refugia for tortoises. Plants like globemallow (*Sphaeralcea spp.*), four-o'clock (*Mirabilis spp.*), milkvetch (*Astragalus spp.*), primrose (*Eremothera spp.*), and plantain (*Plantago spp.*) serve as common food sources (Germano *et al.* 1994; Jennings and Berry 2015; Esque *et al.* 2021).

Ideally, the site where enclosures are constructed should have sufficient native vegetation. Native vegetation can be difficult to establish (Lovich and Bainbridge 1999; Abella 2010); therefore, it is best to avoid disturbing native plants when possible. If native perennial plants are required for enclosures, contact local commercial nurseries, a U.S. Forest Service nursery, the Bureau of Land Management (BLM) (plant salvage), or plan ahead for native plant sales (e.g., Mojave Desert Land Trust in Joshua Tree, California, and Springs Preserve in Las Vegas, Nevada).

### **6.8 Watering Native Vegetation**

Pens with native vegetation should receive water monthly if precipitation is limited. A drip irrigation system that leads to every enclosure, a row of sprinklers, or hand watering of plants may be used. The flow of water should point towards the downward slope of each enclosure to avoid flooding burrows should the irrigation system malfunction. The irrigation system must be checked weekly to ensure it is functioning properly. Irrigation systems can be operated from a water line or with generators and pumps. If the irrigation system is shut off, blow out all water lines to prevent breakage which can flood burrows. Procedures for watering, along with frequency, should be included in the Husbandry Plan.

### **6.9 Invasive/Non-Native Plant Removal**

Disturbance can promote the establishment of invasive non-native plant species (Berry *et al.* 2014; Drake *et al.* 2015), which can facilitate the spread of fire across desert landscapes with detrimental ecological consequences (Esque *et al.* 2003; Darst *et al.* 2013). Invasive grasses have also been found to negatively affect overall health and survivorship in juvenile tortoises (Drake *et al.* 2016).

During routine monitoring, vegetation should be checked. Personnel working at the captive husbandry complex should be familiar with common invasive non-native species, especially the Mediterranean grasses (*Bromus spp.* and *Schismus spp.*). Catching an invasion early and acting quickly to remove non-native vegetation can prevent establishment (Berry *et al.* 2014). Planting and caring for native vegetation can also aid in reducing invasive plant species.

### **6.10 Shade and Shade Structures**

Each enclosure must provide areas of sun and shade sufficient to cover the entire tortoise outside a burrow. Ideally, shade above or near the burrow entrance will be supplied by native perennial vegetation or a shade structure. Established native perennials can provide additional areas of temporary shade within enclosures but may not eliminate the need to install artificial shade structures. Temporary shade structures may include shade cloth or other lightweight materials (Figure 8). Shade structures must be lightweight to avoid harming captive tortoises should they become unsecured or fall.

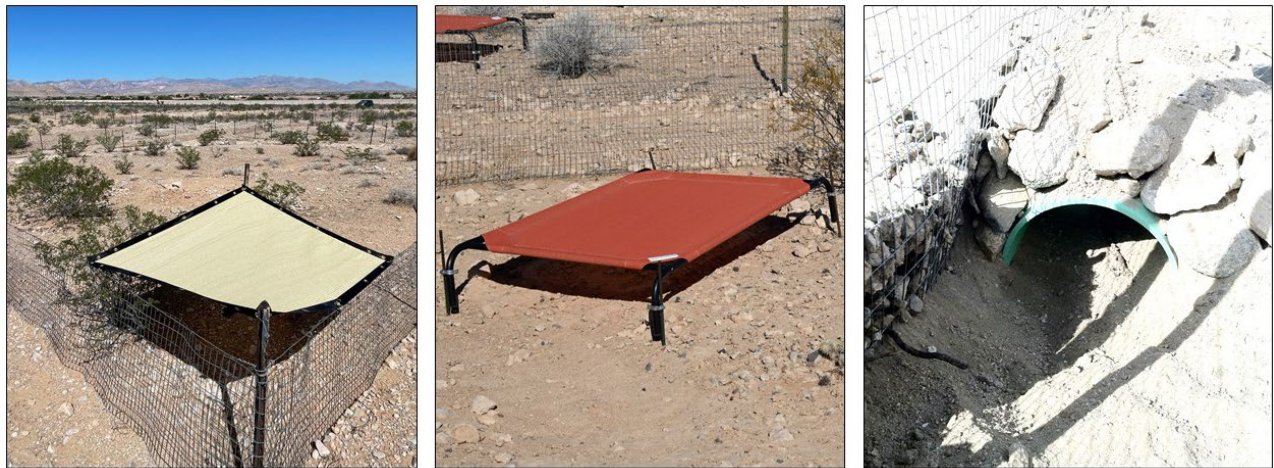


Figure 8. Examples of artificial shade structures in Mojave desert tortoise enclosures. (Left) Securely fastened shade cloth attached to tortoise exclusion fencing to provide temporary shade. (Middle) Dog beds firmly staked into the ground using U-stakes through holes drilled in each leg of the dog bed to create temporary shade. (Right) PVC pipe that was cut in half lengthwise, placed in a shallow trench along a fence-line, and covered with dirt to provide an area of temporary shade. Photos courtesy of Ecocentric..

