Greater Roadrunner (Geococcyx californianus) Care Manual
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Disclaimer: This manual presents a compilation of knowledge provided by recognized animal experts based on the current science, practice, and technology of animal management. The manual assembles basic requirements, best practices, and animal care recommendations to maximize capacity for excellence in animal care and welfare. The manual should be considered a work in progress, since practices continue to evolve through advances in scientific knowledge. The use of information within this manual should be in accordance with all local, state, and federal laws and regulations concerning the care of animals. While some government laws and regulations may be referenced in this manual, these are not all-inclusive nor is this manual intended to serve as an evaluation tool for those agencies. The recommendations included are not meant to be exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Commercial entities and media identified are not necessarily endorsed by AZA. The statements presented throughout the body of the manual do not represent AZA standards of care unless specifically identified as such in clearly marked sidebar boxes.
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Introduction

Preamble
AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (http://www.aza.org), which might not be included in this manual.

Taxonomic Classification
Table 1. Taxonomic classification for greater roadrunner (Payne & de Juana, 2016)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Taxonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom</td>
<td>Animalia</td>
</tr>
<tr>
<td>Phylum</td>
<td>Chordata</td>
</tr>
<tr>
<td>Class</td>
<td>Aves</td>
</tr>
<tr>
<td>Order</td>
<td>Cuculiformes</td>
</tr>
<tr>
<td>Family</td>
<td>Cuculidae</td>
</tr>
</tbody>
</table>

Genus, Species, and Status
Table 2. Genus, species, and status information for greater roadrunner.

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species</th>
<th>Common Name</th>
<th>USA Status</th>
<th>IUCN Status</th>
<th>AZA Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geococcyx</td>
<td>californianus</td>
<td>Greater roadrunner</td>
<td>Not listed under the U.S. Endangered Species Act</td>
<td>Least concern</td>
<td>Yellow SSP</td>
</tr>
</tbody>
</table>

General Information
The information contained within this Animal Care Manual (ACM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including AZA Taxon Advisory Groups (TAGs), Species Survival Plan® Programs (SSPs), biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers (visit the AZA Animal Program page to contact these individuals). It is based on the most current science, practices, and technologies used in animal care and management and is a valuable resource that enhances animal welfare by providing information about the basic requirements needed and best practices known for caring for ex situ greater roadrunner populations. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for greater roadrunners must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations; AZA accreditation standards that are more stringent than these laws and/or regulations must be met (AZA Accreditation Standard 1.1.1).

The ultimate goal of this ACM is to facilitate excellent greater roadrunner management and care, which will ensure superior greater roadrunner welfare at AZA-accredited institutions. Ultimately, success
in our greater roadrunner management and care will allow AZA-accredited institutions to contribute to greater roadrunner conservation, and ensure that greater roadrunners are in our future for generations to come.

There are no recognized subspecies of roadrunner. The lesser roadrunner (Geococcyx velox) occupies habitat similar to that of the greater roadrunner, but generally has a more southern distribution. It has a limited range overlap with the greater roadrunner. The information that follows in this ACM pertains solely to the greater roadrunner (Geococcyx californianus). The greater roadrunner ranges from the foothills of Sacramento Valley in northern California, Owens Valley in eastern California, southern California (McCaskie et al., 1988, Small, 1994), southern Nevada (Ryser, 1985), extreme southwestern Utah (Frost, 1976; Behle et al., 1985), west central and southern Arizona (Monson & Phillips, 1981), south central and northeastern New Mexico (Hubbard, 1978), southeastern Colorado, extreme southern Kansas (Thompson & Ely, 1989), southwestern Missouri, south to southern Baja California, Pacific slope of Mexico to northern Sinaloa, interior south to northern Michoacán and Hidalgo, and Atlantic slope to Tamaulipas (Howell & Webb, 1995), east to east central Arkansas (James & Neal, 1986), northern and western Louisiana (Lowery, 1974), and the Gulf Coast of Texas (Oberholser, 1974). There are occasional records from the north of the described range. Greater roadrunners are rare to uncommon through northern and eastern portions of the range, except coastal Texas and Mexico. They are common to frequent in the Mojave Desert, Sonoran Desert, Chihuahuan Desert, and Tamaulipan thorn regions of the U.S. Southwest and Mexico. They are not found outside the Americas. Recent home range studies (Montalvo, A. et al., 2014) have found that greater roadrunner home ranges can be as large as 200 acres, but shrink by as much as 50-60% in the winter.

Habitat: Greater roadrunners are resident year-round in semiarid and arid open country with scattered scrub (low to 50% cover) and are most frequently associated with a brush layer 2–3 m (6.5–9.8 ft.) high (Folse, 1974). They range in altitude range from about 60 m to 2,300 m (196.8 ft.–7546 ft.) (Small, 1994), but have been observed on southern slopes to 3,000 m (9842 ft.) (Sutton, 1940). In Texas and Oklahoma, they occupy mesquite scrub, juniper savannahs, and chaparral, lowland and mesa riparian woodlands (Hamilton, 1962) and canyons. They are also found in the piñon-juniper woodlands and cholla grasslands of the Colorado foothills and mesas (Andrews & Righter, 1992). In Utah and Nevada, they are associated with blackbrush and creosote scrub, tamarix thickets in bottomlands (Behle, 1943), valley, and riparian areas (Alcorn, 1988). Throughout their range, they are found occasionally on open farmland and in less densely populated suburban developments. They avoid urban areas, heavier deciduous and coniferous woodland (Lehman, 1994), continuous prairie, and bare desert surfaces (Grinnell & Miller, 1944). Near the edge of their range, they occupy less typical habitats. In southwestern Missouri, western Arkansas, and eastern Oklahoma, they are found predominantly in semiarid cedar glade-type vegetation characterized by red juniper and tallgrass prairie plants on rocky terrain strewn with boulders (Brown, 1963). In Louisiana, they occur in shortleaf loblolly pine and hardwood uplands (Goertz & Mowbray, 1971). Their distribution in northern California is restricted to level areas of open ground and tracts of brush and trees (Kimsey, 1953), and valley floors with extensive expanses of grassland and chaparral.

Physical description: Greater roadrunners are slender-bodied, terrestrial cuckoos with long tails and shaggy crests. Their powerful legs have zygodactyl feet that leave distinctive X-shaped tracks in soft substrates. They run quickly, and occasionally fly short distances. They are sexually monomorphic in plumage, and the female is slightly smaller than the male. Recent work by Montalvo et al. (2014) in over 400 birds demonstrated that bill depth was larger in males; this led to the correct sexing of 80% of the birds. Males have white skin in the unfeathered area behind the eye, whereas in females this area is pale blue. The average length and mass of males is 54 cm (21 in.) and 320 g (11.3 oz.), while the average length and mass of females is 52 cm (20.4 in.) and 290 g (10.2 oz.). Adults have a prominent blue-black erectile crest, dark blue orbital skin, and orange postorbital ala that are usually obscured. There is a yellow ring in the iris. Bills are long and stout with a hooked tip. Roadrunners have heavily streaked plumage, which is olive to dark grayish-brown glossed with bronze on the foreneck, chest, back, scapulars, and wings; underparts are unstreaked grayish or buff. The long, dark olive tail has white tips that often are badly tattered. Wings show large white crescents in flight. Juvenile plumage is similar, but generally duller with less distinct markings and lacking the metallic bronze gloss of adult plumage. The greater roadrunner may be confused with the lesser roadrunner, a smaller species of Mexico and Central America. The lesser roadrunner can be distinguished by its unstreaked chest and foreneck, crimson postorbital ala, darker iris, and smaller size of 45–50 cm (17.7 –19.6 in.) long (Johnsgard, 1979).
Comfort activities: Greater roadrunners take frequent dust baths by squatting on their breast, shuffling their feet, and fluttering their wings to force dust into ventral feathers (Rand, 1941). They do not bathe in water (Sutton, 1922). They sunbathe and thermoregulate by orienting their back perpendicularly to the sun with wings drooped and held away from body. Their cervical plumage is erect, exposing the black skin of the interscapular aterium and the black plumage of the dorsal spinal tract (Ohmart & Lasiewski, 1971). They may sunbathe for 2–3 hours in early morning (Ohmart, 1989). In winter when the temperature is about 20 °C (68 °F), they may sunbathe several times throughout the day in sessions of >30 min. Nestlings have black skin capable of absorbing solar radiation.

Conservation and management: The AZA greater roadrunner population is managed as a Species Survival Plan® (SSP) by AZA. Greater roadrunners have been persecuted because they allegedly consume eggs and young of quail, species favored by hunters. In the early twentieth century, federal and state bounties (“chaparral drives”) were imposed in an attempt to rescue declining quail populations (Stimson, 1975; Meinzer, 1993). Rumors of predation likely originated from observations of greater roadrunners following quail coveys to benefit from insects flushed by movement of quail through vegetation (Gorsuch, 1932). Comprehensive feeding studies of roadrunners indicate that quail are rarely consumed and confirm the value of the greater roadrunner in crop and household pest control (Dobie, 1939). Despite this evidence, as recently as 1993, greater roadrunners continued to be shot illegally (Meinzer, 1993). Greater roadrunners are also subject to being killed by vehicular traffic, particularly when crossing highways. The greater roadrunner is not listed under the U.S. Endangered Species Act or as a CITES species, but is listed under the Migratory Bird Treaty Act (16 U.S.C. 703-712).
1.1 Temperature and Humidity

Animal collections within AZA-accredited institutions must be protected or provided accommodation from weather and any adverse conditions detrimental to their health or welfare (AZA Accreditation Standard 1.5.7). Animals not normally exposed to cold weather/water temperatures should be provided heated enclosures/pool water. Likewise, protection from excessive cold weather/water temperatures should be provided to those animals normally living in warmer climates/water temperatures.

**Cold weather:** In winter, birds roost in dense trees protected from winds. They conserve energy at night by lowering their core body temperature from about 40 °C (104 °F) to 34 °C (93.2 °F) (Vehrencamp, 1982). Sunbathing in a windless location in morning reduces the energy cost of raising body temperature by 60% (Ohmart, 1989). Birds will fluff their feathers to reduce heat loss. Stored subcutaneous and lump fat is an important energy source for the birds, particularly in northern parts of their range (Geluso, 1969; 1970).

Zoos in zones where temperatures fall below 4.5 °C (40 °F) should have winter holding facilities available for housing birds during inclement weather and birds should be locked in heated shelters when temperatures are below 4.5 °C (40 °F), as well as during periods of snow and freezing rain. Feathers will be fluffed and body movement limited when birds are cold. Access to heated areas should be available at all times. Sheds should be heated to 10–15.5 °C (50–60 °F). Heat bulbs, if used, should be mounted above the perch so that the heat shines down on the birds, and should be encased in protective cases to prevent bulb breakage in case a bird makes contact with the bulb. One heat bulb per bird is sufficient. Radiant heaters can be used in addition to heat bulbs. Birds should be able to move to cooler parts of the holding area if they so desire (S. Hallager, personal observation 2015).

**Hot weather:** Roadrunners exhibit several physiological and behavioral adaptations to arid regions, such as the ability to dissipate excess body heat by evaporative water loss through the respiratory system and skin (Lasiewski et al., 1971). Nestlings can maintain internal body temperature through gular fluffing by 5 days of age (Ohmart, 1973). Roadrunners are able to maintain a low brain temperature through a system of internal carotid arteries, called rete mirabile, that help in temperature regulation (Kilgore et al., 1976). They are able to conserve water by reabsorption through mucosa of their rectum, ceca, and cloaca. Preorbital salt-secreting nasal glands eliminate excess sodium loads in concentrations about 6 times that of the renal system (Ohmart et al., 1970). Adults may secrete salt after shading chicks for an hour or more during the hottest parts of day. Nestlings secrete salt shortly after feeding, especially if the food is low in water content. Heaviest salt secretions occur from about 5 days of age until fledging, which corresponds to increased food requirements of young when adults are free from brooding or shading duties to forage (Ohmart, 1972). A generalized reduction in activity at midday reduces demands for heat dissipation and water expenditure for evaporative heat loss. Activity is reduced by half during midday hours, when adults frequently rest in the shade (Calder, 1967b).

Despite their adaptations to high temperatures, birds should still be provided with areas of shade both on the ground and above, and preferred perches should be available. Supplemental cooling for birds housed outdoors may be necessary if temperatures routinely reach over 37 °C (100 °F). Cooling can consist of an evaporative cooler that blows through the exhibit's holding area and a thorough soaking of the ground with water twice a day. Misters also may be installed to help with cooling body temperatures. These actions can be taken when the daytime temperatures are above 37 °C (100 °F). Greater roadrunners exhibiting heat stress will pant, and the ability to retreat to cooler areas of the pen is critical. Greater roadrunners are not heavy water drinkers, but fresh water should be available at all times.

Areas of full sun should be provided within greater roadrunner exhibits, as greater roadrunners are frequent sunbathers, using the morning sun and warmth to raise their core body temperature. Sunning occurs on the ground, and generally in areas of sandy substrate (S. Hallager, personal communication, 2015).

**Humidity:** Greater roadrunners do not thrive in climates that are consistently wet, rainy, and damp. These conditions lead to poor feather condition because the birds are unable to properly dry off. Poor feather condition will appear in the form of tattered feathers (S. Hallager, personal communication, 2015).
AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animals and emergency backup systems available. Warning mechanisms and backup systems must be tested periodically (AZA Accreditation Standard 10.2.1). The AZA Turaco/Cuckoo TAG and Greater Roadrunner SSP recommend that each institution identify the most appropriate climate control systems suitable for their roadrunner enclosures in order to meet the temperature and humidity recommendations provided above.

1.2 Light
Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums. A basic daily light schedule for birds is 12 hours of daylight and 12 hours of darkness, but can vary according to the season and the birds’ natural range. For instance, a longer schedule of daylight may be needed to induce breeding. During darkness, birds need a restful sleep to minimize stress, reduce fatigue, and maintain a strong immune system. When possible, providing access to natural sunlight is preferable. If natural daylight is not available, then full spectrum lighting may be used. Full spectrum lighting is best as it promotes appropriate molting and plumage quality. If full spectrum lighting is not available, indoor exhibits have used a variety of other types of lights successfully including fluorescent, low pressure sodium, and metal halide skylights in conjunction with artificial lighting (S. Hallager, personal communication, 2015). For dim light or nighttime conditions, blue-colored light bulbs or gels that create a good nighttime light similar to moonlight should be installed within the exhibit for use in avian or life support emergencies. Full spectrum bulbs that emit light in the ultraviolet wavelength mounted 30–46 cm (12–18 in.) above the bird should provide the basic light requirements (Foster & Smith, 2010). Ideally, all artificial lighting, especially emergency lighting, should be on dimmer switches to avoid startling birds more than necessary should the need arise to turn lights on and off during dark hours. The day length can vary according to the season, and care should be given to provide a dawn and dusk period as well. Regular and consistent light cycles are vital.

In regard to outdoor exhibits, any exhibit work should ideally take place after natural light has lit the area. Outdoor exhibit lighting cycles should not extend beyond what is normal for that time of year. In general, it is recommended that outdoor exhibits remain closed for night events in order to help keep birds on their natural light cycle.

1.3 Water and Air Quality
There are no specific recommendations or regulations in regard to air and water quality for greater roadrunners in zoos. Any clean water source that is considered potable for humans is acceptable for greater roadrunners. Greater roadrunners require only small areas of water from which to drink. They are not heavy drinkers, but do drink on a daily basis (S. Hallager, personal observation 2015). Pools or water bowls should not be placed under areas where birds may perch, in order to avoid contamination of the water source by fecal material. Heated water dispensers for northernmost zones are recommended. Greater roadrunners do not bathe in water, and so pools are not required in exhibits (unless for aesthetic reasons). If pools are present in enclosures, they should be shallow enough that a bird can walk through the water, and the sides should gradually slope to the deepest portion. To prevent accidental drowning, pools should be drained once chicks leave the nest. Once chicks are 30 days old, the pools may be refilled to their normal depth (S. Hallager, personal communication, 2015).

Holding areas and indoor or winter enclosures should not be sealed so tightly that they prevent fresh air from entering the area, as this can adversely affect air quality within these enclosures. A ventilation system, small windows with screens, and/or the ability to open windows will allow fresh air to enter these areas, and will discourage the formation of fungal spores.

1.4 Sound and Vibration
Consideration should be given to controlling sounds and vibrations that can be heard by animals in the care of AZA-accredited zoos and aquariums. Little is known about the hearing sensitivity of greater roadrunners, and there is no information available on whether there are certain frequencies of sounds or decibels that will have the greatest negative effect on the welfare of greater roadrunners. Animals should
be carefully monitored in any situations where loud, atypical sounds can be heard by animal caretakers around greater roadrunner enclosures. Additional research on hearing in greater roadrunners would provide some guidance for creating more objective recommendations for managing sound stimuli for this species.

Consideration should be given to controlling sounds and vibrations that can be heard by greater roadrunners in their indoor and outdoor enclosures. Greater roadrunners often become habituated to the routine sounds of normal zoo operation (e.g., trash trucks, nearby construction, leaf blowers), as well as to other environmental sound stimuli (e.g., overhead aircraft, traffic noise, etc.) (S. Hallager, personal observation, 2015). Unusual sounds, however, can act as stressors, and may cause birds to react negatively by running or crouching. Breeding activities can also be interrupted by novel sounds. Timing of planned construction work near greater roadrunner enclosures should coincide with the non-breeding season to minimize stress on the birds. Workers should be cautioned that their activities may stress the birds. Work should be stopped at once if it is causing obvious stress to the birds (e.g., birds not eating, frantically running within their enclosure, or hiding), and the situation should be re-evaluated. In some cases, birds may need to be temporarily housed or even relocated to another exhibit, although the pros and cons of moving animals should be carefully discussed among all relevant staff.
Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

Careful consideration should be given to exhibit design so that all areas meet the physical, social, behavioral, and psychological needs of the species. Animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design (AZA Accreditation Standard 1.5.1). All animals must be housed in safe enclosures that meet their physical and psychological needs, as well as their social needs (AZA Accreditation Standards 1.5.2, 1.5.2.1, 1.5.2.2).

Species appropriate behaviors:

Locomotion: Greater roadrunners can run at speeds of greater than 30 km/h (19 mph) (Kavanau & Ramos, 1970, Ohmart, 1989). When running at top speed, they hold their head and tail parallel to the ground. The long tail swings from side to side like a rudder when changing directions at high speed. They frequently use roads, well-beaten paths, or dry stream beds rather than running through dense vegetation. The species’ cursorial habit is correlated with myological and skeletal adaptations. Several pelvic muscles originate farther cranially and laterally than in arboreal cuckoos such as Coccyzus spp. This improves stability and balance in a running bird that supports its weight alternately on one leg and then the other. Bones of the leg, particularly the tarsometatarsus, are elongated.

Flight: Greater roadrunners have limited flying abilities and in the wild they are usually restricted to open, extended-wing gliding from a nest or other high perch. They are infrequently observed flying short distances of 4–5 m (13.1–16.4 ft.) between treetops or manmade structures.

All enclosures should be large enough for greater roadrunners to exercise their preferred flight distance from animal care staff. Indicators that the size and complexity of the enclosures are not meeting the needs of the birds may include poor physical health, pacing along fence lines, and increased behavioral displacements between males and females (S. Hallager, personal communication, 2015).

Foraging: Roadrunners are predatory birds and like to hunt for insects and small vertebrates. Some naturally occurring leaf litter should be left in enclosures to encourage insects.

Nesting materials: During the breeding season, roadrunners should be provided with nesting material in addition to the material they would naturally collect themselves. All nesting material should be identified and assessed for safety by at least one qualified individual. Nests in the wild are constructed of sticks (0.2 cm–0.8 cm (0.08–0.31 in.) in diameter) loosely laid together, with lining of finer material such as leaves, grass, feathers, mesquite pods, snakeskin, roots, and dry flakes of cattle and horse manure (Hughes, 1996). To avoid injury to chicks and adults, sticks with pointed barbs or sharp ends should not be provided. Roadrunners in non-breeding situations may appreciate nesting material to satisfy any natural breeding urges.

Socialization: Greater roadrunners are generally uniformly dispersed along relevant habitat features (Folse, 1974). The average territory size (per breeding pair) has a diameter of 0.7–0.8 km (0.43–0.49 mi.) in southern California (Bryant, 1916) and 0.8 km (0.49 mi.) in Arizona (Calder, 1967b). Greater roadrunner pairs are sociable by nature, and compatible pairs will usually rest near each other and feed from the same pan. Males will offer females food during the breeding season. During introduction periods, separate food pans are recommended until the birds are compatible. Despite the compatibility of pairs, multiple perches at different levels is necessary. In outdoor spaces perching should be located several feet away from the mesh to reduce overnight predation through that mesh. Birds that prove incompatible should be housed separately until the sex of each bird can be confirmed.
**Enclosure barriers:** Visual barriers, such as thick shrubs, placed 0.3–0.6 m (1–2 ft.) in from the enclosure perimeter may provide an increased sense of security for birds housed in enclosures of a minimum size, and may help mitigate some stressors. Using shade-cloth or tension netting on the roof and sides of aviaries can minimize visual stressors, and can cushion any impact resulting from birds flying within an enclosure as a result of stressors in that environment.

**Enclosure size:** The size of roadrunner pens varies widely. Outdoor enclosures that are small in scale should be longer than they are wide. A survey of 15 AZA zoos (Hallager, unpublished data, 2013) yielded an average exhibit size of 10.4 m long x 6.4 m wide x 4.3 m high (34 ft. x 21 ft. x 14 ft.). However, roadrunners have lived and bred in both smaller and larger exhibits (S. Hallager, personal communication, 2015). Smaller exhibits should provide ample areas for birds to hide. The recommended oblong dimensions provide some exercise space, and allow the birds to distance themselves from keepers during enclosure cleaning. These size recommendations are highly dependent on the compatibility of conspecifics. Larger dimensions or separate shelters may be beneficial for birds that have a lower degree of social compatibility. All pens, regardless of size, should have areas that permit birds to run, and should be high enough that birds can perch at least 1.8–2.4 m (6–8 ft.) off the ground. In the wild, roadrunners nest 1–3 m (3–9 ft.) off the ground. Opportunities for locomotion and exercise (i.e., walking, running and short flights) should be provided to the birds within their exhibits. This includes an area to promote running, by providing long runs within the exhibit. Although roadrunners are very agile and can navigate around obstacles with ease, running areas should be free of items such as perches and stumps. Runs should be long enough that a bird can reach full stride. Long runs are also important for chicks, which need plenty of exercise to avoid developmental problems such as a slipped tendon.

Enclosures designed for roadrunners should minimize negative stressors, allow for efficient handling and restraint when necessary, provide access for emergency and routine procedures, maximize the potential for social interaction (and separation when needed), allow for a full range of species-appropriate behaviors, and effectively integrate enrichment and animal training (see Chapter 9) into the daily husbandry routine.

**Enclosure substrates:** Outdoor enclosures are usually grass, sand, dirt, rocks, or a combination of all four. Greater roadrunners should not be housed in pens consisting solely of rocks or gravel, as this can lead to injuries to their feet, such as broken nails and toes. The floor of indoor enclosures can be covered with dirt or sand and, if desired, a thin layer of bedding hay (straw), wood shavings or leaf litter. All substrate should be routinely changed to keep it fresh and free of contaminants. Some facilities have indoor quarters with cement floors that are hosed daily. As long as sufficient perching is provided, concrete is acceptable for short-term holding and/or winter holding situations. Greater roadrunners do not dust-bathe and so small areas 1.2 m x 1.2 m (4 ft. x 4 ft.) of sand should also be provided in the exhibit as well as in holding. Keepers should provide dust-bathing areas for birds that are housed indoors for extended periods of time, but should ensure that these areas are kept dry, as greater roadrunners will not dust-bathe in wet substrate. Although roadrunners need small areas of fresh water to drink from, slightly larger areas containing a few inches of water may be appreciated by birds for enrichment purposes.

The same careful consideration regarding exhibit size and complexity and its relationship to the greater roadrunners’ overall well-being must be given to the design and size of all enclosures, including those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3). Sufficient shade must be provided by natural or artificial means when sunlight is likely to cause overheating or discomfort to the animals (AZA Accreditation Standard 10.3.4).

It is recommended that all facilities housing greater roadrunners have a holding area available, even if periods of cold/freezing weather are not common. The shelter can be used for medical confinement, minimizing food loss due to wild birds, or times when pen repairs are needed or when birds should be caught up. If birds are compatible, sheds that are 2.4 m x 1.2 m x 1.8 m (8 ft. x 4 ft. x 6 ft.) are sufficient. The taller the shed the better, as greater roadrunners will roost as high as 3 m (9 ft.) in the wild (Folse, 1974). In colder
climates, where sheds are used when temperatures are below freezing, overhead heat panels should be installed. Smaller sheds should have one stump or log per bird for perching; larger sheds can accommodate horizontal perching. Institutions in extreme northern climates that require housing of birds for the entire winter should provide greater roadrunners with holding facilities which are larger than facilities used to house their birds for only a short period of time (e.g. overnight or a few days). These quarters should have several perching areas (high and low perches) and a nesting platform in the event that birds demonstrate breeding behaviors. A skylight is optional, but will help keep birds on a natural light cycle if available. Areas for dust-bathing can be given, provided they remain dry. Winter holding areas should have the capability to be divided in the event that birds are not compatible in small areas. Sheds should be heated to a maximum of 10 °C–15.5 °C (50 °F–60 °F), and less if heating lamps and/or pads provide warmer areas.

Indoor Substrate: The floor of the shed can be dirt or sand that can be covered with bedding hay (straw). Concrete floors should be covered with absorbent material, especially when birds are housed long-term (periods of more than 3 days).

Environmental variability: To satisfy greater roadrunners’ natural curiosity and intelligence, some change within their environment is important. Variation in the enrichment food items offered is one way to accomplish this, along with occasional movement of perches and alterations in feeding times. Greater roadrunner enrichment is currently limited, and requires further development.

2.2 Safety and Containment

Animals housed in free-ranging environments should be carefully selected, monitored and treated humanely so that the safety of these animals and persons viewing them is ensured (AZA Accreditation Standard 11.3.3). Covered enclosures have the added benefit of keeping out unwanted pests or potential predator species, and can help to minimize the spread of parasites and diseases from wild animals to roadrunners. Walk-through exhibits are acceptable for housing breeding pairs or single birds, but will depend upon the personality and tolerance level of the bird or birds. Keepers should inspect the areas of the enclosure where birds have the closest access to the public and immediately remove any foreign materials on a daily basis. While it is not commonly reported, roadrunners can ingest objects such as nails, batteries, broken glass, and coins (S. Hallager, personal communication, 2015). There can be serious health consequences associated with ingestion of these items. Plants in and around enclosures should also be carefully selected to ensure that they do not have any poisonous properties, or do not pose any risk of physical injury to the birds (e.g., from thorns).

Pest control: Pest control methods must be administered so there is no threat to the animals, staff, public, and wildlife (AZA Accreditation Standard 2.8.1). Keepers should check enclosures each day for signs of rodent activity. Spilled food should be removed on a daily basis to aid in rodent control. If snap traps need to be set, they should be covered so that the birds are unable to see or reach the trap. Roadrunners are curious and will investigate a trap if they can see it. Poison should not be used inside roadrunner exhibits. Roadrunners will actively hunt, kill, and possibly consume wild birds and rodents, and secondary poisoning can occur if roadrunners ingest poisoned rodents. When possible, it is advisable to work out a pest control program with a qualified pest control officer.

Predator control: Native/feral predators are dangerous for both adult and young roadrunners. While adult birds are usually fast enough to evade terrestrial predators, they are still subject to predation by raptors, crows and ravens. Eggs and nestlings can be taken by predators such as coyotes (Canis latrans), raccoons (Procyon lotor), rat snakes (Elaphe obsoleta), coachwhips (Masticophis flagellum) and bullsnakes (Pituophis melanoleucus) (Folse, 1974). Outdoor enclosures should be built to minimize predator access. Digging predators (e.g., dogs, foxes) can be excluded by burying the base of the boundary 0.3 m (1 ft.) in the ground. Surrounding the enclosure with electrical wire can deter climbing
predators (e.g., raccoons). For the safety of chicks being raised naturally by their parents, covered pens are strongly recommended. More research is needed to determine if covered pens may also play a role in minimizing the risk of avian-transmitted diseases. In areas where large predators (e.g., coyotes, bobcats, cougars, etc.) are common, birds may need to be housed indoors at night if outdoor pens are not covered. Shifting and housing birds indoors each day may negatively impact breeding success (S. Hallager, personal communication, 2015).

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). All animal exhibit and holding area air and water inflows and outflows must also be securely protected to prevent animal injury or egress (AZA Accreditation Standard 1.5.15). Exhibit design must be considered carefully to ensure that all areas are secure and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction.

An enclosure boundary of wire mesh with a diameter measuring 2.5 cm (1 in.) reduces the chances of chicks getting out. It is common practice for roadrunners to have 24-hour access to exhibits, especially in southern zones where temperatures are warmer. Since most roadrunners are full-winged, covered enclosures are preferable, but not always possible. Maintaining roadrunners in a full-flighted status will not lead to injury, as they are incapable of flying great distances. Housing full-flighted birds in a covered pen removes the need to feather-clip and eliminates any chance of predation. If pens are not covered, birds should be feather-clipped as needed—usually once several flight feathers have grown in. While not recommended, if birds are maintained in open-topped pens, perches should be placed as far away as possible from enclosure barriers to prevent escape from the pen. If hot wire is used on the outside of the enclosure, ensure that birds cannot make contact with it via perching.

Exhibits in which the visiting public is not intended to have contact with animals must have a barrier of sufficient strength and/or design to deter such contact (AZA Accreditation Standard 11.3.6) but the distance may be minimal (S. Hallager, personal communication, 2016). Many roadrunners are exhibited within walk-through aviaries where barriers are not necessary.

All emergency safety procedures must be clearly written, provided to appropriate paid and unpaid staff, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.4). Transport crates should be readily available to move roadrunners in the event of a fire or other natural disaster that requires their immediate relocation. There should be one crate per bird to ensure that translocation can be performed quickly, if needed. For zoos in hurricane-prone zones, birds should be housed in sheds or cement structures (e.g., basements, bathrooms) that can withstand hurricane force winds during the storm. Institutions should develop protocols that provide step-by-step instructions for where birds should be moved, how, when, and by whom. Non-perishable food and sufficient water should be left with the birds in their shelter, and the staff cannot immediately service the birds after the storm. Each institution should have its own emergency response plan (ERP) that would work best for its aviary.

