

## Eastern Indigo Snake (*Drymarchon couperi*) Care Manual



Created by the  
**AZA Snake Taxon Advisory Group**  
in Association with the  
**AZA Animal Welfare Committee**

## **Eastern Indigo Snake (*Drymarchon couperi*) 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. The information presented herein is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. The recommendations are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to the specific needs of individual animals and particular circumstances in each institution. The statements presented throughout the body of the manual do not represent specific 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 ([www.aza.org](http://www.aza.org)) which might not be included in this manual.

### Taxonomic Classification

The eastern indigo snake (*Drymarchon couperi*) has a number of common names: indigo, blue indigo snake, black snake, gopher snake, blue gopher snake, and blue bull snake. The taxon was described by James Edward Holbrook in 1842 and named in honor of J. H. Couper who brought Holbrook the first specimen from south of the Altamaha River in Wayne County, Georgia. *Drymarchon* roughly translates to “forest ruler,” from the Greek words *drymos*, meaning forest, and *archon* meaning ruler (Means, 2008). The species *Drymarchon corais* historically was considered a monotypic species with 8 to 12 subspecies, including *D. c. couperi*. Collins (1991) encouraged elevating the eastern indigo snake, *Drymarchon corais couperi*, to full species level (*Drymarchon couperi*), and most herpetologists have adopted this suggestion, including the Society for the Study of Amphibians and Reptiles in their official names list (Crother, 2008). Populations of *Drymarchon couperi* are isolated (Moler, 1992) from their nearest relative, *Drymarchon melanurus erebennus*, by approximately 1,000km (620mi).

Table 1: Taxonomic Classification of Eastern Indigo Snake

Classification	Taxonomy
Kingdom	Animalia
Phylum	Chordata
Class	Reptilia
Order	Squamata
Suborder	
Family	Colubridae

In this publication, *Drymarchon couperi* has been adopted by all experts/authors who have reviewed the taxonomy of *Drymarchon* sp., however, further study is needed on this wide-ranging and polytypic species complex. The following (Wuster, et al., 2001) is the most recent suggested taxonomic revision:

Scientific name	Range	Common name
<i>Drymarchon corais</i>	S.A., east of the Andes	Yellow-tailed cribo
<i>Drymarchon caudomaculatus</i>	Venezuela	Spotted-tailed cribo
<i>Drymarchon margaritae</i>	Isla Margarita, Venezuela	Margarita Island cribo
<i>Drymarchon melanurus melanurus</i>	S.A. west of Andes	Black-tailed cribo
<i>Drymarchon m. unicolor</i>	Nicaragua to Mexico	Unicolored cribo
<i>Drymarchon m. rubidus</i>	Guatemala to Mexico	Red-tailed cribo
<i>Drymarchon m. orizabensis</i>	Mexico	Orizaba cribo
<i>Drymarchon m. erebennus</i>	Mexico to Texas	Texas indigo snake
<i>Drymarchon couperi</i>	SE U.S. (Florida, Georgia)	Eastern indigo snake

### Genus, Species, and Status

Table 2: Genus, species, and status information for Eastern Indigo Snake

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
<i>Drymarchon</i>	<i>couperi</i>	Eastern Indigo Snake	Threatened	None	SSP

**Regulatory Listings:** *Drymarchon couperi* formerly ranged across southern Mississippi, Alabama, Georgia, South Carolina, and throughout Florida (Speake, 1993), including on at least 10 Florida Keys (U.S. Fish and Wildlife Service, 1998). They are believed to be extirpated from Mississippi, Alabama, and South Carolina, although their status in the latter state is not confirmed. Within the range of *D. couperi*, all wildlife agencies regulate this species.

**U.S. Fish and Wildlife Service Listing:** In 1978, after extensive review; the U.S. Fish and Wildlife Service (USFWS) listed *D. couperi* as threatened under the Endangered Species Act (ESA) throughout its entire range; which includes Florida, Georgia, Mississippi, South Carolina, and Alabama (U.S. Fish and Wildlife Service, 1978). The U.S. Fish and Wildlife Service completed the “Eastern Indigo Snake Recovery Plan” in 1982 (U.S. Fish and Wildlife Service) citing loss or degradation of habitat as the single largest limiting factor of the species. Other limiting factors described in this document include the gassing of gopher tortoise burrows, pet-trade, and collecting. Major objectives of the recovery plan included maintaining and protecting existing populations (including habitat restoration), re-establishing populations where feasible, and improving public opinion of *D. couperi* (U.S. Fish and Wildlife Service, 1982).

In April 2008, the U.S. Fish and Wildlife Service issued the “Eastern Indigo Snake (*Drymarchon couperi*) 5-Year Review Summary and Evaluations” (U.S. Fish and Wildlife Service, 2008). Five-year reviews were also conducted in 1984 and 1992, and *D. couperi* was included in a USFWS regional south Florida multispecies recovery plan (U.S. Fish and Wildlife Service, 1998). Each review concluded that no change to the current listing status was warranted as the species still meets the definition of a threatened species under the ESA.

**State Listings:** In addition to the federal listing of *D. couperi*, all states in which *D. couperi* were known to inhabit offers some form of protection for the species (King and Schrock, 1985), as indicated in Table 3.

Table 3: Status and listing agency of *D. couperi* in range states

State	Status	Listing Agency
Alabama	Protected nongame wildlife species	Alabama Division of Game and Fish
Florida	Threatened	Florida Fish & Wildlife Conservation Commission
Georgia	Threatened	Georgia Department of natural Resources, Game and Fish Division, Non-Game Endangered Wildlife Program
Mississippi	Endangered	Mississippi Department of Wildlife Conservation
South Carolina	Endangered	South Carolina Wildlife and Marine Resources, Non-game and Heritage Trust

## 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. It is based on the most current science, practices, and technologies used in animal care and management and are valuable resources that enhance animal welfare by providing information about the basic requirements needed and best practices known for caring for *ex situ* indigo snake 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 indigo snakes must comply with all relevant local, state, and federal wildlife laws and regulations; AZA accreditation standards that are more stringent than these laws and regulations must be met (AZA Accreditation Standard 1.1.1).

### AZA Accreditation Standard

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

The ultimate goal of this ACM is to facilitate excellent indigo snake management and care, which will ensure superior indigo snake welfare at AZA-accredited institutions. Ultimately, success in our indigo

snake management and care will allow AZA-accredited institutions to contribute to indigo snake conservation, and ensure that they are in our future for generations to come.

**Species Description:** *Drymarchon couperi* is one of the largest snakes in North America, reaching a maximum total length of 2.61m (103.5”) (Conant and Collins, 1991). Most records of wild specimens 2.4m (8’) or longer have been from southern Florida (Carr, 1940; Allen and Neill, 1952; Stevenson et al., 2009). The species is fairly stout-bodied and sexually dimorphic in size, with males attaining greater lengths than females (Stevenson et al., 2003, 2009). Large males are typically 2.13-2.36m (7.0-7.7’) and weigh 3.2-4.5kg (7-10lbs); while large females seldom exceed 2.0m (6.5’) and weigh 1.8-2.7kg (3.96-5.94lbs) (Layne and Steiner, 1996; Stevenson et al., 2003, 2009). Sexual size dimorphism is an ecologically important attribute, as large males are more likely to engage in and win combat bouts, resulting in higher reproductive success (Shine, 1993).

*D. couperi* is a uniform bluish black or gunmetal black, both dorsally and ventrally. A wash of orange-red is often present on the chin, sides of the head, and throat, with some variation in northern Florida where many populations have black lip scales and a white patch in the center of the throat rather than the orange-red (Moler, 1992). The orange-red pigment is more prominent in male eastern indigo snakes and may extend onto the belly of some South Florida snakes (Layne and Steiner, 1996).

The common name “eastern indigo snake” relates to the large, smooth scales of this species which appear iridescent purple in sunlight. Adult males have partial keels on the scales of the mid-dorsal 3-5 scale rows (Layne and Steiner, 1984; Stevenson et al., 2003). Hatchling *D. couperi* are sometimes more light-colored than adults, with evidence of a faint pattern of cream speckling forming faint lateral bands.

**Distribution:** *D. couperi* is a member of a species complex which is primarily tropical in distribution. Its range into temperate North America depends on the ability of deep animal-burrow refugia (e.g., gopher tortoise burrows) to survive cold winter temperatures (Moler, 1992). *D. couperi* occurs throughout most of Florida and much of the Coastal Plain of southern Georgia. The historic range included southeastern Mississippi, southernmost Alabama, and possibly southeastern South Carolina; however, indigo snake populations no longer inhabit these states (Moler, 1992; U.S. Fish and Wildlife Service, 2008).

The current strongholds for the species are peninsular Florida and southeastern Georgia (Stevenson, 2006). *D. couperi* are rare and of very local occurrence in the Florida panhandle (west of Tallahassee) and in southwestern Georgia (Stevenson, 2006; Gunzberger and Aresco, 2007).

**Habitat Preferences:** Throughout its range, *D. couperi* can be found in a wide variety of habitats depending on the region in which it is found. In peninsular Florida, *D. couperi* occur in diverse habitat types, including sandhills, oak scrub, sand pine scrub, mangrove swamps, wet prairies, cabbage palm-live oak hammocks, and pine flatwoods. Some *D. couperi* populations in south Florida inhabit vegetated, rock-strewn canal banks surrounded by sugarcane fields or citrus groves.

In the northern parts of the range (i.e., southern Georgia and northern Florida, including the Panhandle region) *D. couperi* appear to be dependent on gopher tortoise (*Gopherus polyphemus*) burrows for winter dens and thus are more largely restricted to sandy, longleaf pine habitats (Speake et al., 1978; Diemer and Speake, 1983). Gopher tortoise burrows in these areas play a central role in the ecology of *D. couperi* and their presence would be required in repatriation sites at these northern latitudes.

In the Coastal Plain of Georgia, aeolian dunes, wind-blown deposits of sand 3-9m (9.8-29.5’) deep, located along the northeastern sides of major blackwater streams, are favored eastern indigo habitats (Diemer and Speake, 1983; Stevenson, 2006). These extensive 8km (4.8mi) long ridges of droughty sands support barren environments with stunted turkey oaks and a patchy ground cover of saw palmetto, rosemary, mints, and reindeer lichens (Wharton, 1978). These upland areas are used by *D. couperi* during winter months while lowland habitats serve as foraging areas during the rest of the year. Wildlife corridors are important in linking these seasonally used habitats (Hallam, et al., 1998; Hyslop, 2007).

Prescribed fires are required every 3 to 5 years to maintain longleaf pine sandhill habitats. Fire impedes plant succession and enhances the open-canopied conditions needed by gopher tortoises and *D. couperi* (Stevenson, 2006). Site fidelity, returning to the same tortoise burrow complexes each winter, has been observed for adult *D. couperi* in Georgia, emphasizing the importance of long-term burrow viability (Hyslop, 2007; Stevenson et al., 2009). In the cooler months, *D. couperi* bask in the vicinity of the gopher tortoise burrows they are using as refugia. Basking often occurs at temperatures of 15.5-22.2°C (59.9-71.96°F), and at temperatures as low as 7.2°C (44.96°F) (Stevenson, et al., 2009). Other member

of the large snake guild in the southeast that are frequent commensals of gopher tortoise burrows are the eastern coachwhip (*Coluber f. flagellum*) and the eastern diamondback rattlesnake (*Crotalus adamanteus*).

Gopher tortoise burrows and small mammal burrows (rodent, armadillo) are also important retreat sites for *D. couperi* particularly during ecdysis, the process of shedding their skins (Dodd and Barichivich, 2007). Additional refugia used throughout the year include stump holes, hollow logs, root channels, limestone solution holes, and land crab burrows.

**Movement and Home Range:** *D. couperi* have among the largest home ranges or territories reported for any North American snake species. Based on radio telemetry conducted to date, *D. couperi* appear to have a larger home range in southern Georgia and north Florida than in more southern sites in Florida. In a Georgia study (Hyslop, 2007) females had a home range of 100ha (250ac) and males 500ha (1,250ac), in the Gulf Hammock region of north Florida (Moler, 1985) a home range of 23-281ha (57-702ac) was reported, and 185ha (462ac) was reported for a male in Putnam County, in north central Florida (Dodd and Barichivich, 2007).

Home range size and movement may be influenced by *D. couperi* population densities, mating opportunities, prey abundance, and the distance traveled between winter refugia and seasonal foraging areas. Individual linear movements can also be significant. One Georgia specimen (Stevenson and Hyslop, 2010) made a long-distance inter-population movement of 22.2km (13.8mi) straight line, or more possibly 27km (16.8mi) if the snake traveled through suitable habitat corridors.

*D. couperi* are most vagile during the warmer months of the year (April-October). During this time they move often and visit numerous habitats, especially low, shaded forests and wetlands where snake, frog, and rodent prey abound (Speake et al., 1978; Hyslop, 2007). When undergoing ecdysis, *D. couperi* are inactive for roughly two weeks to avoid trauma to the integument and hole up in a tortoise burrow or other similar, humid retreat. During this process, snakes are visually impaired and more prone to predation as the outer skin layers separate from the newly-formed underlying dermal layers.