## **7.0 Tortoise Care**

All husbandry activities are to be performed by qualified staff identified in the Husbandry Plan (see 2.0 HUSBANDRY PLAN GUIDELINES section) and approved by USFWS. Tortoise handling should be minimized as much as possible to prevent unintentional disease transmission or possible habituation. Adjustments to the protocols for tortoise care may be approved by USFWS.

## **7.1 Veterinary Services**

Make arrangements in advance with a veterinarian that has experience providing care for desert tortoises in case an emergency occurs. Most veterinarians do not have desert tortoise experience. A local tortoise rescue organization or the Association of Reptilian and Amphibian Veterinarians ([www.arav.org](http://www.arav.org)) may be able to assist in finding the nearest qualified veterinarian.

Tortoises that are grossly emaciated, showing severe clinical signs, or otherwise in ill health will require coordination with USFWS to determine appropriate actions. Include details for identified veterinary care including the name of the veterinarian and/or clinic, phone number, address, directions, and distance (in miles) from the captive husbandry complex in the Husbandry Plan. Transportation procedures, including the use and location of well-ventilated protective containers, should also be defined. Proponents are to review the veterinary information annually to confirm it is current and update internal documents if a new veterinarian is needed.

## **7.2 Feeding**

Individual susceptibility to disease can be heightened by stress and inadequate nutrition (Rideout 2015). It is therefore important for tortoises held in captivity to be properly fed. It is important to provide a varied diet with multiple items. Native vegetation known to be part of their natural diet is the best thing to offer when available. Some non-native food items such as wheat grass, kale, collards, mulberry leaves, dandelion greens, and romaine lettuce can be used as nutrition sources for desert tortoises. In addition, tortoise feeding regimes may include dried grasses (*e.g.*, weed-free Timothy hay). A small amount of Timothy hay should be available daily in the enclosure during the active season. Remove old hay and replace it with fresh hay weekly. The finer, leafier portions should be provided to juvenile and sub-adult tortoises. When native vegetation is not sufficiently available, tortoises should be fed a commercially available diet formulated for tortoises (*e.g.*, Mazuri Tortoise Diet 5E5L™; hereafter Mazuri) mixed with other native food items or commercial greens (*e.g.*, dandelion). Mazuri is a pelleted food that needs to be softened in water prior to feeding, as feeding pellets may not be optimal for herbivorous tortoises (Thompson 2016). Additionally, soaking the pellets can make them more appealing to tortoises (Mazuri Exotic Animal Nutrition 2023). Add water until it just reaches the top of the pellets and allow for a 5-minute soaking period. Overwatering will result in a loss of water-soluble nutrients and occurs when excess water can be poured from the food after the 5-minute soaking period. Use a gloved hand to mix the pelleted food, then add organic produce.

When feeding tortoises, avoid entering enclosures. An appropriate system of walkways will allow personnel to stay outside of enclosures for routine tasks (see 6.0 TORTOISE ENCLOSURES section). Mazuri Tortoise Diet and Timothy hay should be placed in different locations near the perimeter of the enclosure. Timothy hay may be placed in more than one location, especially if the enclosure is large. It's best to place food items on non-porous surfaces (*e.g.*, tiles or glazed dishes). This approach not only mimics their natural eating habitats, but also reduces the ingestion of excess soil. Remove Mazuri Tortoise Diet left behind from the last feeding; Timothy hay can remain in place for one week, then should be replaced with fresh hay. It is important to note whether a

tortoise is consistently not seen or whether food is frequently not eaten (see 8.0 MONITORING AND REPORTING section).

Native vegetation and non-native food items (including Mazuri Tortoise Diet) should be offered twice weekly from the time tortoises emerge from hibernation until the end of September. Feed tortoises during hours of expected activity, usually in the morning. In summer, workers will likely need to start feeding just before sunrise, with slightly later feeding times in spring and fall. Because it can take weeks for tortoises to digest and pass food (Tracy *et al.* 2006), stop feeding produce, non-native vegetation, and Mazuri Tortoise Diet at the end of September even if temperatures are relatively warm and tortoises are active.

### **7.3 Providing Water**

Drought can negatively affect tortoise health and survival (Turner *et al.* 1984; Longshore *et al.* 2003; Lovich *et al.* 2023). Providing regularly available water may improve tortoise condition and aid in digestion, especially for individuals confined to enclosures (Nagy *et al.* 2015; Tuberville *et al.* 2019). Water availability has also been linked to improved egg production in female desert tortoises (Mitchell *et al.* 2021). Spraying enclosures with water to mimic rain during scheduled feeding and watering events may stimulate tortoises to emerge from burrows to seek available resources.

Tortoises held in captivity are to be provided water in a large shallow non-porous tile, ceramic, or durable plastic dish. Shallow dishes are required to ensure smaller tortoises cannot flip over and drown. In each enclosure, sink a dish into the ground and ensure that it is level. Small pebbles or stones may be placed into the water dish to keep it in place, allow insects to escape, and provide tortoises with traction if they enter the dish. Water should be provided on a weekly basis and allowed to dry between refilling. If ants become a problem, the water dish should be moved to a new location.