Staff training for emergencies must be undertaken and records of such training maintained. Security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of the institution and in some cases, may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2). In regions of North America that experience severe weather events, such as, hurricanes, floods, fire, etc. an emergency response plan (ERP) should be developed and re-

AZA Accreditation Standard

11.3.1 All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

11.3.6 There must be barriers in place (for example, guardrails, fences, walls, etc.) of sufficient strength and/or design to deter public entry into animal exhibits or holding areas, and to deter public contact with animals in all areas where such contact is not intended.

11.2.4 All emergency procedures must be written and provided to appropriate paid and unpaid staff. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

11.6.2 Security personnel, whether employed by the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).
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AZA Accreditation Standard
11.2.5 Live-action emergency drills (functional exercises) must be conducted at least once annually for each of the four basic types of emergency (fire; weather or other environmental emergency appropriate to the region; injury to visitor or paid/unpaid staff; and animal escape). Four separate drills are required. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified (AZA Accreditation Standard 11.2.5). AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.6).

AZA Accreditation Standard
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AZA Accreditation Standard
11.2.0 A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (AZA Accreditation Standard 11.2.0).

AZA-accredited institutions must also ensure that written protocols define how and when local police or other emergency agencies are contacted and specify response times to emergencies (AZA Accreditation Standard 11.2.7).

AZA-accredited institutions which care for potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Animal attack emergency response procedures must be defined and personnel must be trained for these protocols (AZA Accreditation Standard 11.5.3). Due to the nature of the animal, there is no need to develop an animal attack or escape plan for roadrunners.

AZA Accreditation Standard
11.2.7 A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

AZA Accreditation Standard
11.5.3 Institutions maintaining potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

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3.1 Definitions

In the zoo and aquarium world, animal records are defined as “data, regardless of physical form or medium, providing information about individual animals, samples or parts thereof, or groups of animals”. Most animals in zoo and aquarium collections are recorded as (referred to as) individuals, though some types of animals are recorded as (referred to as) groups or colonies of animals, particularly with invertebrates and in aquariums (see Appendix B for definitions and Recordkeeping Guidelines for Group Accessions). The decision about how to record its animals usually resides with each institution, but in certain cases, the AZA Animal Program Leader (i.e., TAG Chair, SSP Coordinator, or Studbook Keeper) may request that animals be recorded in a certain manner, whether as individuals or as groups. Roadrunners are to be identified as individual birds within all AZA facilities.

3.2 Types of Records

There are many types of records kept for the animals in our care, including but not limited to, veterinary, husbandry, behavior, enrichment, nutrition and collection management. These types of records may be kept as separate records as logs in separate locations or as part of the collection records and some may be required by regulating agencies (e.g., primate enrichment records) or per AZA Accreditation Standards (e.g., emergency drill records).

Recordkeeping is an important element of animal care and ensures that information about individual animals or groups of animals is always available. The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information (AZA Accreditation Standard 1.4.0). These records contain important information about an individual animal or group of animals, including but not limited to, taxonomic name, transaction history, parentage, identifiers, gender, weights, enclosure locations and moves, and reproductive status (see Appendix C for Guidelines for Creating and Sharing Animal and Collection Records).

Records for the entire life of each roadrunner should be kept within institutional records, and should include information on:

- **Diet**: Dietary components, amount of food fed, and method of feeding.
- **Housing**: Dates when birds are moved indoors, outdoors, or to new enclosures.
- **Egg production and reproduction**: Yearly onset of egg-laying, male display, copulation observations, egg fertility, egg measurements.
- **Weights during all stages of life**.
- **Behavior**: Observations of aggressive behavior and animals involved.
- **Medical problems**: As required by institutional veterinary programs.
- **Cause of death**.

In the event that a greater roadrunner is under veterinary care, the following information is recommended to be included in daily records: body weight, appetite, energy level, health condition, medications administered, food intake, water intake, fecal output, presence of regurgitation or abnormal symptoms, and any treatments/procedures performed by the veterinarian.

A designated paid staff member must be responsible for maintaining the animal record-keeping system and for conveying relevant laws and regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and current (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4).
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AZA Accreditation Standard (1.4.4) and at least one set of historical records safely stored and protected (AZA Accreditation Standard 1.4.5).

AZA member institutions must inventory their greater roadrunner population at least annually and document all roadrunner acquisitions, transfers, euthanasia’s, releases, and reintroductions (AZA Accreditation Standard 1.4.1). All greater roadrunners owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2). All AZA-accredited institutions must abide by the AZA Policy on Responsible Population Management (Appendix D) and the long-term welfare of animals should be considered in all acquisition, transfer, and transition decisions. There are no special recordkeeping and/or transaction form(s) unique to roadrunners.

3.3 Permit Considerations

The greater roadrunner is regulated by federal and/or state governments within the United States. Therefore, possession and/or specific activities involving these species usually require a permit(s) issued by the regulating agency, granting permission for possession and/or the specific activities. Depending on the agency involved, the application and approval process may take a few days to many months. These permits must be received by the applicant before the proposed possession or activity can occur.

The greater roadrunner is IUCN Red List Least Concern and has no special status under the U.S. Endangered Species Act or CITES, but is protected under the U.S. Migratory Bird Treaty Act (16 U.S.C. 703-712). Because Migratory Bird Treaty Act regulations are often confusing, institutions should contact their regional Migratory Bird Office for the requirements to hold greater roadrunners at their facility. Depending on whether a bird is acquired under “exempt” status or under the terms of a permit, further transfer may be restricted. The regional Migratory Bird Office should be consulted prior to any transfer in order to ascertain the permits needed for the transfer and the possible implications on subsequent transfers.

3.4 Identification

Ensuring that greater roadrunners are identifiable through various means increases the ability to care for individuals more effectively. All animals held at AZA facilities must be individually identifiable whenever practical, and have corresponding identification (ID) numbers. For animals maintained in colonies or groups, or other animals not considered readily identifiable, institutions must have a procedure for identifying and recording information about these groups or colonies. (AZA Accreditation Standard 1.4.3). These IDs should be included in specimen, collection and/or transaction records and veterinary records. Types of identifiers include:

Physical identifier: These include, but are not limited to leg bands, microchips/transponders and RFID devices. Leg bands should be monitored to prevent constriction injuries.

Intangible identifiers (called ‘logical identifiers’ in the Zoological Information Management System (ZIMS)): These include, but are not limited to, institutional accession numbers, house names, public names, studbook numbers, and ZIMS Global Accession Numbers.

A basic requirement for successful management of greater roadrunners is individual identification. Common techniques include leg bands and transponders. Leg bands aid in quick identification of the bird, while transponders are a permanent marking system. Colored metal or plastic leg bands (8 mm (0.31 in.)) are recommended for zoos with multiple birds in order to aid in fast, easy identification. Zoos should follow the standard practice of banding males on the right leg and females on the left leg. Birds should be monitored closely as the bands can cause constrictions. This can occur if they slide proximally and get stuck, or when they are placed on young birds and become tight as the bird matures and grows.
Transponders can be injected by syringe under the skin near the shoulder area, where they can be detected and read by an electronic scanner. Due to the large size of the needle required to implant a transponder, anesthesia may be advisable, particularly if other procedures such as radiographs are going to be performed at the same time (S. Hallager, personal communication, 2015).
Chapter 4. Transport

4.1 Preparations

Animal transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). All temporary, seasonal, and traveling live animal exhibits must meet the same accreditation standards as the institution’s permanent resident animals, with foremost attention to animal welfare considerations (AZA Accreditation Standard 1.5.10). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order. Include copies of appropriate permits and authorizations in transport documentation. If the animal is not owned by the shipping institution, permission is to be obtained from the owner well in advance of the move. Loan agreements between institutions are usually arranged ahead of the shipment. Some states require permits to transport animals into or through the state and this information should be checked prior to the transport. There are no government regulations, Department of Transportation or other authorizations necessary to transport roadrunners.

The equipment must provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the animal(s). Transport protocols should be developed to ensure the safe transport of greater roadrunners between shipping and receiving institutions, and both institutions should have appropriate equipment and supplies to care for the birds immediately before and after they are loaded onto aircraft for transport. Sufficient diet should be shipped ahead of the animal to allow for a gradual transition to a new diet at the receiving institution. “Live Animal” labels with up arrows should be attached to the crate on at least three sides. As a substitute for red arrow and live animal stickers provided by the airline, red paint or pen can be used to draw arrows and to write “Live Animal” on three sides of the crate. Contact information and telephone numbers for the sending and receiving institutions should be securely attached to the crate during shipment.

Greater roadrunners are best transported in small-size (e.g., 53.3 cm x 40.6 cm x 38.1 cm (21 in. x 16 in. x 15 in.)) commercial pet carriers (e.g., sky kennels) and may be transported by air or by land. Roadrunners should always be shipped singly in crates to eliminate aggression and injury. Crate requirements for greater roadrunners can be found in the International Air Transport Association manual – container requirement #11F (IATA, 2015). Close confinement will help reduce struggling. The inside roof of the kennel should be padded with foam. The best way to attach this covering is via zip ties to the roof, since duct tape could become loose and stick to the bird. The padding serves to protect the birds from hurting themselves if they attempt to fly in the kennel. The standard ventilation openings on the kennel should be covered in a dark shade cloth that has mesh with holes approximately 1–2 mm (0.04–0.08 in.) in diameter to partially block the bird from being exposed to too much activity/movement around its transport container. The kennel door should be closed and secured with at least two plastic tie wraps on each side of the door, one set to secure the door shut and one set to secure the door to the crate, should it pop out of the holes. Small food and water bowls should be fastened to the inside of the kennel so they do not tip over to the inside of the kennel to comply with IATA regulations. Consultation with airlines is recommended prior to shipping. Upon being picked up from the airport, the bird should be placed in a climate-controlled vehicle as soon as possible to minimize heat stress if temperatures are warm, or to warm the bird if temperatures are cold. The bird should not be able to see out of the crate easily. Darkness reduces stress. However, good ventilation is also important (S. Hallager, personal communication, 2015).

Safe transport also requires the assignment of an adequate number of appropriately trained personnel (by institution or contractor) who are equipped and prepared to handle contingencies and/or emergencies that may occur in the course of transport. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies and
contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger (AZA Accreditation Standard 1.5.11).

Transport crates should not be opened during transport unless there is a medical emergency, and only under the supervision of a veterinarian or animal caretaker from either the shipping or receiving institution. Transport crates should be opened in a secure location to avoid the possibility of escape.

4.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. In order to reduce risk to during transport, the following recommendations are useful:

- Have the birds well fed and watered before transport.
- Obtain the most direct flight.
- It is recommended that shipments be carried out early in the day during the warmer summer months, and during times of extreme heat, so that the birds are not subjected to extreme temperatures while in their crates waiting to be loaded onto planes or trucks. Shipments should not occur when outside temperatures are below -1°C (30°F) or above 32.3°C (90°F).
- Avoid transports during a breeding season (especially if female could be carrying eggs) or when a bird is molting.
- Have a written protocol established for shipping.
- Confirm previously-made flight arrangements 24 hours prior to shipping.

Crating animals for transport: Protocols for successfully capturing and crating birds in preparation for transport (either on grounds or between facilities) are described in Chapter 7, Section 7.5. The use of operant conditioning to train birds to enter crates without the need for capture is discussed in Chapter 9, Section 9.1.

Food and water: Small food and water bowls should be fastened to the inside of the kennel so they do not tip over to the inside of the kennel to comply with IATA regulations. Birds should be well fed prior to transport, as they may not eat immediately upon their arrival at their new destination. Wild-caught and/or parent-reared birds, even those previously held in zoos, may not eat for several days after shipping. Hand-reared birds will likely eat within a day of arrival (if not sooner). Water should be immediately available once the bird has arrived at the receiving institution. If it is known that transport will take longer than 24 hours, transport crates should be designed to allow food and water to be provided to the bird through appropriate access ports. Small dead mice are appropriate food items during transport.

Substrate and bedding: The floor of the transport crate should be covered with a non-slip material such as indoor/outdoor carpeting. Hay, straw or wood shavings should only be placed on top of non-slip materials, as they do not provide enough traction when placed directly on a plastic floor. Hay, straw and wood shavings can be used effectively to absorb urates during transport.

Temperature, light, and sound: Shipments should be carried out early in the day during the warmer summer months and during times of extreme heat, so that the birds are not subjected to extreme temperatures while in their crates waiting to be loaded onto planes or trucks. Temperatures within the crate should remain within the range of 7.2–29.4 °C (45–85 °F) to ensure the safety and comfort of the bird. Air holes in crates are necessary to provide sufficient ventilation (IATA Live Animal Regulations, 2015), and these can be covered with breathable fabrics (e.g., burlap) if more darkness is required for the bird within the crate. Low light conditions may help to minimize the stress associated with transport. The bird within the crate should not be able to see out of the crate easily. The shade-cloth material should not restrict ventilation within the crate.

Animal monitoring: Greater roadrunners should always be shipped singly in crates. There is no requirement for animal caretakers to accompany greater roadrunners during shipping, although some zoos have their own requirements for keepers to accompany birds on international flights. Where possible, roadrunners should not be held in a crate longer than 24 hours. Transport crates should not be opened during transport unless there is a medical emergency, and only under the supervision of a veterinarian or animal caretaker from either the shipping or receiving institution. Transport crates should be opened in a secure location to avoid the possibility of escape.
Post-transport release: When recovering from transport, it is important to make sure the bird is safe from injury and has recovered completely before it is released, although release should occur as soon as possible after prolonged transport. The release protocol should be similar to the manual release described in Chapter 7, Section 7.5, with the crate door directed toward an open space within the bird’s new enclosure (e.g., quarantine enclosure) that the bird can see. Handlers may also want to consider facing the crate door toward a bush to slow the bird down. Once the kennel has reached its final destination, but before releasing the bird from the crate, it is important to make sure that the bird has not been injured in shipment. After that has been determined, the weight of the crate (still with the bird inside) should be taken and recorded. Once the bird has been released, the crate should be weighed again to get a baseline weight on the bird without having to restrain it. For release, only trained staff should open the crate door. It is less stressful if the bird can be allowed to exit the crate on its own timetable, of its own accord. Each institution will have its own protocol for post-transport release. Once the bird has moved away from the crate, the crate can be removed while the bird continues to be watched for any negative reactions associated with the shipping experience. Water should be immediately available. The transport of roadrunners is a low-risk endeavor provided all appropriate safety measures are followed.

Within-institution transportation: For the transportation of greater roadrunners within an institution, it is generally recommended that the bird be transported in a crate. Transport crates should be covered with a towel or sheet to give the bird a sheltered environment. Greater roadrunners used in conservation and education demonstrations should also be crated when moved. The floor of the transport crate should be covered with a non-slip material such as indoor/outdoor carpeting. Hay or straw may be placed on top of non-slip materials to absorb urates during transport. Food and water are not needed for in-house moves.
Chapter 5. Social Environment

5.1 Group Structure and Size

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of those animals and facilitate species-appropriate behaviors. Wild greater roadrunners are most often seen alone or in pairs. Groups of three or more birds are most likely parents and offspring. More than one pair of greater roadrunners should not be exhibited in the same enclosure, as they are extremely territorial. Young will leave the nest at 14–25 days of age. They may frequently chase each other, but not aggressively (Whitson, 1971). Young birds are able to catch slow-moving prey at about 21 days of age (Sutton, 1940), but parents and young generally forage together until the young are able to feed themselves, which occurs about 30–40 days after fledging (Whitson, 1975). Both sexes can breed as early as 6–7 months of age. Consequently, chicks should be removed no later than 4 months of age to allow the parents adequate time to re-nest. Adults will chase and attack immature birds to drive them from natal territory, but do not inflict physical damage on the young (Whitson, 1971).

Mated pairs maintain territories year-round in which they forage, court, and rear young. Territories are strongly defended by both sexes, although the male is more prominent in territorial defense. Average territory size in the wild has been reported at 0.7–0.8 km (0.4–0.5 miles) in diameter (Bryant, 1916; Calder, 1967b). Male/Male or female/female pairs have not been reported for greater roadrunners. Birds used as ambassador animals benefit from being hand reared, as their human caretakers take the place of a mate. However, whenever possible, a bird of the opposite sex should also be kept even if just for companionship, as greater roadrunners are social birds (S. Hallager, personal communication, 2015). Although roadrunners are monogamous and remain together year round, caretakers should observe birds for signs of male aggression during breeding season and separate birds at night. In some cases, pairs will prove incompatible and will need to be permanently separated. Aggression (e.g., head pecking, excessive chasing) may be triggered by an overzealous male wanting to breed a female who is a little older and perhaps not quite as responsive to breeding as when she was younger (S. Collinsworth, personal communication, 2016).

5.2 Influence of Others and Conspecifics

Animals cared for by AZA-accredited institutions are often found residing with conspecifics, but may also be found residing with animals of other species. Greater roadrunners can be exhibited with a wide variety of bird species, as illustrated in the table below (Table 3). However, roadrunners are hunters, and small fledglings or young of any taxa will be consumed if the opportunity presents itself. The following table lists species of birds and other animals that have been successfully exhibited with greater roadrunners.

Table 3. Species successfully kept with roadrunners.

<table>
<thead>
<tr>
<th>Birds</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Burrowing owl (Athene cunicularia)</td>
<td>Lilac-breasted roller (Coracias caudatus)</td>
</tr>
<tr>
<td>Screech owl (Megascops)</td>
<td>Scarlet ibis (Eudocimus ruber)</td>
</tr>
<tr>
<td>White faced ibis (Plegadis chihi)</td>
<td>Roseate spoonbill (Ajaja ajaja)</td>
</tr>
<tr>
<td>Double-crested cormorant (Phalacrocorax auritus)</td>
<td>California quail (Callipepla californica)</td>
</tr>
<tr>
<td>Ring-necked pheasant (Phasianus colchicus)</td>
<td>Various waterfowl species</td>
</tr>
<tr>
<td>Northern mockingbird (Mimus polyglottos)</td>
<td>Mourning dove (Zenaida macroura)</td>
</tr>
<tr>
<td>Incarnata (Larosterna inca)</td>
<td>Little blue heron (Egretta caerulea)</td>
</tr>
<tr>
<td>Cattle egret (Bubulcus ibis)</td>
<td>Thick-billed parrot (Rhynchopsitta pachyrhyncha)</td>
</tr>
<tr>
<td>Masked bobwhite (Colinus virginianus)</td>
<td>Gambel's quail (Callipepla gambelii)</td>
</tr>
<tr>
<td>White-winged dove (Zenaida asiatica)</td>
<td>Curve-billed thrasher (Toxostoma curvirostre)</td>
</tr>
<tr>
<td>Gila woodpecker (Melanerpes uropygialis)</td>
<td>Cape thick-knee (Burhinus capensis)</td>
</tr>
<tr>
<td>Crested quail dove (Geotrygon versicolor)</td>
<td>American avocet (Recurvirostra americana)</td>
</tr>
<tr>
<td>White-throated magpie jay (Calocitta Formosa)</td>
<td>Red-winged blackbird (Agelaius phoeniceus)</td>
</tr>
<tr>
<td>Pyrrhuloxia (Cardinalis sinuatus)</td>
<td>Scaled quail (Callipepla squamata)</td>
</tr>
<tr>
<td>Yellow-headed blackbird (Xanthocephalus xanthocephalus)</td>
<td>American robin (Turdus migratorius)</td>
</tr>
<tr>
<td>Wild turkey (Meleagris gallopavo)</td>
<td>Lady Ross' turaco (Musophaga rossae)</td>
</tr>
<tr>
<td>Laughing kookaburra (Dacelo novaeguineae)</td>
<td>Abdim's stork (Ciconia abdimii)</td>
</tr>
</tbody>
</table>

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Greater Roadrunner (Geococcyx californianus) Care Manual

Greater Roadrunners need an area where they feel secure, and where predators cannot enter. Space, complexity, and design of exhibits are just as important for mixed-species enclosures as they are for single-species enclosures. To promote breeding and encourage normal socialization, keepers should limit their interaction with animals to routine husbandry tasks. However, good management of greater roadrunners should include scale training and crate training (see Section 9.1). The use of greater roadrunners in educational programs and shows can be beneficial in promoting conservation messages about greater roadrunners, and birds in general. Curators are encouraged to consult the AZA SSP Coordinator when considering the use of a greater roadrunner in a show, as some birds are more genetically valuable than other birds, and are therefore better suited for placement in a breeding situation.

### 5.3 Introductions and Reintroductions

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals born in or moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved.

Greater roadrunners should not be introduced to new mates during the breeding season. Males can be overly amorous in their efforts to breed, causing undue stress upon a newly introduced female. During the initial introduction period, birds should be separated from each other by fencing off part of the yard to allow for visual introductions. Prolonged introductions are generally not necessary, as males and females are usually quite compatible. Aggression is rare but does occur, especially if birds are incorrectly sexed. Consider releasing birds during days with lower visitor attendance, avoiding weekend crowds. All birds should be monitored closely after introductions to watch for aggression. Both introductions and reintroductions should be done at a time of day when staff will be around to observe for several hours. Additional visual barriers may be needed, such as plants, driftwood, tarps, etc. The exhibit should be designed in a way that no bird can become trapped in a tight spot in the exhibit where it cannot escape from another bird. If more aggressive birds are on exhibit, consideration should be given to remove them while the introduction is happening, giving the new bird a chance to settle in before reintroducing the more aggressive birds (S. Hallager, personal communication, 2015).
6.1 Nutritional Requirements

A formal nutrition program is recommended to meet the nutritional and behavioral needs of all species (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the AZA Nutrition Scientific Advisory Group (NAG) feeding guidelines (http://nagonline.net/guidelines-aza-institutions/feeding-guidelines/), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal’s nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

Digestive System Morphology and Physiology: The gastrointestinal tract of the greater roadrunner has not been described. As an opportunistic mostly-carnivorous omnivore, with the majority of its diet composed of insects, herps, and small mammals (Hughes, 1996; Bryant, 1916; Miller and Stebbins, 1964), its gastrointestinal tract is expected to resemble that of a smaller, generalist raptor (based on similarity of food sources; Stevens and Hume 1995, Figure 2). The crop is likely poorly developed, and is represented by a simple enlargement of the esophagus. This likely allows for immediate storage of smaller prey items as a prelude to the digestion process, but does not allow space for extensive storage as may be the case with other avian species (Maxon, 2005). The stomach is likely simple, allowing for the initiation of enzymatic and acidic digestion, which continues in the small intestine. The ceca in roadrunners may be vestigial or absent. Mean retention times in insectivorous and carnivorous birds range widely, with insectivores reported as 30-90 minutes and carnivores as 360-600 minutes (Klasing, 1998). Roadrunners have been anecdotally reported to cast pellets when managed in captivity in small spaces and offered entirely vertebrate diets (Maxon, 2005).

Water may be conserved by reabsorption through the mucosa of the rectum, ceca, and cloaca in roadrunners. In addition, a nasal salt gland was reported by Ohmart (1972). The gland functions to remove salt using less water than through kidney filtration, further conserving water. Nasal glands may have the greatest importance in nestlings, due in part to the time they spend in the nest unshaded and their increased need to conserve water.

Free-Ranging Diet Composition: Greater roadrunners are reported to rely heavily on insects year-round, but consume a wide variety of species (Table 4). Whole prey (of various taxa) make up about 90% of their diet. They infrequently eat the fruit of tasajillo, prickly pear cacti, and sumac. They will also eat carrion when available. Specific data on preferences, amounts consumed, and nutrient content of items consumed by free-ranging birds is not available.

![Figure 2. Gastrointestinal Tract of the red-tailed hawk (Buteo jamaicensis) as a general model for the roadrunner (Stevens and Hume 1995).](image)

### Table 4. Reported prey species of greater roadrunner.¹

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insects</td>
<td>Orthoptera, Coleoptera, Hemiptera, spiders and scorpions</td>
</tr>
<tr>
<td>Lizards</td>
<td>Striped whiptail, <em>Cnemidophorus inornatus</em>; round-tailed horned lizard, <em>Phrynosoma modestum</em>, Texas horned lizard, <em>P. cornutum</em></td>
</tr>
<tr>
<td>Snakes</td>
<td>Massasauga <em>Sistrurus catenatus</em>, pigmy rattlesnake <em>S. miliarius</em></td>
</tr>
</tbody>
</table>

¹ Specific data on preferences, amounts consumed, and nutrient content of items consumed by free-ranging birds is not available.
**Nutrient Requirements:** Nutrient requirements for greater roadrunners are not available, but target nutrient values are proposed in Table 5. There are many reports of food items consumed by free-ranging roadrunners, but none contain any information on the nutrient content of those items. Because of this, target nutrient values are based on commonly studied domestic avian species and carnivorous mammalian species. Ranges are provided to best describe the needs, lacking species-specific information, taking into account the foraging strategy of the birds. Of note, calcium supplementation is recommended for birds producing multiple clutches and the overall calcium to phosphorus ratio should be between 1.2:1 and 2:1.

**Table 5. Target nutrient ranges for greater roadrunner (dry matter basis).**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Target Nutrient Content&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein, %</td>
<td>12.5-30</td>
</tr>
<tr>
<td>Fat, %</td>
<td>9-15</td>
</tr>
<tr>
<td>Vitamin A, IU/g</td>
<td>1.67-7.5</td>
</tr>
<tr>
<td>Vitamin D, IU/g</td>
<td>0.25-1.0</td>
</tr>
<tr>
<td>Vitamin E, mg/kg</td>
<td>5-80</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.29-2.5&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.26-0.76</td>
</tr>
<tr>
<td>Magnesium, %</td>
<td>0.04-0.07</td>
</tr>
<tr>
<td>Potassium, %</td>
<td>0.25-0.52</td>
</tr>
<tr>
<td>Sodium, %</td>
<td>0.068-0.17</td>
</tr>
<tr>
<td>Iron, mg/kg</td>
<td>67-130</td>
</tr>
<tr>
<td>Copper, mg/kg</td>
<td>4.4-8.9</td>
</tr>
<tr>
<td>Manganese, mg/kg</td>
<td>48-78</td>
</tr>
<tr>
<td>Zinc, mg/kg</td>
<td>40-80</td>
</tr>
<tr>
<td>Selenium, mg/kg</td>
<td>0.11-0.4</td>
</tr>
</tbody>
</table>

<sup>1</sup> Target nutrient values are based on a range of requirements for poultry (NRC 1994) and cats (NRC 2006).

<sup>2</sup> The higher level may only be appropriate for females laying multiple clutches (normal clutch size is 8 eggs).

**Energy Requirements:** Energy requirements are expressed in a variety of ways, not all of which are useful/practical for captive management. Typically, the requirement is expressed as metabolizable energy (ME), which can be determined via direct calorimetry (measure of heat released from a bird), indirect calorimetry (rate of oxygen consumption), or empirically (measuring the actual energy consumed in order to perform specific functions – weight maintenance, growth, egg laying, etc).

At air temperatures of 27–36 °C (81–96 °F; thermoneutral zone), the rate of oxygen consumption in an adult roadrunner is reported as 0.92 ± 0.09 ml/g/h; within the range predicted for body weight. At temperatures above 36 °C (96 °F), oxygen consumption increases and at 44.3 °C (111.7 °F), the mean oxygen consumption rate is 31% above standard metabolism. Below 27 °C (81 °F), oxygen consumption increases with decreasing temperature (Calder and Schmidt-Nielsen, 1967). Both measurements indicate the expected increase of ME when roadrunners are maintained outside of their thermoneutral zone.

In addition, incubation may be metabolically expensive. Non-incubating adults become hypothermic at night, reducing core body temperature from about 40 °C (104 °F) to 34 °C (93.2 °F). At 10 °C (50 °F) a non-incubating, hypothermic bird expends about 1.1 cm3/g/h of oxygen, while an incubating bird that is thermoneutral expends about 1.5 cm3/g/h of oxygen, metabolizing about 36% more energy than a hypothermic individual (Vehrencamp, 1982). This observation may prove useful to manage incubating and non-incubating roadrunners in captivity across a range of temperatures. Incubating adults can use sunlight to increase their core body temperature to daytime values, as an energy-saving mechanism (Ohmart & Lasiewski, 1971).

The minimal energy needed to maintain metabolic processes in a resting, thermoneutral, post-absorptive bird is called the basal metabolic rate (BMR) and provides a point of reference to determine the daily energy requirements of captive (and free-ranging) birds. For roadrunners, several equations...
may be appropriate for this BMR calculation. For example, BMR (kcal/d) may be calculated as: (308 (BW kg) ^ 0.73)/4.184 (non-passerines, Aschoff and Pohl, 1970). The ME need for a captive roadrunner is going to be some multiple (greater) of this value, based on activity and environment (maintenance, growth, egg-laying, temperature, humidity, etc). It may be a useful exercise to determine the energy content of the diet consumed by an animal that is maintaining body weight while being “normally” active (this will provide a point of reference for seasonal, life stage, or other change that may impact metabolism).

6.2 Diets

The formulation, preparation, and delivery of all roadrunner diets must be of a quality and quantity suitable to meet the animal’s psychological and behavioral needs (AZA Accreditation Standard 2.6.2). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

Food preparation must be performed in accordance with all relevant federal, state, or local laws and/or regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for greater roadrunners. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

Sample Diets: A variety of diets have been used to feed greater roadrunners in zoo settings (captured in an informal survey conducted in 2013). Most often, adult mice, crickets, mealworms, and commercial meat diets are used in various combinations, with fewer zoos using younger rodents, anoles, commercial dry feeds (insectivore, dog food, softbill bird diet, gamebird mix, etc), earthworms, superworms, waxworms, and fruit. Three sample diets are listed in Table 6 (note the variation among them). It is important to note that no commercially manufactured feeds are endorsed by their inclusion as a part of sample diets. There are many combinations of ingredients (and ingredients themselves) that can deliver appropriate nutrients for roadrunners.

Table 6. Sample daily diets offered to greater roadrunners.

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount, Zoo A</th>
<th>Amount, Zoo B</th>
<th>Amount, Zoo C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial meat mix¹</td>
<td>12 g</td>
<td>15 g</td>
<td>-</td>
</tr>
<tr>
<td>Commercial dry feed²</td>
<td>-</td>
<td>20 g</td>
<td>-</td>
</tr>
<tr>
<td>Mice, small adult</td>
<td>60 g</td>
<td>-</td>
<td>60 g</td>
</tr>
<tr>
<td>Mice, hoppers</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Crickets, adult</td>
<td>3 g</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mealworms</td>
<td>3 g</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Superworms</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Produce, assorted</td>
<td>-</td>
<td>-</td>
<td>15 g</td>
</tr>
</tbody>
</table>

¹ Commercial meat mixes are designed to meet the target nutrient values for zoo carnivores. They are most often beef, horse, and/or pork-based.