*D. couperi* do not hibernate and are not quiescent during the winter. Frequent basking during the winter may help heal crusty skin lesions the snakes develop from spending so much time at the bottom of dank, humid burrows. *D. couperi* may disperse up to 1.6-4.8km (0.96-2.88mi) or more away from their winter den sites and are vulnerable to negative impacts of habitat fragmentation (Breininger et al., 2004; Hyslop, 2007). A study conducted along the Atlantic Coast of Florida (Breininger et al., 2004) found that indigo snakes living in more fragmented areas were lost more often to unnatural sources of attrition (such as being killed by persons or vehicles) than snakes living in less fragmented areas. Female *D. couperi* generally fared better in habitat fragments than did wider-ranging males.

In consideration of the large spatial requirements for viable *D. couperi* populations, conservation strategies pivot on protecting large, contiguous sections of unfragmented habitat (Dodd and Barichivich, 2007). Unlike most game animals, the more edges in relation to the protected habitat, the less likely that populations of large snakes can be maintained due to exposure to hazards. Minimum preserve size has been estimated at 4,000ha (10,000ac) but larger areas will increase the probability of robust self-sustaining populations over time (Moler, 1992; U.S. Fish and Wildlife Service, 1998).

**Ecological Role in Natural Communities:** *D. couperi* is an active member of the communities in which it is found, playing a significant role as both predator and prey. As adults, *D. couperi* are large predators that seasonally travel long distances throughout a variety of habitats. Prey includes all vertebrate species that they can overpower, and *D. couperi* may place significant pressure on local amphibian, reptile, and small mammal populations.

*D. couperi* is also a prey species for a variety of vertebrates. Predation pressure is size-related, greatly impacting neonate and juvenile life stages and lessening as snakes reach adulthood. Common predators of *D. couperi* are ophiophagus snakes, wading and raptorial birds, and omnivorous and carnivorous mammals.

## Chapter 1. Ambient Environment

### 1.1 Temperature and Humidity

Animal collections within AZA-accredited institutions must be protected from weather detrimental to their health (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.

#### AZA Accreditation Standard

(1.5.7) The animal collection must be protected from weather detrimental to their health.

**Temperature:** Indoor ambient temperatures for *Drymarchon couperi* should approximate 26.6°C (80°F) during the day and may be allowed to drop slightly during the night. Some *D. couperi* breeders (Albury, 2001) recommend a thermal gradient of 23-28°C (74-82°F) with lower night time temperatures of 18°C (65°F) during winter periods. Secondary heat sources (commonly low wattage light bulbs) are only necessary for basking gravid females to offer a thermal gradient. Hot spots for *D. couperi* should not reach over 35°C (95°F) and should always be evaluated with a thermometer or temperature gun. Testing should be done prior to introducing the snake to the cage to ensure heat parameters are stabilized. The heat source should be located at one end of the cage and the hide box and water bowl at the opposite end to create as much of a thermal gradient as possible. Heat sources should be placed on timers for 8 hours of mid-day exposure in the summer, and reduced to 6 hours during the winter. Hot spots may be eliminated during the winter cycle to achieve winter target temperatures (Kevin Murphy, pers. comm).

**Humidity:** Enclosures for *D. couperi* should be kept clean and dry. However, misting with water is recommended daily towards the end of the shedding cycle (once the spectacle is no longer opaque) as stuck sheds, particularly eyecaps, may be routinely retained. Shedding is a one-event process. If partial shedding occurs, manual assistance with removing shed is appropriate at the time of shedding. If the old skin does not come off easily, soaking in clean water is recommended to facilitate removal. Large water bowls, offered during shed cycles, may help to maintain cage humidity which is important for a species that is prone to cutaneous water loss.

AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animal collection and emergency backup systems available, while all mechanical equipment should be included in a documented preventative maintenance program. Special equipment should be maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1).

Facilities housing reptiles should have back up emergency lighting systems and adequate generator back up to maintain appropriate environmental temperatures. These systems should be checked quarterly and equipment maintenance logs kept current. No additional special equipment or life support systems are needed to maintain *D. couperi*.

#### AZA Accreditation Standard

(10.2.1) Critical life-support systems for the animal collection, 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. All mechanical equipment should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

### 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 full spectrum UV light is not required for the maintenance of *D. couperi*, but it is recommended. Depending on the choice of light for this purpose, the UV light may also act as the hot spot. All lighting and heating systems should be used very conservatively with indigo snake and testing temperatures is crucial for these systems to be successful. All lights should be mounted outside the cage and separated from the snake by a screen barrier to prevent thermal burns.

Photoperiod plays an important role in establishing seasonal physiological rhythms in reptiles. *D. couperi* should be exposed to the normal annual changes in photoperiod that occurs at their range

latitude. Windows and skylights may offer this naturally, or light cycles can be adjusted in buildings using timers.

### 1.3 Water and Air Quality

AZA-accredited institutions must have a regular program of monitoring water quality for collections of aquatic animals and a written record must document long-term water quality results and chemical additions (AZA Accreditation Standard 1.5.9). Monitoring selected water quality parameters provides confirmation of the correct operation of filtration and disinfection of the water supply available for the collection. Additionally, high quality water enhances animal health programs instituted for aquatic collections.

#### AZA Accreditation Standard

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

Water and air quality requirements for *D. couperi* follow that of normal standards associated with AZA herpetological programs. Water bowls containing fresh water should always be available. Water bowls should be heavy (ceramic, glass, heavy plastic) to avoid the snake from upsetting them. Many snakes will not drink “stale” water, but are attracted to fresh water when changed. Hydration in *D. couperi* is an important aspect of their husbandry and water should be changed daily.

Enclosure ventilation is critical to a healthy environment. Adequate air circulation in enclosures is important for a species that, due to a high metabolic rate, has the tendency to defecate frequently. Domineering behaviors in *D. couperi* often result in upsetting the water bowl, which could also contribute to unsanitary conditions.

### 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. Snakes have a reduced ability to perceive air borne sounds but are highly adapted and stimulated by the conduction of vibrations passing through solid objects. Vibrations emanating from ground vibration, opening and closing doors, mechanical equipment, and visitors knocking on exhibit glass may result in stress. The reduction of these factors should be considered when placing enclosures within a reptile facility.

## 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 should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs (AZA Accreditation Standard 1.5.2). As *Drymarchon couperi* can be cannibalistic, specimens are maintained individually except when introduced for breeding. Housing snakes individually also helps in monitoring health, feeding, and with behavioral observations

The same careful consideration regarding exhibit size and complexity and its relationship to the indigo snake's 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). Over the last 40 years, dramatic advances have been made in reptile husbandry with research interests focused on social behaviors, reproductive biology, veterinary medicine, environmental requisites, and physiological processes. General parameters for the *ex situ* maintenance and husbandry of *D. couperi* follow those of many large snake species. Acclimation of adult wild-caught specimens can be difficult as these individuals are quick to display defensive behaviors and may be disturbed by the general activities associated with managed environments, which can result in maladaptation syndrome (Cowan, 1980). These challenges and others specific to *D. couperi* can be successfully resolved by following appropriate procedures and protocols.

#### AZA Accreditation Standard

(1.5.2) Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

#### AZA Accreditation Standard

(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; and exhibit enclosures must include provisions for the behavioral enrichment of the animals.

### 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). Although *D. couperi* has traditionally been housed inside reptile facilities, future trends will emphasize the attributes of outdoor enclosures with appropriate winter hibernacula in southern-tier zoological parks.

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). 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.

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

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

**Indoor Caging:** Adult *D. couperi* are large, active animals and require large environments. Cage dimensions of at least 1.83mL X 0.61mW X 0.61mH (72"L X 24"W X 24"H) are required for single adult specimens. Enclosures should be constructed of nonporous materials such as composite plastics, PVC plastics, or waterproofed wood to facilitate cleaning. Cage surfaces should be smooth and include ventilation holes or wire-screened surfaces covered with non-abrasive material to avoid rostral abrasions during periods of activity. A screened area, located at one end of the top portion of the cage, is desirable for the placement of a basking lamp (mounted on the outside of the enclosure), should one be desired for thermoregulation. Basking lamps or "hot spots" can be important for gravid females and snakes with health problems. Access doors should be flush with inside surfaces and feature appropriate locking mechanisms for security.

Interior caging accommodations for *D. couperi* should provide for both their physical and psychological requirements in zoos and aquariums. These elements should attempt to replicate physiological and behavioral stimuli of that are found in the wild. Although it is impossible to provide some of these aspects (e.g., exercise via long distance movements, basking in the sun, chemosensory spectrums), an attempt to replicate these elements as much as possible will prove beneficial.

**Hide boxes:** These act as retreats and offer snakes the opportunity to withdraw visually from activities happening outside their cages. Hide boxes also provide tactile security that can be important for comfort, particularly for newly acquired specimens. Once acclimated, *D. couperi* normally are out of their hide boxes during the day, but retreat to them at night. Hide boxes need to be large enough for the snake to maintain a normal resting coil, but most snakes like to reside in hide boxes that are not much larger than what they can fit into. Many snakes will wedge themselves tightly into spaces, giving them tactile security and less exposure to predators during resting periods. The opening into the hide box should be just slightly larger than their widest girth. Boxes can be made from a variety of materials, but should be such that they are easy to clean and positioned on the opposite end of the cage from the heat source. This will help to create a thermal gradient within the cage.

**Cage furnishings:** Furnishings and props should offer physical and tactile objects to explore while creating areas of security. Small logs, branches, and nonabrasive rocks may be strategically placed in the environment to accommodate the snake's movement and provide a secure resting area when out of the hide box. These objects will also assist in the shedding process. *D. couperi* are strong and domineering snakes and can move relatively heavy objects by wedging themselves between objects. The cage environment should be kept simple and safe for the snakes as large specimens can move or upset cage furnishings, sometimes creating hazards such as tails becoming caught under or between cage props.

Caging styles for neonate and juvenile indigo snakes vary in size, materials, and design. Small specimens can be maintained in tray rack systems or other commercially available fabricated reptile caging systems. A 20-gallon aquarium, or similar sized enclosure, is suitable for neonates. As specimens grow they should graduate to larger enclosures appropriate for their size, such as glass or Plexiglas-fronted wooden enclosures or fiberglass units. Paper substrate facilitates easy cleaning, but aspen shavings or shredded bark mulch (not pine mulch) may also be used if kept clean. Hide boxes of suitable size to provide tactile and visual security are particularly important for young animals that are normally shy and retiring and who react negatively to routine environmental stimuli. Hide boxes that contain a small amount of clean, moist sphagnum moss can also help with the process of shedding in young animals.

**Outdoor enclosures:** Historical approaches to the maintenance of snakes have, with relatively few exceptions, been limited to indoor environments. Traditional reptile buildings in zoos and private collections maintain snakes in mostly small enclosures with little fluctuation in temperature, humidity, UV lighting, photoperiod, feeding regimens, and behavioral enrichment. Although it is recognized that these factors can be manipulated to induce normal physiological responses (usually for reproduction), most reptile collections maintain large quantities of snakes from a variety of global habitats and an environmental compromise is reached for the majority of the collection. Over time, this homogeneity of environmental factors can result in suboptimal health in some species resulting in "captive stagnation." This term has been used when describing reptiles whose normal seasonal activity and fecundity appreciably deteriorate due to lack of proper stimulation by environmental cues. All of these factors can be optimally supplied by maintaining snakes in outdoor enclosures, especially when these facilities are located within the species normal range. This approach has proven successful with the eastern diamondback rattlesnake (*Crotalus adamanteus*) (Clark and Antonio, 2009), a species sympatric with *D. couperi*.

Outdoor enclosures for *D. couperi* may be designed for exhibit or off-exhibit areas. The enclosure size, design, and materials may vary but each should have the following design elements:

- Naturalistic enclosure with areas for tactile and visual security.
- Enclosure should be totally enclosed and secure to prevent escape and predation.
- Winter refugia, via a den or hibernacula that can be easily monitored.
- "Soft" enclosure surfaces to avoid rostral trauma.
- Easily accessible and simple to maintain husbandry protocols.

Keep in mind that *D. couperi* is a large, powerful, and domineering species that has a tendency to explore, push, shove, search, investigate, wedge into, and get entangled with any and all aspects of their

environment. This is normally not an issue in traditional indoor set ups, but can present problematic opportunities in enriched outdoor enclosures, incurring unintentional self-induced trauma or escape. Multiple staff should inspect these environments for potential problems prior to introducing snakes.

Exhibits in which the visiting public may have contact with animals must have a guardrail/barrier that separates the two (AZA Accreditation Standard 11.3.6). If novel “walk-in” exhibits are created for *D. couperi*, care must be taken so that the visitors cannot contact or come within striking range of the snake. *D. couperi* have a reputation of being tame when handled properly, but a defensive or feeding response bite could be significant, due to their strong jaws and large sharp teeth. In both defensive bites and feeding response bites, *D. couperi* has the tendency to hold on and not immediately release the victim. A bite release must be initiated by the snake and not the handler or victim to prevent additional bite wound trauma. Bite wounds should be treated as a simple laceration. Should the question of suturing the laceration site arise, the opinion of a physician should be sought immediately.