### **7.4 Tortoise Egg Discovery**

Generally, tortoises lay eggs from late April to mid-July and may produce more than one clutch a year (Turner *et al.* 1984; Baxter *et al.* 2008; Mitchell *et al.* 2021). Tortoises tend to lay their eggs 60 - 70 cm (24 - 28 in.) down the burrow at a soil depth of 8 - 10 cm (3 - 4 in.; Turner *et al.* 1986; Baxter *et al.* 2008) or in locations suitable for nesting. Because female tortoises become sexually mature around 190 mm MCL (Medica *et al.* 2012) and can store sperm for multiple years (Palmer *et al.* 1998; Murphy *et al.* 2007), tortoise eggs may be discovered in individual enclosures. Depending on research needs, some projects may request radiographs or ultrasounds of adult female tortoises to evaluate gravidity from 15 April through 15 July. The Husbandry Plan should include a protocol for egg discovery and related x-radiography and ultrasound procedures as applicable.

All gravid females, tortoise egg discoveries, and related details will be reported to USFWS within 24 hours via email and included in the summary and annual reports. USFWS will advise on appropriate actions. Eggs may be left in place, incubated on site, or transferred to another location

for incubation. Proponents should expect to pay associated costs. Take a photograph of the eggs in their environmental context. Record the project name and captive husbandry complex information along with the date, time, location (pen number), ID number of the tortoise occupying (or that last occupied) the enclosure, and any other pertinent information.

Until USFWS provides direction, ensure eggs are safe in their existing location. This may require moving a tortoise from an enclosure (see 5.0 DISINFECTION AND SANITATION section) if it is safe for the animal. Do not disturb animals during hibernation or if the temperature is 35°C (95°F) or higher unless the tortoise is in imminent danger. If eggs are to be moved, personnel with experience and authorization are needed. Eggs are to be moved into a clean, dry, durable container that contains dirt from the egg location. Handle eggs minimally to ensure best incubation and hatching success. Place eggs carefully on dirt in the specific orientation of discovery. Eggs should be incubated at or near known pivotal temperatures for temperature-dependent sex determination outcomes (30.5 - 32.5°C; Rostal and Wibbels 2014).

### **7.5 Ants and Ectoparasites**

Ants can harm tortoises (Jacobson 1994) and have been documented to cause trauma to, and possibly even mortality of, juvenile tortoises in captivity (Nagy and Hillard 2013; Mack *et al.* 2018). If there is evidence of ants in enclosures, address the issue immediately before an incident occurs that may harm a tortoise. Look for ant trails to or from the enclosure and especially around resources such as water and food that may attract ants. To combat any issues, check under water dishes for ants or ant nests during routine cleaning. If ants or their nests are found under a dish, relocate the dish to a different area. Regularly inspect areas where food is typically left and promptly remove any old food. If ants are repeatedly found on food, consistently change the feeding location to prevent further issues. If needed, ant bait may be approved for use outside enclosures following USFWS recommendations and land management guidance. Select a product with low toxicity for vertebrates to reduce environmental impact and do not allow tortoises to come into contact with or ingest the product (*e.g.*, bricks impassible to tortoises may be used to house ant bait). Pesticides to prevent and mitigate against ants may be deployed in the enclosure in coordination with USFWS and in accordance with a Pesticide Use Permit if applicable.

Soft ticks (*Ornithodoros spp.*) naturally occur on desert tortoises (Jacobson 1994) and throughout tortoise habitats. They survive in burrows (Berry and Christopher 2001; Bechtel *et al.* 2021; Bechtel 2022) and are often found on tortoise skin or in the seam margins between scutes (Greene *et al.* 1986). Ticks are more likely to be present on captive tortoises and can become problematic when animals are confined to small areas (Bechtel 2022). Check for ticks during routine monitoring of tortoises, enclosures, and burrows. When ticks are seen, remove them by hand or with tweezers that are disinfected before coming into contact with the tortoise. Always wear gloves. Following USFWS health assessment guidelines, collect up to 20 ticks in a 1 - 2.0 ml O-ring cryovial labeled "Ticks" and store in freezer. All remaining ticks are to be removed and disposed of in ethanol (USFWS 2019). If an enclosure becomes infested with ticks (ticks are repeatedly seen on a tortoise or within an enclosure), the tortoise may need to be moved. Communication and coordination with USFWS is essential. If a tortoise is moved from an enclosure because of ticks,



remove all ticks from the animal prior to placing it in a new location. Remove and disinfect the burrow and any other items in the enclosure. Rake the area where the burrow sat. Once dry, begin the 5-day sunlight exposure period (see 5.0 DISINFECTION AND SANITATION section); however, should ticks persist in an enclosure, it may need to remain empty.

## 8.0 Monitoring and Reporting

### 8.1 Monitoring and Reporting Protocol

All tortoises held in captivity, their burrows, shade structures, enclosures, and any irrigation systems need to be examined consistently throughout the year, not just during the tortoise active season. Rigorous monitoring will document the effectiveness of temporary care of tortoises while improving measures to minimize negative impacts. Include a monitoring schedule for tortoises, enclosures, burrows, shade structures, vegetation, irrigation (if applicable), and the perimeter fence in the Husbandry Plan. The date and time of inspection should always be recorded. Table 1 shows an example monitoring schedule. More frequent monitoring may be required under certain circumstances and adjustments will be approved by USFWS as appropriate.

Table 1. Example monitoring schedule for Mojave desert tortoises and enclosures. \*Enclosures should be monitored within 24 hours of significant rain events or unexpected disturbances.