² Commercial dry feeds include pelleted and/or extruded items such as gamebird pellets, crane diet, softbill pellets, poultry layer pellets, insectivore diet, etc.

General Feeding Information and Supplementation: For most diets that meet target nutrient values, additional supplementation is not necessary. Calcium supplementation for birds producing multiple clutches may be needed in order to support appropriately calcified eggs over time. This can be readily accomplished by using a reasonable calcium source (CaCO₃ or dicalcium phosphate, as an example) to increase the calcium content of the diet to as high as 2.0-2.5% calcium (ensuring an appropriate Ca:P ratio as previously mentioned). It may be easiest to “top dress” or dust the calcium powder onto the diet (a small amount of oil works better than water for this purpose). It should be noted that for most primarily insectivorous species, insects should be gut loaded according to a proven protocol. This helps increase their calcium content and overall calcium content of the diet (Bernard & Allen, 1997).
**Provision of diet:** The diet can be offered in pans, tubs, buckets, platforms, etc. or on the ground. Individuals can be hand-fed. Diets containing raw meat need careful consideration in terms of preparation, handling, and provision. Meat is a perishable item and spoilage can occur for a variety of reasons. Meat and whole prey should be held at appropriate temperatures during thawing, preparation, and storage, and meat items should not remain at temperatures capable of promoting excessive microbial growth once offered to animals (Crissey et al., 2001). The provision of live insects can allow these birds to exhibit more "natural" feeding behaviors (note comments on gut loading).

6.3 Nutritional Evaluations

Several systems to objectively evaluate body condition have been proposed for avian species. These systems are primarily focused on passerine species that spend considerable amount of time in flight (locally or in migration) and are based on the adipose stores visible and palpable at specific landmark locations around the body. They require to have the bird in hand. This is not always appropriate or possible for greater roadrunners. In addition, because of the differences in locomotion between roadrunners and the small passerines for which the systems were developed (roadrunners “run” and have more developed leg muscles), these systems may be of decreased value. Development of a body condition scoring system for roadrunners, considering not only the pectoral muscling and adipose storage, but also the leg muscling, could be valuable.

As a general reference, roadrunners are sexually monomorphic in plumage with males slightly larger than females. Mean body weight for adult male roadrunners is reported as 320g (11.29 oz.), whereas for females it is 290g (10.23 oz.) (Hughes, 1996).

There is currently no data available on blood chemistry values in roadrunners that delineate normal values for healthy individuals, or otherwise. Serial body weight measurements (monthly) would be advisable to manage individuals throughout changing of seasons and environmental conditions.
Chapter 7. Veterinary Care

7.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices. A full-time staff veterinarian is recommended; however, in cases where this is not necessary, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and to respond to any emergencies (AZA Accreditation Standard 2.1.1). In some instances, because of their size or nature, exceptions may be made to the twice-monthly inspection requirement for certain institutions (e.g., insects only, etc.). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). All AZA-accredited institutions should adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV), available at the AAZV website under “Publications”, at http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839 (AZA Accreditation Standard 2.0.1).

It is highly recommended that greater roadrunners are observed daily by animal care staff and at least twice monthly by veterinary staff. In addition, greater roadrunners may be trained to obtain weekly weights. As with other bird species, a deviation of 10% or more in weight may precede clinical signs of disease. Weight logs should be maintained so veterinary staff can properly monitor health of the roadrunner. The AAZV is also an excellent resource for health and behavior related issues in birds.

A preventative health plan for greater roadrunners is the most ideal way to medically manage the birds. A yearly physical exam should be performed by the veterinarian with routine health monitoring diagnostics such as CBC and plasma chemistries. Fecal tests including fecal floatation and wet mounts should be performed twice yearly. Full body radiographs are ideal to monitor various health issues and serve as a baseline for comparison when health issues arise. Other aspects of the preventative health plan for greater roadrunners may include vaccination for West Nile Virus in areas of risk. Yearly veterinary review of the roadrunner’s diet is also recommended. Ideally, roadrunners are properly identified by microchip to ensure that specific individual monitoring is possible.

Protocols for the use and security of drugs used for veterinary purposes must be formally written and available to animal care staff (AZA Accreditation Standard 2.2.1). Procedures should include, but are not limited to: a list of persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure.

The current AZA Turaco/Cuckoo TAG Veterinary Advisor is Maryanne Tocidlowski. However, since there is no Veterinary Advisor to the AZA Greater Roadrunner SSP, the AZA Turaco/Cuckoo TAG recommends that veterinarians at each institution be involved in formulating their own institutional protocols for the storage and use of drugs that could be used in the care and management of greater roadrunners. Given the wide variation in veterinary practices, veterinary staff, and equipment available to veterinarians at different institutions, no greater roadrunner-specific recommendations can be made. Institutional veterinarians will also be needed to determine which drugs and medications are important for the treatment of greater roadrunners and individual animals. Any of the drugs kept in a veterinary
pharmacy may pose a toxicology hazard. Other drugs may trigger anaphylactic reactions in sensitive individuals. It is not possible to know ahead of time which animals may develop an allergic reaction.

Antimicrobials are used to treat or prevent infectious agents when appropriate. Antibiotics such as enrofloxacin, doxycycline, ceftazidime, trimethoprim sulfa, etc. are commonly used in roadrunners. Antifungals include itraconazole, amphotericin B, and topical silver sulfadiazene cream. Antiparasitic medications, including ivermectin and ponazuril, are all appropriate for roadrunners. Fenbendazole has been associated with significant immune suppression in some species of birds, but this has not been reported in roadrunners. Analgesics for orthopedic issues or other painful conditions include meloxicam, butorphanol, lidocaine, bupivacaine. Anesthetic inhalants such as sevoflurane or isoflurane have been safely used in greater roadrunners. Possible other drugs to consider include hormonal therapy like leuprolide acetate and potentially deslorelin implants (A. Siegrist, personal communication, 2015).

Whenever possible, drugs should be stored and used as recommended on drug labels. Any controlled drugs should be properly housed and documented as required by Drug Enforcement Administration (DEA) instructions. Special attention should be given to expiration dates, and unused portions of the drugs should be appropriately disposed of as required by state and federal laws.

Veterinary recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining accurate animal veterinary record keeping. All pertinent health information for greater roadrunners should be recorded in ARKS and MedARKS or another similar record keeping database as required by institutional animal recordkeeping protocols. All pertinent health information for greater roadrunners should be recorded in the Zoological Information Management System (ZIMS) or another similar record keeping database as required by institutional and animal recordkeeping protocols. ZIMS provides the opportunity to record key animal behavior information along with health records, including data collected on aggressive or abnormal behavior, and responses to enrichment initiatives, conspecifics, or heterospecifics.

Records for the entire life of each bird should be kept within institutional records. See Section 3.2 for more information.

In the event that a greater roadrunner is under veterinary care, the following information is recommended to be included in daily records: body weight, appetite, energy level, health condition, medications administered, food intake, water intake, fecal output, presence of regurgitation or abnormal symptoms and any treatments/procedures performed by the veterinarian.

7.2 Transfer Examination and Diagnostic Testing Recommendations

The transfer of animals between AZA-accredited institutions or certified related facilities due to AZA Animal Program recommendations occurs often as part of a concerted effort to preserve these species. These transfers should be done as altruistically as possible and the costs associated with specific examination and diagnostic testing for determining the health of these animals should be considered.

Pre-transfer examination of the greater roadrunner should be conducted with the same attention to detail as a normal physical examination. Prior to restraint, the greater roadrunner should be observed in its normal habitat by the veterinarian to assess body stance, gait, respiratory rate and general attitude while the animal is relaxed. Greater roadrunners are typically tolerant of manual restraint, especially when using a medium-sized towel to protect the wings and body. Care should be taken during a manual restraint event since feathers in greater roadrunners may easily fall out. A complete physical exam should be conducted and recorded to provide the veterinarian’s evaluation of vital signs (e.g. heart rate, respiratory rate, mucous membrane color, etc.) and assessment of body systems including weight and body condition score. Legs and feet should be closely examined for any swelling, lameness or bumblefoot. Careful examination of the feathers and non-feathered facial region should reveal any evidence of external parasites. If a transponder is present, the animal should be scanned to make sure the transponder is still functional and to confirm that the proper individual is being evaluated. The following tests should be conducted prior to transfer of the greater roadrunner: CBC and plasma chemistries, fecal floatation and fecal smear test, and full body radiographs. Avian DNA sexing is recommended if sex was not previously established since greater roadrunners are not obviously sexually dimorphic.

A greater roadrunner should be bright and alert and have an upright body posture. No obvious lameness when walking or standing should be observed. Eyes should be bright and nares clear of debris. Mucous membranes should be pink and sharp choanal papillae should be noted in the oral cavity. CBC
and serum chemistry reference ranges for the greater roadrunner are available from Species360 (see Appendix H).

7.3 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare (AZA Accreditation Standard 2.7.1). All quarantine, hospital, and isolation areas should be in compliance with AZA standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix E). All quarantine procedures should be supervised by a veterinarian, formally written and available to paid and unpaid staff working with quarantined animals (AZA Accreditation Standard 2.7.2). If a specific quarantine facility is not present, then newly acquired animals should be kept separate from the established collection to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

Quarantine facilities should consist of at least a 2.4 m x 1.2 m x 1.8 m (8 ft. x 4 ft. x 6 ft.) fully enclosed stall (with covered outside access if possible), with an area of soft substrate (e.g., hay) and perching availability. Upon arrival at the new destination, the bird should be let out of the crate as soon as possible. Water should be immediately available. When newly arrived birds are placed in quarantine after shipping, they may initially refuse to eat; privacy and a continuous abundance of live insects and young mice are recommended. Wild-caught birds, even those previously held in zoos, may not eat for several days. Hand-reared birds will likely eat within a day of arrival (if not sooner). If pairs arrive together, they should be housed together as this will help them acclimate faster to their new environment. Quarantine stalls should be set up with a few stumps and perches so that birds can get off the ground and perch slightly elevated. Birds arriving together may be quarantined together, but this is dependent upon the quarantine protocol of the receiving institution. If no quarantine-specific facilities are available at the institution, the decision may be made to quarantine the roadrunner in its exhibit. This may be an appropriate alternative if the following conditions can be met: no other pre-existing animals share the enclosure, exhibit access can be limited to quarantine keeper staff only, and public viewing can be withheld. Most importantly, if the roadrunner is to be quarantined on exhibit, the staff will need to be able to access the bird at regular intervals to complete quarantine requirements safely. Quarantine can be a very stressful situation for any bird, and it is important to make the bird as comfortable as possible during this period. Providing the security of a hide (e.g., plants, driftwood) is recommended, and offering favorite food items can also be considered. Stress behaviors could include pacing, lack of appetite, flying/crashing into walls, and/or lethargy (S. Hallager, personal communication, 2015). The utilization of mirrors may be successful as an alternative to a live companion bird, but staff should observe the bird closely to ensure the mirror does not serve as a source of stress.

AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals, including those newly acquired in quarantine. Keepers should be designated to care only for quarantined animals if possible. If keepers must care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the resident animals. Care should be taken to ensure that these keepers are “decontaminated” before caring for the healthy resident animals.
again. Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items must be appropriately disinfected, as designated by the veterinarian supervising quarantine, before use with resident animals.

The stall should be cleaned daily by a dedicated staff member who will ideally not be interacting with other birds throughout the day. Staff should change clothes (i.e. scrubs and booties) before and after they enter the quarantine area. Additionally, there should be a disinfectant foot bath to minimize carrying potential disease into or out of the quarantine area. Surfaces of caging and equipment should be cleaned with a disinfectant (refer to MSDS recommendations prior to use). All disinfectants have the potential to harm the sensitive respiratory systems, skin, feathers, mucous membranes and eyes of birds. The disinfectants should be used in a well-ventilated area away from birds. The activation time of many disinfectants is 10 minutes (C. Bradford, personal communication, 2016). Disinfection protocols should take into consideration the material to be disinfected, and should ensure that disinfectants are thoroughly rinsed off or neutralized before the equipment or enrichment initiative is used again with the birds.

The AZA Turaco/Cuckoo TAG recommends that veterinarians at each institution develop their own specific zoonotic disease and disinfection protocols for animal caretakers, animal management equipment, and enrichment initiatives provided in quarantine and hospital facilities. There are no significant risks of zoonotic disease transmission between people and roadrunners but effective measures that help prevent the transmission of diseases between animals include (as designated by veterinarians at each institution):

- Washing hands between and after handling animals, feces and urates, other bodily fluids or secretions, or animal diets.
- Wearing gloves, goggles, and a mask when cleaning animal enclosures.
- Wearing gloves when handling any animal tissues.

The recommended quarantine period for greater roadrunners is 30 days (unless otherwise directed by the staff veterinarian). If additional birds of the same order are introduced into their corresponding quarantine areas, the minimum quarantine period must begin over again. However, the addition of birds of a different order to those already in quarantine will not require the re-initiation of the quarantine period.

During the quarantine period, specific diagnostic tests should be conducted with each animal if possible or from a representative sample of a larger population (e.g., birds in an aviary) (see Appendix E). Animals should be evaluated for ectoparasites and treated accordingly. Blood should be collected, analyzed and the sera banked in either a -80 °C (-112 °F) freezer or a frost-free -20 °C (-4 °F) freezer for retrospective evaluation. Fecal samples should be collected and analyzed for gastrointestinal parasites and the animals should be treated accordingly. Vaccinations should be updated as appropriate, and if the vaccination history is not known, the animal should be treated as immunologically naive and given the appropriate series of vaccinations.

During the quarantine period, greater roadrunners should be given a full physical examination and tested/treated for fecal parasites. The AZA Turaco/Cuckoo TAG recommends that all institutions follow AZA Quarantine Guidelines (Appendix E), and veterinarians should develop appropriate quarantine testing protocols for their greater roadrunners. The birds should be evaluated for endoparasites and ectoparasites and treated accordingly. Endoparasites can be treated with pyrantel, ivermectin, or fenbendazole. Ectoparasites can be treated with dilute pyrethrin spray topically or systemic ivermectin. Blood should be taken for a complete blood count (CBC) and chemistry panel. Blood should also be collected, analyzed, and then both heparinized plasma and serum or plasma banking should be performed, when feasible, and stored in a -80 °C (-112 °F) freezer or a frost-free -20 °C (-4 °F) freezer for possible future analysis and retrospective evaluation.

When there is an indication, viral testing may also be appropriate (see Section 7.6 – Viral diseases in greater roadrunner). There are currently no recommended greater roadrunner-specific vaccination protocols or regulations to follow. It may be appropriate, however, that the greater roadrunner is vaccinated against West Nile Virus if the institution is located in a region of high risk. According to the CDC (Centers for Disease Control and Prevention) the greater roadrunner is listed as a species in which West Nile Virus has been detected in a dead bird (http://www.cdc.gov/westnile/resources/pdfs/birdspecies1999-2012.pdf). Birds can also be anesthetized for radiographs in order to establish a “normal” radiograph baseline, and also to check for any abnormalities, including the presence of a foreign body that the birds may have ingested in their previous
environment. While birds are anesthetized for their physical assessment, they should also be permanently identified (see Chapter 3).

Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test to yearly repetitions of diagnostic tests as determined by the veterinarian. Animals should be permanently identified by leg bands, transponders or, if necessary, marked (e.g. tattoo) when anesthetized. Release from quarantine should be contingent upon normal results from diagnostic testing and two negative fecal tests that are spaced a minimum of two weeks apart. Medical records for each animal should be accurately maintained and easily available during the quarantine period.

Quarantine release parameters for the greater roadrunner should follow the quarantine procedure and requirements for birds according to the latest AZA Accreditation Standards. The greater roadrunner may be released from its quarantine period of at least 30 days after the following are complete and results are normal: complete physical exam with normal findings, three negative fecal tests, Chlamydia testing, CBC/Serum Chemistries, and vaccination if applicable per institution.

If a roadrunner should die, a necropsy should be performed on it to determine cause of death in order to strengthen the program of veterinary care and meet SSP-related requests (AZA Accreditation Standard 2.5.1). The institution should have an area dedicated to performing necropsies, and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standards 2.5.2 and 2.5.3). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner’s wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination (see Chapter 7.6).

7.4 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.0.2). AZA institutions should be aware of and prepared for periodic disease outbreaks in other animal populations that might affect the institution’s animals, and should develop plans to protect the institution’s animals in these situations (AZA Accreditation Standard 2.0.3). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals:


Parasite screening: Greater roadrunners should be screened biannually for parasites and de-wormed if necessary.

Molt: Molt is physiologically stressful for birds. Regeneration of new feathers requires a large amount of energy. If possible, roadrunners should not be shipped during molt. Handling should be kept to a minimum to minimize damage to feathers. It is important that institutions are familiar with their normal birds’ normal molting times and plan management appropriately.

Vaccinations: Vaccination policies for greater roadrunners depend upon individual institution policies that are generally based on a risk/benefit analysis. This analysis usually involves the prevalence of the specific disease, subsequent threat of exposure, efficacy and safety of a vaccine, and risk to the bird.
Blood sampling: Blood can be taken from greater roadrunners when they are appropriately restrained (Section 7.5). Blood sampling plays an important role in assessing the overall health of individual animals. Blood samples may be collected from the jugular, medial metatarsal or ulnar veins. Appendix H lists normal greater roadrunner blood values. Additional hematological reference values for mature and growing greater roadrunners can be found in Appendix H and should be consulted to compare them with the current health status of birds as part of each institution’s preventative veterinary health program.

Medical management of hatchlings: Male and female greater roadrunners have a similar death rate during the first year of life with a Qx of 0.35 for males (N=284) and 0.33 for females (N=299) (S. Hallager, personal communication, 2015).

Information on some of the main issues encountered in the veterinary management of parent- and hand-reared chicks in zoos is provided below:

- Dehydration: Newly hatched chicks may be prone to dehydration for the first 2–3 days of life. Hand-reared chicks can be properly hydrated by dipping food items in water immediately prior to feeding. Subcutaneous fluids may need to be administered if oral hydration is not sufficient. Feces should be moist, indicating good hydration.

- Weighing and handling: Hand-reared chicks should be weighed daily. If chicks show weight loss, then supplemental feedings or medical treatment may be needed. Determination of sex can be accomplished by taking a small amount of blood for DNA sexing or by saving the egg shell and sending it in for DNA determination.

- Hypothermia: For the first couple of months after hatching, greater roadrunner chicks are sensitive to the cold. Care should be taken to provide sufficient heating, especially to debilitated chicks that are hospitalized. Managers should follow the advice of the referring aviculturist or veterinarian for temperature guidelines. Under sub-optimal temperature conditions, greater roadrunner chicks and even juvenile birds can suffer from hypothermia. Hypothermic chicks may not feed until their body temperature has returned to normal again.

Medical management of geriatrics: The greatest confirmed recorded longevities of greater roadrunners born in zoos are a male who lived for 14 years and a female who lived for 17 years (Hallager 2015). Older birds may need to be housed inside more often than younger birds during inclement weather, and may need to be supplied with supplemental heat earlier and later in the season. Assessments of the behavioral response of older birds to changing temperatures should be used to evaluate the needs of the animals. Older birds should be moved slowly when being caught or herded, as some may experience arthritic symptoms in their legs. Older birds may benefit from a daily supplement of nutraceuticals such as Cosequin® (a patented combination of glucosamine, purified chondroitin sulfate, and manganese ascorbate). Cosequin® is considered an adjunctive therapy for osteoarthritis in many species, but its use should be based on recommendations made by veterinarians. Some older birds may also be partially or totally deaf. If this is the case, animal caretakers should maintain visual contact with the birds when working within or near the enclosure to ensure that these birds are not startled during daily management. Geriatric females may need to be isolated from breeding males during the breeding season, as overly aggressive males may harass them in an attempt to copulate.

Similar equipment and technologies are recommended for the greater roadrunner as for other small to medium sized birds. This includes a gram scale with a flat or perching platform and a towel or net for restraint. Crate training for safe capture of the roadrunner is ideal to minimize potential for injury during the immobilization process. Having access to avian laboratories is necessary for monitoring blood. Radiology equipment is important since greater roadrunners may be higher at risk for orthopedic issues. No specific veterinary standards exist for the greater roadrunner. Veterinary care standards for the greater roadrunner are extrapolated from similar avian species.

Animals that are taken off zoo/aquarium grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution’s healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5). While currently there are no known roadrunners used for off-grounds programs, the potential does exist. Such
birds should be housed separately from collection roadrunners and cared for by separate staff. Birds that go off grounds for medical testing (i.e., x-rays, CT scans, etc.) should not be exposed to other birds while off grounds. If exposure is unavoidable, the bird should re-enter a quarantine period after arriving back on zoo grounds, the length of which should be determined by the staff veterinarian.

A tuberculin testing and surveillance program must be established for animal care staff, as appropriate, to protect the health of both staff and animals (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test, to annual repetitions of diagnostic tests as determined by the veterinarian. To prevent specific disease transmission, vaccinations should be updated as appropriate for the species. Staff members working with roadrunners do not need to be tested for TB (C. Bradford, personal communication, 2015).

7.5 Capture, Restraint, and Immobilization

The need for capturing, restraining and/or immobilizing an animal for normal or emergency husbandry procedures may be required. All capture equipment must be in good working order and available to authorized and trained animal care staff at all times (AZA Accreditation Standard 2.3.1).

Capture and restraint: Greater roadrunners are caught using a net with a tight mesh weave that does not allow the body, feet or head of the bird to push through the mesh, or they can be herded into a shed and captured there. Show birds may crate themselves using a recall and some are also tame enough to be approached and picked up calmly.

Flight restraint: The three main methods of flight restraint for flighted birds are pinioning, feather clipping, and the use of covered enclosures. The AZA Greater Roadrunner SSP recommends birds are left full winged in covered aviaries. Please consult Appendix K “Recommendations for Developing an Institutional Flight Restriction Policy Developed by the AZA Avian Scientific Advisory Group, December, 2013” for further information on flight restriction. Feather clipping is the recommended procedure for rendering adult birds flightless. Educating handlers on the proper techniques of catching adult birds is necessary to minimize trauma to the birds during feather clipping.

Chemical immobilization: It is recommended that institution-specific anesthesia protocols be developed for greater roadrunners by veterinarians at each institution, and that effective protocols should be shared with the AZA Turaco/Cuckoo TAG for wider dissemination.

Release/recovery: When recovering a bird from anesthesia, it will be necessary to manually restrain the bird until it is stable enough not to injure itself upon release. Birds recovering from anesthesia should be manually restrained using firm, constant pressure, and the body and legs of the animals should be carefully controlled to restrict any sudden outbursts of energy. Covering the eyes of the bird with a hood or towel will help in reducing this reaction (ensuring that the nares are not covered). The chest area and keel needs to be free to move with respiration, and respirations should be watched closely during the recovery period. Once the animal has fully recovered from anesthesia, it can be released, as long as the bird has regained sufficient control of its legs to be stable.

7.6 Management of Diseases, Disorders, Injuries and/or Isolation

AZA-accredited institutions should have an extensive veterinary program that manages animal diseases, disorders, or injuries and has the ability to isolate these animals in a hospital setting for treatment if necessary. The owner of an animal on loan at a facility is to be consulted prior to any elective invasive procedures, including permanent contraception.

Greater roadrunner care staff should be trained in meeting the animal’s dietary, husbandry, and enrichment needs, as well as in restraint techniques. Staff should also be trained to assess
animal welfare and recognize behavioral indicators animals may display if their health becomes compromised; however, animal care staff must not diagnose illnesses nor prescribe treatment (AZA Accreditation Standard 2.1.3). Protocols should be established for reporting these observations to the veterinary department. Hospital facilities for greater roadrunners must have radiographic equipment or access to radiographic services (AZA Accreditation Standard 2.3.2), contain appropriate equipment and supplies on hand for treatment of diseases, disorders or injuries, and have staff available that are trained to address health issues, manage short and long term medical treatments and control for zoonotic disease transmission.

Like many birds, greater roadrunners can be very good at hiding an illness (Hallager, personal observation 2015). For this reason, animal caretakers should be especially vigilant, and immediately communicate their concerns to a curator and/or veterinarian, as required by institutional protocols. Animal caretakers should report any signs of illness, especially a reduced appetite, as soon as possible. Greater roadrunners usually have a very good appetite, and any deviation from this behavior is unusual and should be reported at once. Any lameness issues observed should also be reported and monitored, as greater roadrunners can develop foot and leg problems. If these musculoskeletal health issues are detected early, more serious physical health complications can possibly be avoided. Familiarity with individual birds is essential when caring for this species effectively (Hallager, personal observation 2015).

**Trauma:** Greater roadrunners are generally hardy birds, but individuals can sustain life-threatening trauma such as puncture wounds, or compound fractures of legs or wings. The complications resulting from these injuries can be made worse if individuals are housed with incompatible enclosure-mates. In response to stressors in the environment, roadrunners will run into or pace against the perimeter fencing or walls of their enclosures in attempts to flee from the stressor (or potential stressor). Excessive pacing may also lead to compaction of the soil, which can be a contributing factor to lameness and pododermatitis (bumblefoot) in these birds. Roadrunners seem particularly prone to leg fractures, the exact cause of which is currently being investigated (S. Hallager and T. Grand, personal communication, 2014).

Ingestion of certain non-food items by roadrunners can lead to perforation or impaction of the gastrointestinal tract, and can be a significant source of morbidity and mortality. Clinical signs of possible gastrointestinal trauma associated with the ingestion of foreign objects can include decreased appetite, poor pectoral muscle condition, weight loss, palpable abscesses in the abdominal wall, and hematological indicators associated with an inflammatory response.

**Viral diseases:** Roadrunners, like other birds, may be susceptible to West Nile Virus, avian paramyxovirus, Avian Influenza, Avian pox and Newcastle’s disease. Generally, supportive care is recommended for viral disease in avian species. There is little published information on the use of antiviral medications in birds (C. Bradford, personal communication, 2016).

**Bacterial diseases:** A wide variety of pathogenic or opportunistic bacteria can infect roadrunners. Bacterial infections may be treated with a broad spectrum antibiotic until culture and sensitivity results are available. Culture and sensitivity testing is recommended when possible for significant infections (C. Bradford, personal communication, 2016).

**Fungal diseases:** Greater roadrunners are likely susceptible to aspergillosis, however, a roadrunner’s natural environment is generally arid and not conducive to most fungal elements. Exposure to an overwhelming spore load and/or a suppressed immune system could likely induce infection in roadrunners. Diagnostics include a complete blood count, biochemistry panel, aspergillosis antigen and antibody levels, protein electrophoresis, radiography and/or endoscopy, and fungal culture. Because the disease is often advanced by the time the bird exhibits signs of illness, aspergillosis may be diagnosed post-mortem. Treatment is difficult and may include systemic antifungal agents, such as itraconazole, topical application of antifungal agents to granulomas using endoscopy, or nebulization with antifungal agent such as terbinafine. Similar treatment methods can be used as with other avian species. Prevention of aspergillosis can be attempted through adequate ventilation, removal of decaying organic debris, and monitoring risk through fungal spore surveys, including air spore sampling (Dykstra, 1997; Faucette et al., 1999).
Protozoal diseases: Greater roadrunners are likely susceptible to the same protozoal diseases as other birds (e.g. giardia, avian nematodes, etc.). Metronidazole, sulfa drugs, ponazuril, and fenbendazole have been used successfully in birds. Caution should be used with fenbendazole as it has caused bone marrow suppression in several species (C. Bradford, personal communication, 2016).

Parasites: Greater roadrunners are likely susceptible to the common avian ectoparasites and endoparasites. Sticktight fleas (Echidnophaga gallinacea) have been noted on roadrunners, especially on the nonfeathered areas of the face and periocular region (C. Bradford, personal communication, 2015). Enteral or parenteral ivermectin or topical carbaryl (Sevin dust) may be used to treat sticktight fleas, in addition to environmental management (C. Bradford, personal communication, 2016).

Metabolic disorders: Developmental metabolic bone disease has occurred with hand-raised roadrunner chicks. This condition may be due to hypocalcemia, hypovitaminosis D, or a combination of both. It is recommended to supplement with both calcium and vitamin D if feeding neonatal mice to roadrunner chicks. In addition, soft shelled eggs may be produced if a female’s calcium status is less than ideal. Metabolic bone disease may be treated with enteral or parenteral calcium with or without vitamin D, depending upon the husbandry issues contributing to the disorder (C. Bradford, personal communication, 2016).

Musculoskeletal disorders: Leg fractures and soft tissue trauma to the legs are fairly common in roadrunners. Trauma may be sustained from self-inflicted running into objects, from enclosure-mates, or from predators. Fractures may be treated with internal or external coaptation, analgesics and antibiotics as necessary (C. Bradford, personal communication, 2016).

Hereditary issues: There are no known hereditary diseases or disorders that have been reported in greater roadrunners.

Hospitalization: Greater roadrunners that have to be hospitalized benefit from surroundings that are free from noise and disturbance. While hand-reared or zoo-born birds are not as stress-prone, they should not be housed in areas where sudden noise or frequent disturbances are a possibility. Sudden and unexpected noises have the potential to lead to injury and death to birds in unfamiliar surroundings. During hospitalization, hand-reared birds may benefit from increased visits by keepers, the installation of a mirror within their hospital enclosure, an increase in favored food items, and quiet surroundings. The response of the animal to a mirror should be monitored to ensure that it is not seen as an additional stressor. Wild-caught birds may benefit from a reduction in keeper presence, and environments as free from noise and disruption as possible. Hospitalization facilities for greater roadrunners do not need to be elaborate or expensive.

Appropriate pen sizes are 2.4 m x 1.2 m x 1.8 m (8 ft. x 4 ft. x 6 ft.). Perches of varying texture should be provided at several different levels. When birds are housed within specific hospital enclosures, stays should be as short as possible and the birds returned to their normal enclosures as soon as possible. While housed in hospital facilities, favored food items should be offered to encourage eating. The presence of a familiar keeper may also help some birds adjust to their temporary quarters.

AZA-accredited institutions must have a clear and transparent process for identifying and addressing greater roadrunner animal welfare concerns within the institution (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee. This process should identify the protocols needed for animal care staff members to communicate animal welfare questions or concerns to their supervisors, their Institutional Animal Welfare Committee or if necessary, the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues, coordination and implementation of appropriate responses to these issues, evaluation (and adjustment of these responses if necessary) of the outcome of these responses, and the dissemination of the knowledge gained from these issues.