All emergency safety procedures must be clearly written, provided to appropriate staff and volunteers, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.3). As *D. couperi* do not pose a public health concern upon escape or exposure to people, normal institutional protocols can be followed in regard to emergencies associated with fire, weather, environment hazards, floods, hurricanes, tornados, earth quakes, and other conditions that trigger an emergency institutional response.

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). Emergency drills should be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills should be recorded and evaluated to ensure that procedures are being followed, that staff training is effective and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills should be maintained and improvements in the procedures duly noted whenever such are identified. AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.4).

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 11.2.5)

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

#### AZA Accreditation Standard

(11.3.6) Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

#### AZA Accreditation Standard

(11.2.3) All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

#### AZA Accreditation Standard

(11.6.2) Security personnel, whether staff of 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).

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

(11.2.5) 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 (sharks, whales, tigers, bears, etc.) 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.

Standard 11.5.3).

Animal attack emergency drills should be conducted at least once annually to ensure that the institution's staff know their duties and responsibilities and know how to handle emergencies properly when they occur. All drills need to be recorded and evaluated to ensure that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures duly noted whenever such are identified (AZA Accreditation Standard 11.5.3).

If an animal attack occurs and injuries result from the incident, 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 (AZA Accreditation Standard 11.5.3).

## Chapter 3. Transport

### 3.1 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). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order.

The handling, restraint and transport of *Drymarchon couperi* follow normal methodologies for a non-venomous snake species, and are detailed in section 6.6. Materials and methods are dependent on the size of the specimen. Snakes are usually handled by keeper staff without restraint as most are accustomed to handling and the probability of incurring a bite is low. However, if the snake's behavior appears to be defensive or the individual is prone to biting, restraint behind the head to insure safe handling is recommended.

*D. couperi* can be removed from an enclosure and placed in a cloth bag or other container for transport. Cloth sacks should be made of a strong material that lacks holes and loose hem threads in which they can become entangled. Cloth sacks should be made of a material that allows for air flow through the material to avoid suffocation. If sacks become wet, this may impede air flow through the material. Cloth sacks should be knotted and secured with a plastic cable tie to prevent escape. All other transport or holding containers should have tight-fitting secure lids, preferably with a locking option to keep the curious from opening the container, and be well ventilated. If snakes are to be maintained in these temporary holding conditions for prolonged amount of time, the combination of these two methods (cloth bag placed inside a container) is recommended.

Shipping containers for *D. couperi* should follow the parameters listed above. A cloth bag, an option of double bagging, and placement in a ventilated and secure wooden shipping box is adequate. Most airlines follow the recommendations of the International Air Transport Association (IATA). A copy of these recommendations should be included with the shipping paperwork to ensure acceptance of the shipment at the airport. 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) 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 local, state, and federal laws must be adhered to.

### 3.2 Protocols

Transport protocols should be well-defined and clear to all animal care staff. No species-specific protocols are associated with the safe transport of *D. couperi* and normal procedures associated with the transport of non-venomous snakes can be followed. Basic guidelines are as follows:

- Assign a specific staff person to be responsible for the preparation, containment, and transport of the specimen(s).
- Snake should not be fed for 5 days prior to transport to avoid regurgitation.
- The container should be kept out of the sun and away from temperature extremes. A temperature range of 18-24°C (65-75°F) is desirable during transport.
- The container should be kept out of activity areas and not shaken or stirred.
- Snakes should be kept in these temporary holding conditions for as short of time as possible.

## Chapter 4. Social Environment

### 4.1 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. Social recommendations for *Drymarchon couperi* are limited as this species is best maintained solitarily to avoid the possibility of cannibalism.

### 4.2 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 other species. These opportunities for mixed displays are extremely limited with *D. couperi* as they normally feed opportunistically on virtually any vertebrate they can overpower. Some institutions have been successful in creating upland sandhill community-type exhibits that house *D. couperi* with gopher tortoise (*Gopherus polyphemus*). This can be an interesting exhibit that offers lessons on the ecology of the gopher tortoise community and the reliance of *D. couperi* on tortoise burrows as winter refugia in the northern part of their range. However gopher tortoises housed with *D. couperi* must be large enough not to be considered prey item size as hatchling and small juvenile gopher tortoises have been found in the stomachs of wild-caught adult *D. couperi*. In addition, the size of the enclosure for a mixed exhibit of this kind must be large enough for all animals to be able to avoid each other and have safe retreats during periods of activity.

### 4.3 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.

As *D. couperi* can be cannibalistic, attacking a newly introduced cage mate in a feeding response, therefore, introductions for breeding purposes must be conducted carefully and under observation. Parameters associated with introductions for breeding are discussed further in section 7.1.

## Chapter 5. Nutrition

### 5.1 Nutritional Requirements

A formal nutrition program is recommended to meet the nutritional and behavioral needs of all indigo snakes (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the Nutrition Scientific Advisory Group (<http://www.aza.org/nutrition-advisory-group/>), veterinarians, as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plans® (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.

#### AZA Accreditation Standard

(2.6.2) A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

**Feeding Ecology of *Drymarchon couperi*:** *Drymarchon couperi* are indiscriminate carnivores known to feed on virtually any vertebrate they can overpower. *D. couperi* is a dietary generalist that opportunistically feeds on a wide range of vertebrate species including fish, frogs, toads, small alligators, hatchling aquatic turtles, hatchling and juvenile gopher tortoises, lizards, snakes (including venomous species), birds and their eggs, and small mammals (Moler, 1992). A recent review of prey records for wild indigos (Stevenson, et al. 2010) included 48 prey species, with 85% of the prey species being anurans, gopher tortoise, snakes, and rodents. An adult *D. couperi* found in southern Georgia regurgitated a pigmy rattlesnake (*Sistrurus miliarius*), a hatchling gopher tortoise (*Gopherus polyphemus*), a southern hognose snake (*Heterodon simus*), and a southern toad (*Bufo terrestris*) (Mount, 1975). *D. couperi* are sometimes cannibalistic, but observations documenting this for wild snakes are rare (Dan Speake, pers. comm.; Fred Antonio, pers. obs.). Campbell (1998) notes an instance of cannibalism in a Guatemalan *D. corais melanurus*. As all *Drymarchon* sp. appear to be opportunistic generalists, it is expected that with further field observations, cannibalism will be documented in more taxa. An incidence of carrion feeding on a decapitated shark head has also been recorded in a Florida beach dune habitat (Smith and Antonio, 2007).

*D. couperi* are a robust and domineering species that overpowers their prey by using strong jaws while pinning the prey item to the substrate with a body coil, often swallowing the prey alive. When feeding on snakes, they may chew until the prey is immobilized and then swallow it head first. *D. couperi* have a high degree of immunity to the venom of sympatric snakes, and usually suffer no lasting injury if they are bitten by any venomous snakes on which they prey (Allen and Neill, 1952; Moulis, 1976).

### 5.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation Standard 2.6.3). Food should be purchased from reliable, sustainable, and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

**Feeding *D. couperi* in Managed Settings:** Murphy and Campbell (1987) reviewed feeding behaviors and techniques for snakes in zoos and aquariums. These basic feeding techniques apply to *D. couperi* who, once acclimated to *ex situ* environments, exhibit an impressive feeding response to food items.

In zoos and aquariums, *D. couperi* are normally maintained on rodent prey items. At least one *D. couperi* breeder (Albury, 2001) supplements a rodent based diet with thawed frozen smelt. Large wild caught specimens and neonates may not recognize laboratory mice and rats as prey items due to dissimilarity of scent to their wild counterparts. In these instances, *D. couperi* may be enticed to feed by offering natural prey items such as fish, frogs, or snakes, and subsequently scenting rodents with these odors. Neonates, which in the wild feed almost exclusively on invertebrates, amphibians, and small reptiles, may respond well to scenting pink mice with canned sardine water (unflavored), raw egg yolk, or a piece of shed skin from another species of snake. Feeding appropriately-sized frogs (e.g., *Hyla*, *Lithobates*) and small mice together in the same feeding session can also establish the scent of rodent as

#### AZA Accreditation Standard

(2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

part of their prey repertoire. One *D. couperi* breeder (Albury, 2001) noted that it is not uncommon for hatched neonates to go 60-90 days before they consume their first meal.

Young *Drymarchon couperi* have a high metabolic rate (research study in progress, Javan Bauder, The Oriante Society) and should be fed once or twice a week. The size of the food item should increase as the snake grows. Although snakes have the impressive ability to swallow large prey items, it is preferable to offer moderate-size food items more often than a large food item that may require a prolonged period for digestion. As young snakes grow, food item size increases and mice are replaced by young rats. Adult *D. couperi* are usually maintained on medium-sized laboratory rats. Prey items should be offered from tongs, as *D. couperi* can be very aggressive feeders, and have very strong jaws and sharp teeth. Care must be taken that during a feeding response; snakes do not inadvertently bite metal tongs and damage teeth and oral tissues. This can be accomplished by applying soft, non-toxic coatings or plastic tubing to the distal surfaces of feeding tongs. Acclimated specimens will readily take frozen/thawed or fresh killed rodents of appropriate size by jiggling the prey item in front of the snake with a pair of long tongs to elicit a feeding response.

For snakes that are problem or shy feeders, it is best to offer food items at the end of the day and leave the facility to avoid distractions or the induction of defensive behavior during the snake's feeding process. Tube-feeding is a last resort, should a specimen continue to refuse food and exhibit critical weight loss. Offering whole prey items should resume as soon as possible. Young *D. couperi* are fed weekly or three times biweekly; adults once a week or every 10 days. Obesity should be avoided. During winter months (corresponding to the breeding season), some specimens will reduce food intake or cease feeding for 4 to 12 weeks, while others may feed opportunistically throughout the year.

Individual snakes raised in zoos but scheduled for repatriation programs should be "retrained" to feed on the locally available prey items found at the specific release sites. Opportunities to practice and hone hunting skills on live prey items in complex outdoor enclosures will increase hunting success post-release.

The sources of rodents used as food items must have consistent quality control to insure that only healthy prey items, raised on an optimal plane of nutrition, are offered to *D. couperi*. Frozen food items need to be thawed and handled properly prior to feeding. Offering wild-caught food items should be discouraged to avoid potential disease and parasite vectoring, except for snakes scheduled for wild release in repatriation programs. However, future studies are needed to evaluate the nutritional importance of incorporating non-rodent prey items (anurans, fish, snakes) into the diet of *D. couperi*.

Food preparation must be performed in accordance with all relevant federal, state, or local 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) for food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for the taxa or species specified. 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.

#### AZA Accreditation Standard

(2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

### 5.3 Nutritional Evaluations

Specific clinical tests for the routine monitoring of nutritional problems in snakes are lacking. As snakes consume whole prey items, nutritional problems are rare. Annual physicals and blood work can reveal health concerns, but most clinical work ups on *D. couperi* are initiated as a result of keepers noting abnormalities in appearance or behavior. At that time the feeding record, food items, and nutritional issues may be discussed and reviewed. During annual physicals, body condition scores (BCS) should be developed to show patterns over time and individual trends in body mass, with this kind of evaluation incorporated into a preventative veterinary program (see Chapter 6). However at this time, standard BCS systems have not been developed for most snake species, including *Drymarchon* spp.

## Chapter 6. Veterinary Care

### 6.1 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 practical, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and be available to respond to any emergencies (AZA Accreditation Standard 2.1.1). 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) [www.aazv.org/associations/6442files/zoo\\_aquarium\\_vet\\_med\\_guidelines.pdf](http://www.aazv.org/associations/6442files/zoo_aquarium_vet_med_guidelines.pdf).

Veterinary protocols associated with the health care of *Drymarchon couperi* and described herein, were primarily developed by Terry Norton, DVM, Georgia Sea Turtle Center. These procedures and protocols were created as recommendations for field workers and researchers, but can easily be adapted to *ex situ* programs. Incorporating the guidelines herein with existing institutional veterinary protocols should result in a comprehensive preventative medicine program while also offering treatment strategies.

The veterinary program should emphasize preventative medicine, 90 to 120 day quarantine periods for incoming snakes, and ongoing health assessments (blood work, parasitology, viral screening, cultures, husbandry protocols, etc). All relevant veterinary procedures and protocols associated with both the quarantine period and annual physicals should be established for every snake. Continued research into indigo snake-prone conditions (skin lesions, parasitism, hypercalcemia, hyperphosphotemia, high vitamin D blood levels, egg binding) will help determine what is normal and abnormal for the species and help to establish therapeutic regimens. The keeper staff is crucial to and responsible for noticing and alerting curators and veterinarians should any health concerns arise. Prompt evaluations, testing and medical recommendations are vital to an appropriate team response.