Monitor	Frequency	Action
Tortoises	Initial adjustment period: Daily Active season: 2 times a week Hibernation: 1 time a week	Evaluate behavior and activity
Enclosures	1 time a week Rain event * Unexpected disturbance*	Evaluate condition, repair immediately
Burrows	1 time a week Rain event* Unexpected disturbance*	Evaluate condition, repair immediately
Shade structures	1 time a week Rain event* Unexpected disturbance*	Evaluate condition, repair immediately

Vegetation	1 time a week	Evaluate condition, modify as needed
Irrigation	1 time a week	Evaluate condition, repair immediately
Perimeter Fence	1 time a week Rain event Unexpected disturbance	Evaluate condition, repair immediately

Keep detailed monitoring records on a standardized form and specify how data will be recorded in the Husbandry Plan. All collated records must be maintained and provided to USFWS by May 1<sup>st</sup> and December 1<sup>st</sup> each year. Annual Reports (Annual Summary Reports and Comprehensive Reports) are to be prepared and submitted to USFWS per recovery permit requirements (by January 31<sup>st</sup>). Reports should provide an overview of completed activities related to tortoises, enclosures, and perimeter fence monitoring. They also are to document events or incidents that occurred with tortoises (*i.e.*, injury, illness, mortality, predation, and parasitism), enclosures (*i.e.*, pens, burrows, shade structures, vegetation, and irrigation), and the perimeter fence. Tortoise injury and mortality require reporting within 24 hours to USFWS (see 8.2.2 Injured and Ill Tortoises and 8.2.3 Tortoise Mortality sections below). Identification numbers (assigned by USFWS) for tortoises and their enclosures are to be provided to USFWS. See APPENDIX 2: TORTOISE CHECK TEMPLATE and APPENDIX 3: ENCLOSURE CHECK TEMPLATE. Note that these templates may be adapted as necessary.

## **8.2 Tortoise Monitoring and Reporting**

Translocated tortoises use burrows less frequently and spend more time above ground, increasing their risk of thermal stress (Brand *et al.* 2016; Sah *et al.* 2016). Newly moved animals are likely to exhibit increased movement patterns and may pace physical barriers (Ruby *et al.* 1994; Farnsworth *et al.* 2015; Hinderle *et al.* 2015; Hromada *et al.* 2020), such as enclosure boundaries. Check on tortoises daily for at least 14 consecutive days following their transfer to captivity. If necessary, make multiple rounds at each enclosure to obtain a daily visual and ensure each tortoise is safe. Monitoring should occur at variable times including early in the morning (when tortoises are likely to be active), during the hottest part of the day in warm months, and during the coldest part of the day in cool months. Take care to ensure that tortoises that are not behaving irregularly or improperly thermoregulating. If normal behavior is not observed during this period, continue daily monitoring on a week-by-week basis until normal behavior is observed for at least three consecutive days. If normal behavior is observed for at least three consecutive days, monitoring may be reduced.

From spring emergence through winter hibernation, monitoring may occur two times a week, at a minimum (with 3 - 4 days between observations). It is important to obtain a visual on every tortoise weekly. During the winter months, check each tortoise once a week without disturbing hibernation unless the animal is sick or distressed. Record whether the tortoise was observed and its activity (*e.g.*, basking, pacing, eating). Unusual activity or appearance should be recorded during routine checks. When possible, without handling the tortoise, verify that the tortoise identification correctly matches the enclosure assignment. For tortoises in burrows, record which direction they are facing (*i.e.*, head out, head in, or sideways) so that tortoises without changes in position can be further investigated for wellness.

If a tortoise is in distress or requires veterinary attention, immediate care should be provided (see the 7.1 VETERINARY SERVICES section). During hibernation, do not remove a tortoise from a burrow unless it is sick, in distress, or believed to be dead. During the active season, if a tortoise has not moved from a burrow in four consecutive checks or two weeks, investigate to determine whether the tortoise is in danger or stuck in the burrow. Spraying the enclosure with water to mimic rain may stimulate the tortoise to emerge. If they do not emerge, coax, or gently pull the tortoise from the burrow to assess their condition. Tortoise handling is not to occur at temperatures of 35°C (95°F) or higher unless an animal is in mortal danger. A tortoise not observed eating or drinking for 30 days during the active season should receive a health assessment without sample collection by experienced personnel to determine if medical attention is needed (see USFWS 2019 for details). If a tortoise cannot be found after using a burrow scope on all burrows and conducting a thorough search of the enclosure, carefully excavate the burrows until the tortoise is located (see 8.3.1 BURROWS MONITORING and 8.3.2 SHADE STRUCTURE MONITORING sections).

### **8.2.1 Health Assessment Schedule**

At a minimum, tortoises should receive health assessments twice a year (spring and fall), once with a full assessment of clinical health (USFWS 2019) and once without sample collection, or as agreed upon by USFWS. Additionally, a full health assessment will be conducted on each tortoise prior to placement in captive enclosures. Collection of tissues (oral swabs, blood) and related laboratory analysis may be required to evaluate the presence of targeted pathogens and immune responses. Proponents should expect to pay all associated costs including expenses associated with archiving biological samples and maintaining the sample bank (see USFWS 2019; USFWS 2020). A schedule for health assessments should be included in the Husbandry Plan. Collated health data (including datasheets) will be provided to USFWS by May 1<sup>st</sup> and December 1<sup>st</sup> each year and included within all Annual Reports (provided by January 31<sup>st</sup>).