Given the wide variety of zoos that house greater roadrunners, the AZA Turaco/Cuckoo TAG cannot provide specific recommendations for the best approaches to take to communicate animal welfare issues effectively within every institution. All animal caretakers that work with roadrunners should be aware of...
institutional protocols in place for them to identify, communicate, and address potential animal welfare issues that are associated with the care and management of these animals. There are no specific protocols for reporting welfare concerns for roadrunners and each individual institution’s policies should be followed. If necessary, the AZA Greater Roadrunner SSP should be contacted.

**Death and Necropsy:** AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support greater roadrunner longevity. In the occurrence of death however, information obtained from necropsies is added to a database of information that assists researchers and veterinarians in zoos and aquariums to enhance the lives of greater roadrunners both in their care and in the wild. As stated earlier, necropsies should be conducted on deceased greater roadrunners to determine their cause of death, and the subsequent disposal of the body must be done in accordance with local, state, or federal laws (AZA Accreditation Standards 2.5.1 and 2.5.3). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner’s wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination. Many institutions utilize private labs, partner with Universities or have their own in-house pathology department to analyze these samples. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA Greater Roadrunner SSP Program approved active research requests that could be filled from a necropsy.

The AZA Turaco/Cuckoo TAG does not currently have any specific recommended protocols for greater roadrunner euthanasia within zoos. Each institution housing greater roadrunners should have a euthanasia protocol in place, developed by the veterinary team, in case euthanasia becomes necessary in a particular situation. The AZA Animal Welfare Committee also encourages each institution to develop a process to determine when elective euthanasia might be appropriate from a quality of life perspective, taking into account behavioral, health, social, nutritional, and animal caretaker perspectives. Examples of approaches used by institutions are available from the AZA Animal Welfare Committee. Greater roadrunners display normal avian anatomy, which should be reflected in histopathological results.

Shipment and quarantine is a stressful time for avian species and underlying disease not detected prior to shipment may result in death. Stress also suppresses the immune system, making birds more susceptible to disease such as aspergillosis. Birds that die during quarantine should be necropsied as soon as possible. Post-mortem examination should include assessment of body weight and condition. Tissue samples should be placed in formalin for histopathology and should include the following: brain, eye, tongue, skin, muscle, bone, trachea, esophagus, proventriculus, ventriculus, intestine, pancreas, heart, lung, thyroid, liver, kidney, adrenal, spleen, and gonad. In certain cases it may be advisable to obtain samples for culture or to freeze tissue for additional testing. A pathologist familiar with avian pathology should perform histopathology.

The AZA Greater Roadrunner SSP Coordinator is currently conducting a research study into the apparent high incidence of leg fractures in the species. This study examines deceased roadrunners (terrestrial cuckoo) and deceased guira cuckoos (arboreal cuckoo) to determine if anatomy plays a role in the high incidence of leg fractures in roadrunners. The theory is that the high ratio between muscle and bone in roadrunners leads to a high and abnormal rate of stress/compression fractures. Institutions should contact the SSP Coordinator when a bird dies to determine if the bird is a suitable candidate for the study (S. Hallager and T. Grand, personal communication, 2015).

The Greater Roadrunner Studbook (2016 studbook data) lists the following causes of death for roadrunners in human care (n=608). Facilities are encouraged to report the cause of death so that a more accurate understanding of mortality can be tabulated.

<table>
<thead>
<tr>
<th>Circumstance of death</th>
<th>Total number of deaths recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euthanasia - medical</td>
<td>115</td>
</tr>
<tr>
<td>Euthanasia - cull</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 7. Cause of death of roadrunners in zoos and aquariums (2016 studbook data)
Self Inflicted Injuries | 20 | 3%  
Injury from Exhibit Mate | 50 | 8%  
Malicious Destruction | 6 | 1%  
Old Age | 1 | 0%  
Infection Associated | 64 | 11%  
Injury from Predator | 25 | 4%  
Env. or Beh. Conditions | 16 | 3%  
Dead in shell (DIS) | 2 | 0%  
Late dead embryo | 0 | 0%  
Anesth./Restraint Assoc. | 10 | 2%  
Died in Transit | 2 | 0%  
Stranded/Beached | 0 | 0%  
Other/Unknown | 297 | 49%  

Table 8. Common normal and abnormal gross and histopathological results at necropsy are as follows (2016 studbook data)

Necropsy Code-Topographic  
Generalized | 111 | 18%  
Integumentary | 3 | 0%  
Musculoskeletal | 72 | 12%  
Respiratory | 25 | 4%  
Cardiovascular | 9 | 1%  
Hemic and Lymph | 3 | 0%  
Digestive | 28 | 5%  
Urinary | 7 | 1%  
Endocrine | 0 | 0%  
Nervous | 12 | 2%  
Reproductive | 14 | 2%  
Sense Organs | 4 | 1%  
No Necropsy Planned | 198 | 33%  
Necropsy Planned Later | 8 | 1%  
Unknown (after Necropsy) | 108 | 18%  
Necropsy done (no info) | 6 | 1%  

Necropsy Code-Etiological  
Genetic and Prenatal | 7 | 1%  
Bacterial | 20 | 3%  
Fungal | 6 | 1%  
Metazoan | 1 | 0%  
PPLO | 5 | 1%  
Protothecal | 0 | 0%  
Protozoan | 3 | 0%  
Rickettsial | 5 | 1%  
Viral | 3 | 0%  
Toxicity | 3 | 0%  
Trauma | 131 | 22%
Circulatory, secondary 5 1%
Enervation, secondary 0 0%
Mechanical Abnormality 45 7%
Metabolism 11 2%
Nutrition 8 1%
New Growths 10 2%


<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths within 1 day</td>
<td>32</td>
<td>6%</td>
</tr>
<tr>
<td>Addl deaths within 1 week</td>
<td>58</td>
<td>11%</td>
</tr>
<tr>
<td>Addl deaths within 1 month</td>
<td>49</td>
<td>9%</td>
</tr>
<tr>
<td>Addl deaths within 1 year</td>
<td>69</td>
<td>13%</td>
</tr>
</tbody>
</table>

Total number of hatches recorded: 544
Total number of deaths recorded: 429
Chapter 8. Reproduction

8.1 Reproductive Physiology and Behavior

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of the animals in our care. This knowledge facilitates all aspects of reproduction, artificial insemination, birthing, rearing, and even contraception efforts that AZA-accredited zoos and aquariums strive to achieve.

Greater roadrunners are monogamous and are believed to maintain long-term pair bonds (Whitson 1971). Therefore, pairs should be kept together year-round. Eggs can be laid as early as April in northern parts of roadrunner range and as late as October in more southern zones. The average age for first breeding is 2 years, 8 months for females and 3 years, 2 months for males, although both sexes have bred at 6-7 months of age (Hallager, 2015). Birds do not need extended periods of introductions or housing before breeding will occur, and most roadrunners in zoos breed readily (S. Hallager, personal observation, 2016). New pairs are best introduced during the non-breeding season when reproductive hormone levels are at their lowest.

Pair formation and behavior: Hormonal studies have not been conducted on roadrunners to determine exact timing of reproductive onset. Therefore, managers should observe birds for signs of pairing such as foraging behavior, chasing, stick-carrying and vocalizations. During pair formation, males and females forage together, usually 5–30 m (16–98 ft.) apart, exchanging acoustic signals. Preliminary courtship displays include ground chases, often lasting several hours, with both birds stopping frequently to rest and running interspersed with low gliding flights. The pursuing bird lunges at the forward bird with wings and tail raised and fanned. A “clack” vocalization is frequently given by both birds during the courtship. The male gives a “coo” call from an elevated perch. In “Stick-Offer Display”, either sex approaches its mate carrying a stick in its bill, and drops the stick in front of its mate or transfers it to its mate’s bill. This display may stimulate and synchronize nest-building efforts in the pair (Whitson, 1971).

Precopulatory displays precede copulation by several minutes. The male performs the “Prance Display”, in which he runs from his mate with lifted wings and tail, then lowers his wings and brings them close to his body with a pop sound. The display contains four or five wing-raising cycles (lasting about 2.5 minutes total). The closed tail is held over the body in early cycles and gradually lowered in later cycles. The postorbital apteria are maximally exposed, the crest is erected, and contour feathers are sleeked. The “Tail-Wag Display” by the male consists of horizontal wagging of the tail while the head is intermittently bowed and slowly lifted. The male faces the female during this display with fully exposed postorbital apteria and erect crest. A “whirr” call is given. The male usually holds food or plant material in his bill (lizards 40% of the time, nesting material 18%, snakes 5%, grasshoppers 5%, and nothing 31% of the time) to present to the female. During the male’s “Tail-Wag Display”, the female flicks her tail rapidly in a vertical plane with her crest fully erect and postorbital apteria exposed. This is usually followed by mounting (Whitson, 1971, 1975).

Copulation: During copulation, the male mounts the female from the rear with a 0.5–1 m (1.6–3.2 ft.) jump into the air. Rapid wing-flapping accompanies descent and may continue to aid in balancing after the male lands on the female’s humeral areas. The male’s crest is fully erect and postorbital apteria are maximally exposed (Whitson, 1971). During copulation, the male gives “whirr” vocalizations. Cloacal contact occurs as the male’s tail is swung forward and upward. The female rises from the substrate and lifts her bill toward the offered food item. Both animals will hold the food for a short time before the male releases it. Copulation typically lasts a total of 2–3 minutes. Copulation may occur throughout the daylight hours, most frequently in the afternoon, and generally within 20 m (65.6 ft.) of the nest site. Greater roadrunners copulate during all breeding phases, but with decreasing frequency immediately following egg-laying (Whitson, 1975). Following dismount, both sexes have their tails raised and crests partially erect. The male begins to circle the female. At intervals, he stops, bows, lowers his wings, and gives a single “coo” call, then rapidly flicks his head and tail upward, fully erecting his crest and exposing the postorbital apteria during the flick of the tail (“Flick-Bow Display”). The female remains stationary and flicks her tail either simultaneously or alternately with the male. After this display, both birds walk away in opposite directions. The female will eat the presentation food, or feed it to the young if copulation has occurred after hatching (Whitson, 1975).
The AZA Greater Roadrunner SSP recommends hand-rearing primarily for birds that are destined for ambassador purposes. For future breeding success, chicks should be parent-reared whenever possible. However, sometimes hand-rearing is required when one chick is weak or not receiving proper care from its parents. Future breeding is not necessarily compromised when chicks are hand-reared and should be attempted particularly from pairs that have been recommended to breed by the SSP Coordinator (S. Hallager, personal communication, 2015). A detailed hand-rearing protocol can be found in Appendix I.

8.2 Assisted Reproductive Technology

The practical use of artificial insemination (AI) with animals was developed during the early 1900s to replicate desirable livestock characteristics to more progeny. Over the last decade or so, AZA-accredited zoos and aquariums have begun using AI processes more often with many of the animals residing in their care. AZA Studbooks are designed to help manage animal populations by providing detailed genetic and demographic analyses to promote genetic diversity with breeding pair decisions within and between our institutions. While these decisions are based upon sound biological reasoning, the efforts needed to ensure that transports and introductions are done properly to facilitate breeding between the animals are often quite complex, exhaustive, and expensive, and conception is not guaranteed.

AI has become an increasingly popular technology that is being used to meet the needs identified in the AZA Studbooks without having to re-locate animals. Males are trained to voluntarily produce semen samples and females are being trained for voluntary insemination and pregnancy monitoring procedures such as blood and urine hormone measurements and ultrasound evaluations. Techniques used to
preserve and freeze semen have been achieved with a variety, but not all, species and should be investigated further.

Besides physical issues, AI procedures also bring issues of ownership of semen and/or the animal being inseminated. Very often, semen from multiple animals may be used. As with any natural (physical) breeding, the rights of the owners of all materials and animals involved need to be considered. Appropriate transaction documents (and loan agreements, if appropriate) should be fully completed before AI is attempted. Artificial insemination has not been performed with greater roadrunners in AZA-accredited institutions, and given the high availability of birds from rehab centers, is not a necessary procedure.

8.3 Egg-laying/Parturition

**Nest construction:** Females do almost all of the nest construction. The male brings nest material to the site. Nest-building may continue through most of the incubation period (Woods, 1960). The height of the nest walls may be increased as nestlings grow larger and occupy a greater proportion of the nest (Calder, 1967a). Nests are shallow but compact platforms constructed of thorny sticks loosely laid together, with a lining of finer material such as leaves, grass, feathers, mesquite pods, snakeskin, roots, and dry flakes of cattle and horse manure. Larger sticks towards the outside of the nest grade to smaller ones placed towards the center. The outside diameter measures about 30 cm (12 in.), but may exceed 45 cm (18 in.). The outside depth is 15–20 cm (6–7.8 in.) (Sutton, 1940). Some nests are situated so that bands of shade can cross them during the hottest part of the day as a cooling aid for nestlings (Ohmart, 1973). Others are more or less uniformly shaded by foliage, with only small rays of sunlight penetrating to the nest surface. A dappled light pattern shades nestlings and helps conceal the incubating parent. Occasionally, nests are reused in subsequent breeding seasons (Folse, 1974). Only rarely do roadrunners reuse a nest within a breeding season (Woods, 1960; Meinzer, 1993). Old nests may be used for winter roosts (Rylander, 1972).

**Egg-laying:** Commonly, one egg is laid every other day. The average clutch size of birds in U.S. zoos is 2.3 (n=192 clutches) (Hallager, 2015). Incubation is carried out by both sexes and lasts 17 to 20 days. Incubation is continuous and begins after the first egg is laid (Folse, 1974). If desired, and to allow chicks to hatch at the same time, eggs may be pulled when they are laid and replaced with dummies in the nest. Place the eggs on their side on a clean paper towel, in an area with a temperature of 12.7-18.3 °C (55-65 °F). Rotate the eggs by hand twice daily. Return the eggs to the nest when the clutch is complete.

Chicks that hatch several days before their sibling will be much larger (see Figure 5 at right). This may lead to food competition in the nest and reduced survival of the younger chick.

A brood patch is present in both sexes during breeding season. The incubating parent will not leave the nest until the other parent arrives to relieve it. Only the male incubates at night. Although the body temperature of females and non-breeding males drops at night, the body temperature of incubating males remains constant. Overnight incubation is expensive metabolically and incubating males expend about 36% more energy than non-incubating females. Breeding males have conspicuous fat deposits and are significantly heavier than nonbreeding males or post-laying females (Vehrencamp, 1982). Nesting pairs should be given privacy as soon as the eggs are laid. All unnecessary yard work should cease until chicks have fledged. Parents disturbed by normal yard maintenance during the incubation period, and
when chicks are small, may eject or reject the eggs from the nest or abandon chicks (S. Hallager, personal communication, 2015).

**Incubation parameters:** Incubation is optimal at 99.5 °F (37.5 °C), with a relative humidity between 50–60% although one zoo had success with 98.5 °F and 45% relative humidity (T. Henderson, personal communication, 2016). Most chicks will be positioned correctly and pip into the air cell. Those that pip at some other location can still be easily hatched with assistance. Incubation time is approximately 17.5 days. Chicks will often hatch overnight in the incubator. Once the chick is in the air cell, turning by the incubator needs to stop because the actual time in the air cell before hatch seems to be quite short. Exact data is not available because many of the steps to hatching occur overnight. But 12–15 hours in the air cell seems probable followed by an external pip-to-hatching time of 12–15 hours at the outside range. Once the chick starts turning in the shell, hatching occurs shortly thereafter (P. Shannon, personal observation).

**Condition at hatching:** Roadrunner chicks are altricial, but strong and active upon hatching. They respond to touch by gaping. Their eyes are closed (Muller, 1971). Their skin and legs are black and the skin has an oily appearance to it. The apteria are bare. A light-colored egg tooth is noticeable (Sutton, 1940). Weight at hatching averages 14 g (0.5 oz.). The body temperature of chicks is 40.6 °C (105 °F) and they should feel hot to the touch. Birds which refuse food should be evaluated for temperature, hydration, and overall physical condition (P. Shannon, personal communication, 2015).

Chicks seem to do better after hatching in a hot incubator (35.2°C–35.5°C (95.5 °F – 96°F)). If the chick is too cool, it will be sluggish and not respond adequately to stimulation. If successive chicks are being housed together, the older chicks can tolerate these high temperatures for 6 to 7 days without any apparent ill effect (P. Shannon, personal communication, 2015).

**Growth and Development:** See Appendix J for weights of ex situ chicks. Chicks hatch quickly. They are vocal in the air cell. The time from external pip to hatching is typically about 12 to 15 hours. Chicks hatch completely dry. The black skin is covered in sparsely placed stiff white feathers and the eyes are closed. At 3 days, sheathed tips of primary and rectrices feathers beginning to emerge. At 4 days, tips of secondary feathers are visible, there is improvement in the muscular control of the neck, and the eyes open. At 5 days, chicks can begin to focus on incoming food.

At 6 days pinfeathers start emerging on all pterylae. The nestling will gape and flutter its wings in response to visual stimulation, and produce a hissing sound. It can rise on tarsometatarsus and will exhibit a strong grasping reflex when lifted. It has greater control of its head and neck movements. The chicks will start to reach for and take food from forceps, as opposed to gaping and waiting for food to be placed in the mouth. After 8 days, the chicks can move around the enclosure. Their legs and feet are disproportionately large. Chicks will start to take food in the tip of the bill and then swallow it, although gaping continues. They will also be sitting up on their hocks at this age. At 10 days, chicks will not be standing yet, but will be very mobile, moving around the nest bowl easily. The chicks will try to out-compete each other to grab food, although there does not appear to be any direct chick-on-chick aggression. If feeding has been delayed and chicks in the groups are very hungry, larger chicks will try to swallow fingers or heads of smaller chicks. Anything within reach will be potential food items. At 11 days most feather tips are visible and chicks are able to walk around on their feet. Their feet change from black to gray in color, and ventral portions of feet and toes are flesh-colored. Twelve days after hatching, chicks should be hopping in and out of the nest container easily. At 14 days, all feathers clear of their sheaths except the primaries, secondaries, and rectrices. Natal hairs are still visible on the distal ends of feathers. The chicks start to show the plumage color patterns of an adult and the orange portion of the postorbital apteria is present. Chicks should be standing easily at this point. They may start to exhibit sunning behavior as well. They may pick up food items and play with them, but rarely swallow the food. At 16 days, the chicks can clack their bills and
exhibit tail-bobbing and crest-raising behaviors. They are able to run rapidly with full-legged strides. They can make simple preening motions as well. The young will continue to beg, but they can pick up and swallow some food items. At 21 days of age, chicks begin to whack and eat their prey and by 4 weeks, they are able to kill live prey (Hughes, 1996; P. Shannon, personal communication, 2013).

**Brooding:** Adults shade the chicks by spreading and drooping their wings slightly. The male broods the chicks throughout night and is relieved by the female shortly after dawn (Ohmart, 1973). During the first few days following hatching, at least one parent tends to the nest, brooding or shading the young (Whitson, 1975). After the youngest nestling is about 4 days old, however, the parents are frequently absent from the nest, but resume brooding about 2 hours before sunset (Folse, 1974). The change in the overall brooding pattern corresponds with the nestlings’ rapidly increasing food requirements, more favorable surface-mass ratio to reduce heat loss, and development of heat dissipation mechanisms (Ohmart, 1973).

**Feeding:** Both parents bring food to the nest. The male provides slightly more, and larger, prey items (Ohmart, 1973). The adults utter a series of soft coos to elicit gaping from the chicks (Calder, 1967a). Newly hatched young are generally fed insects. Older chicks are often fed reptiles (Woods, 1960; Ohmart, 1973; Folse, 1974; Meinzer, 1993). Food demands peak as the chicks approach 7 days of age (Ohmart, 1972). During this period, parents spend most of the day foraging separately to feed the young (Whitson, 1975). The most active foraging occurs between 07:00 and 13:00, corresponding to the period of greatest reptile activity (Folse, 1974). Upon return to the nest, the parent may inspect the chicks by picking them up by the head. Overly lethargic nestlings that do not beg for food are tossed into the air and swallowed whole by the parent, or fed to stronger nestlings (Ohmart, 1989).

**Nest sanitation:** Adults eat the fecal sacs immediately following defecation by nestlings (Calder, 1967a).

**Departure from the nest:** Adults give a series of soft coos to call the young to fledge from the nest. Young chicks will leave the nest between 14–25 days. Fledglings perch in a nearby tree for about one day. Once they leave the nesting tree, they remain undercover in the vicinity for several days. Each day, parents coax them farther from the natal nest site by offering food and emitting muffled purring calls (Meinzer, 1993). According to Ransom (as cited in Ledbetter, 2009) juvenile dispersal has been documented up to 6 miles from the natal home range.

**Growth:** Mean weight at fledging is about 11 times the hatching weight, but still only 50% of the average adult weight (Ohmart, 1973). By 24 days of age, the young seldom beg for food. They can fly and perch on their own at this point. Overall, they resemble adults but are smaller, with dark eyes, and at about 75% growth in the tail. At 60 days, the size and appearance is almost indistinguishable from that of an adult (Muller, 1971).

### 8.4 Hatching Facilities

As hatching approaches, animal care staff should ensure that the mother is comfortable in the area where the hatch will take place, and that this area is “baby-proofed.” Particularly with first-time parents, it is important to monitor the nestlings to ensure chicks are vigorous and determine whether parents are feeding successfully. Chicks in a parent-rearing situation can be easily supplemented with food in the

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nest up to the age that they start moving beyond the edge of the nest (P. Shannon, personal communication, 2013).

All roadrunners housed as breeding pairs should be provided with adequate nesting material and proper nesting locations to stimulate pair bond formation and nesting. Pairs currently not recommended to breed should have eggs replaced with artificial eggs to encourage development of the incubation experience by the pair. To ensure proper nest construction, pairs should be provided with a variety of small sticks (0.2–0.8 cm (0.08–0.3 in.)), leaves, grass, and even feathers. Many sham nests are started before the final site is selected by the female. A suitable-sized nest will be 30–45 cm (12–18 in.) in diameter with an inside depth of 5–10 cm (2–4 in.). In the wild, nests are usually located in thickets of small trees and bushes about 1–3 m (3.3–9.8 ft.) above the ground. They are situated close to an open or short-grass area (Folse, 1974), which is required for courtship display and foraging. Keepers should try to replicate this in roadrunner enclosures as much as possible.

Roadrunner chicks typically fledge between 14–25 days. Fledglings perch in a nearby nesting tree for about a day. Once they leave the nesting tree, they remain undercover in the vicinity for several days. It is best to allow fledglings to remain with parents for at least 3 months post-fledging to allow the juveniles to develop the skills needed for adult life. Adults chase and attack immature birds to drive them from their natal territory, and while they rarely inflict harm, offspring should nonetheless be removed from the enclosure where they hatched at no later than 5 months of age. Roadrunners can breed as young as 6 months (S. Hallager, 2015).

8.5 Assisted Rearing

Although dams may successfully hatch eggs, there are times when they are not able to properly care for their offspring, both in the wild and in ex situ populations. Fortunately, animal care staff in AZA-accredited institutions are able to assist with the rearing of these offspring when deemed necessary.

Artificial incubation: The following table provides a summary of the artificial incubation protocols for greater roadrunner eggs used at six AZA Accredited Institutions.

Table 10. Artificial incubation protocols for greater roadrunner eggs at AZA-accredited institutions (Hallager, unpublished data).

<table>
<thead>
<tr>
<th>AZA Facility</th>
<th>Temperature (°C/°F)</th>
<th>Relative Humidity %</th>
<th>Incubator type</th>
<th>Hatching Temperature (°C/°F)</th>
<th>Hatching Relative Humidity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoo A</td>
<td>37.5/99.5</td>
<td>45–60</td>
<td>Grumbach</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Zoo B</td>
<td>37.5/99.5</td>
<td>55–60</td>
<td>Grumbach and Humidaire GQF</td>
<td>37/99</td>
<td>&quot;higher&quot;</td>
</tr>
<tr>
<td>Zoo C</td>
<td>37.5/99.5</td>
<td>55–60</td>
<td>GQF</td>
<td>37/99</td>
<td>65–70</td>
</tr>
<tr>
<td>Zoo D</td>
<td>37.5/99.5</td>
<td>50–60</td>
<td>Brinsea octagon 20 OX and GQF 1500 Pro</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Zoo E</td>
<td>37.5/99.5</td>
<td>47–50</td>
<td>R-Com 20</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Zoo F</td>
<td>98.5</td>
<td>45</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
</tbody>
</table>

When greater roadrunner eggs are artificially incubated, an average weight loss of 12–14% should be expected. If artificially incubated greater roadrunner chicks do not hatch within established pipping intervals, or seem to be weak, then it is possible to perform radiography, endoscopy, and ovotomy to determine the status of the embryo. Assisted hatching techniques can be successful, but lead to lower survival of chicks (see Bailey & Anderson, 2000 for details on this process in bustard eggs).

Hand-rearing: Hand-rearing should be considered, and is strongly recommended, for any situation where greater roadrunner enclosures are not predator-proof. Greater roadrunner chicks are vulnerable to predation by bird and mammal species that commonly occur in and around zoos in the United States. Hand-rearing should also be considered when parents do not show normal chick rearing behaviors. Complete day-to-day hand-rearing protocols for greater roadrunner chicks are summarized in Appendix I.
**Diet:** Newly hatched chicks begin to feed within a couple hours of hatching. Caretakers should resist the urge to feed too often (even though chicks beg) to ensure that food is properly processed by the gut. Frequency and consistency of fecal output is the major factor to monitor. After the first few feedings, a large fecal sac should always be produced after a feeding event. If this doesn’t happen, or the product is small and dry, the chick is dehydrated. Feedings need to be done quickly and with confidence, because if the chick defecates, it is hard to get it to beg again for a while. In the early days (day 1-3), dipping the food items in Pedialyte® is the easiest way to supply moisture. If the feedings are consistently loose, smelly, and brown, there is another problem. In most chicks, the brown smelly fecals should pass in a day or so. If it persists, a veterinarian should be consulted (personal communication, P. Shannon 2016). Most chicks hatch in the incubator overnight, so they should be fed immediately after the initial weight is taken. Chicks that hatch during working hours should be given a couple hours to stabilize and then fed. Initial diet consists of a mouse pinkie piece and/or soaked Science Diet pellets. Pinkie pieces are always dipped in Pedialyte® or reverse osmosis water to promote hydration. The Science Diet pellets are pre-soaked in water for two and a half to three hours prior to feeding so that pieces are moist and soft. Because feedings are about three hours apart, commencement of soaking following each feeding is ideal. Newly hatched chicks can only swallow part of a pellet. Within a day, they can swallow whole soaked pellets. Feedings can include both pinkie and pellets. At about 5–6 days, a dusting of powdered calcium is added. At 9–10 days, the diet can start shifting to fuzzies. Then as the chicks develop, add small chopped mice, then ultimately whole mice, to the diet. Some chicks will accept ground meat as they near weaning and self-feeding (P. Shannon and S. Collinsworth, personal communication, 2013).

**Housing:** Chicks seem to do better after hatching in a hot brooder at 35 °C (95.5 to 96 °F). If the chick is too cool, it will be sluggish and not respond adequately to stimulation. If successive chicks are being housed together, the older chicks can tolerate these high temperatures for 6 to 7 days without any apparent ill effect. The chick’s nest structure cannot be smooth, as the chick needs something secure to push against as it develops in order for the legs to develop normally (P. Shannon and S. Collinsworth, personal communication, 2013). Figure 9 at the right shows a chick in a small cup resting on rubber shelf liner. The rubber lining reduces the incidence of splayed legs (T. Henderson, personal communication, 2016).

**Fecals:** The first fecals occur after a couple of feedings. These first one or two fecals are typically watery with some urates. There will not be any dark material for several fecal cycles. By the third fecal, solids begin to appear. The first few fecals with dark solid material can be unformed and stringy. The fourth or fifth fecal should present in the typical sac. At early ages, as little as one piece of food stimulates production of a fecal. As they get older, chicks may not defecate at every feeding but rather at every other feeding. This probably depends on the “fullness” of the chick from the previous feeding. Whenever a fecal opportunity is skipped, the next fecal will typically be larger than normal. At all ages, chicks will generally try to orient themselves toward the edge of the container/nest bowl to deposit fecals over the edge if they can. Some chicks will spin frantically to find the “edge” before passing the fecal sac. Fecal material can occasionally go through a brown smelly stage. As long as the chick continues to respond to stimulation and eats well, these periods pass without need for medical attention. As they get older, they may defecate on their own between feedings. As chicks near fledging, they are less prone to try to deposit fecals off the side of the nest structure. This may be because by this age, wild chicks would be perching on the nest rim and have no need to drop it over the edge – they are already sitting on the edge (P. Shannon and S. Collinsworth, personal communication, 2013).
Feeding: Chicks beg for food soon after hatching. Disturbance of the nest causes an immediate gaping response. There is a slight vocalization that accompanies the gaping. After being handled for weighing first thing in the morning, chicks should be left alone for a while before they will respond to jiggling of the nest for feeding. This is true for all ages of chicks, but more so for younger chicks. With hatchlings, their food searching is random. Blunt forceps should be always be used when feeding roadrunner chicks because of the vigorous way chicks latch onto food (T. Henderson, personal communication, 2016). Good aim is necessary to catch the mouth as it flails around trying to find a target with a food item. For very young chicks, once they defecate, it is very hard to get them to respond to stimulus again. So, whatever they ingest before defecating is all they will take until the next feeding. These feedings should be done quickly and without hesitation. At an early age, chicks will learn to respond to human voices. Jiggling the nest container works best the first few days. As they get older, voice is the most effective stimulus after the first few bits of food have been fed. After the first few days, a shadow passing over the nest can help to elicit a feeding response. Visual and vocal stimulation then becomes the most effective means of eliciting a feeding response after the first few bites have been taken. As chicks get older, they will lunge at food as it is offered. Care should be taken to avoid impaling chicks on forceps. Between 8-10 days of age, it becomes easier to present food from the side rather than from the front or above. This is the point at which the bill has grown enough that that a side presentation is mechanically easier. Older chicks do not appear to be aggressive to younger chicks housed with them, but they will out-compete the younger chicks for food, and there is always the danger of older/heavier birds trampling younger ones inadvertently. As chicks get older, they begin to naturally resist the number of feedings. Reducing the number of daily feedings seems to be a natural progression that they signal they are ready for by becoming difficult to stimulate to eat. With all these chicks, the time of the reductions seemed to follow the same pattern. At hatching, chicks are fed six times a day starting at 7 a.m., then every three hours or so until 9 or 10 p.m. Feedings more frequent than that are often less successful. Once the chick reaches 100 g (3.5 oz.), which typically occurs at 11 days of age, but as short as 9 and as long as 13 days, one feeding is removed. Two days later, another feeding is removed so that there are just four feedings during typical working hours. Beyond that, feedings are reduced based on the chicks’ acceptance of feedings and their growing inclination to self-feed (P. Shannon and S. Collinsworth, personal communication, 2013).