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 medical treatment of *D. couperi* follows that of other regimens established for colubrid snakes. However, some drug sensitivities have been noted and all treatments should be approached conservatively. For example, mtronidazole (Flagyl) has been shown to be toxic to *D. couperi*.

Animal 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 an 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 documented on a daily basis (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal

#### AZA Accreditation Standard

(2.1.1) A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

(S2.2.1) Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes and appropriate security of the drugs must be provided.

#### AZA Accreditation Standard

(S1.4.6) A 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 animal care staff members apprised of relevant laws and regulations regarding the institution's animal collection.

records must be retained in a fireproof container within the institution (AZA Accreditation Standard 1.4.5) as well as be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4).

*D. couperi* is managed by a Species Survival Plan® (SSP) Program and much of the snake's individual records are important to maintaining a current database for this program. All changes and updated information should be entered into the animal's record and forwarded to the institutional registrar on a timely basis. The SSP Coordinator should be copied on all relevant data important to the population management of *D. couperi*. In addition, any information or observations that may be deemed scientifically important, or that may influence management techniques, should also be forwarded to the Population Manager so that new trends and developments can be disseminated to the institutions holding *D. couperi*.

**AZA Accreditation Standard**  
(1.4.7) Animal records must be kept current, and data must be logged daily.

*D. couperi* is listed as a threatened species by the U.S. Fish and Wildlife Service and by the states within their current and historical range. Copies of all institutional permits and historic permits for individual *D. couperi* should be kept by the Registrar and the Curator of Herpetology.

## 6.2 Identification Methods

Ensuring that indigo snakes are identifiable through various means increases the ability to care for individuals more effectively. Animals must be identifiable and have corresponding ID numbers whenever practical, or a means for accurately maintaining animal records must be identified if individual identifications are not practical (AZA Accreditation Standard 1.4.3).

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

Unique visual and morphological characteristics of each *D. couperi* should be correlated with the institutional accession number (ID number). These traits include any unique coloration of the head and neck region which may have varying degrees of white, cream, or red, and are best documented by photography. Neonate and juvenile *D. couperi* may have various light patterns and coloration that will change over time. Significant scars or congenital defects should also be part of the identification record.

Once *D. couperi* reach an appropriate size, ≈1m (38"), a Passive Integrated Transponder (PIT-tag) should be implanted as an additional method for identification. Insertion of PIT-tags is a simple procedure but specific precautions must be followed to avoid complications. PIT-tags should be inserted approximately 20 scale rows anterior to the vent, on the snake's right side.

### PIT Tag Insertion:

1. Latex gloves should be worn when placing the PIT-tag and handling the snake.
2. Clean the area with a betadine scrub and alcohol; at least one scrub of each.
3. The PIT-tag should be inserted in the body cavity.
4. Follow insert directions provided by the manufacturer.
5. Hands should be cleaned with a disinfectant soap or solution and latex gloves changed prior to handling the next snake.

AZA member institutions must inventory their indigo snake population at least annually and document all indigo snake acquisitions and dispositions (AZA Accreditation Standard 1.4.1). Transaction forms help document that potential recipients or providers of the animals should adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy (see Appendix B), and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal, and international authorities. All AZA-accredited institutions must abide by the AZA Acquisition and Disposition policy (Appendix B) and the long-term welfare of animals should be considered in all acquisition and disposition decisions. All species owned by an AZA institution must be listed

**AZA Accreditation Standard**  
(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions in the animal collection.

**AZA Accreditation Standard**  
(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. In both cases, notations should be made on the inventory.

on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2).

### 6.3 Transfer Examination and Diagnostic Testing Recommendations

The transfer of animals between AZA-accredited institutions or certified related facilities due to SSP 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 indigo snakes should be considered.

**Pre-shipping health screening protocols:** A standard set of sampling, testing, and screening should be applied to every individual snake transferred between facilities. Pre-ship health assessments may include a complete physical examination and body condition score, complete blood count (CBC), blood chemistry, protein electrophoresis, multiple fecal enteric bacterial pathogen cultures, fecal examination including checking for amoebiasis and other protozoal organisms and performing multiple fecal flotations. Diagnostics for *Cryptosporidia* should be performed [acid fast staining of feces, indirect fluorescent antibody test (IFA) if available] as well as Paramyxovirus serology and other viral diagnostics if appropriate. It is usually not feasible, or sometimes desirable, to perform all the tests listed above. However, coordination between the shipping and the receiving institutions should be such that all pertinent tests, as determined by the veterinary staff of both institutions, be performed either pre or post shipping.

### 6.4 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived animals, isolation facilities, and procedures for the treatment of sick/injured animals (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 C). All quarantine procedures should be supervised by a veterinarian, formally written, and available to 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 recommendations have precedence.

A strict quarantine program is the most important aspect of a long-term propagation program. This not only helps to assure a thorough health assessment for the individual *D. couperi* entering the collection, but also serves to protect the resident herpetological collection from potential disease exposure. Basic quarantine procedures should follow established best practices in reptile medicine.

**Quarantine period:** Quarantine should be a minimum 90 days, but may be extended to 120 days or longer depending on the origin and health status of the snake(s). Upon entry, and once the quarantine population of *D. couperi* has been reached, the building (unit or room) should be shut down to further additional occupants. An animal will be released from quarantine only following veterinary approval.

**Health screening protocols:** As noted above, a standard set of sampling, testing, and screening will be determined by staff veterinarians based on institutional veterinary protocols. This health assessment may include a complete physical examination and body condition score, complete blood count (CBC), blood chemistry, protein electrophoresis, multiple fecal enteric bacterial pathogen cultures, fecal examination including checking for amoebiasis and other protozoal organisms and performing multiple fecal flotations. Diagnostics for *Cryptosporidia* should be performed [acid fast staining of feces, indirect fluorescent

#### AZA Accreditation Standard

(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.

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

antibody test (IFA) if available] as well as Paramyxovirus serology and other viral diagnostics if appropriate.

**Acclimation:** During the quarantine period, behavioral notes and feeding records should be kept. An effort to reduce stress during quarantine and an assessment of behaviors indicating that the snake is adjusting well to its new surroundings is integral to its overall well-being and will serve to judge its future exhibit and program potential. A consistent feeding response and a significant weight gain must be demonstrated prior to exiting quarantine. Individual specimen records will be maintained on all aspects of the animal's health profile.

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.

**AZA Accreditation Standard**

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

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. 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.

Quarantine durations span a minimum of 90 days (unless otherwise directed by the staff veterinarian). If additional animals of the same order are introduced into corresponding quarantine areas, the minimum quarantine period must begin over again. However, the addition of animals 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 or frogs in a terrarium) (see Appendix C). A complete physical, including a dental examination if applicable, should be performed. Animals should be evaluated for ectoparasites and treated accordingly. Blood should be collected, analyzed, and the sera banked in either a -70°C freezer or a frost-free -20°C 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.

A tuberculin testing and surveillance program must be established for animal care staff as appropriate to protect both 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 yearly repetitions of diagnostic tests as determined by the veterinarian. Animals should be permanently identified by their natural markings or, if necessary, marked when anesthetized or restrained (see section 6.2 for appropriate identification methods). 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.

**AZA Accreditation Standard**

(11.1.3) A tuberculin testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

If an indigo snake should die in quarantine, a necropsy should be performed and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standard 2.5.1). 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.

**AZA Accreditation Standard**

(2.5.1) Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

Upon death, all *D. couperi* should receive a thorough necropsy. *D. couperi* that succumb post-quarantine should also be submitted for necropsy. Dead snakes should be refrigerated immediately following death and a gross necropsy performed by an experienced pathologist within 24 to 48 hours. A standardized institutional necropsy protocol for snakes should be followed and tissues should be submitted for histology. Common disease concerns in *D. couperi* (Terry Norton, pers. comm) include skin

lesions (can be a mix of fungal and bacterial components), Cryptosporidiosis, amoebiasis, fungal pneumonia, and systemic granulomas. A thorough examination of the reproductive tract should be made.

Determining a cause of death should take precedence over deposition of the specimen in a vertebrate museum or research collection or use as animal artifacts for education programs. Final necropsy reports will be evaluated and procedural recommendations for changes in husbandry will be made if warranted. A copy of the final necropsy report should be sent to the Eastern Indigo Snake Population Manager.

## 6.5 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.4.1). 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 ([www.aazv.org/associations/6442/files/zoo\\_aquarium\\_vet\\_med\\_guidelines.pdf](http://www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf)). Surveillance of disease concerns, elevating abnormalities, and recommended treatment in *D. couperi* is a team approach involving keeper staff, curators and veterinarians. Some of the more common ailments of *D. couperi* are discussed below.

### AZA Accreditation Standard

(2.4.1) The veterinary care program must emphasize disease prevention.

**Known Health Issues in *D. couperi*:** Skin lesions caused by a mixed fungal and bacterial infection are common, especially during the cooler months of the year. Under natural conditions, snakes are predisposed to skin infections while residing in gopher tortoise burrows due to humidity and low winter temperatures causing immunosuppression. In zoos and aquariums, these lesions may erupt if kept in too moist or unsanitary conditions. Normally these lesions resolve when the snakes become active during spring/summer and have resumed shedding on a regular basis. However, these skin ailments can lead to severe systemic bacterial infections if the snake is stressed by suboptimal conditions. The cage environment, especially during winter months, should be kept dry and clean to avoid these problems.

*D. couperi* can be carriers of *Cryptosporidium*, but no clinical disease has been documented in wild populations despite the presence of the organism (Terry Norton, pers. comm). In zoos and aquariums, this coccidian protozoan parasite is an opportunistic pathogen with a fecal-oral transmission usually associated with contaminated water bowls, but can also be transmitted by direct contact with other snakes, fomites, or contaminated caretakers. Cryptosporidiosis causes gastric hypertrophy and chronic wasting, resulting in significant disease. In zoos and aquariums, *Cryptosporidium* has caused pathology in *D. couperi* which present with gastro-intestinal swelling, weight loss, and inappetence associated with gastro-intestinal mucosal cell damage. Treatment is usually unrewarding and emphasizes the importance of quarantine and sanitation.

Amoebiasis is a severe protozoal parasitic disease and has been documented in a free-ranging *D. couperi* implanted with a radio transmitter. The vector most likely was a gopher tortoise. Stress associated with capture and surgery may have predisposed this snake to clinical disease. Other parasites of importance are pentastomes, ancanthocephalans, nematodes, and chiggers on the skin in summer months (not winter). Parasites definitely cause pathology in free-ranging snakes but do not typically compromise overall health and reproduction. Bringing free ranging snakes into an *ex situ* setting may predispose them to clinical disease, thus anti-parasite therapy is probably warranted but can be complicated. Drug sensitivities and metronidazole (Flagyl) toxicity have been documented in *D. couperi* and treatment regimens should only be initiated using species-specific protocols.

Fungal pneumonia and systemic fungal granulomas can also present in both wild and managed *D. couperi*. Symptomology can be cryptic and detection by husbandry staff requires attention to minute details deviating from normal behaviors and presentations. *Salmonella* spp. can be expected in most reptiles and is more of a zoonotic concern for caretakers rather than causing illness in snakes. Viral diseases of *D. couperi* can be expected to follow that of other temperate colubrids but little work has been done in this area. Screening for Paramyxovirus (serological test) is available from the University of Florida, College of Veterinary Medicine, Wildlife and Zoological Medicine Service.

Additional aspects of the biology of *D. couperi* that are peculiar from a health perspective are hypercalcemia and hyperphosphatemia; both of which have been seen in snakes in zoos and aquariums. Hypercalcemia and high vitamin D levels have also been documented in free ranging snakes. The significance of these findings and the compiling of normal blood values and ranges require further study.

As stated in the section 6.4, 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. Keepers should be designated to care for only healthy resident animals, however if they need to care for both quarantined and resident animals of the same class, they should care for the resident animals before caring for the quarantined animals. Care should be taken to ensure that these keepers are “decontaminated” before caring for the healthy resident animals again. Equipment used to feed and care for animals should only be used with those animals.

Some bacterial diseases of snakes are zoonotic. As stated above, *Salmonella* spp. can be expected in most reptiles. Frequent hand-washing and keeping environments free from fecal accumulation will help in containment and lessen the opportunities for exposure. This includes the disinfection of all fomites that can be the mode of transmission for fecal/oral contact. Attention to the details of efficient and effective sanitation will also reduce the vectoring of parasitic ova, some of which may be zoonotic.

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).

As *D. couperi* are commonly used as education program animals, often in contact with the public, handlers should offer appropriate hand disinfectants to those who physically contact the snakes. This presents a good opportunity to educate guests about the importance of hand washing in all aspects of their normal activities.

#### AZA Accreditation Standard

(S1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the collection from exposure to infectious agents.