### **8.2.2 Injured and Ill Tortoises**

If a tortoise appears ill or injured and requires medical care, immediately remove it from the enclosure, place it in a well-ventilated protective container, maintain the temperature at approximately 26 - 29°C (80 - 85°F), and seek veterinary attention (see the 7.1 VETERINARY SERVICES section). Details related to tortoise illness or injury should be reported to USFWS within 24 hours via email and included in the summary and annual reports.

If a tortoise appears dehydrated (eyes sunken) or there is concern of overheating (increased salivation), soak it in a container containing a shallow amount of tepid water for 30 minutes. The water level should be just below the tortoise's chin. If the tortoise's condition improves and outside temperatures are between 18 - 30°C (65 - 85°F) and remain in that range for at least three days, return the tortoise to its enclosure and monitor it daily for the next two weeks. If the tortoise does not appear or behave normally within 24 hours of soaking it, seek veterinary care and contact USFWS within 24 hours via email.

If a tortoise requires short-term indoor housing or if outdoor temperatures are suboptimal, maintain the tortoise indoors in a temperature-controlled environment until their condition improves and outdoor temperatures are appropriate. This period is not to exceed two weeks without permission from USFWS. Indoor enclosures must be clean and appropriately sized for tortoises to move freely (Figure 8). Indoor enclosures must prevent contact between tortoises and be appropriately sanitized prior to use to prevent disease transmission (see 5.0 DISINFECTION AND SANITATION section). Generally, soil from the tortoise's enclosure should be used as a substrate. Animals must be able to appropriately thermoregulate in enclosures. Provide heat (~within 2°C of outdoor daily average temperatures), visible light, and ultraviolet light (UVA and UVB) using a mercury halide light in a ceramic fixture on a timer to approximate the natural photoperiod (*e.g.* ZooMed 160-watt PowerSun UV lamp) if tortoises are indoors and not allowed to hibernate, feed and water them weekly. Tortoises should be soaked weekly using tepid water for 15 - 30 minutes during the active season (McGovern *et al.* 2020). Because humidity is relatively stable and high in tortoise burrows and can affect evaporative water loss, body mass (Wilson *et al.* 2001; Bulova 2002), and shell growth (Wiesner and Iben 2003), it is important to provide a shelter with increased humidity for indoor burrowing and overwintering. A humid shelter can be made for juvenile tortoises by cutting a burrow shaped entrance into a dark plastic tote large enough to contain the animal. The bottom of the shelter should be lined with peat moss about 4 cm (1.5 in.) deep, moistened with water every 3 – 4 days, and replaced every two weeks (McGovern *et al.* 2020). To moisten the peat moss, use a spray bottle or watering can and knead the substrate with a gloved hand to uniformly distribute the water. Change gloves between enclosures. Avoid water contact with electrical outlets or light bulbs to prevent hazards.



Figure 8. Example of indoor enclosures for temporarily housing Mojave desert tortoises. Tortoises are to be maintained in a temperature-controlled environment in enclosures that prevent contact between individuals/cohorts and are appropriately sanitized to prevent the transmission of disease. Soil from the tortoise's enclosure should be used for substrate. Enclosures must allow animals to appropriately thermoregulate and provide heat, visible light, and ultraviolet light. In this example, the enclosures are 189 L (50-gallon) Rubbermaid™ tanks, hide shelters are PVC pipe that has been cut in half lengthwise, and humid shelters are 11 L (3-gallon) Rubbermaid™ Roughneck tote boxes that have been cut on one side to allow access and lined with moist peat moss. Photos courtesy of the Ivanpah Desert Tortoise Research Facility.

### **8.2.3 Tortoise Mortality**

If a tortoise mortality occurs, notify the USFWS Desert Tortoise Recovery Coordinator by phone or email within 24 hours. Within three working days, detailed information of the tortoise (identification number, sex, carapace length), mortality event, environmental conditions, and suggested adaptive management must be emailed to the Desert Tortoise Recovery Coordinator, pertinent USFWS staff, and appropriate agencies (also review reporting requirements within associated 10(a)(1)(A) recovery permit). Disclosures must include the date, time, project name, enclosure number, tortoise identification, carcass location, photographs, cause of death (if suspected or known), and other pertinent information. See APPENDIX 4: TORTOISE MORTALITY TEMPLATE. All tortoise mortalities and related details should be included in the summary and annual reports.

Upon finding a dead tortoise, take a minimum of three photographs: (1) before moving the carcass in the environmental context, including surroundings; (2) a close-up of the carcass before moving; and (3) any details that may relate to the cause of death (*e.g.*, burrow collapse, improper

enclosure construction, predation). The tortoise may be moved to better capture details. Following discovery and documentation, remove the carcass from the enclosure. Always wear gloves when handling a carcass.

Carcasses will not be disposed of until details are discussed and direction provided by USFWS. Until instruction is received, handle it such that biological material is best preserved. Because routine tortoise and enclosure checks will be conducted on site the carcass tissues should be viable for necropsy. Place the carcass in a plastic bag and, if possible, store it on ice or keep it refrigerated (not frozen).

#### **8.2.4 Suspected Predation or Parasitism in an Injury or Mortality**

Ensuring the safety of tortoises in captivity is a top priority. If predation or parasites are suspected following an injury or mortality, promptly repair any enclosure issues and contact USFWS. Act immediately upon noticing signs of predators within the captive husbandry complex to prevent incidents, address the issue straightaway (If parasites are observed, quickly remove them and take steps to reduce their presence (see 7.5 ANTS AND ECTOPARASITES section)).