Weaning: Between 14 and 16 days, chicks will begin responding to food dropped directly in front of them and will begin to pick up food on their own, with some encouragement. At this time they are down to four feedings a day. They fairly quickly move into self-feeding after this stage. By day 20, they are down to three assisted feedings a day. By 24 days, they are typically completely self-feeding with fresh food offered three times a day. As long as weight gain continues, assisted feedings can be reduced while leaving food available at all times between feedings. At some point, the birds will be completely self-feeding without assistance (P. Shannon and S. Collinsworth, personal communication, 2013).

Environment: Small chicks will sometimes hang their heads over the edge of the container (depending on the size of the bowl and the height of the edge) and will actually look dead, or at least incapable of breathing. In some cases this is a temperature issue, but often it just seems to be the way they choose to sleep. Chicks at all ages will pant if they get too warm (P. Shannon and S. Collinsworth, personal communication, 2013). If imprinted chicks are not desired, handlers should avoid talking and cover the brooder with a breathable fabric so chicks do not see handlers. Playing vocalizations of wild roadrunners may also help (T. Henderson, personal communication, 2016).

Development: Splaying of the legs seems to come and go with some chicks. Chicks that put on a lot of weight quickly seem to be more prone to splaying, largely because the body grows beyond the capacity of the legs to remain under the body. Container size should be increased as chicks get older. Splaying in young chicks can be corrected with a more tightly packed bowl that limits movement. Improved substrate that allows chicks to push against the sides without too much give can allow legs to catch up with the size of the belly. Chicks should be transitioned to bigger facilities as they grow. They are easily housed and transported in a cooler brooder until they become mobile. Then the number of daily feedings should be dropped as chicks are moved to progressively larger stationary brooder boxes. Transitioning to outside housing is done over a period of several days. Depending on facilities, chicks can be moved outside during the day, and then moved back into indoor brooder boxes at night. They do not seem to have a
problem integrating with other roadrunner chicks of different ages (P. Shannon and S. Collinsworth, personal communication, 2013).

8.6 Contraception

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size. In the case of an animal on loan from another facility, consult the loan agreement or owner regarding authority to contracept. In the case of permanent contraception, prior permission of the animal’s owner must be obtained.

When the recommendation is made not to breed roadrunners, eggs should be pulled as soon as they are laid, discarded, and replaced with dummy eggs. The pair should be allowed to sit on the nest until they desert it. Eggs that are pulled should always be replaced with dummies in order to stop the female from laying excessive eggs, thereby becoming calcium depleted.

The American Association of Zoo Veterinarians states that the neural tube of avian embryos has developed sufficiently for pain perception by 50% gestation and so any bird embryos that have reached this stage or beyond should be euthanized using methods appropriate for hatched birds (i.e., chemical euthanasia) (AVMA guidelines for the euthanasia of animals: 2013 edition. Schaumburg, Ill: AVMA, 2013. Available at:www.avma.org/KB/Policies/Documents/euthanasia.pdf). Since incubation is 17 to 20 days in greater roadrunners, if the eggs are to be terminated, incubation should cease by day 9, preferably sooner. Areas in need of future research include DNA sexing of eggs to better manage sex ratios.
Chapter 9. Behavior Management

9.1 Animal Training

Classical and operant conditioning techniques have been used to train animals for over a century. Classical conditioning is a form of associative learning demonstrated by Ivan Pavlov. Classical conditioning involves the presentation of a neutral stimulus that will be conditioned (CS) along with an unconditioned stimulus (US) that evokes an innate, often reflexive, response. If the CS and the US are repeatedly paired, eventually the two stimuli become associated and the animal will begin to produce a conditioned behavioral response to the CS.

Operant conditioning uses the consequences of a behavior to modify the occurrence and form of that behavior. Reinforcement and punishment are the core tools of operant conditioning. Positive reinforcement occurs when a behavior is followed by a favorable stimulus to increase the frequency of that behavior. Negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus to also increase the frequency of that behavior. Positive punishment occurs when a behavior is followed by an aversive stimulus to decrease the frequency of that behavior. Negative punishment occurs when a behavior is followed by the removal of a favorable stimulus also to decrease the frequency of that behavior.

AZA-accredited institutions are expected to utilize reinforcing conditioning techniques to facilitate husbandry procedures and behavioral research investigations. Institutions should follow a formal written animal training program that facilitates husbandry, science, and veterinary procedures and enhances the health and well-being of the animals (AZA Accreditation Standard 1.6.4).

Scale training: To avoid excessive handling, a small scale can be used to monitor weights of birds on a routine basis. The scale should be positioned in an area where the birds feel comfortable. If the scale is installed permanently, it should be located near a dry area where the scale indicator can be located. Indoor/outdoor carpet can be placed over the scale in order to hide the bright silver color of the scale, and provide the birds with good footing when they step on the scale. The process of scale training can begin by placing mealworms or some other favored food item on the scale to encourage the birds to step onto it. Once the birds feel comfortable stepping onto the scale, routine weighing can begin. Breeding males have conspicuous fat deposits and are significantly heavier than nonbreeding males or post-laying females (Vehrencamp, 1982). Routine weighing of birds is the best way to monitor the overall health of the bird. Any change in weight should be noted and reported.

Crate training: Birds can be trained to enter a crate to retrieve a favored food item. This is advantageous for times when birds should be transported, as it reduces stress associated with a prolonged capture.

Training a greater roadrunner for basic husbandry management (e.g., stationing, crating, and targeting) can prove important if the animal faces medical problems. All aspects of greater roadrunner husbandry are dependent on the basic design of the facilities. Institutions should design facilities that: minimize stress on animals by providing areas where birds can hide and long runs where birds can properly exercise; allow for efficient handling and restraint (e.g., sheds where birds can be trained to enter for exams); provide access for emergency and routine procedures; maximize the potential for social interaction and separation through suitably sized pens; integrate enrichment into the daily husbandry routine; provide opportunities for specimens to display species-appropriate behavior; and provide for exhibition opportunities where applicable. Essential husbandry procedures, such as weighing, should be considered during enclosure design, and opportunities for these procedures to be optimized should be included. Outdoor enclosures should be covered to allow birds to remain full winged.

Effective techniques for training greater roadrunners include desensitization, acclimation, operant conditioning, and the use of positive reinforcement (using preferred food items, for example). Animals can be approximated to specific sites through operant conditioning or strategic feeding. This can be useful in crate training. Target training can be useful for training animals to station for weights on a platform scale.
Scale training, crate training, and shed training can be effective and useful trained behaviors in the management of greater roadrunners.

9.2 Environmental Enrichment

Environmental enrichment, also called behavioral enrichment, refers to the practice of providing a variety of stimuli to the animal’s environment, or changing the environment itself to increase physical activity, stimulate cognition, and promote natural behaviors. Stimuli, including natural and artificial objects, scents, and sounds are presented in a safe way for the greater roadrunner to interact with. Some suggestions include providing food in a variety of ways (i.e., frozen in ice or in a manner that requires an animal to solve simple puzzles to obtain it), using the presence or scent/sounds of other animals of the same or different species, and incorporating an animal training (husbandry or behavioral research) regime in the daily schedule.

Enrichment programs for greater roadrunner should take into account the natural history of the species, individual needs of the animals, and facility constraints. The greater roadrunner enrichment plan should include the following elements: goal setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. The greater roadrunner enrichment program should ensure that all environmental enrichment devices (EEDs) are “greater roadrunner” safe and are presented on a variable schedule to prevent habituation. AZA-accredited institutions must have a formal written enrichment program that promotes greater roadrunner-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1). Enrichment activities must be documented and evaluated, and the program should be refined based on the results, if appropriate. Records must be kept current (AZA Accreditation Standard 1.6.3).

Greater roadrunner enrichment programs should be integrated with veterinary care, nutrition, and animal training programs to maximize the effectiveness and quality of animal care provided. AZA-accredited institutions must have a specific paid staff member(s) assigned to oversee, implement, assess, and coordinate interdepartmental enrichment programs (AZA Accreditation Standard 1.6.2).

Some variation in the environment of greater roadrunners is important to satisfy their natural curiosity and intelligence. With approval from institution veterinarians and nutritionists, food items may be offered as a form of enrichment. Non-food enrichment initiatives can also be developed as part of a formalized enrichment program (e.g., see www.animalenrichment.org), and should provide opportunities for the birds to express their full range of behaviors. Keepers should observe the animals’ interactions with enrichment initiatives to ensure that there are no health or safety concerns. Research is needed to determine the efficacy of enrichment.

The development of enrichment ideas for greater roadrunners should be goal-oriented, proactive, based upon the animal’s natural history, individual history, and exhibit constraints, and should be integrated into all aspects of greater roadrunner management. Senses important to greater roadrunner should be involved in any enrichment program (e.g., sight, hearing, touch). Food should be accounted for in the animal’s diet, and the exhibit display and its furnishings also should become part of the enrichment program. Successful enrichment techniques include variation of exhibit schedule, variation of feeding schedule, and modest re-arranging of the exhibit display. It is important that enrichment items are not merely thrown in an exhibit.
and allowed to stay for extended periods—an enrichment program is only successful and useful if actively managed and constantly reviewed to ensure that it encourages species appropriate behaviors. Examples of roadrunner enrichment include tubs filled with sand and dirt, shredded newspapers, small sticks, small Boomer Balls®, pinecones, browse, cardboard tubes, paper bags, and parrot toys (Biggans-Adams, unknown date). Some roadrunners will “paint”, and pictures can be used for keeper talks or fundraising events.

The American Association of Zoo Keepers (AAZK) Enrichment Committee provides the following general guidelines about enrichment: The goal of enrichment should be to maximize the benefit while minimizing unacceptable risks. All enrichment should be evaluated on three levels: 1) whether the enrichment item itself poses an unacceptable risk to the animals, 2) what benefit the animals will derive from the enrichment, and 3) whether the manner of enrichment delivery is apt to lead to problems. A written plan of action that eliminates the most dangerous risk factors while maintaining the benefits of a challenging and complex environment can help animal managers develop a safe and successful enrichment program. Keepers should evaluate new and creative enrichment ideas with their managers and staff from other departments (e.g., curatorial, veterinary, nutritional, etc.) to decrease the frequency of abnormal and stereotypic behaviors or low activity levels, and to fine-tune enrichment ideas. For enrichment to be safely provided, it is strongly recommended that each institution establish enrichment procedures, protocols, and a chain of command that keepers can follow. The AAZK Enrichment Committee provides an excellent cautionary list for the various types of enrichment provided (www.aazk.org). This list includes key questions that should be answered for all enrichment items or programs to assess potential hazards.

Frequency of enrichment provision: Factors that should be considered when determining how often behavioral or environmental enrichment is offered include the species and individual(s) involved as well as the physical characteristics of the exhibit. Large, complex exhibits with appropriate enclosure designs, substrates, and furnishings may offer ample opportunities for animals to exercise natural behaviors with infrequent enrichment (once daily). Other exhibits or individuals may require more frequent enrichment (multiple times per day). Husbandry staff should monitor all individuals in an exhibit and structure an enrichment schedule for the needs of those animals, providing them opportunities several times a day to interact positively with their environment. Enrichment should never be offered on a regular schedule—instead times, items, and delivery methods should be rotated so there is always an element of novelty associated with each item or activity. It is important to note that the provision of well-designed, complex environments is the foundation of a successful enrichment program. Enrichment should also be evaluated to see if it is achieving its goals. All enrichment items should be approved by the appropriate management staff, including the veterinarian, curator, horticulturist, and/or nutritionist.

Behavioral enrichment for roadrunners can easily be achieved by placing food items in novel places, scattering bugs or feeding at different times. Beyond normal stimuli in a zoo environment such as water, and conspecifics, roadrunners generally tend to respond with curiosity to novel objects (e.g. mirrors, baskets, change in perching, hay with scattered insects, paper bags with food inside or paper towel rolls) and increase their exploratory behavior (J. Kiseda, personal communication, 2016). Enrichment does not require elaborate or costly apparatus. Insects frozen in ice blocks placed in the exhibit are a novel and inexpensive idea for roadrunners. Enrichment devices should be provided on a variable schedule. This can be accomplished by varying time of day and duration of presentation. Catalogs and calendars for enrichment initiatives can also be created to allow a variable schedule of enrichment delivery to be developed. Participation in training programs and in behavioral research programs can be enriching as they allow the bird to have cognitive stimulations that differ from the normal zoo or aquarium experience. Interaction and mental stimulation are important aspects of training and are essentially enriching. Training reinforcers can include items that the birds find enriching such as novel foods. Training and enrichment can also be utilized to address issues such as veterinary or nutritional needs. Lack of activity can be addressed by enrichment, and offering different food choices and presentations can be used to deal with nutritional requirements. Training can make necessary interactions more cooperative and create an environment of choice and control. As with all taxa, safety is of utmost concern with environmental enrichment devices. Food enrichment should be appropriate for the species and follow the institutional approval process prior to offering.

Browse: If browse plants are used for enrichment or nesting materials, all plants need to be identified and assessed for safety. The responsibility for approval of plants and oversight of the program should be
Greater Roadrunner (Geococcyx californianus) Care Manual

assigned to at least one qualified individual. The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants are safe for the species. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available.

A sample enrichment plan from an AZA accredited zoo is provided below.

**Goal behavior:** The goal is to get the roadrunner to associate the sound of the bridge with the reward. The next goal will be to get the roadrunner to connect a brightly colored Frisbee with stationing. Once this is accomplished, the station can be moved around, and eventually used as a way to weigh the bird.

**Materials needed:** a mouse for food reward, clicker, Frisbee for stationing

**Considerations:** The male roadrunner is very friendly, and will take mice that are thrown in his direction. However, he is still a bird and has a very quick flight response. Patience and slow movement will be required to allow this training to be possible.

1) **Associating a bridge:** For the roadrunner conditioning, a clicker will be used as the bridge. The first few training attempts will be to get the roadrunner to associate the clicking noise with receiving a reward. The trainer will wait until the roadrunner gets within a couple feet and toss the mouse to him. As the roadrunner takes the mouse, the trainer will click. As the roadrunner becomes more comfortable, the trainer will try to get the roadrunner to take the mouse from their hand and then they will click.

2) **Introducing the station:** As soon as the roadrunner is confident taking mice from the trainers and associates the bridge with receiving the reward, station training can begin. The roadrunner diet is often placed on or near the platform by the waterfall. The roadrunner is already comfortable in this area of the aviary. The Frisbee will be placed on top of the platform and the roadrunner will be fed a treat on the Frisbee and then bridged.

3) **Establishing the Station:** Once the trainer is confident that the roadrunner has associated the Frisbee with receiving a treat, the trainer can change the location of the Frisbee, thus changing the station location. The Frisbee can also be moved on top of a scale at this point in an attempt to get weight information. The distance the Frisbee can move will depend on the roadrunner’s progress.

**9.3 Staff and Animal Interactions**

Animal training and environmental enrichment protocols and techniques should be based on interactions that promote safety for all involved. Greater roadrunners are not aggressive by nature. Unprotected, free contact management of these animals is the most common form of interaction between the keeper and the bird.

Attention to the design of enclosures and facilities housing greater roadrunners, and to the behavior of staff members working with these birds, is important to minimize trauma-related problems during human-animal interactions, such as capture/restraint events and animal training. In the daily management of greater roadrunners, the likelihood of trauma to the birds can be reduced in the following ways:

- Using plastic coated foam padding to surround the sides of enclosures or pens, especially in areas where birds are regularly caught, such as in hospital or quarantine pens. Padding minimizes abrasion injuries to wingtips.
- Using shade-cloth or tension netting on the roof and sides of aviaries to cushion the impact that may result from birds flying within an enclosure (birds can still attempt flight whether they are flight restricted or not).
- Modifying behavior of the birds by habituating nervous individuals to common stimuli that may occur within the zoo environment (e.g., noises, presence of veterinarians, visitors, etc.), or housing such birds in naturalistic pens with plenty of cover to allow them to avoid potential negative stressors.
- Minimizing stress by reducing the number of non-essential people who enter enclosures or the off-exhibit areas directly around these enclosures.
9.4 Staff Skills and Training

Greater roadrunner staff members should be trained in all areas of greater roadrunner behavior management. Funding should be provided for AZA continuing education courses, related meetings, conference participation, and other professional opportunities. A reference library appropriate to the size and complexity of the institution should be available to all staff and volunteers to provide them with accurate information on the behavioral needs of the animals with which they work.

Animal care staff should have a complete understanding of the natural history, behavior, and biology of greater roadrunners. They should be able to capture and restrain the bird quickly and safely when needed. New keepers should be trained by keepers experienced in all aspects of husbandry, training, etc. whenever possible. The AZA Turaco/Cuckoo TAG does not have any specific recommendations for certifications and qualifications needed by animal care staff working with roadrunners, but encourage all institutions to provide opportunities for animal caretakers to gain additional experience in all fields of animal management and care.

All staff members working with roadrunners should be aware of all behavioral tendencies exhibited by the birds. Animal and staff safety is a top priority for training and enrichment programs, and appropriate protocols should be approved prior to implementation by management and husbandry staff. The following list provides general recommendations for technical skills, knowledge, and experience for animal care staff working with roadrunners:

- In-depth understanding of the species’ natural history and the individual’s history.
- In-depth understanding of the individual roadrunner’s behaviors, and understanding of the function of those behaviors.
- Ability to recognize signs of illness and injury.
- Possession of the skills to safely capture or restrain a greater roadrunner.
- Understanding of the species’ natural diet and foraging style.
- Understanding of enrichment concepts and a commitment to enhance the environments of greater roadrunner on a consistent basis.
- Understanding of the concepts of animal learning and training, ability to use a variety of techniques (e.g., habituation, operant conditioning) to train the animals under their care, and to create a training plan (identifying training steps, cues, and criteria). See www.animaltraining.org for details.
Chapter 10. Ambassador Animals

10.1 Ambassador Animal Policy

AZA recognizes many public education and, ultimately, conservation benefits from ambassador animal presentations. AZA’s Conservation Education Committee’s Ambassador (previously called Program) Animal Position Statement (Appendix F) summarizes the value of ambassador animal presentations. For the purpose of this policy, an ambassador animal is described as an animal presented either within or outside of its normal exhibit or holding area that is intended to have regular proximity to or physical contact with trainers, handlers, the public, or will be part of an ongoing conservation education/outreach program.

Ambassador animal presentations bring a host of responsibilities, including the welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that give ambassador animal presentations to develop an institutional ambassador animal policy that clearly identifies and justifies those species and individuals approved as ambassador animals and details their long-term management plan and educational program objectives. The policy must incorporate the elements contained in AZA’s “Recommendations For Developing an Institutional Ambassador Animal Policy”. If an animal on loan from another facility is used as an ambassador animal, the owner’s permission is to be obtained prior to program use.

AZA’s accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, sound and environmental enrichment, access to veterinary care, nutrition, and other related standards (AZA Accreditation Standard 1.5.4). All record-keeping requirements noted previously apply to ambassador animals (AZA Accreditation Standards 1.4.1, 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6, and 1.4.7). In addition, providing ambassador animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management (AZA Accreditation Standard 1.5.2.2). Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, housing may be reduced in size compared to a primary enclosure as long as the animal’s physical and psychological needs are being met during the program; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

The use of greater roadrunners in educational programs and shows can be beneficial in promoting conservation messages about birds in general. Animal care staff are encouraged to consult the SSP Coordinator when considering the use of a greater roadrunner in a show, as some greater roadrunners are more genetically valuable than other birds and are therefore better suited for placement in a breeding situation. Some institutions and private show contractors clip their roadrunners, but many do not and instead rely on their knowledge of the bird’s behavior.

The use of an established recall behavior is necessary when using a roadrunner in a free flight situation indoors or out. This could be in the form of a strong crate behavior, but it is not always possible to get a crate to where the roadrunner might end up. The use of an established “come” and “here” behavior, clicker, whistle or other auditory sound is very useful when free flying a roadrunner as the bird can be recalled back and then crated for transport (K. Garrison, personal communication, 2016).

Greater roadrunners should be housed in a manner that allows for full range of movement, bathing, sunning, and choice of varied perching areas. Greater roadrunners will spend time on high perching as well as the ground, and should have various perching levels available. Roadrunners should have access to adequately sized sandy areas for dust bathing. Greater roadrunners spend much time sunning and should have full access to sun and shelter from inclement weather. Contact with non-collection, native birds through co-mingling in the enclosure or scavenging of diet items can expose collection birds to...
disease. Attempts should be made to eliminate or to limit direct contact exposure to native species through enclosure mesh and roofing.

Greater roadrunners are intelligent, social and interactive and require a high level of mental stimulation and interaction. The ability to view conspecifics and other species and handlers throughout the day allows for many hours of stimulation. Greater roadrunners trained with operant conditioning techniques and offered the opportunity to free fly or otherwise participate in educational programs have the ability to get additional exercise and conditioning. Birds that are imprinted on humans may choose to interact with humans directly through tactile stimulation, and will typically engage in courtship and breeding behavior when sexually mature. Human imprints require a significant amount of human interaction in lieu of interaction with conspecifics. Size of housing varies depending on the bird’s opportunities for outside access to exercise, i.e., free flight in programs. Enclosures smaller than 2.4 m x 1.2 m x 1.8 m (8 ft. x 4 ft. x 6 ft.) are not recommended due to the size of the birds’ wingspan and their need to move from perch to perch. Being conditioned to enter and exit travel kennels voluntarily allows for daily weight collection and transport for educational programs/shows, as well as for veterinary procedures. Birds can also be crated for daily enclosure and exhibit servicing if needed in order to allow for thorough cleaning/disinfecting of housing areas. For imprinted birds that have a strong relationship with the handlers, physical examinations without restraint are possible.

10.2 Institutional Ambassador Animal Plans

AZA’s policy on the presentation of animals is as follows: AZA is dedicated to excellence in animal care and welfare, conservation, education, research, and the presentation of animals in ways that inspire respect for wildlife and nature. AZA’s position is that animals should always be presented in adherence to the following core principles:

- Animal and human health, safety, and welfare are never compromised.
- Education and a meaningful conservation message are integral components of the presentation.
- The individual animals involved are consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs.

AZA-accredited institutions that have designated ambassador animals are required to develop their own Institutional Ambassador Animal Policy that articulates and evaluates the program benefits (see Appendix G for recommendations). Ambassador animals should be consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs. Education and conservation messaging must be an integral component of any ambassador animal demonstration (AZA Accreditation Standard 1.5.3).

Facilities that maintain a collection of birds for educational programming provide daily attention and enrichment through training and servicing of the animals. A well-developed program designs its facility and schedule to meet the needs of highly social animals like greater roadrunners. These facilities have staff available 365 days a year, 8 to 10 hours a day, and provide each bird’s needs on a daily basis. Birds utilized in programs are closely monitored daily, and food intake can be monitored for each individual bird. Trained birds can be weighed daily and separated from other birds when necessary to ensure consumption of diet items. A variety of food can be offered and consumption closely monitored and recorded.

Daily record keeping systems should include daily diet intake, weight, behavioral observations, comments on training sessions and interactions, and steps taken in training sessions. Courtship and breeding behavior or abnormal behavior should also be noted. Any aggression should be detailed and highlighted. Any aggressive incidents should be communicated to staff through records and reports when involving bites to trainers or aggression directed toward bystanders. Any developing patterns of aggressive behavior should be thoroughly discussed and assessed. Medical notes and observations, as well as any medications dispensed, should also be recorded.

Greater roadrunners may be involved in conservation/education programs outside of their enclosures, as well as in animal training demonstrations that zoo visitors can observe, whether out on exhibit or during “behind the scenes” tours. The provision of enrichment to roadrunners in the view of the public could also be considered an educational program based on the definition of “ambassador animals” provided in section 10.1.
Animal care and education staff should be trained in ambassador animal-specific handling protocols, conservation, education messaging techniques, and public interaction procedures. Paid and/or unpaid staff assigned to handle animals during demonstrations or educational programs must be trained in accordance with the institution’s written animal handling protocols. Such training must take place before handling may occur (AZA Accreditation Standard 1.5.12). These staff members should be competent in recognizing stress or discomfort behaviors exhibited by the ambassador animals and be able to address any safety issues that arise. Additionally, when in operation, animal contact areas must be supervised by trained paid and/or unpaid staff (AZA Accreditation Standard 1.5.13).

Greater roadrunners should always be handled in a manner that creates a comfortable environment for the bird, with the choice to participate or not to participate in the training program and activity. Individual birds vary and some individuals are highly motivated by tactile reinforcement from trainers. Well socialized birds that have demonstrated a low level of aggressive tendencies, and that are under stimulus control through operant conditioning techniques, can be handled in areas close to the public. Birds that demonstrate aggression to handlers should be assessed for the potential for aggression towards the public. The topography should facilitate the free flight of the bird over or near the public with a safe end/landing point that encourages the bird to successfully complete the behavior without interacting with the public. It is not recommended to allow guest contact with this taxon, as there is the potential for injury. Indicators that a greater roadrunner is experiencing stress include flying at walls, running back and forth on the ground with mouth open and crest raised, vocalizing with a low "growl", and if spooked, running and not focusing on the trainer until a safe distance from the cause of stress. An unclipped bird could potentially fly off if frightened enough.

Thorough records should be kept documenting the birds’ behaviors. Any part time or seasonal staff should be assessed for their level of experience when re-entering the work area. Level of experience and length of time out of the area will determine whether re-training of staff is required before handling individuals in this taxon.

The public should remain seated during demonstrations. When these stress signs are observed all factors (e.g., proximity of bird to activity, noise levels) should be assessed to determine their effects. If activity in the area is causing high levels of stress (e.g., a construction project), and the bird’s physical reactions are likely to result in injury, then action should be taken to calm the bird through visual barriers, temporary re-location or permanent relocation if desensitization is not possible or conducive to the situation.

Ambassador animals that are taken off zoo or aquarium grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution’s healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5). Animals leaving the facility for off-site programming should be fully protected from interaction with non-collection animals. Representatives from the facility should contact the destination (news station, hotel, event center, school, etc.) before the event/arrival to determine that no other animals will share the facility just prior to or during the scheduled event. Furniture such as bath pans, carpets and perching utilized for the presentation should be brought with the collection birds. All diet items should also be brought from the home facility.

Careful consideration must be given to the design and size of all ambassador animal enclosures, including exhibit, off-exhibit holding, hospital, quarantine, and isolation areas, such that the physical, social, behavioral, and psychological needs of the species are met and species-appropriate behaviors are facilitated (AZA Accreditation Standard 10.3.3; AZA Accreditation Standard 1.5.2).

Similar consideration needs to be given to the means in which an animal will be transported both within the Institution’s grounds, and to/from an off-grounds program. Animal transportation must be conducted in a manner that is lawful, safe, well planned, and coordinated, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11).
Greater Roadrunner (Geococcyx californianus) Care Manual

Operant conditioning training techniques should be utilized to condition birds to enter and exit the enclosure. Transport carriers should be large enough for the bird to stand at full height and turn around comfortably, and be designed for ease of entry and exit. Any openings should be covered if needed to protect feathers from damage while still allowing adequate air circulation. Fans should be mounted on travel carriers in hot temperatures. Birds naive to a transport crate should be trained using positive reinforcement. The bird should have the choice to enter and exit for reinforcement. When transporting a bird in a carrier, handlers should handle the crate with sensitivity and balance to prevent unnecessary jostling and discomfort to the bird. Transport crates should be covered with a towel or sheet to give the bird a sheltered environment.

Custom-made transport carriers of appropriate size should adequately contain the bird and prevent accidental release, and should be inspected to ensure that no sharp edges or other potential hazards exist inside the crate. Birds that are trained with operant conditioning techniques to enter and exit transport carriers can be transported for programs as well as crated for routine weighing, trips to the veterinarian, and enclosure servicing. The bird should not be forced, chased or netted to enter the crate in lieu of training except in an emergency situation or evacuation.

Birds that live in excessively hot or cold environments and are acclimated to the temperature will have a wider range of temperature tolerance. A bird’s behavior should always be monitored in hot climates and assessed based on physical signs of heat related stress. If birds are flying, or otherwise engaged in programs during hot weather, they should be monitored and removed from programs when needed. Fresh water should always be available, but handlers should be aware that birds may not necessarily utilize water elements to cool themselves when overheated. Hose spray, overhead mister systems, or air-conditioned areas should be utilized if birds appear to be suffering from heat-related stress. Housing areas should offer shelter from sun and inclement weather, giving birds the option of sun or shade as well as shelter from wind, rain or snow.

Each bird is an individual and may have a longer or shorter attention span or desire for interaction. With operant conditioning training techniques, birds are given the choice to participate. It should be clear to the trainers that the bird is choosing to participate, as the bird is given the ability to choose to approach trainers or retreat, exit the enclosure, or enter or exit the transport crate. During programs, the demonstrations should be designed so that the bird can choose to exit at any time into a safe environment (e.g. backstage, into a crate, back into the enclosure, etc.). Greater roadrunners are medium-sized birds, and long distance travel may involve being confined to a small space. On long journeys, the bird should have a larger enclosure available at the destination to allow for full wing extension, full range of movement, bathing and preening. All behavior should be documented in daily records and any aggression or avoidance behavior should be noted. If the bird is showing signs of stress or displacement, further travel or program involvement should be re-evaluated. As long as the bird is choosing to cooperate without being coerced, then the length of time will vary significantly from bird to bird. The bird’s threshold for program involvement should be determined based on behavior, and may have seasonal variations and vary depending on whether the bird is parent-raised or imprinted on humans.

10.3 Program Evaluation

AZA-accredited institutions that have an Institutional Ambassador Animal Plan are required to evaluate the efficacy of the plan routinely (see Appendix G for recommendations). Education and conservation messaging content retention, animal health and well-being, guest responses, policy effectiveness, and accountability and ramifications of policy violations should be assessed and revised as needed. It is recommended that presentation and handling guidelines and protocols should be re-evaluated annually or bi-annually. All staff should have access to these guidelines and be provided with updates as needed. All new staff should be signed off on receiving and reading the standards and protocols during orientation and before commencing work in the area.