## 6.6 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).

The handling and restraint of *D. couperi* follows that of any large colubrid snake. Although *D. couperi* have a reputation for being tame and not biting, when defensive or in a feeding response mode, they are very capable of inflicting a significant and impressive bite. This kind of behavior may be elicited during non-routine handlings such as veterinary examinations, media and photographic sessions, and when handled by novices. As with all non-venomous snakes, the following are general recommendations for appropriate handling:

- Never approach a snake directly from a “head on” position as movement in front of its head may induce a feeding response. A snake hook can be used initially to direct the snake’s head away from the handler. This can also be a cue that they are going to be handled and that it is not feeding time.
- Always use both hands to offer as much support as possible to the main mass of the body. Do not allow the snake to drape most of its length without support. Allow the snakes to move or travel over your hands with minimal restraint. Offer as much tactile security as possible. Make slow deliberate movements when holding the snake and always direct the public on the proper approach and methods of contact.
- If a snake is irritable and appears prone to striking or biting, return the snake back to its container. If the snake must be handled for a procedure, secure the snake behind the head with the minimal amount of pressure that it will take for restraint.
- Snakes may be manually held while being gassed down for anesthesia prior to intubation or placed in an induction box.
- In veterinary situations, disinfect equipment and objects that have been in snake contact with isopropyl alcohol or other appropriate disinfectants (dilute bleach, Roccal, etc.) after or between each snake handled. Wash hands with disinfectant after handling each snake or wear separate disposable latex gloves for each snake.
- Use a separate clean pillowcase or other appropriate container for each individual snake. Place snakes in separate, well-ventilated, plastic containers for transport. Avoid overheating or low

#### AZA Accreditation Standard

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

temperatures during transport. A temperature range of 18-24°C (65-75°F) is preferred. See Chapter 3 for more information on transport.

## 6.7 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. Indigo snake keepers should be trained for meeting the animal's dietary, husbandry, and enrichment needs, as well as in restraint techniques, and recognizing behavioral indicators animals may display if their health becomes compromised (AZA Accreditation Standard 2.4.2). Protocols should be established for reporting these observations to the veterinary department. Indigo snake hospital facilities should have x-ray equipment or access to x-ray 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.

Knowing what is normal behavior for *D. couperi* is essential to be able to appreciate the abnormal. Abrupt changes in behavior, daily activity patterns, lethargy, an odd body conformation when laying in a resting coil, trauma or skin lesions, and erratic behavior can indicate to the keeper that further observations and examination is required to define problems. All concerns should be immediately reported to curatorial staff to discuss further actions if necessary. Any animal showing signs of disease should be removed from the main collection and isolated for further diagnostics and testing.

AZA-accredited institutions must have a clear process for identifying and addressing animal welfare concerns associated with the maintenance of *D. couperi* within the institution (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee. Mostly these concerns center on quality of care provided by individual keeper staff. 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. Consistent and professional care and the implementation of established husbandry protocols for *D. couperi* will help assure that welfare concerns are preempted by best institutional practices.

AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support quality snake 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 indigo snakes both in their care and in the wild. As stated in section 6.4, necropsies should be conducted on deceased indigo snakes 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 Standard 2.5.1). 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. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA Snake TAG-approved active research requests that could be filled from a necropsy. If appropriate, euthanasia, as determined by veterinary and curatorial staff, should be conducted via the administration of chemical euthanasia as recommended by the AAZV and not by other (more historic) means for ectotherms such as freezing.

### AZA Accreditation Standard

(2.4.2) Keepers should be trained to recognize abnormal behavior and clinical symptoms 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, keepers should not evaluate illnesses nor prescribe treatment.

### AZA Accreditation Standard

(2.3.2) Hospital facilities should have x-ray equipment or have access to x-ray services.

### AZA Accreditation Standard

(1.5.8) The institution must develop a clear process for identifying and addressing animal welfare concerns within the institution.

## Chapter 7. Reproduction

### 7.1 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.

**Ex situ Reproduction:** *Drymarchon couperi* has been characterized as a “late-maturing colubrid snake” (Parker and Plummer, 1987; Stevenson et al., 2009). Traits of this type of snake include high adult survivorship, high longevity, low to medium fecundity, small annual clutches, low juvenile survivorship, male-biased sexual size dimorphism, high ratio of mature to immature individuals in the population, and a significant proportion of the population that is older than 4 years old. Reproductive readiness can be increased in zoos and aquariums by offering optimal feeding regimens to maximize individual growth. There is a strong correlation between size and sexual maturity in many colubrids. Reproductive cycling can be encouraged by seasonally changing the environmental parameters to mimic those found under natural conditions.

**Sex Determination:** The determination of sex in *D. couperi* follows standard methodologies for sexing snakes. In mature males, the basal portion of the tail appears enlarged where the hemipenes are located. This distinct bulge at the base of the tail extends distally approximately 5.0cm (1.5-2”) in adults. The tail of female indigo snakes tapers fairly symmetrically. Female *D. couperi* may have swollen anal glands at the base of the tail that appear as local bilateral enlargements of the anal glands. When visually sexing *D. couperi*, the appearance of these glands should not be confused with the more massive and extensive enlargement of the basal portion of the tail in males. Also adult males longer than 1200mm (47.24”) snout-vent length usually possess weak keels on 3 to 5 middorsal scale rows (Layne and Steiner, 1984; Stevenson et al., 2003).

Visually sexing *D. couperi* can be easy for those experienced in doing so, but sex should always be confirmed by cloacal probing (Laszlo, 1975), especially for hatchling and juvenile snakes, to determine the presence of an inverted hemipenis. In males, probing into the hemipenal pocket can extend at least to 8 subcaudal scales. Females probe only into a blind pocket, associated with the anal gland. Hemipenal eversion in neonates can be accomplished by applying manual pressure with the thumb at the base of the tail and rolling forward toward the vent to express (evert) the basal portions of the hemipenis. This method generally is not recommended as vascular damage may occur. *D. couperi* exhibits male-biased sexual size dimorphism (Stevenson et al., 2009) with males growing significantly larger than females. Sexual maturity in *D. couperi* is reached in 3 to 5 years of age at total lengths of 1.2-1.5m (4-5’). Zoo and aquarium-raised individuals fed weekly may grow faster and reach sexual maturity sooner than their wild counterparts. In southeast Georgia, it is presumed that males do not attempt to breed until 2-3 years old, and females at 3-4 years old. However, exceptions can occur as a two year old captured in Georgia (Stevenson, pers. comm.) was found to be gravid. One *D. couperi* breeder does not recommend breeding females less than 4 years old due to their tendency to become egg-bound (Albury, 2001). However, many factors contribute to judging whether young females should be bred for the first time, including total body length, body mass, physical activity, and opportunities for exercise to help ensure prime physical condition. Muscle tone may be a critical factor in avoiding egg-binding (Kevin Murphy, pers. comm).

**Temperature Cycling:** *D. couperi* is a winter-active colubrid that emerges from refugia during periods of suitable daytime temperatures to bask and breed. The height of the mating season is November through January, but breeding may occur from October through March.

In most reptile facilities a standard ambient temperature of 26.6°C (80°F) is maintained throughout the year. This average temperature is suitable for a wide variety of temperate and tropical species, with additional basking sites offered to species with higher preferred optimal thermal requirements. Artificial hibernation of temperate colubrids and viperids to induce gonadal development is a technique that has been used in zoos since the 1970s. This winter cooling down period usually lasts approximately three months and is accomplished in a separate temperature-controlled room or walk-in cooler. The temperatures are generally lowered one degree a day to reach a specific target temperature of 10-12.8°C (50-55°F). If this technique is used for reproductively cycling *D. couperi*, a temperature of 10°C (50°F) for 8 to 10 weeks should be adequate. When maintained at this lower temperature, *D. couperi* continue to

drink so fresh water in a water bowl should be provided at all times. Additionally as this species can suffer from cutaneous water loss, a hide box containing moist sphagnum moss may be helpful during this period. Caution must be taken to make sure this environment is clean and not too wet, or skin lesions may result. Monitoring the health status of snakes during “hibernation” is essential to assure that a significant decline in health is not occurring during this time.

**Photoperiod:** A decrease in photoperiod may play an important role in managed breeding. In facilities where snakes are not exposed to natural temperate light cycles, artificial light reduction beginning in October, that result in reducing the light cycle to 10 hours a day (Alessandrini, 2002), may be beneficial to replicate natural biological rhythms.

**Social and Reproductive Behavior:** Maintaining snakes individually outside breeding times may induce social activity when they are placed together for breeding (Radcliffe and Murphy, 1984). Introducing male and female *D. couperi* for breeding requires timing and vigilant observation. Large enclosures (minimum size 6x2x2 feet high) are required to maintain *D. couperi*, particularly mature males which tend to be more active. Standard zoo methods used include introducing the female to the male’s enclosure following female ecdysis. A freshly shed skin from the female can also be placed in the male’s enclosure prior to introducing the female to induce olfactory excitement in the male. The breeding environment should be quiet and undisturbed so as not to interrupt precourtship and courtship behaviors.

Male combat (Stevenson, 2003) has been observed in free-ranging *D. couperi* and is also a tool used for initiating courtship behavior in zoos and aquariums. Introduction of an additional male to an unresponsive pair can induce male combat behavior. Following the height of a ritualized combat event, the subordinate male should be removed to avoid injury. Often combat behaviors displayed by the dominate male will be displaced by courtship behavior directed towards the female, resulting in successful courtship and copulation. This technique can also be used by introducing two males in the absence of a female. Once one of the males has achieved dominance (usually by dorsal positioning, pressing the other to the substrate) over the subordinate snake, the subordinate individual is removed and a female is then introduced to the dominant male. Again, the combat behavior is often displaced by courtship behavior directed towards the female. A male may bite the neck and anterior region of the female in an attempt to induce submission for copulatory positioning. Biting in this context usually does not result in serious lesions. Bite wounds on necks have also been seen in free-ranging *D. couperi* (Allen and Neill, 1952); however in zoos and aquariums, where there is not the opportunity for a subordinate to flee, care must be taken not to allow biting to progress to the point where significant wounds result, particularly in male-male combat episodes. In some cases, a male may also inflict significant wounds (requiring suturing) to a female but this is uncommon (Kevin Murphy, pers. comm).

Successful copulation in *D. couperi* may last from 10 minutes to as long as 12 hours (Alessandrini, 2002). Successive introductions and mating may be helpful for ensuring fertilization. However, if the female is not receptive and becomes frantic in her attempts to flee, she should be removed. Defensive posturing towards a cage mate or withdrawing the head under a body coil indicates negative (rejection) behavior. The keeper should always be aware that inappropriate social interactions in *D. couperi* can result in serious bite wounds and cannibalism.

In addition to altering environmental parameters in preparation for the breeding season, individual behavioral stimulation (e.g., simulated rain, altering props, olfactory stimulation, and placing snakes in novel enclosures) may increase exploratory behavior resulting in an increase in social stimuli which may stimulate courtship and reproductive behavior (Murphy and Campbell, 1987).

The preferred alternative to manipulating environmental parameters indoors is to maintain *D. couperi* in outdoor enclosures. These environments offer ideal thermoregulatory, direct sunlight basking options, and natural season variations lacking in traditional indoor environments. As a reduction of fecundity may be attributed to suboptimal stimuli inherent in indoor facilities, these issues are resolved in outdoor enclosures. Even changes in barometric pressure caused by advancing storms can induce activity and shelter-seeking behavior.

## 7.2 Artificial Insemination

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 produce semen samples voluntarily 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 has been achieved with a variety of, but not all, taxa and should be investigated further.

Experimental studies developing AI techniques for squamates have been generally unrewarding and using this method to achieve reproductive success is not considered practical at this time.

### 7.3 Pregnancy and Egg-laying

It is extremely important to understand the physiological and behavioral changes that occur throughout an animal's pregnancy. Female *D. couperi* deposit a single clutch of 4-14 large eggs between April and June, usually in an open-canopied sandy microhabitat (Speake et al. 1987; O'Connor, 1991). Eggs measure approximately 7.6cm (3.0") in total length. The eggs are soft shelled, oval, and granular-surfaced. Females have the ability to retain live sperm for prolonged periods, possibly over 4 years, for later release and egg fertilization (Carson, 1945).

Nesting sites for free-ranging *D. couperi* include gopher tortoise burrows and stump holes (Smith, 1987). Reports of nest sites are rare but appear to be mostly associated with gopher tortoise burrows (Newberry et al., 2009). Eggs hatch in August-September, and neonates measure 40.6 – 61cm (15.8-23.8") upon hatching.

In zoos and aquariums, gravid female *D. couperi* should be provided with a nest box containing moist sphagnum moss or the equivalent (e.g., properly prepared vermiculite, leaves, sand mixes, etc.) as an oviposition site. The oviposition site may include the addition of nesting material to the female's normal hide box (if large enough) or the addition of a nest box specifically created for nesting and oviposition. Nest boxes can be constructed out of plywood or modified plastic storage containers. Some females show preference to dark wooden boxes rather than those made of translucent plastics. Care must be taken that the substrate used in the nest box is moist but not too wet, as evidenced by free standing water in the bottom of the container. The nest box should be placed in the darkest end of the enclosure away from the lighting/heat source.

### 7.4 Hatching Facilities

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed."