### **8.3 Enclosure Monitoring**

Check tortoise enclosures weekly during normal conditions to ensure there are no holes, slides, breaches, or escape routes. Check access points, rodent-proof flashing, and enclosure covers to confirm they are predator-proof. Because the risk of breaches increases in certain areas (*e.g.* washes) and following precipitation (USFWS 2009), monitoring may need to be performed more frequently. Check enclosures during or immediately after rain events with surface flow, unexpected natural disturbances, or anthropogenic disruptions. Perform necessary repairs, attend to issues, and accurately record all completed and pending tasks. Repairs may include realigning, reburying, or reconstructing enclosures. Replacing damaged sections and filling gaps or holes may be required. Because tortoises can climb enclosure walls that are too low, debris that has accumulated along an enclosure edge should be removed. Carry a shovel or other tools to make repairs.

Ensure that each enclosure is correctly labeled with a visible tortoise identification number or other system, so workers can easily identify occupied enclosures without entering. If anyone enters an enclosure for any reason, always disinfect shoes upon exiting (see 5.0 SANITATION AND DISINFECTION section).

#### **8.3.1 Burrow Monitoring**

Inspect and maintain all burrows, both natural and artificial, weekly. During the active season each enclosure may need to be entered to properly inspect burrows. During hibernation, check the general integrity of each enclosure and burrow weekly. This may not require entrance into the enclosure. However, a more thorough inspection will be done monthly during this period to ensure the burrow is functional and that animals are safe. During or after heavy rains, winds, or other extreme events, check every burrow to ensure tortoises are safe. Carry a shovel to make

burrow repairs as needed and disinfect shoes upon exiting each enclosure (see 5.0 SANITATION AND DISINFECTION section).

Artificial burrows must be completely covered by dirt at all times. To effectively protect tortoises, check that the artificial burrow tube is not exposed, and that soil coverage is adequate. Because the end of the burrow is at least 61 cm (24 in.) below the surface, it must be covered by at least 30 cm (12 in.) of dirt on that end. Add dirt, gravel, and cobbles to adequately cover the artificial burrow tube. Sprinkle the area with water to promote compaction. When inspecting burrows, take the temperature in the chamber of the burrow, if possible, without routinely entering the enclosure. You may use a handheld thermometer placed far back into the burrow or a thermometer gun that can take the surface temperature of the back of a burrow. Burrow temperature should generally fall within 15 - 30°C (59 - 85°F). However, during the winter, burrow temperatures may be a few degrees lower (7°C or 45°F; Nussear *et al.* 2007) and during the summer, burrow temperatures may be a few degrees higher (35°C or 95°F) for short periods. If a burrow consistently shows issues, consider relocating it or digging it deeper to adjust the temperature or structural integrity.

Regularly inspect all burrows, both natural and artificial, using a flashlight or mirror to ensure the path is clear of debris and accessible to tortoises. Continue inspections even if a tortoise has recently emerged, as the burrow may have collapsed behind it. If the back of the burrow is not visible, use a burrow scope to check for obstructions. Burrow collapse can place tortoises at risk of thermal stress (Berry 1986) or animals may become entombed, especially during rain events (Lovich *et al.* 2011). If a burrow has collapsed on a tortoise, dig the animal out as quickly and carefully as possible. However, burrows occupied by adult female tortoises should be carefully excavated to determine if nests and/or hatchlings are present. It is useful to put a hose, shovel handle, or other placeholder inside the burrow before digging so the tunnel can be relocated in the event of further collapse. Be especially careful when digging a burrow that contains, or is suspected to contain, a small tortoise as they are difficult to find and may dig in unpredictable directions. Once the tortoise is removed, keep it in a safe place (*e.g.*, a well-ventilated protective container) until the burrow can be rebuilt. If the temperature is over 95°F place tortoise indoors in a temperature-controlled environment until the temperature is below 85°F.

### **8.3.2 Shade Structure Monitoring**

During routine enclosure checks, ensure that shade structures are functional, safe, and provide adequate shade. Shade structures should be continuously maintained, and all issues immediately addressed.

### **8.3.3 Vegetation and Irrigation Monitoring**

To ensure enclosures have sufficient and living native perennial vegetation cover for tortoises (typically 14-22% in natural environments) and are free of invasive and nonnative forage plants, routine vegetation monitoring should occur at least quarterly. Native vegetation should be recorded as perennial or annual. If perennial, record the species along with an estimate of percent cover. Should invasive or nonnative plants be present, record the species, hand pull, and dispose

of in a sealed bag (see 6.9 INVASIVE/NON-NATIVE PLANT REMOVAL section). If using irrigation, check that the system is functioning correctly, not leaking, and providing tortoises and/or native vegetation with an adequate water supply.

#### **8.4 Perimeter Fence Monitoring**

Perimeter fences should be monitored at least once a week during normal conditions to ensure there are no holes, slides, breaches, or escape routes. Because the risk of breaches increases in certain areas (*e.g.*, washes) and following precipitation (USFWS 2009), checks may need to be performed more frequently. See APPENDIX 5: PERIMETER FENCE CHECK TEMPLATE. Check the fence immediately after rains, unexpected natural disturbances, or anthropogenic disruptions. Make necessary temporary repairs, attend to issues, and document work done or needed within 24 hours of a rain event. Repairs may include realigning, reburying, or reconstructing the fence. Replacing damaged sections and filling gaps or holes may be required. Document issues and work done or needed. Carry a shovel or other tools to make on-the-spot repairs.