Protocols should be clear and expectations consistent for all staff. Incidents should be reported to management and any violations of protocols should be dealt with through verbal and/or written disciplinary measures. Repeated violation of protocols that have the potential for or result in the endangerment of animals, staff or public health and/or safety should be dealt with by management through verbal and/or written documentation and punitive measures taken when necessary. Standards of care can be measured through physical condition and behavior of collection birds. Physical condition of
feet, feathers, and vitality should be assessed, as well as overall behavior through daily record keeping and daily, monthly, and annual physical inspection.

Significant feedback can be gained through formal and informal surveying of shows and educational programs. Surveys should be designed to measure the impact of educational messaging and the benefits of utilizing live animals for programs, as well as to gather useful information on the audience and demographics. Exit surveys are a valuable tool and can be designed to gather data on the level of entertainment and educational value of the program and the impact of the messaging. The content of programs should always be up to date and accurate, and messages consistent. Guests should leave with an understanding of the animal’s natural history and its relationship to humans, and a feeling of respect and responsibility towards the natural world and global conservation.
Chapter 11. Research

11.1 Known Methodologies

AZA believes that contemporary greater roadrunner management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected, to conduct or facilitate research in both in situ and ex situ settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. Participating in AZA Taxon Advisory Group (TAG) or Species Survival Plan® (SSP) Program sponsored research when applicable, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials could help achieve this (AZA Accreditation Standard 5.3). An AZA institution must demonstrate a commitment to scientific study that is in proportion to the size and scope of its facilities, staff, and animals (AZA Accreditation Standard 5.0).

All record-keeping requirements noted previously apply to most research animals, especially those which are part of the exhibit collection. When an animal on loan to a facility is subject to an invasive research procedure, including when done as part of a routine health exam, the owner’s prior permission is to be obtained.

The difficulties in studying roadrunners in the field have limited the general understanding of many aspects of its life history, although technology such as radio telemetry is now being used to study home range (Montalvo, A. et al., 2014). With the decline of roadrunners in some areas, understanding life history, juvenile dispersal, recruitment, habitat use, fecundity and life expectancy, human disturbances, pesticide use becomes important in the event of larger scale population declines. Partnering with related organizations or universities and encouraging research of this species would be valuable and add to the extensive observations conducted by Hughes (1996).

Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of the species being investigated and may provide results which benefit the health or welfare of animals in wild populations. Many AZA-accredited institutions incorporate superior positive reinforcement training programs into their routine schedules to facilitate sensory, cognitive, and physiological research investigations and these types of programs are strongly encouraged by the AZA.

All sound research approaches should be viable for use on greater roadrunners, as long as they are not too invasive and do not require extensive surgery or cause pain or discomfort. Researchers can use the following methodologies to study greater roadrunners:

- Behavioral observation including banding birds.
- Fecal hormone analysis.
- Keeper research: Keepers are in a great position to contribute to greater roadrunner management and husbandry advances and research, as they work with the species on a daily basis. Some areas where keeper input and participation can be very valuable include:
  - Instituting scale training so that birds can be routinely weighed in order to assess body mass.
  - Documenting physical development of chicks, including data collection on weight, specific diet ingredient intake (weighed amounts), mornomorphics, and plumage changes.
  - Weighing and measuring all eggs (fresh weight and length/width).
  - Collecting data on activity budgets of adults and chicks.
  - Determining food preferences of pairs when feeding chicks.
  - Documenting molt patterns.
AZA-accredited institutions are required to have a clearly written research policy that includes a process for the evaluation of project proposals and identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified staff member or committee to oversee and direct its research program (AZA Accreditation Standard 5.1).

An Institutional Animal Care and Use Committee (IACUC) should be established within the institution if animals are included in research or instructional programs. The IACUC should be responsible for reviewing all research protocols and conducting evaluations of the institution’s animal care and use.

If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by Taxon Advisory Groups (TAGs) or Species Survival Plans® (SSP) Programs. The AZA Turaco and Cuckoo TAG has identified the following three field conservation goals in its 2015 Regional Collection Plan: 1) identify existing research and conservation programs 2) evaluate possibilities for support and 3) enhance contacts with individuals and organizations working in the field. Currently, there are no roadrunner conservation activities being coordinated in AZA facilities.

11.2 Future Research Needs

This Animal Care Manual is a dynamic document that will need to be updated as new information is acquired. Knowledge gaps have been identified throughout the Manual and are included in this section to promote future research investigations. Knowledge gained from these areas will maximize AZA-accredited institutions’ capacity for excellence in animal care and welfare as well as enhance conservation initiatives for the species.

- Greater roadrunners appear to be prone to leg fractures (S. Hallager, personal observation 2015). Research into this observation is needed to determine if the cause is nutritional, anatomical, or management-related in origin.
- If covered pens may also play a role in minimizing the risk of avian transmitted diseases.
- Little is known about the hearing sensitivity of greater roadrunners. There is no information available on whether there are certain frequencies of sounds or decibels that have the greatest negative effect on the welfare of greater roadrunners, and how these can be minimized. Additional research on hearing in greater roadrunners would provide some guidance for creating more objective recommendations for managing sound stimuli for this species.
- Greater roadrunner enrichment is currently limited, and requires further development.
- Additional research on the welfare of flight restricted greater roadrunners is still needed in order to develop the most effective animal care recommendations for housing these animals in zoos.
- Research on DNA sexing of eggs would aid in improving the management of sex ratios.
- Documenting physical development of chicks, including research on data collection of:
  - Weight
  - Specific diet ingredient intake (weighed amounts)
  - Morphometrics and plumage changes
  - Weighing and measuring all eggs (fresh weight and length/width)
  - Collecting data on activity budgets of adults and chicks
  - Determining food preferences of pairs when feeding chicks
  - Documenting molt patterns

Priorities for conservation: The difficulties in studying this elusive bird in the field have limited the general understanding of many aspects of its life history. Juvenile dispersal and recruitment are virtually
unknown. Habitat use and ecology of northern and eastern populations warrants detailed study. Factors regulating populations have yet to be identified and quantified. In addition, banding programs should be increased to determine fecundity and life expectancy more accurately. All banding initiatives should include provisions for the subsequent recovery of banded birds. The impact of human disturbance such as urban development, pesticide use, and illegal hunting on some declining local populations also needs further investigation (Hughes, 1996).

Famolaro (2002) identified the following action plan for this species:

1. Acquire or protect remaining breeding sites throughout the coastal slope of California. Concentrate conservation where the largest blocks of habitat can be effectively preserved with minimal human disturbance or edge effects (i.e., roads, pets, pesticides, etc.). Participate with federal, state, and local agencies on open space planning and Natural Community Conservation Plans to avoid small patch and fragmented natural open space.

2. Work with scientific community to address information needs to determine sustainable populations. Design and implement necessary studies.

3. Investigate funding sources and develop proposals for habitat acquisition and research needs.

4. Discuss the need for additional protection of roadrunners and their habitats with state and federal wildlife regulatory agencies. If warranted, propose for threatened or endangered status.

5. Work with enforcement agencies and implement public outreach to eliminate illegal hunting of roadrunners. Education should be conducted to refute claims that roadrunners pose a major threat to quail populations.

6. Work with state and local agencies to develop and install road signs for roads which pose a threat to roadrunners.
Chapter 12. Other Considerations

12.1 Additional Information

Roadrunners in folklore: Roadrunners are the subject of myths and folklore. One of the best-known tales suggests greater roadrunners are capable of trapping sleeping rattlesnakes by encircling them with joints of spiny, round-stemmed cacti (*Cholla* spp.). When the corral is completed, the bird wakes up the snake by dropping a cactus joint on it. While trying to escape enclosure, the snake fatally injures itself on the spines and is consumed by the roadrunner (Gambel, 1849).

Many Native American societies invested the spirit of the greater roadrunner with supernatural powers, and it has been referred to as "War Bird", "Snake Eater", and "Medicine Bird". Roadrunners have been depicted in petroglyphs along Llano Estacado, TX (Meinzer, 1993), and in the canyons of southern New Mexico (Schaafsma, 1989).

Hopi tribes used the symbol "X," to depict the distinctive track of the zygodactyl foot on kachina figures and used these figures to ward off evil spirits that are unable to follow the roadrunner because the direction of its travel is unknown.

In Pueblo culture, a safe afterlife was ensured by placing roadrunner tracks around the house of the dead in order to mislead evil spirits from the course taken by the departed soul. In addition, the left sole and palm of funeral participants were marked with an "X" to keep the dead from following them (Schaafsma, 1989). Roadrunner feathers tied to cradle boards and skins hung over lodge doors provided good luck and confuse evil spirits (Dobie, 1939).

Many native peoples ate roadrunners to acquire stamina and swiftness. In Mexico, roadrunner flesh was thought to cure itch and boils, purify blood, and stimulate growth in flowers. The greater roadrunner took the place of stork in bringing babies. Early frontiers people believed a roadrunner would always lead a lost person to a trail (Dobie, 1939).

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Photo courtesy of John Kïsedâ
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Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to greater roadrunner are taken from the AZA Accreditation Standards and Related Policies (AZA, 2017) and are referenced fully within the chapters of this animal care manual:

General Information

(1.1.1) The institution must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and/or regulations. In these cases the AZA standard must be met.

Chapter 1

(1.5.7) The animals must be protected or provided accommodation from weather or other conditions clearly known to be detrimental to their health or welfare.

(10.2.1) Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. Warning mechanisms and emergency backup systems must be tested periodically.

(1.5.9) The institution must have a regular program of monitoring water quality for fish, marine mammals, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Chapter 2

(1.5.1) All animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design, balancing animals’ welfare requirements with aesthetic and educational considerations.

(1.5.2) All animals must be housed in enclosures which are safe for the animals and meet their physical and psychological needs.

(1.5.2.1) All animals must be kept in appropriate groupings which meet their social and welfare needs.

(1.5.2.2) All animals should be provided the opportunity to choose among a variety of conditions within their environment.

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal’s physical, social, and psychological well-being. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

(10.3.4) When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

(11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to either the institution’s animals, the free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully monitored, and treated humanely at all times.

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

(1.5.15) All animal exhibit and holding area air and water inflows and outflows must be securely protected to prevent animal injury or egress.

(2.8.1) Pest control management programs must be administered in such a manner that the animals, paid and unpaid staff, the public, and wildlife are not threatened by the pests, contamination from pests, or the control methods used.

(11.3.6) There must be barriers in place (for example, guardrails, fences, walls, etc.) of sufficient strength and/or design to deter public entry into animal exhibits or holding areas, and to deter public contact with animals in all areas where such contact is not intended.
(11.2.4) All emergency procedures must be written and provided to appropriate paid and unpaid staff. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

(11.2.5) Live-action emergency drills (functional exercises) must be conducted at least once annually for each of the four basic types of emergency (fire; weather or other environmental emergency appropriate to the region; injury to visitor or paid/unpaid staff; and animal escape). Four separate drills are required. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified. (See 11.7.4 for other required drills).

(11.6.2) Security personnel, whether employed by the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

(11.2.6) The institution must have a communication system that can be quickly accessed in case of an emergency.

(11.2.0) A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (see 11.2.5, 11.5.2, and 11.7.4).

(11.2.7) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

(11.5.3) Institutions maintaining potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

Chapter 3

(1.4.0) The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information.

(1.4.6) A paid staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all paid and unpaid animal care staff members, apprised of relevant laws and regulations regarding the institution's animals.

(1.4.7) Animal and veterinary records must be kept current.

(1.4.4) Animal records and veterinary records, whether in electronic or paper form, must be duplicated and stored in a separate location. Animal records are defined as data, regardless of physical form or medium, providing information about individual animals, or samples or parts thereof, or groups of animals.

(1.4.5) At least one set of the institution's historical animal and veterinary records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisition, transfer, euthanasia, release, and reintroduction.

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution.

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.
Chapter 4

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

(1.5.10) Temporary, seasonal and traveling live animal exhibits, programs, or presentations (regardless of ownership or contractual arrangements) must be maintained at the same level of care as the institution’s permanent resident animals, with foremost attention to animal welfare considerations, both onsite and at the location where the animals are permanently housed.

Chapter 6

(2.6.2) The institution must follow a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal’s nutritional and psychological needs.

(2.6.1) Animal food preparation and storage must meet all applicable laws and/or regulations.

Chapter 7

(2.1.1) A full-time staff veterinarian is recommended. In cases where such is not necessary because of the number and/or nature of the animals residing there, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals 24 hours a day, 7 days a week.

(2.0.1) The institution should adopt the Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals, and policies developed or supported by the American Association of Zoo Veterinarians (AAZV). The most recent edition of the medical programs and hospitals booklet is available at the AAZV website, under “Publications”, at http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839, and can also be obtained in PDF format by contacting AZA staff.

(2.2.1) Written, formal procedures must be available to paid and unpaid animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare.

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839.

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all paid and unpaid staff working with quarantined animals.

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

(11.1.3) A tuberculin (TB) testing/surveillance program must be established for appropriate paid and unpaid staff in order to assure the health of both the paid and unpaid staff and the animals.

(2.5.1) Deceased animals should be necropsied to determine the cause of death for tracking morbidity and mortality trends to strengthen the program of veterinary care and meet SSP-related requests.

(2.5.2) The institution should have an area dedicated to performing necropsies.

(2.5.3) Cadavers must be kept in a dedicated storage area before and after necropsy. Remains must be disposed of in accordance with local/federal laws.

(2.0.2) The veterinary care program must emphasize disease prevention.
(2.0.3) Institutions should be aware of and prepared for periodic disease outbreaks in wild or other domestic or exotic animal populations that might affect the institution’s animals (ex – Avian Influenza, Eastern Equine Encephalitis Virus, etc.). Plans should be developed that outline steps to be taken to protect the institution’s animals in these situations.

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

(2.1.3) Paid and unpaid animal care staff should be trained to assess welfare and recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, animal care staff (paid and unpaid) must not diagnose illnesses nor prescribe treatment.

(2.3.2) Institution facilities must have radiographic equipment or have access to radiographic services.

(1.5.8) The institution must develop and implement a clear and transparent process for identifying, communicating, and addressing animal welfare concerns from paid or unpaid staff within the institution in a timely manner, and without retribution.

Chapter 9

(1.6.4) The institution should follow a formal written animal training program that facilitates husbandry, science, and veterinary procedures and enhances the overall health and well-being of the animals.

(1.6.1) The institution must follow a formal written enrichment program that promotes species-appropriate behavioral opportunities.

(1.6.3) Enrichment activities must be documented and evaluated, and program refinements should be made based on the results, if appropriate. Records must be kept current.

(1.6.2) The institution must have a specific paid staff member(s) or committee assigned for enrichment program oversight, implementation, assessment, and interdepartmental coordination of enrichment efforts.

Chapter 10

(1.5.4) If ambassador animals are used, a written policy on the use of live animals in programs must be on file and incorporate the elements contained in AZA’s “Recommendations For Developing an Institutional Ambassador Animal Policy” (see policy in the current edition of the Accreditation Standards and Related Policies booklet). An education, conservation, and welfare message must be an integral component of all programs. Animals in education programs must be maintained and cared for by paid and/or unpaid trained staff, and housing conditions must meet standards required for the remainder of the animals in the institution. While outside their primary enclosure, although the conditions may be different, animal safety and welfare need to be assured at all times.

(1.5.3) If animal demonstrations are a part of the institution’s programs, an educational/conservation message must be an integral component.

(1.5.12) Paid and/or unpaid staff assigned to handle animals during demonstrations or educational programs must be trained in accordance with the institution’s written animal handling protocols. Such training must take place before handling may occur.

(1.5.13) When in operation, animal contact areas (petting zoos, touch tanks, etc.) must be supervised by trained, paid and/or unpaid staff.

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

Chapter 11

(5.3) The institution should maximize the generation and dissemination of scientific knowledge gained. This might be achieved by participating in AZA TAG/SSP sponsored studies when applicable,
conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

(5.0) The institution must have a demonstrated commitment to scientific study that is in proportion to the size and scope of its facilities, staff (paid and unpaid), and animals.

(5.2) The institution must follow a formal written policy that includes a process for the evaluation and approval of scientific project proposals, and outlines the type of studies it conducts, methods, staff (paid and unpaid) involvement, evaluations, animals that may be involved, and guidelines for publication of findings.

(5.1) Scientific studies must be under the direction of a paid or unpaid staff member or committee qualified to make informed decisions.
Appendix B: Recordkeeping Guidelines for Group Accessions

Developed by the AZA Institutional Data Management Scientific Advisory Group
Published 23 May 2014
Edited to replace the document entitled “Updated Data Entry for Groups” published 16 December 2002

Animals can be accessioned into a collection as either individuals or as part of a group. The term "group" has many definitions when used in zoos and aquariums, and is usually defined by its application, such as a social group or animals grouped for husbandry purposes. To provide a consistent language that can be used throughout the Association of Zoos and Aquariums (AZA), the term “group accession”, as defined by the AZA Institutional Data Management Scientific Advisory Group (IDMAG),

• contains multiple animals of the same species or subspecies, which
• cannot be differentiated from one another, either physically (there are no scars or color pattern differences), artificially (they are not tagged or transpondered), or spatially (they are not held in separate enclosures), and
• are cared for as a whole.

Thus, no individually accessioned animals are included in a group accession and no individually identifiable animals are included in a group accession. As soon as an animal becomes individually identifiable, it is recommended that it be split from the group record and accessioned as an individual. For example, large clutches of amphibian tadpoles should first be accessioned as a group; then as individuals become identifiable, they should be removed from the group record and accessioned as individuals. Otherwise, information about an individual animal that could otherwise be tracked through the animal’s life will be lost in the group record. An exception to this occurs occasionally when a group member is removed and temporarily held separately for medical treatment, with the expectation that it will be returned to the group when treatment ends. In this case, the animal remains part of the group even though separated from it. As with individual records, group record accession numbers should not duplicate any other accession number, and once a group accession number has been assigned, it should not be changed.

Group accession provides less information on specific individuals than does individual accession. Group records make information less retrievable, and often need more clarifying comments than individual records. Whenever information applies to only part of the group, notes should be used to indicate which animal(s) the information applies to. It is of utmost importance that these notes be thorough and clear so future readers can easily understand them. Examples of information needing additional notations in group records include, but are not limited to, parentage when not every member of the group has the same parentage.

Thus, though it is preferable to accession animals as individuals, a group accession can capture considerable information when individual accession is not appropriate.

Although colonies are often confused with groups, the term “colony” should be used to designate truly colonial organisms: those that must live and function as an intact unit, such as corals and eusocial insects. Individuals within a colony are components of a single entity rather than separate members of a group. Also, colony members generally cannot be counted and true census data is not possible, so for the purposes of inventory, a colony is a singular unit while a group is composed of a number of individuals. However, for accessioning purposes, colonies are treated in the same manner as are groups.

Examples of Appropriate Group Accessions

• A group of animals that are not individually identifiable and are the same species or subspecies.
  Your institution receives 50 Puerto Rican crested toad tadpoles to rear. Unless each tadpole is raised in a separate numbered tank, there is no way to tell one tadpole from another. All tadpoles housed together are accessioned as one group.

• Colonial species, such as coral or eusocial insects (e.g., some species of bees or ants).
  Your institution receives a piece of coral. Since the coral is in one piece, you accession it as a group of one. You make a note of the dimensions or mass of the piece to give an estimate of colony size, since it is not possible to count individual animals in the colony. In the inventory,
the colony counts as one animal. When a section of the coral breaks off, you accession that new piece as a new colony.

- A self-sustaining, breeding group of small rodents or insects.

  Your institution has a large number of Cairo spiny mice. No daily count is made, though births and deaths increase and decrease the count. A census is taken periodically, and the new count is recorded by sex and life stage. Exact counts are made whenever possible – for example, when the group is moved to a new enclosure.

- Young born to several females of the same species or subspecies and raised together without means of identifying which offspring were born to which mother.

  A flock of 3.6 peafowl raise 25 chicks this year. Identity of the hens incubating each nest, hatch dates, and number of chicks hatched from each nest can be determined and recorded. However, unless the chicks are caught and banded at hatching, once the mothers and chicks join the main flock, it is no longer possible to tell which chicks belong to which females. All chicks in the flock have the same possible parents: all the peacocks and those peahens that incubated the nests. The chicks are accessioned as a group and are split out only when they are banded or tagged (and are thus individually identifiable).

- Historical records for a species or subspecies for which there is insufficient information to attribute events to specific individuals.

  Some of your historical records are found as simple lists of events. Though there are dates for all transactions, and maybe even specified vendors or recipients for those events, you cannot create individual records for any of these animals without additional information: there is nothing connecting any specific individual to both acquisition and disposition information. If additional information is uncovered that makes this connection, then that individual can be removed from the group accession and given an individual record.

Managing Group Records

Maintaining Group Records - As with individual records, group records should also be maintained and updated. Addition of animals through births or transactions such as loans, purchases, donations, or trades are entered as acquisitions. Subtraction of animals through deaths or transactions such as loans, sales, donations, or trades are entered as dispositions.

Weights and lengths can be entered into a group record even if that data cannot be attributed to a specific individual. This information is still useful in describing the overall condition of group members, although care should be given to describe the animal that the measurement came from. For example, is the animal a juvenile or a breeding adult? Is it healthy, or sickly? Alternatively, average and/or median measurements can be entered into the record to give an indication of what size a “normal” individual might be. In this case, notes should include the maximum and minimum measurements, and how many animals were measured to calculate the average or median.

Censuses - Groups should be censused at regular intervals - ideally, no longer than one inter-birth interval. Institutions should establish and follow a census schedule for each group. An inventory must be done at least once yearly (AZA Accreditation Standard 1.4.1) but the frequency at which a group is censused depends on species biology, husbandry protocols, and animal welfare. For species in which births/hatches and deaths tend to go undetected, or for species that have high fecundity and mortality (which makes counting every animal very difficult or impossible), census data should be obtained more frequently than for species with longer inter-birth intervals. These more frequent censuses should not be undertaken when intrusion on the group has a negative effect on the welfare of the group, e.g., disruption of maternal care.

Censuses should provide as much detail as possible by recording numbers in distinctive life stages (such as newborn, immature, adult) and/or sex ratio (such as male, female, unknown/undetermined). If the census count is estimated, the estimation method and (when possible) the accuracy of the estimate should be included. When updating the sex ratio, who sexed the animals and how they were sexed should also be recorded.

Splitting And Combining (Merging) Groups - Splitting animals from groups and combining groups together are realities of group management. Animals may be removed to create additional groups, or perhaps new
animals are received from another institution. When new groups are created, new group records also need to be created. However, if the entire group moves to a new location (such as a different tank), it retains the same accession number, and notation of the change in location is made.

When a single group is split into two or more groups, one of the new groups keeps the original accession number and the others are assigned new accession numbers. This is also true if a portion of a group is sent to another institution: the subgroup making the transfer must have an accession number distinct from that of the main group. The accession number(s) for the new group(s) should follow institutional procedures for the assignment of new accession numbers. Note of the new group accession number(s) should appear in the originating group record, and the new group accession record(s) should contain the originating group number. The reason for the split should be entered into both the originating and new group records.

When two or more groups combine to form a larger group, all but one of the groups are deaccessioned and their counts brought to zero. Notes in all the group records should indicate why the groups were merged, as well as the accession numbers of all groups involved – both the closed (empty) groups and the remaining group.

In all cases of splits and merges, the date of creation of the new record should be the same as the date of removal from the previous group or individual. Detailed notes should explain the reasons for all splits and merges.

Merging Individuals Into Groups and Splitting Individuals From Groups - Good husbandry dictates the use of identification methods that allow animals to be tracked as individuals whenever possible (AZA Accreditation Standard 1.4.3). Thus, most institutions initially accession newly-acquired animals as individual animals with individual identifiers.

Despite the best intentions, individual identification sometimes becomes impossible. For example, birds in large aviaries lose their bands; small frogs in a large terrarium die and decompose without being noticed. When individual identification of several of the animals in the group is lost and can't be resolved in a reasonable amount of time, it is best to move all potentially unidentifiable animals to a group record, by either creating a new group or merging them into an existing group. As with splitting and merging groups, the group record should contain the identities of the originating individuals and the individual records should show the new group identity. If the animals in the group ever become individually identifiable again, they can be split back to individual records to better capture demographic information. If this occurs, new accession numbers are generally needed for the new individual records since it is rarely possible to know which old individual record would apply to the newly identifiable group member.

Conversely, if one or more group members become identifiable, for example, the previously unbanded young of the year are caught up and banded, they should be split from the group record and given individual accessions. The group record should include the individual numbers assigned, and the records of all individuals should show the number of the originating group. In the case of new individual records, information particular to the animal being given the individual record (if known) should be transferred to the individual record. This includes birth date, origin, parent identification, etc. As in the cases of splitting and merging groups, the date of creation of the new record is the same as the date of removal from the previous group or individual, and detailed notes should explain the reasons for all changes in accession type.

Transfers Between Institutions - When accessioning a number of animals that were received from another institution, the new animals should be accessioned using the same type of record that the sending institution used, regardless of how the animals will ultimately be managed. If a group is received but the members will be managed as individuals, they should be accessioned as a group first, then split out as individuals. Similarly, if a number of individuals are received but the plan is to manage them as a group, they should be accessioned as individuals, then merged into a group. Although this is an extra step in the accession process, it allows the records from both institutions to more seamlessly link.

Removing Individuals From Historical Group Records - The decision of whether to use individual or group accession for historical records should be made thoughtfully and carefully. As detailed above, group accession should be used if there is insufficient information to create an accurate individual record. The
use of group accession is preferable to the inclusion of “best guess” information, i.e. fiction, to fill the information necessary to complete an individual record.

If additional information is later found that allows the creation of an individual record for one of the members of a historical group record, the procedure for removal from the group is different from that for current records. This situation is treated differently because the historical individual was not truly part of a group accession – the information necessary for a complete individual record was merely not known and the group accession was used “temporarily” until the required information was found or learned. For this reason, the individual should NOT be split from the group, but all reference to the individual should instead be deleted entirely from the group, as if it were never part of the group. This will allow the individual record to begin with the initial acquisition (instead of the date of removal from a group) and will include the animal's entire history in one record. It also prevents inflation of inventory numbers by eliminating the possible duplication of the same information in both the group and the individual records.
Appendix C: Guidelines for Creating and Sharing Animal and Collection Records

Developed by the AZA Institutional Data Management Scientific Advisory Group
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The goal of maintaining a centralized, compiled record for each animal cared for in a zoo or aquarium is ideal, however, oftentimes, information belonging in an animal record is spread across many departments and may originate with any member of the animal care staff. Therefore, it is important for zoos and aquariums to have a formal method for collecting or linking various pieces of information into the official records and that the roles and responsibilities for each named record type are clearly defined in written protocols for the reporting, recording, distribution, storage, and retrieval processes; there should also be a stated process of review for the accuracy and completeness of these records. For example, a recording/reporting protocol would state who reports births or deaths, to whom they are reported, in what manner and in what time frame they are reported, who officially records the information, and who reviews the resulting record for accuracy and completeness. Then, the maintenance and archiving protocol would state where the record is to be filed, who may have access, and how long the record is to be maintained before being archived or disposed of.

Information contained in animal records is essential not only to the immediate care of the individual animal but also as pooled data to manage larger concerns (e.g., providing norms for species-related veterinary and population management decisions, evidence of compliance with laws and regulations, showing trends in populations on every level from institutional to global, etc.). No matter what its use, it is critical for the information contained in an animal record to be factual, clear, complete, and documented. Because zoos and aquariums vary greatly in size and organizational structure, it is impossible to set defined procedures that would be applicable to all; therefore the following guidelines for creating and sharing animal records have been developed to assist with the establishment of written policies that best fit their own internal structure and protocols.

Animal and Collection Records – Definitions and Examples
The AZA Institutional Data Management Scientific Advisory Group (IDMAG) defines an animal record as: “data, regardless of physical form or medium, providing information about individual animals, groups of animals, or samples or parts thereof”. An animal’s record may include, but is not limited to, information about its provenance, history, daily care, activities, and condition; some may originate in non-animal care departments. Some examples of animal records are:

- transaction documents (including proof of legal ownership, purchase contracts, etc.)
- identification information
- reports of collection changes (including in-house moves)
- pedigrees/lineages
- veterinary information, including images, test results, etc.
- nutrition and body condition information
- information on sampling and parts/products distribution

In addition, the IDMAG defines collection records as: “information, evidence, rationalizations about an animal collection as a whole that may supplement or explain information contained in an animal record”. Collection records may include, but are not limited to, documentation of collection decisions and changes, evidence of structural change at the institution, evidence of building name changes, and documentation of institution level or unit level husbandry protocols and changes. Some examples of collection records are:

- collection plans
- permits
- annual inventories (which include reconciliation with the previous year)
- area journals/notebooks (including information to/from/between other animal care staff)
- keeper reports
animal management protocols (e.g., species hand-rearing protocols, special care or treatments, etc.)
enclosure maps/trees
enclosure/exhibit information (monitoring, maintenance, modifications, etc.)
research plans and published papers

Animal and Collection Records - Development
It is recommended that each zoo and aquarium develop written policies and procedures, applicable to all staff involved with animal care, that:

- define the types of records that are required.
  For example, daily keeper reports might be required from the keeper staff and weekly summaries of activities might be required from the animal curator and senior veterinarian.
- define the information that is to be included in each type of record.
  Following the example above, the institution would state the specific types of information to be recorded on the daily keeper report and the weekly summaries.
- define the primary location where each record can be found.
  For example, if a zoo does not employ a nutritionist, the policy or procedures might state that animal diet information will be found in keeper daily reports, curator-developed daily diets, and/or veterinarian-prescribed treatment diets.
- assign responsibility for the generation of each record type and set time limits for their creation.
  For example, keepers might be held responsible for producing daily reports by the start of the next day and curators might be held responsible for producing weekly summaries by the Tuesday of the following week.
- define a process to review the accuracy of each record type and assign responsibility for that review process.
  For example, the identity of who will review each type of record, the date of reviews, and the review/correction processes might be included in the policy.
- define a process to identify official records and assign responsibility for the recording of, or linking of, information into these records.
  For example, the identity of who will be responsible for placing information into the official records and the processes of how to identify official records might be included in the policy.
- ensure entries in official records are never erased or deleted.
  For example, if an entry is determined to be erroneous, rather than deleting it, the entry should be amended and an audit trail should be created that identifies what data was changed, who made the change, the date it was changed, and the reason for the change.
- ensure records relating to specific animals in the collection, including the records of non-animal care departments, are permanently archived as part of the animal's record.
  For example, if your zoo or aquarium’s records retention schedules differ from this recommendation every attempt should be made to exempt these records from schedules requiring their destruction.