**Oviposition and Incubation:** *D. couperi* normally produce clutches of 5 to 12 eggs, normally laid between April and July, with hatching occurring about 90-100 days later. Dystocia is commonly seen in females maintained under poor environmental conditions, bred at an early age, and females that have not reproduced for a number of years. Often these eggs lack adequate calcium in the egg shell and are infertile. Surgical removal of retained eggs in these cases is an appropriate solution.

The rate of embryonic development in *D. couperi* is temperature dependent and eggs may incubate up to 110 days before hatching (Alessandrini, 2002), although 90-100 days is the normal range. Incubation temperatures in zoos and aquariums approximate 25.5-26.6°C (78-80°F), which is lower than most standard incubator settings for multi-species collections. Higher incubation temperatures may result in caudal deformities. Eggs can be set up in containers using standard methods for incubating reptile eggs. Egg substrate can be moist vermiculite, sphagnum moss, paper towels, or other appropriate incubation mediums. Containers in which the eggs are held should be opened daily for inspection. During this time a check for mold on the egg shells, adequate humidity in the container, and an exchange of oxygen during inspection is important for monitoring progress during the three month incubation period.

## 7.5 Assisted Rearing

Although mothers may successfully give birth, there are times when they are not able to care for their offspring properly, both in the wild and in *ex situ* populations. Fortunately, animal care staff in AZA-accredited institutions is able to assist with the rearing of these offspring if necessary.

Neonate *D. couperi* may take 1 to 3 days to emerge from the egg following pipping. Neonates measure 432-610mm (17-24") total length at hatching and may have a speckling pattern. Upon hatching, neonates should be weighed, measured, and set up individually in separate containers. Moist paper towels, a hide box, and water bowl are recommended as neonate *D. couperi* need to be kept in relatively moist conditions until the first shed.

**Growth and longevity:** *D. couperi* is the largest snake in North America. The record length of 2,629mm (103.5") (Conant and Collins, 1991) translates into a massive snake, with males over 6 feet in total length attaining a mid-body diameter of over 5cm (2in). Male *D. couperi* grow larger than females. Factors contributing to male size bias may include a faster growth rate, greater longevity, hormonal influences triggered by male-male combat, or differences in mortality factors associated with activity patterns. Females have additional energetic costs associated with reproduction (vitellogenesis), may have higher predation rates due to their smaller size, and possibly experience a higher overwinter mortality due to the costs associated with reproduction. Generally, survival improves with size.

Growth rates are influenced by food intake, environmental temperatures, physical activity, and sex (i.e., males grow larger than females). Growth rates are expected to be greater in the southern part of the range than individuals in the northern part of the range, correlating with a prolonged annual activity period. Zoo-hatched *D. couperi* have reached 1.8m (6') in total length in their third year (Kathy Russell, pers. comm.) under optimal conditions.

Ecdysis occurs frequently in *D. couperi* with young growing specimens shedding monthly and older specimens shedding 4 to 6 times annually. Observation on *ex situ* specimens show that *D. couperi* have a high rate of ecdysis compared to most other snake species. Snakes should be misted down daily prior to shedding to avoid the old outer skin from becoming dry and adhering to the new underlying layers. Stuck sheds are common with *D. couperi* as they are prone to cutaneous water loss. Stuck sheds should be manually removed with careful attention to retained spectacles.

Monthly maximum growth rates for free-ranging *D. couperi* in southeast Georgia (Stevenson et al., 2009) are 35.7mm (1.41in) for males and 22.1mm (0.87in) for females, with age classes and size (snout-vent length) described in Table 4.

Table 4: Age classes and size, by sex

Age	Sex	Size
2 <sup>nd</sup> winter (1.5 yrs)	Males	960-1200mm (38-48")
	Females	960-1150mm (38-46")
3 <sup>rd</sup> winter (2.5 yrs)	Males	1350-1500mm (54-60")
	Females	1250-1350mm (50-54")
4 <sup>th</sup> winter (3.5 yrs)	Males	1500-1650mm (60-66")
	Females	1350-1450mm (54-58")
5-7 years old	Males	1800 mm(72")
	Females	1500 mm(60")

*D. couperi* is a long-lived colubrid. Two documented specimens are known to have lived over 27 years in zoos (Antonio, 2008, 2010). It is suspected that snakes in the wild may live to be 10-20 years old (Stevenson et al., 2009).

## 7.6 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. Fortunately for *D. couperi*, contraception is not an issue as they are maintained solitarily and not in social groups where random or unintentional matings can occur. However, long-term sperm storage has been documented in *D. couperi* (Carson, 1945), multiple paternity in successive reproductive seasons may occur, and the list of parthenogenetic snake species is growing all the time. These unusual reproductive modes should be considered when unusual reproductive events occur.

## Chapter 8. Behavior Management

### 8.1 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 that evokes an innate, often reflexive, response (US). 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. Application of these techniques is new to zoo herpetology as most techniques have been developed in mammalian and avian programs to facilitate management and veterinary procedures.

In Reptilia, advances in crocodylian training and management have led the way in behavioral conditioning to achieve management goals. Cognitive capabilities vary greatly in reptiles as do reward systems to achieve specific training goals. As most snakes feed on relatively large whole prey items, they pose a greater challenge as repeated food rewards in a single training session may not fit their normal feeding pattern. As *Drymarchon couperi* is easily handled, restrained, and transported, there is not a need for management training to perform close visual examinations.

### 8.2 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 snakes 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 snakes should take into account the natural history of the species, individual needs of the animals, and facility constraints. The indigo snake enrichment plan should include the following elements: goal-setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. The indigo snake enrichment program should ensure that all environmental enrichment devices (EEDs) are "snake" safe and are presented on a variable schedule to prevent habituation. AZA-accredited institutions must have a formal written enrichment program that promotes snake-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1).

Snake 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 specific staff members assigned to oversee, implement, train, and coordinate interdepartmental enrichment programs (AZA Accreditation Standard 1.6.2).

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

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

Outdoor enclosures for *D. couperi* offer the best option for providing environmental and behavioral enrichment experiences. In southern tier zoological parks and seasonally in more northern latitudes, exposure to natural elements is easily facilitated in outdoor enclosures. Many of these elements cannot be provided adequately inside a traditional reptile building. The natural daily and seasonal cycles of temperature and precipitation is vital for the long term reproductive cycling of adult breeders. The opportunity to bask in the sun (ideal for daily thermoregulation and calcium metabolism), exposure to natural photoperiods, cool winter temperatures, and the elements (rain, wind), keeps snakes in their normal physiologically rhythms. In addition, a variety of behavioral enrichment essentials create a stimulating environment to increase exercise and promote both psychological and physical fitness.

Indoor environments in reserve areas or exhibits can also offer a repertoire of enrichment opportunities. Changing the complexity of props and furnishings in the enclosure by changing substrates, adding climbing and exploring opportunities, and offering live prey (when appropriate), can be important elements in a changing and stimulating environment. Physical challenges stimulated by new objects and scents may be helpful in acquiring and maintaining behavioral skills. Predator recognition and avoidance behavior may be stimulated by sheds from sympatric ophiophagus snakes such as common kingsnakes (*Lampropeltis getula*) and coachwhips (*Masticophis flagellum*). Other natural predators of *D. couperi* in which scents may be available in zoological institutions include coyote, bobcat, fox, opossum, and raccoon.

### 8.3 Staff and Animal Interactions

Animal training and environmental enrichment protocols and techniques should be based on interactions that promote safety for all involved. The safe handling and restraint of *D. couperi* follow normal methodologies for a non-venomous snake species, and are detailed in section 6.6. Materials and methods are dependent on the size of the specimen. Snakes are usually handled by keeper staff without restraint behind the head as most are used to handling and the probability of incurring a bite is low. However, if the snake's behavior appears to be defensive or that individual is prone to biting, restraint behind the head to insure safe handling is recommended. Although *D. couperi* have a reputation for being tame and not biting, when defensive or in a feeding response mode, they are very capable of inflicting a significant and impressive bite. This kind of behavior may be elicited during feeding times or in non-routine handlings such as veterinary examinations, media and photographic sessions, and when handled by novices.

### 8.4 Staff Skills and Training

Herpetological keeper staff should be trained in all areas of indigo snake 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. Attendance and participation in annual AZA Herp TAG meetings presents a forum by which keeper staff can exchange methodologies and ideas that can improve husbandry programs. Zoo staff exchange programs and internships can also be invaluable in elevating husbandry procedures and engaging in new projects.

## Chapter 9. Program Animals

### 9.1 Program Animal Policy

AZA recognizes many public education and, ultimately, conservation benefits from program animal presentations. AZA's Conservation Education Committee's Program Animal Position Statement (Appendix D) summarizes the value of program animal presentations.

For the purpose of this policy, a program 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.

Program 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 program animal presentations to develop an institutional program animal policy that clearly identifies and justifies those species and individuals approved as program animals and details their long-term management plan and educational program objectives.

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). In addition, providing program 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, 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.

#### AZA Accreditation Standard

(1.5.4) A written policy on the use of live animals in programs should be on file. Animals in education programs must be maintained and cared for by trained staff, and housing conditions must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, social and environmental enrichment, access to veterinary care, nutrition, etc. Since some of these requirements can be met outside of the primary enclosure, for example, enclosures may be reduced in size provided that the animal's physical and psychological needs are being met.

*Drymarchon couperi* are popular education animals and their importance in conservation education programs should not be underestimated. Historically they have been used as an impressive show animal in county fairs, roadside zoos, reptile shows, nature centers, and zoological parks due to their large size and tame behavior once they become accustomed to handling. This large, impressive, shiny black snake has been the first snake touched by many children and adults alike. Many Florida residents and tourists (especially during the 1940s – 1960s at Ross Allen's Reptile Institute at Silver Springs) had their first encounter touching a live snake when an indigo snake was offered or draped around their neck for a souvenir photo. Often touted as a "good snake" due to its reputation of consuming rattlesnakes, *D. couperi* has long held a special place in the memories of those fortunate enough and brave enough to have experienced a first-hand encounter.

During education encounters, many aspects of the "indigo story" can be themed to support almost any biological or environmental lesson. Equating animals and environments, particularly connecting to the gopher tortoise as a "keystone" species, can help students visualize wildlife communities as exciting and dynamic places. On a larger scale, education emphasizing the remarkable attributes and the uniqueness and beauty of sandhill habitats may result in the public becoming a little more "snake friendly" while appreciating the uniqueness of this disappearing environment (Stevenson, 2006). Their impressive appearance, relative easy maintenance in zoos and aquariums, and generally docile behavior when handled properly, renders *D. couperi* an ideal candidate for use in conservation education programs.

Zoo education programs and facilities are often sites where many animals are housed in one area and can be intense areas of staff and visitor activities. However, these programs should be viewed as opportunities for behavioral enrichment for *D. couperi* which may be handled by multiple people. Curatorial oversight of programs and observant keeper staff will help insure that the physical and psychological well-being of *D. couperi* used in programs is not compromised. All aspects of procedures

and protocols for *D. couperi* described in this Care Manual can and should be incorporated into the practices of the education department program.

## 9.2 Institutional Program 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 which have designated program animals are required to develop their own Institutional Program Animal Policy that articulates and evaluates the program benefits (see Appendix E for recommendations). Program animals should be consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs.

### AZA Accreditation Standard

(1.5.3) If animal demonstrations are a part of the institution's programs, an education and conservation message must be an integral component.

Education and conservation messaging must be an integral component of any program animal demonstration (AZA Accreditation Standard 1.5.3). When using *D. couperi* in public programs, conservation education messages can easily be tailored to specific themes to drive messages. As *D. couperi* is an impressive and tame animal, it is easy to impress guests while presenting positive messages about snake biology, ecology, and conservation. Zoos of the southeast can also tie in the importance of preserving local upland habitats, describe the gopher tortoise community and burrow ecology as "keystone" for hundreds of species, and impress the importance of preserving large tracts of habitats (due to the indigo snake's large home range) with connecting corridors for genetic flow.

Animal care and education staff should be trained in program animal-specific handling protocols, conservation and education messaging techniques, and public interaction procedures. These staff members should be competent in recognizing stress or discomfort behaviors exhibited by the program animals and should be able to address any safety issues that arise. See section 6.6 for tips on handling.

**Keeper Training:** It is important that hands-on training also be required for volunteer and docents that will be handling *D. couperi* in education programs. As some specimens used in these programs are large, impressive animals, it is important that all presenters become comfortable with handling these animals prior to engaging in public venues. This is usually not an issue with this species as *D. couperi* easily become conditioned to handling by multiple educators. In fact, there is a tendency for seasoned volunteers and docents to take pride in confidently handling and presenting large *D. couperi* to the public.

**Off-Grounds Transport:** Program 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). It is important that staff who handle *D. couperi* do not handle any other reptiles in outreach programs that are not residents of the education department's collection. Education department handlers must also be cognizant of disease and zoonotic vectoring when working in environments in which other animals not in their zoo collection are present. This includes not only wildlife but also domestic species.

Careful consideration must be given to the design and size of all program 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). Enclosure recommendations for *D. couperi* can be found in Chapter 2.