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# Appendix 1: Husbandry Plan Template

Husbandry Plan for the  
[PROJECT NAME] MOJAVE DESERT TORTOISES  
at the  
[Captive Enclosure Husbandry Complex Name]  
in  
[County, State]

Prepared by [Name, Affiliation]  
Date [Version date]  
Effective [date]  
Expires [date]

**Purpose of Captive Holding:** [e.g., research, pre-translocation, medical treatment]

**Origin of Tortoises**    **Critical Habitat Unit:** [name]  
**Recovery Unit:** [name]  
**State:** [Arizona, California, Nevada, Utah]  
**Landowner/Manager:** [e.g., Bureau of Land Management]

## Actions Permitted by Federal and State Wildlife Agencies

1. **Take of wild tortoises and transfer to captivity:** [list USFWS 10(a)(1)(A) recovery permit; list all other related permits, Biological Opinions, MOUs]
2. **Husbandry of tortoises in captivity:** [list permits, Biological Opinions, MOUs]
3. **Primary husbandry contact:** [name]
4. **Number of tortoises to be held in captivity:** [specify number of adult, juvenile, hatchling if possible]

## 1.0 HUSBANDRY PLAN FOR MOJAVE DESERT TORTOISES

[Include project name, captive enclosure husbandry complex name, and county and state of husbandry complex]

## 2.0 REGULATORY INFORMATION

### **2.1 *Regulatory and Lands Authorizations***

[Include federal recovery permit, biological opinion numbers, state permit numbers, required land management authorization, Institutional Animal Care and Use Committee (IACUC) authorization]

### **2.2 *Authorized Personnel***

[Include full name of each person that will be providing care for tortoises or conducting related monitoring] Resumes/qualifications/husbandry specific experience must be provided separately to the Desert Tortoise Recovery Coordinator along with your request for or modifications to the 10(a)(1)(A) recovery permit *List of Authorized Individuals* (LAI). All persons involved need to be permitted/approved by USFWS.

## 3.0 CAPTIVE ENCLOSURE INFORMATION

### **3.1 *Project Site/Resident Habitat Information***

[Include address/UTMs, location relative to quarantine husbandry complex; map required]

### **3.2 *Location of Captive Enclosures***

[Include address/UTMs, location relative to project site; map required]

### **3.3 *Construction Practices to Minimize Disturbance to Vegetation***

### **3.4 *Resident Tortoises***

### **3.5 *Final Disposition of Captive Enclosures***

[Describe your organizations actions to prepare husbandry complex upon completion]

## 4.0 CAPTIVE ENCLOSURE SECURITY AND PERIMETER FENCE

### **4.1 *Perimeter Fence Specifications***

[Material, construction, height, gates, locks, include a map]

### **4.2 *Additional Security Measures***

## 5.0 DISINFECTION AND SANITATION

### **5.1 *Personnel Exposed to Other Herpetofauna Species***

[At another workplace or home, protocol and biosecurity]

## **5.2 Entering Husbandry Complex**

[Sanitizing hands, shoes, informing all visitors of biosecurity measures]

## **5.3 Tortoise Handling**

[Policy on gloves, biosecurity, and contamination prevention]

## **5.4 Protocol for Sanitizing Skin, Clothing, and Shoes**

## **5.5 Disinfecting Equipment and Work Stations**

## **5.6 Protective Containers for Tortoises**

[Material, specify reusable or single-use, provide protocol for disinfecting if reusable]

## **5.7 Disinfecting Tortoise Enclosures**

[Policy on moving tortoises, disinfecting pens, burrows, enclosure items]

## **5.8 Disinfectant(s) To Be Used, Preparation Instructions, Contact Time, Expiration**

# **6.0 CAPTIVE TORTOISE ENCLOSURES**

## **6.1 Enclosure Description**

[Number of enclosures by tortoise size class, include pens and walkways in map]

## **6.2 Construction by Tortoise Size**

[Materials, construction, enclosed or open, outdoor or indoor, tortoises per pen, preventing tortoise contact, enclosure size(s) and height, walkway description and size]

## **6.3 Enclosure Labels**

[How enclosures are identified as occupied]

## **6.4 Multiple Projects or Adjacent Complexes**

[Yes or No; If yes, describe barrier between projects]

## **6.5 Predator-Proofing by Tortoise Size**

[Materials, construction]

## **6.6 Burrows by Tortoise Size**

[Minimum number per pen, natural burrows present, artificial burrow present and materials, reusable or single-use, construction, sizing procedure, temperature monitoring]

## **6.7 Soil Conditions and Native Vegetation**



[Specify Appropriate, Compacted, Sandy; Percent perennial plant cover per enclosure, Perennial vegetation species]

### **6.8 Watering Native Vegetation**

[Procedures, frequency of watering]

### **6.9 Invasive/Non-Native Plant Removal**

### **6.10 Shade and Shade Structures**

[Percent range per enclosure, shade structure material, construction]

## **7.0 TORTOISE CARE**

[Do not handle at temperatures  $\geq 35^{\circ}\text{C}$  ( $95^{\circ}\text{F}$ ) or during hibernation unless tortoise is ill, distressed, or in danger]