Animal and Collection Records – Sharing of Information
Each zoo and aquarium should assess the ownership of their animal and collection records and determine the rights of employees and outside entities to the information contained in them. It is recommended that each zoo and aquarium develop written policies and procedures for the distribution and/or availability of the animal and collection records that:

- identify who has access to animal and collection records and under what conditions.
  For example, animal care staff whose duties require a direct need for information about specific animals or collection of animals should be identified as individuals who are allowed access to any or specified records, regardless of who created them or when they were created.
- assign responsibility for the distribution, archiving and retrieval of each record type.
For example, the recordkeeper or registrar might be held responsible for maintaining all past and current transaction documents and the curator might be held responsible for maintaining the daily keeper reports from his/her section.

- define a notification system that specifies what information will be provided in the notification, who will be notified, the date they will be notified by, and the mechanism that will be used to ensure the notification is communicated appropriately.
  For example, the shipment of an animal might require that written notice be made to the senior keeper in the animal’s area, the curator, and the veterinarian at least 30 days prior to the move, and identifies the animal by group or individual identification/accession number, sex, and tag/transponder number, etc.

- define where each record type (stored or archived) is available and what format (paper or digital) it is in.
  For example, all original animal transaction documents might be kept in the registrar’s office in fire-proof file cabinets but copies of the Animal Data Transfer Forms are kept in the appropriate keeper area.

- define a system for obtaining necessary information such that the information is available regardless of department and regardless of staffing issues.
  For example, keeper daily reports might be maintained in an electronic database run on the institution’s network, to which all animal care staff members have at least read-only access.

Implementation of these Recommendations
Well-written, consistent data-recording protocols and clear lines of communication will increase the quality of animal records and should be implemented by all institutions, regardless of technical resources. While the best option for availability of information is an electronic database system run on a computer network (intranet) to which all animal care staff members have unrestricted access, the above recommendations may also be adopted by zoos and aquariums without full electronic connections.
Appendix D: AZA Policy on Responsible Population Management

PREAMBLE

The stringent requirements for AZA accreditation, and high ethical standards of professional conduct, are unmatched by similar organizations and far surpass the United States Department of Agriculture’s Animal and Plant Health Inspection Service’s requirements for licensed animal exhibitors. Every AZA member must abide by a Code of Professional Ethics (https://www.aza.org/code-of-ethics). In order to continue these high standards, AZA-accredited institutions and certified related facilities should make it a priority, when possible, to acquire animals from and transfer them to other AZA member institutions, or members of other regional zoo associations that have professionally recognized accreditation programs.

AZA-accredited institutions and certified related facilities cannot fulfill their important missions of conservation, education, and science without live animals. Responsible management and the long-term sustainability of living animal populations necessitates that some individuals be acquired and transferred, reintroduced or even humanely euthanized at certain times. The acquisition and transfer of animals should be prioritized by the long-term sustainability needs of the species and AZA-managed populations among AZA-accredited and certified related facilities, and between AZA member institutions and non-AZA entities with animal care and welfare standards aligned with AZA. AZA member institutions that acquire animals from the wild, directly or through commercial vendors, should perform due diligence to ensure that such activities do not have a negative impact on species in the wild. Animals should only be acquired from non-AZA entities that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this Policy.

I. INTRODUCTION

This AZA Policy on Responsible Population Management provides guidance to AZA members to:

1. Assure that animals from AZA member institutions and certified related facilities are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them (see taxa specific appendices (in development)),

2. Assure that the health and conservation of wild populations and ecosystems are carefully considered as appropriate,

3. Maintain a proper standard of conduct for AZA members during acquisition and transfer/reintroduction activities, including adherence to all applicable laws and regulations,

4. Assure that the health and welfare of individual animals is a priority during acquisition and transfer/reintroduction activities, and

5. Support the goals of AZA’s cooperatively managed populations and associated Animal Programs (Species Survival Plans® (SSPs), Studbooks, and Taxon Advisory Groups (TAGs)).

This AZA Policy on Responsible Population Management will serve as the default policy for AZA member institutions. Institutions should develop their own Policy on Responsible Population Management in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and transfer/transition standards.

II. LAWS, AUTHORITY, RECORD-KEEPING, IDENTIFICATION AND DOCUMENTATION

The following must be considered with regard to the acquisition or transfer/management of all living animals and specimens (their living and non-living parts, materials, and/or products):
1. Any acquisitions, transfers, euthanasia and reintroductions must meet the requirements of all applicable local, state, federal and international laws and regulations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV’s Guidelines on the Euthanasia of Non-Domestic Animals. Ownership and any applicable chain-of-custody must be documented. If such information does not exist, an explanation must be provided regarding such animals and specimens. Any acquisition of free-ranging animals must be done in accordance with all local, state, federal, and international laws and regulations and must not be detrimental to the long-term viability of the species in the wild.

2. The Director/Chief Executive Officer of the institution must have final authority for all acquisitions, transfers, and euthanasia.

3. Acquisitions or transfers/euthanasia/reintroductions must be documented through institutional record keeping systems. The ability to identify which animal is being transferred is very important and the method of identifying each individual animal should be documented. Any existing documentation must accompany all transfers. Institutional animal records data, records guidelines have been developed for certain species to standardize the process (https://www.aza.org/idmag-documents-and-guidelines).

4. For some colonial, group-living, or prolific species, it may be impossible or highly impractical to identify individual animals when these individuals are maintained in a group. These species can be maintained, acquisitioned, transferred, and managed as a group or colony, or as part of a group or colony.

5. If the intended use of specimens from animals either living or non-living is to create live animal(s), their acquisition and transfer should follow the same guidelines. If germplasm is acquired or transferred with the intention of creating live animal(s), ownership of the offspring must be clearly defined in transaction documents (e.g., breeding loan agreements).

   Institutions acquiring, transferring or otherwise managing specimens should consider current and possible future uses as new technologies become available. All specimens from which nuclear DNA could be recovered should be carefully considered for preservation as these basic DNA extraction technologies already exist.

6. AZA member institutions must maintain transaction documents (e.g., confirmation forms, breeding agreements) which provide the terms and conditions of animal acquisitions, transfers and loans, including documentation for animal parts, products and materials. These documents should require the potential recipient or provider to adhere to the AZA Policy on Responsible Population Management, and the AZA Code of Professional Ethics, and must require compliance with the applicable laws and regulations of local, state, federal, and international authorities.

7. In the case of animals (living or non-living) and their parts, materials, or products (living or non-living) held on loan, the owner’s written permission should be obtained prior to any transfer and documented in the institutional records.

8. AZA SSP and TAG necropsy and sampling protocols should be accommodated.

9. Some governments maintain ownership of the species naturally found within their borders. It is therefore incumbent on institutions to determine whether animals they are acquiring or transferring are owned by a government entity, foreign or domestic, and act accordingly by reviewing the government ownership policies available on the AZA website. In the case of government owned animals, proposals for and/or notifications of transfers must be sent to the species manager for the government owned species.
III. ACQUISITION REQUIREMENTS

A. General Acquisitions

1. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals regarding the individual or species.

2. Animals (wild, feral, and domestic) may be held temporarily for reasons such as assisting governmental agencies or other institutions, rescue and/or rehabilitation, research, propagation or headstarting for reintroduction, or special exhibits.

3. Any receiving institution must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met.

4. If the acquisition involves a species managed by an AZA Animal Program, the institution should communicate with the Animal Program Leader and, in the case of Green SSP Programs, must adhere to the AZA Full Participation Policy (https://www.aza.org/board-approved-policies-and-position-statements).

5. AZA member institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved TAG Regional Collection Plans (RCPs), Animal Program Leaders, and AZA Animal Care Manuals (ACMs) when making acquisition decisions.

6. AZA member institutions that work with commercial vendors that acquire animals from the wild, must perform due diligence to assure the vendors’ collection of animals is legal and using ethical practices. Commercial vendors should have conservation and animal welfare goals similar to those of AZA institutions.

7. AZA member institutions may acquire animals through public donations and other non-AZA entities when it is in the best interest of the animal and/or species.

B. Acquisitions from the Wild

Maintaining wild animal populations for exhibition, education and wildlife conservation purposes is a core function of AZA-member institutions. AZA zoos and aquariums have saving species and conservation of wildlife and wildlands as a basic part of their public mission. As such, the AZA recognizes that there are circumstances where acquisitions from the wild are needed in order to maintain healthy, diverse animal populations. Healthy, sustainable populations support the objectives of managed species programs and the core mission of AZA members. In some cases, acquiring individuals from the wild may be a viable option in addition to, or instead of, relying on breeding programs with animals already in human care.

Acquiring animals from the wild can result in socioeconomic benefit and environmental protection and therefore the AZA supports environmentally sustainable/beneficial acquisition from the wild when conservation is a positive outcome.

1. Before acquiring animals from the wild, institutions are encouraged to examine alternative sources including other AZA institutions and other regional zoological associations or other non-AZA entities.

2. When acquiring animals from the wild, both the long-term health and welfare impacts on the wild population as well as on individual animals must be considered. In crisis situations, when the survival of a population is at risk, rescue decisions will be made on a case-by-case basis by the appropriate agency and institution.
3. AZA zoos and aquariums may assist wildlife agencies by providing homes for animals born in nature if they are incapable of surviving on their own (e.g., in case of orphaned or injured animals) or by euthanizing the animals because they pose a risk to humans or for humane reasons.

4. Institutions should only accept animals from the wild after a risk assessment determines the zoo/aquarium can mitigate any potential adverse impacts on the health, care and maintenance of the existing animals already being housed at the zoo or aquarium, and the new animals being acquired.

IV. TRANSFER, EUTHANASIA AND REINTRODUCTION REQUIREMENTS

A. Living Animals

Successful conservation and animal management relies on the cooperation of many entities, both AZA and non-AZA. While preference is given to placing animals with AZA-accredited institutions or certified related facilities, it is important to foster a cooperative culture among those who share AZA’s mission of saving species and excellence in animal care.

1. AZA members should assure that all animals in their care are transferred, humanely euthanized and/or reintroduced in a manner that meets the standards of AZA, and that animals are not transferred to those not qualified to care for them properly. Refer to IV.12, below, for further requirements regarding euthanasia.

2. If the transfer of animals or their specimens (parts, materials, and products) involves a species managed by an AZA Animal Program, the institution should communicate with that Animal Program Leader and, in the case of Green SSP Programs must adhere to the AZA Full Participation Policy (https://www.aza.org/board-approved-policies-and-position-statements).

3. AZA member institutions should consult WCMC-approved TAG Regional Collection Plans, Animal Program Leaders, and Animal Care Manuals when making transfer decisions.

4. Animals acquired solely as a food source for animals in the institution’s care are not typically accessioned. There may be occasions, however, when it is appropriate to use accessioned animals that exceed population carrying capacity as feeder animals to support other animals. In some cases, accessioned animals may have their status changed to “feeder animal” status by the institution as part of their program for long-term sustained population management of the species.

5. In transfers to non-AZA entities, AZA members must perform due diligence and should have documented validation, including one or more letters of reference, for example from an appropriate AZA Professional Fellow or other trusted source with expertise in animal care and welfare, who is familiar with the proposed recipient and their current practices, and that the recipient has the expertise and resources required to properly care for and maintain the animals. Any recipient must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met within the parameters of modern zoological philosophy and practice. Supporting documentation must be kept at the AZA member institution (see #IV.9 below).

6. Domestic animals should be transferred in accordance with locally acceptable humane farming practices, including auctions, and must be subject to all relevant laws and regulations.

7. AZA members must not send any non-domestic animal to auction or to any organization or individual that may display or sell the animal at an animal auction. See certain taxa-specific appendices to this Policy (in development) for information regarding exceptions.

8. Animals must not be sent to organizations or individuals that allow the hunting of these individual animals; that is, no individual animal transferred from an AZA institution may be hunted. For purposes of maintaining genetically healthy, sustainable zoo and aquarium populations, AZA-accredited institutions and certified related facilities may send animals to non-AZA organizations or individuals.
(refer to #IV.5 above). These non-AZA entities (for instance, ranching operations) should follow appropriate ranch management practices and other conservation minded practices to support population sustainability.

9. Every loaning institution must annually monitor and document the conditions of any loaned specimen(s) and the ability of the recipient(s) to provide proper care (refer to #IV.5 above). If the conditions and care of animals are in violation of the loan agreement, the loaning institution must recall the animal or assure prompt correction of the situation. Furthermore, an institution’s loaning policy must not be in conflict with this AZA Policy on Responsible Population Management.

10. If living animals are sent to a non-AZA entity for research purposes, it must be a registered research facility by the U.S. Department of Agriculture and accredited by the Association for the Assessment and Accreditation of Laboratory Animal Care, International (AAALAC), if eligible. For international transactions, the receiving facility must be registered by that country’s equivalent body having enforcement over animal welfare. In cases where research is conducted, but governmental oversight is not required, institutions should do due diligence to assure the welfare of the animals during the research.

11. Reintroductions and release of animals into the wild must meet all applicable local, state, and international laws and regulations. Any reintroduction requires adherence to best health and veterinary practices to ensure that non-native pathogens are not released into the environment exposing naive wild animals to danger. Reintroductions may be a part of a recovery program and must be compatible with the IUCN Reintroduction Specialist Group’s Reintroduction Guidelines (http://www.iucnsscrsg.org/index.php).

12. Humane euthanasia may be employed for medical reasons to address quality of life issues for animals or to prevent the transmission of disease. AZA also recognizes that humane euthanasia may be employed for managing the demographics, genetics, and diversity of animal populations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV’s Guidelines on the Euthanasia of Non-Domestic Animals.

B. Non-Living Animals and Specimens

AZA members should optimize the use and recovery of animal remains. All transfers must meet the requirements of all applicable laws and regulations.

1. Optimal recovery of animal remains may include performing a complete necropsy including, if possible, histologic evaluation of tissues which should take priority over specimens’ use in education/exhibits. AZA SSP and TAG necropsy and sampling protocols should be accommodated. This information should be available to SSP Programs for population management.

2. The educational use of non-living animals, parts, materials, and products should be maximized, and their use in Animal Program sponsored projects and other scientific projects that provide data for species management and/or conservation must be considered.

3. Non-living animals, if handled properly to protect the health of the recipient animals, may be utilized as feeder animals to support other animals as deemed appropriate by the institution.

4. AZA members should consult with AZA Animal Program Leaders prior to transferring or disposing of remains/samples to determine if existing projects or protocols are in place to optimize use.

5. AZA member institutions should develop agreements for the transfer or donation of non-living animals, parts, materials, products, and specimens and associated documentation, to non-AZA entities such as universities and museums. These agreements should be made with entities that have
appropriate long term curation/collections capacity and research protocols, or needs for educational programs and/or exhibits.
**DEFINITIONS**

Acquisition: Acquisition of animals can occur through breeding (births, hatchings, cloning, and division of marine invertebrates = “fragging”), trade, donation, lease, loan, transfer (inter- and intra-institution), purchase, collection, confiscation, appearing on zoo property, or rescue and/or rehabilitation for release.

Annual monitoring and Due diligence: Due diligence for the health of animals on loan is important. Examples of annual monitoring and documentation include and are not limited to inventory records, health records, photos of the recipient’s facilities, and direct inspections by AZA professionals with knowledge of animal care. The level of due diligence will depend on professional relationships.

AZA member institution: In this Policy “AZA member institutions” refers to AZA-accredited institutions and certified related facilities (zoological parks and aquariums). “AZA members” may refer to either institutions or individuals.

Data sharing: When specimens are transferred, the transferring and receiving institutions should agree on data that must be transferred with the specimen(s). Examples of associated documentation include provenance of the animal, original permits, tags and other metadata, life history data for the animal, how and when specimens were collected and conserved, etc.

Dispose: “Dispose/Disposing of” in this document is limited to complete and permanent removal of an individual via incineration, burying or other means of permanent destruction.

Documentation: Examples of documentation include ZIMS records, “Breeding Loan” agreements, chain-of-custody logs, letters of reference, transfer agreements, and transaction documents. This is documentation that maximizes data sharing.

Domestic animal: Examples of domestic animals may include certain camelids, cattle, cats, dogs, ferrets, goats, pigs, reindeer, rodents, sheep, budgerigars, chickens, doves, ducks, geese, pheasants, turkeys, and goldfish or koi.

Ethics of Acquisition/Transfer/Euthanasia: Attempts by members to circumvent AZA Animal Programs in the acquisition of animals can be detrimental to the Association and its Animal Programs. Such action may also be detrimental to the species involved and may be a violation of the Association’s Code of Professional Ethics. Attempts by members to circumvent AZA Animal Programs in the transfer, euthanasia or reintroduction of animals may be detrimental to the Association and its Animal Programs (unless the animal or animals are deemed extra in the Animal Program population by the Animal Program Coordinator). Such action may be detrimental to the species involved and may be a violation of the Association’s Code of Professional Ethics.

“Extra” or Surplus: AZA’s scientifically-managed Animal Programs, including SSPs, have successfully bred and reintroduced critically endangered species for the benefit of humankind. To accomplish these critical conservation goals, populations must be managed within “carrying capacity” limits. At times, the number of individual animals in a population exceeds carrying capacity, and while meaning no disrespect for these individual animals, we refer to these individual animals as “extra” within the managed population.

Euthanasia: Humane death. This act removes an animal from the managed population. Specimens can be maintained in museums or cryopreserved collections. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV’s Guidelines on the Euthanasia of Non-Domestic Animals.

Feral: Feral animals are animals that have escaped from domestication or have been abandoned to the wild and have become wild, and the offspring of such animals. Feral animals may be acquired for temporary or permanent reasons.

Group: Examples of colonial, group-living, or prolific species include and are not limited to certain terrestrial and aquatic invertebrates, fish, sharks/rays, amphibians, reptiles, birds, rodents, bats, big herds, and other mammals.

Lacey act: The Lacey Act prohibits the importation, exportation, transportation, sale, receipt, acquisition or purchase of wildlife taken or possessed in violation of any law, treaty or regulation of the United States or any Indian tribal law of wildlife law. In cases when there is no documentation accompanying an acquisition, the animal(s) may not be transferred across state lines. If the animal was illegally acquired at any time then any movement across state or international borders would be a violation of the Lacey Act.

Museum: It is best practice for modern zoos and aquariums to establish relationships with nearby museums or other biorepositories, so that they can maximize the value of animals when they die (e.g., knowing who to call when they have an animal in necropsy, or specimens for cryopreservation). Natural history museums that are members of the Natural Science Collections Alliance (NSCA) and frozen biorepositories that are members of the International Society of Biological and Environmental Repositories (ISBER) are potential collaborators that could help zoos find appropriate repositories for biological specimens.

Non-AZA entity: Non – AZA entities includes facilities not accredited or certified by the AZA, facilities in other zoological regions, academic institutions, museums, research facilities, private individuals, etc.

Reintroduction: Examples of transfers outside of a living zoological population include movements of animals from zoo/aquarium populations to the wild through reintroductions or other legal means.
Specimen: Examples of specimens include animal parts, materials and products including bodily fluids, cell lines, clones, digestive content, DNA, feces, marine invertebrate (coral) fragments ("frags"), germplasm, and tissues.

Transaction documents: Transaction documents must be signed by the authorized representatives of both parties, and copies must be retained by both parties*. In the case of loans, the owner’s permission for appropriate activities should be documented in the institutional records. This document(s) should be completed prior to any transfer. In the case of rescue, confiscation, and evacuation due to natural disasters, it is understood that documents may not be available until after acceptance or shipping. In this case documentation (e.g., a log) must be kept to reconcile the inventory and chain of custody after the event occurs. (*In the case of government owned animals, notification of transfers must be sent to species manager for the government owned species).

Transfer: Transfer occurs when an animal leaves the institution for any reason. Reasons for transfer or euthanasia may include cooperative population management (genetic, demographic or behavioral management), animal welfare or behavior management reasons (including sexual maturation and individual management needs). Types of transfer include withdrawal through donation, trade, lease, loan, inter- and intra-institution transfers, sale, escape, theft. Reintroduction to the wild, humane euthanasia or natural death are other possible individual animal changes in a population.
**RECIPIENT PROFILE EXAMPLE**

Example questions for transfers to non-AZA entities (from AZA-member Recipient Profile documents):

**Has your organization, or any of its officers, been indicted, convicted, or fined by a State or Federal agency for any statute or regulation involving the care or welfare of animals housed at your facility? (If yes, please explain on a separate sheet).**

**Recipients agree that the specimen(s) or their offspring will not be utilized, sold or traded for any purpose contrary to the Association of Zoos and Aquariums (AZA) Code of Ethics (enclosed)**

**References, other than (LOCAL ZOO/AQUARIUM) employees, 2 minimum (please provide additional references on separate sheet):**

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**How are animals identified at your facility? If animals are not identified at your facility, please provide an explanation about why they are not here:**

**Where do you acquire and send animals? (Select all that apply)**

- AZA Institutions
- Non-AZA Institutions
- Exotic Animal Auctions
- Pet Stores
- Hunting Ranches
- Dealers
- Private Breeders
- Non-hunting Game Ranches
- Entertainment Industry
- Hobbyists
- Research Labs
- Wild
- Other

**What specific criteria are used to evaluate if a facility is appropriate to receive animals from you?**

**Please provide all of the documents listed below:**

- **Required:**
  1. Please provide a brief statement of intent for the specimens requested.
  2. Resumes of primary caretakers and those who will be responsible for the husbandry and management of animals.
  3. Description (including photographs) of facilities and exhibits where animals will be housed.
  4. Copy of your current animal inventory.

- **Only if Applicable:**
  5. Copies of your last two USDA inspection reports (if applicable).
7. Copy of your institutional acquisition/disposition policy.

(in-house use only) In-Person Inspection of this facility (Staff member/Date, attach notes):

(Local institution: provide Legal language certifying that the information contained herein is true and correct)

(Validity of this: This document and all materials associated will be valid for a period of 2 years from date of signature.)

Example agreement for Receiving institution (agrees to following condition upon signing):
RECIPIENT AGREES THAT THE ANIMAL(S) AND ITS (THEIR) OFFSPRING WILL NOT BE UTILIZED, SOLD OR TRADED FOR THE PURPOSE OF COMMERCE OR SPORT HUNTING, OR FOR USE IN ANY STRESSFUL OR TERMINAL RESEARCH OR SENT TO ANY ANIMAL AUCTION. RECIPIENT FURTHER AGREES THAT IN THE EVENT THE RECIPIENT INTENDS TO DISPOSE OF AN ANIMAL DONATED BY (INSTITUTION), RECIPIENT WILL FIRST NOTIFY (INSTITUTION) OF THE IDENTITY OF THE PROPOSED TRANSFEREE AND THE TERMS AND CONDITIONS OF SUCH DISPOSITION AND WILL PROVIDE (INSTITUTION) THE OPPORTUNITY TO ACQUIRE THE ANIMAL(S) WITHOUT CHARGE. IF (INSTITUTION) ELECTS NOT TO RECLAIM THE ANIMAL WITHIN TEN (10) BUSINESS DAYS FOLLOWING SUCH NOTIFICATION, THEN, IN SUCH EVENT, (INSTITUTION) WAIVES ANY RIGHT IT MAY HAVE TO THE ANIMAL AND RECIPIENT MAY DISPOSE OF THE ANIMAL AS PROPOSED.

Institutional note: The text above is similar to the language most dog breeders use in their contracts when they sell a puppy. If people can provide that protection to the puppies they place, zoos/aquariums can provide it for animals that we place too! Some entities have been reluctant to sign it, and in that case we revert to a loan and our institution retains ownership of the animal. Either way, we are advised of the animal’s eventual placement and location.
Appendix E: Recommended Quarantine Procedures

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a 70 °C (-94 °F) frost-free freezer or a 20 °C (-4 °F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., transponder or leg band.). Also, whenever animals are restrained or immobilized, a complete physical, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for greater roadrunner:
Greater Roadrunner:  
**Required:**  
1. Direct and floatation fecals  
2. Vaccinate as appropriate  

**Strongly recommended:**  
1. CBC/sera profile  
2. Appropriate serology
Appendix F: Ambassador (Program) Animal Policy and Position Statement

Ambassador (Program) Animal Policy

Originally approved by the AZA Board of Directors—2003
Updated and approved by the Board—July 2008 and June 2011

The Association of Zoos and Aquariums (AZA) recognizes many benefits for public education and, ultimately, for conservation in ambassador animal presentations. AZA’s Conservation Education Committee’s Ambassador Animal Position Statement summarizes the value of ambassador animal presentations (see pages 42–44).

For the purpose of this policy, an Ambassador animal is defined as “an animal whose role includes handling and/or training by staff or volunteers for interaction with the public and in support of institutional education and conservation goals.” Some animals are designated as Ambassador Animals on a full-time basis, while others are designated as such only occasionally. Ambassador Animal-related Accreditation Standards are applicable to all animals during the times that they are designated as Ambassador Animals.

There are three main categories of Ambassador Animal interactions:

1. On Grounds with the Ambassador Animal Inside the Exhibit/Enclosure:
   a. Public access outside the exhibit/enclosure. Public may interact with animals from outside the exhibit/enclosure (e.g., giraffe feeding, touch tanks).
   b. Public access inside the exhibit/enclosure. Public may interact with animals from inside the exhibit/enclosure (e.g., lorikeet feedings, ‘swim with’ programs, camel/pony rides).

2. On Grounds with the Ambassador Animal Outside the Exhibit/Enclosure:
   a. Minimal handling and training techniques are used to present Ambassador Animals to the public. Public has minimal or no opportunity to directly interact with Ambassador Animals when they are outside the exhibit/enclosure (e.g., raptors on the glove, reptiles held “presentation style”).
   b. Moderate handling and training techniques are used to present Ambassador Animals to the public. Public may be in close proximity to, or have direct contact with, Ambassador Animals when they’re outside the exhibit/enclosure (e.g., media, fund raising, photo, and/or touch opportunities).
   c. Significant handling and training techniques are used to present Ambassador Animals to the public. Public may have direct contact with Ambassador Animals or simply observe the in-depth presentations when they’re outside the exhibit/enclosure (e.g., wildlife education shows).

3. Off Grounds:
   a. Handling and training techniques are used to present Ambassador Animals to the public outside of the zoo/aquarium grounds. Public may have minimal contact or be in close proximity to and have direct contact with Ambassador Animals (e.g., animals transported to schools, media, fund raising events).

These categories assist staff and accreditation inspectors in determining when animals are designated as Ambassador Animals and the periods during which the Ambassador Animal-related Accreditation Standards are applicable. In addition, these Ambassador Animal categories establish a framework for understanding increasing degrees of an animal’s involvement in Ambassador Animal activities.

Ambassador Animal presentations bring a host of responsibilities, including the safety and welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that make Ambassador Animal presentations to develop an institutional Ambassador Animal policy that clearly...
identifies and justifies those species and individuals approved as Ambassador Animals and details their long-term management plan and educational program objectives.

AZA's accreditation standards require that education and conservation messages must be an integral component of all Ambassador Animal presentations. In addition, the accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, appropriate environmental enrichment, access to veterinary care, nutrition, and other related standards. In addition, providing Ambassador Animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management. Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, free-flight birds may receive appropriate exercise during regular programs, reducing the need for additional exercise. However, the institution must ensure that in such cases, the animals participate in programs on a basis sufficient to meet these needs or provide for their needs in their home enclosures; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

Ambassador Animal Position Statement

Last revision 1/28/03
Re-authorized by the Board June 2011

The Conservation Education Committee (CEC) of the Association of Zoos and Aquariums supports the appropriate use of Ambassador Animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective (emotional) messages about conservation, wildlife and animal welfare. Utilizing these animals allows educators to strongly engage audiences. As discussed below, the use of Ambassador Animals has been demonstrated to result in lengthened learning periods, increased knowledge acquisition and retention, enhanced environmental attitudes, and the creation of positive perceptions concerning zoo and aquarium animals.

Audience Engagement

Zoos and aquariums are ideal venues for developing emotional ties to wildlife and fostering an appreciation for the natural world. However, developing and delivering effective educational messages in the free-choice learning environments of zoos and aquariums is a difficult task. Zoo and aquarium educators are constantly challenged to develop methods for engaging and teaching visitors who often view a trip to the zoo as a social or recreational experience (Morgan & Hodgkinson, 1999). The use of Ambassador Animals can provide the compelling experience necessary to attract and maintain personal connections with visitors of all motivations, thus preparing them for learning and reflection on their own relationships with nature.

Ambassador Animals are powerful catalysts for learning for a variety of reasons. They are generally active, easily viewed, and usually presented in close proximity to the public. These factors have proven to contribute to increasing the length of time that people spend watching animals in zoo exhibits (Bitgood, Patterson & Benefield, 1986, 1988; Wolf & Tymitz, 1981).

In addition, the provocative nature of a handled animal likely plays an important role in captivating a visitor. In two studies (Povey, 2002; Povey & Rios, 2001), visitors viewed animals three and four times longer while they were being presented in demonstrations outside of their enclosure with an educator than while they were on exhibit. Clearly, the use of Ambassador Animals in shows or informal presentations can be effective in lengthening the potential time period for learning and overall impact.

Ambassador Animals also provide the opportunity to personalize the learning experience, tailoring the teaching session to what interests the visitors. Traditional graphics offer little opportunity for this level of personalization of information delivery and are frequently not read by visitors (Churchman, 1985; Johnston, 1998). For example, Povey (2001) found that only 25% of visitors to an animal exhibit read the accompanying graphic; whereas, 45% of visitors watching the same animal handled in an educational presentation asked at least one question and some asked as many as seven questions. Having an animal accompany the educator allowed the visitors to make specific inquiries about topics in which they were interested.
Knowledge Acquisition
Improving our visitors’ knowledge and understanding regarding wildlife and wildlife conservation is a fundamental goal for many zoo educators using Ambassador Animals. A growing body of evidence supports the validity of using Ambassador Animals to enhance delivery of these cognitive messages as well.