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). All employees, volunteers, and docents must strictly adhere to institutional protocols when transporting *D. couperi* off-site. Some individuals of *D. couperi* have a tendency to become hyperactive when placed in a cloth sack or pillow case, most likely due to a feeling of constraint and lack

of visual orientation. Often their relentless attempts at pushing through the cloth material can result in rubbed and traumatized rostral scales. In a relatively short period of time this activity can result in significant blood loss. For these individuals, it is best to contain and transport them in large locking plastic storage boxes; 30 gallon trash cans modified to hold snakes, or appropriately sized air kennels where the smooth materials used in these items are non-abrasive.

When *D. couperi* are transported in vehicles, it is imperative that the responsible staff is cognizant and responsive to temperatures during all phases of the transport that may affect the snake's health and welfare. *D. couperi* are prone to heat stress more than most other temperate snake species and when temperature choices have to be made, it is better to expose them to cooler temperatures than temperatures that approach critical maximum (32°C/90°F).

### 9.3 Program Evaluation

AZA-accredited institutions which have Institutional Program Animal Plans are required to evaluate the efficacy of the plan routinely (see Appendix E 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.

*D. couperi* are an ideal animal to be used for a number of key conservation education messages. Many program themes can use *D. couperi* as the focal animal, tying them in by story line. Subjects such as habitat conservation (sandhill, uplands, longleaf pine), ecology and community structure (gopher tortoise burrows and commensals), snakes as significant rodent predators, and fostering conservation ethics to discourage snake persecution. Each education program that uses *D. couperi* should be periodically reviewed by curatorial staff to update content and the conservation message. Program presenters (zoo staff, docents, volunteers) should also be evaluated as to their style of presentation and effectiveness in teaching. Program reviews and proactive involvement, screening and intervention when necessary, will improve the overall effectiveness of the conservation message.

## Chapter 10. Research

### 10.1 Current Research

AZA believes that contemporary indigo snake management, husbandry, veterinary care, and conservation practices should be based on 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 both in *in situ* and *ex situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. This knowledge might be achieved by participating in AZA Taxon Advisory Group (TAG) or Species Survival Plan® (SSP) Program sponsored research, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials (AZA Accreditation Standard 5.3).

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.

AZA-accredited institutions are required to have a clearly written research policy that identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, the animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified individual to oversee and direct its research program (AZA Accreditation Standard 5.1). 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 Taxonomic Advisory Groups (TAGs) or Species Survival Plans® (SSP) Programs.

**Ex situ Research:** The Oriante Society is currently conducting research on the metabolic rate of young *Drymarchon couperi*.

**Field Research:** The Oriante Society, formerly Project Oriante, LTD, is an AZA Conservation Partner working to ensure the range-wide recovery and viability of *D. couperi* and their habitats by using science to direct conservation. Current research being undertaken by The Oriante Society, universities, The Nature Conservancy, National Forests, and the AZA Eastern Indigo Snake SSP Program includes:

- Inventory and monitoring on *D. couperi* distribution, status, and life history traits in Georgia and at various sites in Florida (Lake Wales Ridge, Florida panhandle, Archbold Research Station).
- Evaluation and monitoring of land management and restoration through prescribed burning in Georgia and Florida.
- Repatriation efforts in Conecuh National Forest, Alabama.
- Genetic assessment and screening of eastern indigo snake populations throughout their current range.
- Assessment of whether dogs can be used to locate indigo snakes and their nest sites specifically, to the exclusion of other snake species.
- Investigations on eastern indigo snake metabolic rate studies and preferred temperature.

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

(5.2) Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

#### AZA Accreditation Standard

(5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

- Examination into habitat requirements, population dynamics, genetics, and evolutionary constraints of specific indigo populations to ensure the best chances of success in repatriation efforts.

Continued and expanded repatriation, as well as improved *ex situ* management practices, will be guided by outcomes from current research and from research to be undertaken at The Oriane Center for Indigo Conservation (OCIC) (currently in development), a facility managed by the Oriane Society and dedicated to propagation and management of eastern indigo snakes for the purpose of repatriation.

## 10.2 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 in the following areas will maximize AZA-accredited institutions' capacity for excellence in animal care and welfare as well as enhance conservation initiatives for the species.

### Behavioral Management and Re-introduction:

- Behavioral enrichment and modes of learning for juvenile *D. couperi* will be essential in preparing snakes for reintroduction and may have important husbandry implications of all managed populations. The OCIC will create stimulating environments to increase exercise and promote both psychological and physical fitness. These techniques will also increase the fitness of snakes scheduled for release by helping them develop hunting skills and enhancing their problem-solving aptitude. This is a new field of research that will explore the relationship of cognition to adaptation.
- Major research efforts for *D. couperi* will focus on post-release monitoring of translocated *D. couperi* which is vital to assessing repatriation success. Sites will be monitored to determine the presence of indigos and to obtain mark-recapture data. This information will assist in evaluating population trends and in estimating demographic parameters (e.g., recruitment, survival). Publication of data will also assist other researchers involved with similar field conservation initiatives.

### Nutrition and Veterinary Medicine:

- Studies are needed to evaluate the nutritional importance of incorporating non-rodent prey items (anurans, fish, snakes) into the diet of *D. couperi*.
- Developing standard body condition scores (BCS) systems for snake species, including *Drymarchon* spp., would be useful for preventative veterinary programs.
- Continued research into indigo snake-prone conditions (including skin lesions, parasitism, hypercalcemia, hyperphosphotemia, high vitamin D blood levels, and egg binding) will help determine what is normal and abnormal for the species and help to establish therapeutic regimens.
- Blood work to analyze differences in values for indoor and outdoor animals may reveal interesting results with husbandry applications.

### Reproduction:

- Research into the physiological requirements that cause reduced fecundity during extended periods of time in zoos is needed.

## Chapter 11. Other Considerations

### 11.1 Additional Information

The conservation of snakes is a relatively recent development in our consciousness of preserving nature. Historically the majority of conservation programs have focused on large charismatic mega-vertebrates (large carnivores, marine mammals, great apes, elephants, etc). Many conservation agencies have worked their way down the vertebrate scale from mammals and birds to the lower vertebrates; reptiles, amphibians, and fishes. Snakes, who as a group suffer from misconceptions and poor marketing, have traditionally been persecuted and do not generally lend themselves to the “cute and cuddly” that are so easily care about. However, recognition of their vital role in the dynamics of natural communities has resulted in their eminent rise on conservation lists.

Current trends in wildlife conservation attempt to protect and manage large habitats, ideally connected by wildlife corridors, to assure the survival of entire ecosystems. The combination of the *ex situ* AZA Species Survival Plan® for *D. couperi* and *in situ* repatriation efforts by Project Orianna and partners, approaches the challenge of indigo conservation with a multi-discipline approach that includes *ex situ* propagation, conservation education, habitat acquisition, habitat management, and an innovative repatriation program based on sound science. This strategy not only supports the conservation of *D. couperi*, but also the members of the natural communities in which they are found. For us and future generations, it helps secure the opportunity to inherit a natural heritage that is inclusive of our nation’s greatest snake, the Eastern Indigo Snake.

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## Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to Indigo Snakes are taken from the AZA Accreditation Standards and Related Policies (AZA 2010) 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, and federal wildlife laws and regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

### Chapter 1

**(1.5.7)** The animal collection must be protected from weather detrimental to their health.

**(10.2.1)** Critical life-support systems for the animal collection, 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. All mechanical equipment should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

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

### Chapter 2

**(1.5.2)** Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

**(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; and exhibit enclosures must include provisions for the behavioral enrichment of the animals.

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

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

**(11.3.6)** Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

**(11.2.3)** All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

**(11.6.2)** Security personnel, whether staff of 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).

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

**(11.2.5)** 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 (sharks, whales, tigers, bears, etc.) 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**

**(1.5.11)** 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 local, state, and federal laws must be adhered to.

**Chapter 5**

**(2.6.2)** A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

**(2.6.3)** Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

**(2.6.1)** Animal food preparations must meet all local, state/provincial, and federal regulations.

**Chapter 6**

**(2.1.1)** A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

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

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

**(1.4.6)** A 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 animal care staff members apprised of relevant laws and regulations regarding the institution's animal collection.

**(1.4.7)** Animal records must be kept current, and data must be logged daily.

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

**(1.4.4)** Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

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

**(1.4.1)** An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions in the animal collection.

**(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. In both cases, notations should be made on the inventory.

**(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.

**(2.7.3)** Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

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

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

**(11.1.3)** A tuberculin testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

**(2.5.1)** Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

**(2.4.1)** The veterinary care program must emphasize disease prevention.

**(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 collection 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.

- (2.4.2)** Keepers should be trained to recognize abnormal behavior and clinical symptoms 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, keepers should not evaluate illnesses nor prescribe treatment.
- (2.3.2)** Hospital facilities should have x-ray equipment or have access to x-ray services.
- (1.5.8)** The institution must develop a clear process for identifying and addressing animal welfare concerns within the institution.

#### **Chapter 8**

- (1.6.1)** The institution must have a formal written enrichment program that promotes species-appropriate behavioral opportunities.
- (1.6.2)** The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

#### **Chapter 9**

- (1.5.4)** A written policy on the use of live animals in programs should be on file. Animals in education programs must be maintained and cared for by trained staff, and housing conditions must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, social and environmental enrichment, access to veterinary care, nutrition, etc. Since some of these requirements can be met outside of the primary enclosure, for example, enclosures may be reduced in size provided that the animal's physical and psychological needs are being met.
- (1.5.3)** If animal demonstrations are a part of the institution's programs, an education and conservation message must be an integral component.

#### **Chapter 10**

- (5.3)** Institutions should maximize the generation of scientific knowledge gained from the animal collection. This might be achieved by participating in AZA TAG/SSP sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.
- (5.2)** Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.
- (5.1)** Research activities must be under the direction of a person qualified to make informed decisions regarding research.

## Appendix B: Acquisition/Disposition Policy

**I. Introduction:** The Association of Zoos and Aquariums (AZA) was established, among other reasons, to foster continued improvement in the zoological park and aquarium profession. One of its most important roles is to provide a forum for debate and consensus building among its members, the intent of which is to attain high ethical standards, especially those related to animal care and professional conduct. The stringent requirements for AZA accreditation and high standards of professional conduct are unmatched by similar organizations and also far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. AZA member facilities must abide by a Code of Professional Ethics - a set of standards that guide all aspects of animal management and welfare. As a matter of priority, AZA institutions should acquire animals from other AZA institutions and dispose of animals to other AZA institutions.

AZA-accredited zoological parks and aquariums cannot fulfill their important missions of conservation, education and science without living animals. Responsible management of living animal populations necessitates that some individuals be acquired and that others be removed from the collection at certain times. Acquisition of animals can occur through propagation, trade, donation, loan, purchase, capture, or rescue. Animals used as animal feed are not accessioned into the collection.

Disposition occurs when an animal leaves the collection for any reason. Reasons for disposition vary widely, but include cooperative population management (genetic or demographic management), reintroduction, behavioral incompatibility, sexual maturation, animal health concerns, loan or transfer, or death.

The AZA Acquisition/Disposition Policy (A/D) was created to help (1) guide and support member institutions in their animal acquisition and disposition decisions, and (2) ensure that all additions and removals are compatible with the Association's stated commitment to "save and protect the wonders of the living natural world." More specifically, the AZA A/D Policy is intended to:

- Ensure that the welfare of individual animals and conservation of populations, species and ecosystems are carefully considered during acquisition and disposition activities;
- Maintain a proper standard of conduct for AZA members during acquisition and disposition activities;
- Ensure that animals from AZA member institutions are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them.
- Support the goal of AZA's cooperatively managed populations and associated programs, including Species Survival Plan® (SSP) Programs and Taxon Advisory Groups (TAGs).

The AZA Acquisition/Disposition Policy will serve as the default policy for AZA member institutions. Institutions may develop their own A/D Policy in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and disposition standards.

Violations of the AZA Acquisition/Disposition Policy will be dealt with in accordance with the AZA Code of Professional Ethics. Violations can result in an institution's or individual's expulsion from membership in the AZA.

**II. Group or Colony-based Identification:** For some colonial, group-living, or prolific species, such as certain insects, aquatic invertebrates, schooling fish, rodents, and bats, it is often impossible or highly impractical to identify individual specimens. These species are therefore maintained, acquisitioned, and disposed of as a group or colony. Therefore, when this A/D Policy refers to animals or specimens, it is in reference to both individuals and groups/colonies.

**III. Germplasm:** Acquisition and disposition of germplasm should follow the same guidelines outlined in this document if its intended use is to create live animal(s). Ownership of germplasm and any resulting animals should be clearly defined. Institutions acquiring or dispositioning germplasm or any animal parts or samples should consider not only its current use, but also future possible uses as new technologies become available.