### **7.1 Veterinary Services**

[Name, phone, address, directions and distance from complex, desert tortoise experience; Describe when veterinary care services will be provided, transportation procedures]

### **7.2 Feeding**

[Food items, preparations, amount, time fed, feeding location, uneaten food, pen entry, include a seasonal feeding schedule]

### **7.3 Providing Water**

[Procedure, dish material, placement, cleaning, ant inspection, pen entry, include a seasonal feeding schedule]

### **7.4 Tortoise Egg Discovery**

[reporting, actions, experienced/authorized personnel]

### **7.5 Ants and Ectoparasites**

[Ants - procedures to minimize presence in pens, removal; Ectoparasites -removal, collection]

## **8.0 MONITORING AND REPORTING**

### **8.1 Reporting Protocol**

[recording and maintaining data, reporting schedule, point-of-contact]

### **8.2 Tortoise Monitoring**

[tortoise checks, new transfers, unusual activity, include a monitoring schedule]

#### **8.2.1 Health Assessment Schedule**

### ***8.2.2 Injured and Ill Tortoises***

[FWS reporting, actions, housing during recovery]

### ***8.2.3 Tortoise Mortality***

[FWS reporting, documentation, carcass removal, tissue preservation]

### ***8.2.4 Suspected Predation or Parasitism in an Injury or Mortality***

[FWS reporting, actions]

## ***8.3 Enclosure Monitoring***

[inspection, repairs, correct labels, include a monitoring schedule]

### ***8.3.1 Burrow Monitoring***

[inspection, repairs, temperature checks, excavation, include a monitoring schedule]

### ***8.3.2 Shade Structure Monitoring***

[procedure for inspection and repair, include a monitoring schedule]

### ***8.3.3 Vegetation & Irrigation Monitoring***

[native and nonnative plants, include a monitoring schedule; irrigation - procedure for inspection and repair, include a monitoring schedule]

## ***8.4 Perimeter Fence Monitoring***

[inspection, repairs, include a monitoring schedule]

## Appendix 2: Tortoise Check Template

Tortoise ID:		Enclosure ID:		ID matches enclosure: YES    NO	
Project:	Captive husbandry complex:	Date:	Time:	Name:	
Observed: YES    NO	Activity:    BURROW BASKING	SHADE (VEG) EATING	SHADE (STRUCTURE) UNKNOWN	PACING OTHER	
If in burrow, direction: HEAD OUT    HEAD IN    SIDEWAYS    OTHER					
Food remaining: YES    NO	Food removed: YES    NO    N/A	Fed: YES    NO		Watered: YES    NO	
Ants observed: <i>If yes, location and action taken</i>		YES    NO			
Ticks observed: <i>If yes, location and action taken</i>		YES    NO			
Notes:					
*All data fields should be included but may be reformatted or displayed as a table as needed.					

### Appendix 3: Enclosure Check Template

Enclosure ID:		Tortoise ID: <i>N/A if unoccupied</i>			Occupied: YES NO	
Project:		Captive husbandry complex:		Date:	Time:	Name:
Purpose: INITIAL FOLLOW-UP			Soil conditions: APPROPRIATE COMPACTED LOOSE			
Enclosure material: 1x2 in. WIRE ¼ in. WIRE BLOCK OTHER					Enclosure quality: GOOD REPAIR	
Raven-proof netting: N/A GOOD REPAIR		Rodent-proof flashing: N/A GOOD REPAIR			Artificial shade: N/A GOOD REPAIR	
Dishes for food and water: 0 1 2 3		Cleaned: YES NO N/A		Ants: <i>If yes, location and action taken</i> YES NO		
Annuals: YES NO		Perennials: YES NO		Perennial coverage %: N/A 1-5 6-10 11-20 >20		
Vegetation watered: YES NO		Irrigation: N/A GOOD REPAIR		Invasives: YES NO		Removed: N/A YES NO
Artificial burrows: 0 1 2 3 4		Natural burrows: 0 1 2 3 4		Other shelter: N/A TUBING OTHER		
Burrow 1: GOOD REPAIR	Burrow 2: GOOD REPAIR		Burrow 3: GOOD REPAIR		Burrow 4: GOOD REPAIR	Burrow 5: GOOD REPAIR
Repairs done:				Repairs needed:		
Notes:						
*All data fields should be included but may be reformatted or displayed as a table as needed.						

## Appendix 4: Mortality Template

Tortoise ID:	Enclosure ID:	<i>Contact all appropriate agencies and notify USFWS via email within 24 hours</i>		
Project:	Captive husbandry complex:	Date:	Time:	Name:
Carcass UTM's:	Location: <i>e.g. open, burrow, etc.</i>	Position: PRONE    FLIPPED    OTHER		
Evidence of predation: YES    NO	Evidence of parasitism: YES    NO	Evidence of ants: YES    NO		
If yes to any of the above, describe evidence, and include photos:				
Photo 1 (carcass in environmental context before moving): <i>provide a brief description</i>				
Photo 2 (close-up of carcass before moving): <i>provide a brief description</i>				
Photo 3 (details that may relate to cause of death): <i>provide a brief description</i>				
Photo 4 (optional): <i>provide a brief description</i>				
Photo 5 (optional): <i>provide a brief description</i>				
Notes:				
*All data fields should be included but may be reformatted or displayed as a table as needed.				