- MacMillen (1994) found that the use of live animals in a zoomobile outreach program significantly enhanced cognitive learning in a vertebrate classification unit for sixth grade students.
- Sherwood and his colleagues (1989) compared the use of live horseshoe crabs and sea stars to the use of dried specimens in an aquarium education program and demonstrated that students made the greatest cognitive gains when exposed to programs utilizing the live animals.
- Povey and Rios (2002) noted that in response to an open-ended survey question (“Before I saw this animal, I never realized that . . .”), visitors watching a presentation utilizing a Ambassador Animal provided 69% cognitive responses (i.e., something they learned) versus 9% made by visitors viewing the same animal in its exhibit (who primarily responded with observations).
- Povey (2002) recorded a marked difference in learning between visitors observing animals on exhibit versus being handled during informal presentations. Visitors to demonstrations utilizing a raven and radiated tortoises were able to answer questions correctly at a rate as much as eleven times higher than visitors to the exhibits.

Enhanced Environmental Attitudes
Ambassador Animals have been clearly demonstrated to increase affective learning and attitudinal change.

- Studies by Yerke and Burns (1991), and Davison and her colleagues (1993) evaluated the effect live animal shows had on visitor attitudes. Both found their shows successfully influenced attitudes about conservation and stewardship.
- Yerke and Burns (1993) also evaluated a live bird outreach program presented to Oregon fifth-graders and recorded a significant increase in students’ environmental attitudes after the presentations.
- Sherwood and his colleagues (1989) found that students who handled live invertebrates in an education program demonstrated both short and long-term attitudinal changes as compared to those who only had exposure to dried specimens.
- Povey and Rios (2002) examined the role Ambassador Animals play in helping visitors develop positive feelings about the care and well-being of zoo animals.
- As observed by Wolf and Tymitz (1981), zoo visitors are deeply concerned with the welfare of zoo animals and desire evidence that they receive personalized care.

Conclusion
Creating positive impressions of aquarium and zoo animals, and wildlife in general, is crucial to the fundamental mission of zoological institutions. Although additional research will help us delve further into this area, the existing research supports the conclusion that Ambassador Animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places.

Acknowledgements
The primary contributors to this paper were Karen Povey and Keith Winsten, with valuable comments provided from members of both the Conservation Education Committee and the Children's Zoo Interest Group.

References


Appendix G: Developing an Institutional Ambassador Animal Policy

Last revision 2003
Re-authorized by the Board, June 2011

Rationale
Membership in AZA requires that an institution meet the AZA Accreditation Standards collectively developed by our professional colleagues. Standards guide all aspects of an institution's operations; however, the accreditation commission has asserted that ensuring that member institutions demonstrate the highest standards of animal care is a top priority. Another fundamental AZA criterion for membership is that education be affirmed as core to an institution's mission. All accredited public institutions are expected to develop a written education plan and to regularly evaluate program effectiveness.

The inclusion of animals (native, exotic, and domestic) in educational presentations, when done correctly, is a powerful tool. CEC's Ambassador Animal Position Statement describes the research underpinning the appropriate use of Ambassador Animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective messages about conservation and wildlife.

Ongoing research, such as AZA's Multi-Institutional Research Project (MIRP) and research conducted by individual AZA institutions will help zoo educators to determine whether the use of Ambassador Animals conveys intended and/or conflicting messages and to modify and improve programs accordingly and to ensure that all Ambassador Animals have the best possible welfare.

When utilizing Ambassador Animals our responsibility is to meet both our high standards of animal care and our educational goals. Additionally, as animal management professionals, we must critically address both the species' conservation needs and the welfare of the individual animal. Because "wild creatures differ endlessly," in their forms, needs, behavior, limitations and abilities (Conway, 1995), AZA, through its Animal Welfare Committee, has recently given the responsibility to develop taxon- and species-specific animal welfare standards and guidelines to the Taxon Advisory Groups (TAG) and Species Survival Plan® Program (SSP). Experts within each TAG or SSP, along with their education advisors, are charged with assessing all aspects of the taxons' and/or species’ biological and social needs and developing Animal Care Manuals (ACMs) that include specifications concerning their use as Ambassador Animals.

However, even the most exacting standards cannot address the individual choices faced by each AZA institution. Therefore, each institution is required to develop a Ambassador Animal policy that articulates and evaluates program benefits. The following recommendations are offered to assist each institution in formulating its own Institutional Ambassador Animal Policy, which incorporates the AZA Ambassador Animal Policy and addresses the following matters.

The Policy Development Process
Within each institution, key stakeholders should be included in the development of that institution's policy, including, but not limited to representatives from:

- The Education Department
- The Animal Husbandry Department
- The Veterinary and Animal Health Department
- The Conservation and Science Department
- The Behavioral Husbandry Department
- Any animal show staff (if in a separate department)
- Departments that frequently request special Ambassador Animal situations (e.g., special events, development, marketing, zoo or aquarium society, administration)

Additionally, staff from all levels of the organization should be involved in this development (e.g., curators, keepers, education managers, interpreters, volunteer coordinators).

To develop a comprehensive Ambassador Animal Policy, we recommend that the following components be included:
I. Philosophy
In general, the position of the AZA is that the use of animals in up close and personal settings, including animal contact, can be extremely positive and powerful, as long as:

1. The use and setting is appropriate.
2. Animal and human welfare is considered at all times.
3. The animal is used in a respectful, safe manner and in a manner that does not misrepresent or degrade the animal.
4. A meaningful conservation message is an integral component. Read the AZA Board-approved Conservation Messages.
5. Suitable species and individual specimens are used.

Institutional Ambassador Animal policies should include a philosophical statement addressing the above, and should relate the use of Ambassador Animals to the institution's overall mission statement.

II. Appropriate Settings
The Ambassador Animal Policy should include a listing of all settings both on and off site, where Ambassador Animal use is permitted. This will clearly vary among institutions. Each institution’s policy should include a comprehensive list of settings specific to that institution. Some institutions may have separate policies for each setting; others may address the various settings within the same policy.

Examples of settings include:

1. On-site programming
   a. Informal and non-registrants:
      i. On-grounds programming with animals being brought out (demonstrations, lectures, parties, special events, and media)
      ii. Children’s zoos and contact yards
      iii. Behind-the-scenes open houses
      iv. Shows
      v. Touch pools
   b. Formal (registration involved) and controlled settings
      i. School group programs
      ii. Summer camps
      iii. Overnights
      iv. Birthday parties
      v. Animal rides
      v. Public animal feeding programs
   c. Offsite and outreach
      i. PR events (TV, radio)
      ii. Fundraising events
      iii. Field programs involving the public
      iv. School visits
      v. Library visits
      vi. Nursing home visits (therapy)
      vii. Hospital visits
      viii. Senior centers
      ix. Civic group events

In some cases, policies will differ from setting to setting (e.g., on-site and off-site use with media). These settings should be addressed separately, and should reflect specific animal health issues, assessment of distress in these situations, limitations, and restrictions.

III. Compliance with Regulations
All AZA institutions housing mammals are regulated by the USDA’s Animal Welfare Act. Other federal regulations, such as the Marine Mammal Protection Act, may apply. Additionally, many states, and some cities, have regulations that apply to animal contact situations. Similarly, all accredited institutions are bound by the AZA Code of Professional Ethics. It is expected that the Institution Ambassador Animal Policy address compliance with appropriate regulations and AZA Accreditation Standards.
IV. Collection Planning

AZA accredited institutions should have a collection planning process in place. Ambassador Animals are part of an institution's overall collection and must be included in the overall collection planning process. The AZA Guide to Accreditation contains specific requirements for the institution collection plan. For more information about collection planning in general, please see the Collection Management pages in the Members Only section.

The following recommendations apply to Ambassador Animals:

1. Listing of approved Ambassador Animals (to be periodically amended as collection changes).
   - Justification of each species should be based upon criteria such as:
     a. Temperament and suitability for program use
     b. Husbandry requirements
     c. Husbandry expertise
     d. Veterinary issues and concerns
     e. Ease and means of acquisition / disposition according to the AZA code of ethics
     f. Educational value and intended conservation message
     g. Conservation Status
     h. Compliance with TAG and SSP guidelines and policies

2. General guidelines as to how each species (and, where necessary, for each individual) will be presented to the public, and in what settings

3. The collection planning section should reference the institution's acquisition and disposition policies.

V. Conservation Education Message

As noted in the AZA Accreditation Standards, if animal demonstrations are part of an institution's programs, an educational and conservation message must be an integral component. The Ambassador Animal Policy should address the specific messages related to the use of Ambassador Animals, as well as the need to be cautious about hidden or conflicting messages (e.g., "petting" an animal while stating verbally that it makes a poor pet). This section may include or reference the AZA Conservation Messages.

Although education value and messages should be part of the general collection planning process, this aspect is so critical to the use of Ambassador Animals that it deserves additional attention. In addition, it is highly recommended to encourage the use of biofacts in addition to or in place of the live animals. Whenever possible, evaluation of the effectiveness of presenting Ambassador Animals should be built into education programs.

VI. Human Health and Safety

The safety of our staff and the public is one of the greatest concerns in working with Ambassador Animals. Although extremely valuable as educational and affective experiences, contact with animals poses certain risks to the handler and the public. Therefore, the human health and safety section of the policy should address:

1. Minimization of the possibility of disease transfer from non-human animals to humans, and vice-versa (e.g., hand washing stations, no touch policies, use of hand sanitizer).

2. Safety issues related to handlers' personal attire and behavior (e.g., discourage or prohibit use of long earrings, perfume and cologne, not eating or drinking around animals, smoking, etc.).

AZA's Animal Contact Policy provides guidelines in this area; these guidelines were incorporated into accreditation standards in 1998.

VII. Animal Health and Welfare

Animal health and welfare are the highest priority of AZA accredited institutions. As a result, the Institutional Ambassador Animal Policy should make a strong statement on the importance of animal welfare. The policy should address:

1. General housing, husbandry, and animal health concerns (e.g. that the housing and husbandry for Ambassador Animals meets or exceeds general AZA standards and that the physical, social and psychological needs of the individual animal, such as adequate rest periods, provision of enrichment, visual cover, contact with conspecifics as appropriate, etc., are accommodated).
2. Where ever possible provide a choice for animal program participation, e.g., retreat areas for touch tanks or contact yards, evaluation of willingness/readiness to participate by handler, etc.

3. The empowerment of handlers to make decisions related to animal health and welfare; such as withdrawing animals from a situation if safety or health is in danger of being compromised.

4. Requirements for supervision of contact areas and touch tanks by trained staff and volunteers.

5. Frequent evaluation of human / animal interactions to assess safety, health, welfare, etc.

6. Ensure that the level of health care for the Ambassador Animals is consistent with that of other animals in the collection.

7. Whenever possible have a “cradle to grave” plan for each Ambassador Animal to ensure that the animal can be taken care of properly when not used as a Ambassador Animal anymore.

8. If lengthy “down” times in Ambassador Animal use occur, staff should ensure that animals accustomed to regular human interactions can still maintain such contact and receive the same level of care when not used in programs.

VIII. Taxon Specific Protocols
We encourage institutions to provide taxonomically specific protocols, either at the genus or species level, or the specimen, or individual, level. Some taxon-specific guidelines may affect the use of Ambassador Animals. To develop these, institutions refer to the Conservation Programs Database.

Taxon and species -specific protocols should address:
1. How to remove the individual animal from and return it to its permanent enclosure, including suggestions for operant conditioning training.
2. How to crate and transport animals.

Situation specific handling protocols (e.g., whether or not animal is allowed to be touched by the public, and how to handle in such situations):
1. Guidelines for disinfecting surfaces, transport carriers, enclosures, etc. using environmentally safe chemicals and cleaners where possible.
3. Limitations and restrictions regarding ambient temperatures and or weather conditions.
4. Time limitations (including animal rotation and rest periods, as appropriate, duration of time each animal can participate, and restrictions on travel distances).
5. The number of trained personnel required to ensure the health and welfare of the animals, handlers and public.
6. The level of training and experience required for handling this species
8. The use of hand lotions by program participants that might touch the animals.

IX. Logistics: Managing the Program
The Institutional Policy should address a number of logistical issues related to Ambassador Animals, including:
1. Where and how the Ambassador Animal collection will be housed, including any quarantine and separation for animals used off-site.
2. Procedures for requesting animals, including the approval process and decision-making process.
3. Accurate documentation and availability of records, including procedures for documenting animal usage, animal behavior, and any other concerns that arise.

X. Staff Training
Thorough training for all handling staff (keepers, educators, and volunteers, and docents) is clearly critical. Staff training is such a large issue that many institutions may have separate training protocols and procedures. Specific training protocols can be included in the Institutional Ambassador Animal Policy or reference can be made that a separate training protocol exists.

It is recommended that the training section of the policy address:
1. Personnel authorized to handle and present animals.
2. Handling protocol during quarantine.
3. The process for training, qualifying and assessing handlers including who is authorized to train handlers.
4. The frequency of required re-training sessions for handlers.
5. Personnel authorized to train animals and training protocols.
6. The process for addressing substandard performance and noncompliance with established procedures.
7. Medical testing and vaccinations required for handlers (e.g., TB testing, tetanus shots, rabies vaccinations, routine fecal cultures, physical exams, etc.).
8. Training content (e.g., taxonomically specific protocols, natural history, relevant conservation education messages, presentation techniques, interpretive techniques, etc.).
9. Protocols to reduce disease transmission (e.g., zoonotic disease transmission, proper hygiene and hand washing requirements, as noted in AZA’s Animal Contact Policy).
10. Procedures for reporting injuries to the animals, handling personnel or public.
11. Visitor management (e.g., ensuring visitors interact appropriately with animals, do not eat or drink around the animal, etc.).

XI. Review of Institutional Policies
All policies should be reviewed regularly. Accountability and ramifications of policy violations should be addressed as well (e.g., retraining, revocation of handling privileges, etc.). Institutional policies should address how frequently the Ambassador Animal Policy will be reviewed and revised, and how accountability will be maintained.

XII. TAG and SSP Recommendations
Following development of taxon-specific recommendations from each TAG and SSP, the institution policy should include a statement regarding compliance with these recommendations. If the institution chooses not to follow these specific recommendations, a brief statement providing rationale is recommended.
## Appendix H: Physiological Reference Intervals for *Geococcyx californianus*

<table>
<thead>
<tr>
<th>Test</th>
<th>Units</th>
<th>Reference Interval</th>
<th>Mean</th>
<th>Median</th>
<th>Low Sample&lt;sup&gt;a&lt;/sup&gt;</th>
<th>High Sample&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Sample Size&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Animals&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Blood Cell Count</td>
<td>*10&lt;sup&gt;3&lt;/sup&gt; cells/µL</td>
<td>4.45 - 28.74</td>
<td>11.84</td>
<td>10.32</td>
<td>3.90</td>
<td>32.40</td>
<td>138</td>
<td>86</td>
</tr>
<tr>
<td>Hematocrit</td>
<td>%</td>
<td>30.9 - 52.9</td>
<td>40.7</td>
<td>40.1</td>
<td>29.0</td>
<td>57.0</td>
<td>155</td>
<td>94</td>
</tr>
<tr>
<td>Heterophils</td>
<td>*10&lt;sup&gt;3&lt;/sup&gt; cells/µL</td>
<td>1.15 - 13.90</td>
<td>4.89</td>
<td>3.77</td>
<td>0.42</td>
<td>16.60</td>
<td>137</td>
<td>86</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>*10&lt;sup&gt;3&lt;/sup&gt; cells/µL</td>
<td>1.02 - 14.55</td>
<td>5.15</td>
<td>4.59</td>
<td>0.51</td>
<td>17.80</td>
<td>137</td>
<td>86</td>
</tr>
<tr>
<td>Monocytes</td>
<td>cells/µL</td>
<td>0 - 2064</td>
<td>747</td>
<td>538</td>
<td>52</td>
<td>3455</td>
<td>111</td>
<td>70</td>
</tr>
<tr>
<td>Eosinophils</td>
<td>cells/µL</td>
<td>0 - 2897</td>
<td>1022</td>
<td>748</td>
<td>39</td>
<td>4644</td>
<td>83</td>
<td>55</td>
</tr>
<tr>
<td>Basophils</td>
<td>cells/µL</td>
<td>0 - 758</td>
<td>312</td>
<td>255</td>
<td>40</td>
<td>1218</td>
<td>65</td>
<td>49</td>
</tr>
<tr>
<td>Glucose</td>
<td>mg/dL</td>
<td>300 - 535</td>
<td>413</td>
<td>413</td>
<td>154</td>
<td>552</td>
<td>140</td>
<td>94</td>
</tr>
<tr>
<td>Blood Urea Nitrogen</td>
<td>mg/dL</td>
<td>0 - 8</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>43</td>
<td>31</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>mg/dL</td>
<td>2.2 - 21.5</td>
<td>8.2</td>
<td>6.7</td>
<td>1.6</td>
<td>26.7</td>
<td>150</td>
<td>96</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/dL</td>
<td>7.5 - 11.8</td>
<td>9.1</td>
<td>9.0</td>
<td>6.6</td>
<td>12.6</td>
<td>126</td>
<td>85</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg/dL</td>
<td>1.4 - 7.7</td>
<td>4.1</td>
<td>3.8</td>
<td>1.0</td>
<td>10.4</td>
<td>122</td>
<td>78</td>
</tr>
<tr>
<td>Ca/Phos ratio</td>
<td></td>
<td>1.2 - 6.0</td>
<td>2.7</td>
<td>2.4</td>
<td>0.8</td>
<td>6.5</td>
<td>121</td>
<td>77</td>
</tr>
<tr>
<td>Sodium</td>
<td>mEq/L</td>
<td>143 - 174</td>
<td>159</td>
<td>158</td>
<td>138</td>
<td>185</td>
<td>105</td>
<td>69</td>
</tr>
<tr>
<td>Potassium</td>
<td>mEq/L</td>
<td>1.2 - 5.4</td>
<td>3.4</td>
<td>3.3</td>
<td>1.5</td>
<td>7.6</td>
<td>111</td>
<td>74</td>
</tr>
<tr>
<td>Na/K ratio</td>
<td></td>
<td>16.8 - 79.7</td>
<td>49.9</td>
<td>48.3</td>
<td>14.4</td>
<td>103.3</td>
<td>103</td>
<td>67</td>
</tr>
<tr>
<td>Chloride</td>
<td>mEq/L</td>
<td>109 - 136</td>
<td>122</td>
<td>123</td>
<td>103</td>
<td>136</td>
<td>71</td>
<td>47</td>
</tr>
<tr>
<td>Total Protein</td>
<td>g/dL</td>
<td>2.4 - 4.3</td>
<td>3.4</td>
<td>3.3</td>
<td>2.1</td>
<td>4.5</td>
<td>128</td>
<td>81</td>
</tr>
<tr>
<td>Albumin</td>
<td>g/dL</td>
<td>0.6 - 2.2</td>
<td>1.5</td>
<td>1.4</td>
<td>0.6</td>
<td>2.8</td>
<td>107</td>
<td>68</td>
</tr>
<tr>
<td>Globulin</td>
<td>g/dL</td>
<td>0.7 - 3.1</td>
<td>1.8</td>
<td>1.9</td>
<td>0.2</td>
<td>3.2</td>
<td>110</td>
<td>68</td>
</tr>
<tr>
<td>Alkaline Phosphatase</td>
<td>IU/L</td>
<td>0 - 167</td>
<td>83</td>
<td>76</td>
<td>22</td>
<td>266</td>
<td>44</td>
<td>32</td>
</tr>
<tr>
<td>Lactate Dehydrogenase</td>
<td>IU/L</td>
<td>0 - 578</td>
<td>274</td>
<td>223</td>
<td>69</td>
<td>825</td>
<td>48</td>
<td>33</td>
</tr>
<tr>
<td>Aspartate Aminotransferase</td>
<td>IU/L</td>
<td>12 - 93</td>
<td>39</td>
<td>33</td>
<td>8</td>
<td>121</td>
<td>137</td>
<td>92</td>
</tr>
<tr>
<td>Creatine Kinase</td>
<td>IU/L</td>
<td>0 - 7460</td>
<td>3622</td>
<td>3276</td>
<td>142</td>
<td>9390</td>
<td>98</td>
<td>67</td>
</tr>
<tr>
<td>Amylase</td>
<td>IU/L</td>
<td>64 - 2181</td>
<td>1170</td>
<td>1122</td>
<td>176</td>
<td>2604</td>
<td>43</td>
<td>29</td>
</tr>
</tbody>
</table>
### Greater Roadrunner (Geococcyx californianus) Care Manual

#### Cholesterol

<table>
<thead>
<tr>
<th>Cholesterol</th>
<th>mg/dL</th>
<th>70 - 317</th>
<th>200</th>
<th>193</th>
<th>92</th>
<th>397</th>
<th>92</th>
<th>57</th>
</tr>
</thead>
</table>

*a* Lowest sample value used to calculate the reference interval.

*b* Highest sample value used to calculate the reference interval.

*c* Number of samples used to calculate the reference interval.

*d* Number of different individuals contributing to the reference interval.

---

**Roadrunner**  
*(Geococcyx californianus)*

**Samples contributed by 28 institutions.**

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**Sample Selection Criteria:**

- No selection by gender.
- All ages combined
- Animal was classified as healthy at the time of sample collection
- Sample was not deteriorated
## Appendix I: Roadrunner Hand-rearing Summary

### HAND-REARING PROTOCOL (Ft Worth Zoo, Albuquerque Zoo) Greater Roadrunner

<table>
<thead>
<tr>
<th>Day</th>
<th>Temp (°F)</th>
<th>Brooder Husbandry</th>
<th>Comments</th>
<th>Feeding Frequency</th>
<th>Food Components</th>
<th>Nutrition Comments</th>
<th>Intake (%Bw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>97</td>
<td>Chicks at all ages will pant if they get too warm.</td>
<td>Newly hatched chicks begin to feed within a couple hours of hatching. The first fecals occur after a few feedings and are typically watery with some urates. By the third fecal, solids begin to appear. Pinkie pieces should be dipped in water to promote hydration. Science Diet is pre-soaked in water for 2 ½ - 3 hours prior to feeding so that pieces are moist and soft.</td>
<td>5 feeds 8, 11, 2, 5, 10</td>
<td>Pinkies (chopped into bite-sized pieces), ground raw meat, soaked Hill's® Science Diet® Adult Optimal Care®, crickets</td>
<td>All pinkie mice sprinkled with calcium carbonate. Crickets should be maintained on a high calcium insect diet for 72 hours prior to being fed. After being handled for weighing first thing in the morning, young chicks need to be left alone for awhile before they will respond to jiggling of the nest for feeding. For very young chicks, once they defecate, it is very hard to get them to respond to stimulus again. So, whatever they ingest before defecating is all they will take until the next feeding. These feedings should be done quickly, without hesitation.</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>96</td>
<td>small cup lined with washcloth and Enkamat (size 7010) matting. Container size should be increased as chicks get older.</td>
<td>Chicks that put on a lot of weight quickly may be prone to splaying, largely because the body grows beyond the capacity of the legs to remain under the body. Splaying in young chicks can be corrected with a more tightly packed bowl that limits movement. Improved substrate that allows chicks to push against the sides without too much give can allow legs to catch up with the size of the belly.</td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>95</td>
<td></td>
<td></td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>95</td>
<td>Older chicks don’t appear to be aggressive to younger chicks housed with them. But they will out-compete the younger chicks for food, and there is always the danger of older/heavier birds trampling younger ones inadvertently.</td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week</td>
<td>Percentage</td>
<td>Description</td>
<td>Feeds</td>
<td>Diet</td>
<td>Calcium Carbonate Percentage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>-------------------------------</td>
<td>------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>95</td>
<td>small cup lined with washcloth and Enkomat matting add sticks for chicks to begin gripping</td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>94</td>
<td></td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>93</td>
<td>small cup lined with wash cloth and sticks</td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>92</td>
<td>At about day 8, chicks begin to sit up on their hocks at this age.</td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>91</td>
<td></td>
<td>5 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>90</td>
<td>add sticks around outside of nest bowl, chicks may start jumping out of the bowl.</td>
<td>4 feeds</td>
<td>Pinkies Milliken, science diet Mice/Fuzzies/ Hoppers</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>90</td>
<td></td>
<td>4 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>90</td>
<td>chicks should be hopping in and out of nest container easily</td>
<td>4 feeds</td>
<td>Pinkies Milliken, science diet Mice/Fuzzies/ Hoppers</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>90</td>
<td></td>
<td>4 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>ambient room with heat lamp move to small cage(corners) with nomad mat, leave nest bowl</td>
<td>chicks should be standing easily.</td>
<td>4 feeds</td>
<td>Milliken, science diet Mice/Fuzzies/ Hoppers</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>ambient room with heat lamp</td>
<td></td>
<td>4 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>ambient room with heat lamp</td>
<td>may not consume all by hand, leave food in pan between feeds</td>
<td>3 feeds 8, 12 4</td>
<td>All pinkie mice sprinkled with calcium carbonate. 20%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>ambient room with heat lamp</td>
<td></td>
<td>3 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate. 20%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>ambient room with heat lamp</td>
<td>encourage self-feeding from pan, record what is consumed, and only hand-feed any chicks who are not maintaining weight well</td>
<td>3 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate. 20%</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>3 feeds</td>
<td>All pinkie mice sprinkled with calcium carbonate. 20%</td>
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<td>Should be self-feeding with fresh food offered three times a day. As long as weight gain continues, assisted feedings can be reduced while leaving food available at all times between feedings</td>
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<td>Ambient room with heat lamp</td>
<td>if capture becomes difficult, discontinue daily weights.</td>
<td>2 feeds 8, 4</td>
<td>All pinkie mice sprinkled with calcium carbonate.</td>
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<td>Ambient room with heat lamp</td>
<td>move outdoors if appropriate given climate</td>
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<td>All pinkie mice sprinkled with calcium carbonate.</td>
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**Appendix J: Greater Roadrunner Weight Growth in Hand-reared Chicks**

Growth weight (grams) in hand-reared chicks in the first 100 days of life*

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*Data compiled from six AZA accredited institutions.
Appendix K: Recommendations for Developing an Institutional Flight Restriction Policy

Developed by the AZA Avian Scientific Advisory Group, December, 2013

Recommendations:

Flight restriction is used by zoo/aquarium bird managers, primarily as a method to allow the display of birds in open spaces while precluding the birds from using flight to depart these spaces. Flight restriction can be accomplished using a variety of reversible or irreversible methods. It is important to note that each method may have benefits associated with it from both an animal welfare and institutional perspective. Therefore, the AZA Avian Scientific Advisory Committee (ASAG) recommends that:

1) Each AZA-accredited institution develops a written policy on if, when, and how flight restriction is employed. The AZA ASAG should be contacted if further information is needed.
2) Institutional flight restriction policies follow species-specific guidelines developed by the avian TAGs or SSPs.

The AZA ASAG encourages all AZA Avian TAGs and AZA institutions to collect data that could be relevant to the choice of flight restriction methodologies on individual animals. It recommends that appropriate scientific and veterinary reviews and investigations into the effects of flight restriction be conducted to best assess welfare considerations.

General Information on Flight Restriction Methods:

Reversible

There are several methods of flight restriction that are reversible. These methods vary in how quickly birds can regain flight when the method is removed:

- **Netted Enclosure** – covered aviaries are a method of flight restriction and employed for a variety of avian species.
- **Tethering** – this is primarily used for raptors in educational shows and programs although other types of birds may also be affected. Tethering involves attaching a leash or tether to a bird’s leg. The range of movement for the tethered bird depends on the design and size of the tethering device. This method should only be used for birds that have been conditioned to tolerate it.
- **Brailing** – a leather or plastic strap (brail) fitted around the primaries and patagium to bind the wing in a closed position. Generally used when temporary flight restriction is needed (such as during pairing introductions between adult birds). It is recommended that full flight ability be restored as soon as possible. Brailing should be done under the supervision of trained veterinary staff to ensure no permanent damage occurs to the brailed wing.
- **Vane Trimming** – vanes of some of the primary and secondary feathers are cut to reduce lift and prevent flight. May be used for young birds until they are old enough to be feather clipped in the more general way (see point below).
- **Wing (feather) Clipping** – cutting the distal portion of some or all of the primary and secondary feathers. Care should be taken to check for, and not to cut, developing feathers with a live blood supply. For some species feather clipping will need to be done only after the next full molt (annually or bi-annually). Species that molt sequentially may need to be clipped monthly or so and it may be more often in certain species.

Irreversible

There are several methods of flight restriction that are irreversible and will render birds flightless:
• **Pinioning** - the surgical removal of part of the metacarpal bone and the phalanges of one wing of a bird. This is commonly performed within the first days of life when the process is considered a minor veterinary medical procedure. Pinioning at this age may, or may not, be performed by trained veterinary staff. Pinioning after 7 days is a surgical procedure requiring anesthesia to be performed by a qualified veterinarian.

• **Tenotomy** – a surgical procedure requiring anesthesia to be performed by a qualified veterinarian involves severing the extensors of the wing. This procedure is generally performed on fully grown birds. Some tenotomized birds are still capable of limited flight. This procedure appears to be uncommon in AZA-accredited institutions at this time.

• **Tenectomy** – a surgical procedure requiring anesthesia to be performed by a qualified veterinarian which entails removal of a portion of the extensor tendons of the wing.

• **Patagiectomy** – a surgical procedure requiring anesthesia to be performed by a qualified veterinarian that entails removal of the patagial membrane and apposition of the radius and humerus. This is often done on fully grown birds as a less complicated method than pinioning. This procedure appears to be uncommon in AZA-accredited institutions.

• **Functional Ankylosis** – a surgical procedure requiring anesthesia to be performed by a qualified veterinarian that entails fixing the ulna, carpal and metacarpal bones with stainless steel wire. This procedure appears to be uncommon in AZA-accredited institutions.

• **Radical Amputation** – a surgical procedure requiring anesthesia to be performed by a qualified veterinarian that entails removal of the whole wing. This is generally an emergency procedure occurring as a result of significant wing trauma and not generally associated with flight restriction for other reasons.

### Potential Considerations When Developing an Institutional Flight Restriction Policy

When developing an Institutional Flight Restriction Policy, several considerations should be taken into account depending on the methods selected to restrict flight. These include the increased potential:

- To provide larger, more naturalistic environments.
- To reduce aggression to/from new or existing enclosure mates.
- To mitigate injury from flying into objects within the habitat.
- If legally required, to meet federal and/or state requirements to ensure that the birds are not accidentally introduced to the wild population.
- For stress and/or injury from implementing the flight restriction method, including during handling and/or the procedures.
- For stress from inability to fly.
- For injury from enclosure mates or wild predators related to reduced mobility.
- For the reduction and/or loss of reproductive capacity and ability to perform courtship displays.

The AZA ASAG has experts and expert resources available to any institution as it develops its policies and as it makes determinations regarding flight restrictions for species and individuals.