**IV(a). General Acquisitions:** Animals are to be acquisitioned into an AZA member institution's collection if the following conditions are met:

1. Acquisitions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all acquisitions.
3. 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.
4. Animals that are acquired for the collection, permanently or temporarily, must be listed on institutional records. All records should follow the Standards for Data Entry and Maintenance of North American Zoo and Aquarium Animal Records Databases<sup>®</sup>.
5. Animals may be acquired temporarily for reasons such as, holding for governmental agencies, rescue and/or rehabilitation, or special exhibits. Animals should only be accepted if they will not jeopardize the health, care or maintenance of the animals in the permanent collection or the animal being acquired.
6. The institution must have the necessary resources to support and provide for the professional care and management of a species, so that the physical and social needs of both specimen and species are met.
7. Attempts by members to circumvent AZA conservation programs in the acquisition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to acquire SSP species and adhere to the AZA Full Participation policy.
8. Animals are only to be acquired from sources 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. Any convictions of state, federal, or international wildlife laws should be reviewed, as well as any previous dealings with other AZA-accredited institutions.
9. When acquiring specimens managed by a PMP, institutions should consult with the PMP manager.
10. Institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved Regional Collection Plans (RCPs) when making acquisition decisions.

IV(b). Acquisitions from the Wild: The maintenance of wild animal populations for education and wildlife conservation purposes is a unique responsibility of AZA member zoos and aquariums. To accomplish these goals, it may be necessary to acquire wild-caught specimens. Before acquiring animals from the wild, institutions are encouraged to examine sources including other AZA institutions or regional zoological associations.

When acquiring animals from the wild, careful consideration must be taken to evaluate the long-term impacts on the wild population. Any capture of free-ranging animals should be done in accordance with all local, state, federal, and international wildlife laws and regulations and not be detrimental to the long-term viability of the species or the wild or captive population(s). In crisis situations, when the survival of a population is at risk, rescue decisions are to be made on a case-by-case basis.

V(a). Disposition Requirements – living animals: Successful conservation and animal management efforts rely on the cooperation of many entities, both within and outside of AZA. While preference is given to placing animals within AZA member institutions, it is important to foster a cooperative culture among those who share the primary mission of AZA-accredited facilities. The AZA draws a strong distinction between the mission, stated or otherwise, of non-AZA member organizations and the mission of professionally managed zoological parks and aquariums accredited by the AZA.

An accredited AZA member balances public display, recreation, and entertainment with demonstrated efforts in education, conservation, and science. While some non-AZA member organizations may meet minimum daily standards of animal care for wildlife, the AZA recognizes that this, by itself, is insufficient to warrant either AZA membership or participation in AZA's cooperative animal management programs. When an animal is sent to a non-member of AZA, it is imperative that the member be confident that the animal will be cared for properly.

Animals may only be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all dispositions.
3. Any disposition must abide by the Mandatory Standards and General Advisories of the AZA Code of Professional Ethics. Specifically, "a member shall make every effort to assure that all animals in his/her collection and under his/her care are disposed of in a manner which meets the current disposition standards of the Association and do not find their way into the hands of those not qualified to care for them properly."
4. Non-domesticated animals shall not be disposed of at animal auctions. Additionally, animals shall not be disposed of to any organization or individual that may use or sell the animal at an animal auction. In transactions with AZA non-members, the recipient must ensure in writing that neither the animal nor its offspring will be disposed of at a wild animal auction or to an individual or organization that allows the hunting of the animal.
5. Animals shall not be disposed of to organizations or individuals that allow the hunting of these animals or their offspring. This does not apply to individuals or organizations which allow the hunting of only free-ranging game species (indigenous to North America) and established long-introduced species such as, but not limited to, white-tailed deer, quail, rabbit, waterfowl, boar, ring-necked pheasant, chukar, partridge, and trout. AZA distinguishes hunting/fishing for sport from culling for sustainable population management and wildlife conservation purposes.
6. Attempts by members to circumvent AZA conservation programs in the disposition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to deacquisition SSP species and adhere to the AZA Full Participation policy.
7. Domesticated animals are to be disposed of in a manner consistent with acceptable farm practices and subject to all relevant laws and regulations.
8. Live specimens may be released within native ranges, subject to all relevant laws and regulations. Releases may be a part of a recovery program and any release must be compatible with the AZA Guidelines for Reintroduction of Animals Born or Held in Captivity, dated June 3, 1992.
9. Detailed disposition records of all living or dead specimens must be maintained. Where applicable, proper animal identification techniques should be utilized.
10. It is the obligation of every loaning institution to monitor, at least annually, the conditions of any loaned specimens and the ability of the recipient to provide proper care. If the conditions and care of animals are in violation of the loan agreement, it is the obligation of the loaning institution to recall the animal. Furthermore, an institution's loaning policy must not be in conflict with this A/D Policy.
11. If live specimens are euthanized, it must be done in accordance with the established policy of the institution and the Report of the American Veterinary Medical Association Panel on Euthanasia (Journal of the American Veterinary Medical Association 218 (5): 669-696, 2001).
12. In dispositions to non-AZA members, the non-AZA member's mission (stated or implied) must not be in conflict with the mission of AZA, or with this A/D Policy.
13. In dispositions to non-AZA member facilities that are open to the public, the non-AZA member must balance public display, recreation, and entertainment with demonstrated efforts in conservation, education, and science.
14. In dispositions to non-AZA members, the AZA members must be convinced that the recipient has the expertise, records management practices, financial stability, facilities, and resources required to properly care for and maintain the animals and their offspring. It is recommended that this documentation be kept in the permanent record of the animals at the AZA member institution.
15. If living animals are sent to a non-AZA member research institution, the institution must be registered under the Animal Welfare Act by the U.S. Department of Agriculture Animal and Plant Health Inspection Service. For international transactions, the receiving facility should be registered by that country's equivalent body with enforcement over animal welfare.
16. No animal disposition should occur if it would create a health or safety risk (to the animal or humans) or have a negative impact on the conservation of the species.

17. Inherently dangerous wild animals or invasive species should not be dispositioned to the pet trade or those unqualified to care for them.
18. Under no circumstances should any primates be dispositioned to a private individual or to the pet trade.
19. Fish and aquatic invertebrate species that meet ANY of the following are inappropriate to be disposed of to private individuals or the pet trade:
  - a. species that grow too large to be housed in a 72-inch long, 180 gallon aquarium (the largest tank commonly sold in retail stores)
  - b. species that require extraordinary life support equipment to maintain an appropriate captive environment (e.g., cold water fish and invertebrates)
  - c. species deemed invasive (e.g., snakeheads)
  - d. species capable of inflicting a serious bite or venomous sting (e.g., piranha, lion fish, blue-ringed octopus)
  - e. species of wildlife conservation concern
20. When dispositioning specimens managed by a PMP, institutions should consult with the PMP manager.
21. Institutions should consult WCMC-approved RCPs when making disposition decisions.

V(b). Disposition Requirements – dead specimens: Dead specimens (including animal parts and samples) are only to be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions of dead specimens must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. Maximum utilization is to be made of the remains, which could include use in educational programs or exhibits.
3. Consideration is given to scientific projects that provide data for species management and/or conservation.
4. Records (including ownership information) are to be kept on all dispositions, including animal body parts, when possible.
5. SSP and TAG necropsy protocols are to be accommodated insofar as possible.

VI. Transaction Forms: AZA member institutions will develop transaction forms to record animal acquisitions and dispositions. These forms will require the potential recipient or provider to adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy, and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities.

## Appendix C: 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 -94°F (-70°C) frost-free freezer or a -4°F (-20°C) 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., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, 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 Indigo Snakes:

Required:

1. direct and floatation fecals
2. vaccinate as appropriate

Strongly Recommended:

1. CBC/sera profile
2. urinalysis
3. appropriate serology (FIP, FeLV, FIV)
4. heartworm testing in appropriate species

## Appendix D: Program Animal Position Statement

The Conservation Education Committee (CEC) of the Association of Zoos and Aquariums supports the appropriate use of program 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 and wildlife. Utilizing these animals allows educators to strongly engage audiences. As discussed below, the use of program 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 and Hodgkinson 1999). The use of program 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.

Program 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 (Wolf & Tymitz 1981; Bitgood, Patterson & Benefield, 1986, 1988). In addition, the provocative nature of a handled animal likely plays an important role in captivating a visitor. In two studies (Povey & Rios 2002; Povey 2002), 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 program animals in shows or informal presentations is effective in lengthening the potential time period for learning and overall impact.

Program 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 (2002) 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 program animals. A growing body of evidence supports the validity of using program 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 et al. (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 program 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: Program animals have been clearly demonstrated to increase affective learning and attitudinal change.

- Studies by Yerke and Burns (1991) and Davison et al. (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 et al. (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 program 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 program animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places.

## Appendix E: Developing an Institutional Program Animal Policy

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 Program Animal Position Statement (Appendix D) describes the research underpinning the appropriate use of program 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 program animals conveys intended and conflicting messages and to modify and improve programs accordingly.

When utilizing program 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-specific animal welfare standards to the Taxon Advisory Groups (TAG) and Species Survival Plan<sup>®</sup> Program (SSP). Experts within each TAG or SSP, along with their education advisors, are charged with assessing all aspects of the taxons' biological and social needs and developing animal care standards that include specifications concerning their use as program 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 program animal policy that articulates and evaluates program benefits. The following recommendations are offered to assist each institution in formulating its own Institutional Program Animal Policy.

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 & Science Department
- Any animal show staff (if in a separate department)
- Departments that frequently request special program 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 Program 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:

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

Institutional program animal policies should include a philosophical statement addressing the above, and should relate the use of program animals to the institution's overall mission statement.

**II. Appropriate settings:** The Program Animal Policy should include a listing of all settings both on and off site, where program 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:

*On-site programming*

*Informal and non-registrants:*

- On-grounds programming with animals being brought out (demonstrations, lectures, parties, special events, and media)
- Children's zoos and contact yards
- Behind-the-scenes open houses
- Shows
- Touch pools

*Formal (registration involved) and controlled settings:*

- School group programs
- Summer Camps
- Overnights
- Birthday parties

*Offsite and outreach:*

- PR events (TV, radio)
- Fundraising events
- Field programs involving the public
- School visits
- Library visits
- Nursing Home visits (therapy)
- Hospital visits
- Senior Centers
- 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 stress 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 Program Animal Policy address compliance with appropriate regulations and AZA Accreditation Standards.

**IV. Collection planning:** All AZA-accredited institutions should have a collection planning process in place. Program 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 of the AZA website ([www.aza.org](http://www.aza.org)). The following recommendations apply to program animals:

1. Listing of approved program 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
  - 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 Program Animal Policy should address the specific messages related to the use of program 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 program 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 program 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 program 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:

- 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).
- 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 Program Animal Policy should make a strong statement on the importance of animal welfare. The policy should address:

- General housing, husbandry, and animal health concerns (e.g., that the housing and husbandry for program animals meets or exceeds general standards and that the needs of the individual animal, such as enrichment and visual cover, are accommodated).
- 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.
- Requirements for supervision of contact areas and touch tanks by trained staff and volunteers.
- Frequent evaluation of human/animal interactions to assess safety, health, welfare, etc.
- Ensure that the level of health care for the program animals is consistent with that of other animals in the collection.

VIII. Taxon specific protocols: The AZA encourages 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 program animals. To develop these, institutions refer to the Conservation Programs Database. Taxon-specific protocols should address:

- How to remove the individual animal from and return it to its permanent enclosure.
- How to crate and transport animals.
- Signs of stress, stress factors and discomfort behaviors.
- 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)
- Guidelines for disinfecting surfaces, transport carriers, enclosures, etc.
- Animal facts and conservation information.
- Limitations and restrictions regarding ambient temperatures and or weather conditions.

- Time limitations (including animal rotation and rest periods, as appropriate, duration of time each animal can participate, and restrictions on travel distances).
- The numbers of trained personnel required to ensure the health and welfare of the animals, handlers and public.
- Taxon-specific guidelines on animal health.

IX. Logistics, and managing the program: The Institutional Policy should address a number of logistical issues related to program animals, including:

- Where and how the program animal collection will be housed, including any quarantine and separation for animals used off-site.
- Procedures for requesting animals, including the approval process and decision making process.
- 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 Program Animal Policy or reference can be made that a separate training protocol exists. It is recommended that the training section of the policy address:

- Personnel authorized to handle and present animals.
- Handling protocol during quarantine.
- The process for training, qualifying and assessing handlers including who is authorized to train handlers.
- The frequency of required re-training sessions for handlers.
- Personnel authorized to train animals and training protocols.
- The process for addressing substandard performance and noncompliance with established procedures.
- Medical testing and vaccinations required for handlers (e.g., TB testing, tetanus shots, rabies vaccinations, routine fecal cultures, physical exams, etc.).
- Training content (e.g., taxonomically specific protocols, natural history, relevant conservation education messages, presentation techniques, interpretive techniques).
- Protocols to reduce disease transmission (e.g., zoonotic disease transmission, proper hygiene and hand washing requirements, as noted in AZA's Animal Contact Policy).
- Procedures for reporting injuries to the animals, handling personnel or public.
- 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 Program 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.