

Regional Collection Plan

AZA Snake Advisory Group

4th Edition

Editors:

Chad Peeling and Ian Recchio

Authors and editors of specific sections as noted

Steering Committee:

Chad Peeling, Clyde Peeling's Reptiland (Chair)

Chris Baker, Memphis Zoo (Vice Chair)

Penny Felski, Buffalo Zoo (Secretary)

Ian Recchio, Los Angeles Zoo

R. Andrew Odum, Toledo Zoo

Diane Barber, Fort Worth Zoo

Andrew Lentini, PhD, Toronto Zoo

Craig Pelke, San Antonio Zoo

Andrew Snider, Brookfield Zoo

Veterinary Advisor:

Brad Lock, DVM, Zoo Atlanta



Introduction & Objectives.....	Page 4
2015 Steering Committee Contacts	
Mission Statement	
Operating Structure	
Taxonomic Purview & Conservation Status	
Conservation & SSPs	
Snake Conservation.....	Page 7
Snake Conservation Program Primer	
Conservation Agency & NGO Resources	
Sustainability in Snake Collections.....	Page 11
Our Limitations	
Our Needs	
Why Bother?	
Program Species Selection Criteria.....	Page 12
Support of Field Conservation	
Ensuring Availability of Flagship Exhibit/Educational Species	
Legacy Commitments	
Species Selected for Management (table 1)	
Program Management Levels.....	Page 14
Sustainability Scores & Space Analysis	
Animal Program Summary Table (table 2)	
Managed Population Accounts	
Aruba Island rattlesnake.....	Page 16
Louisiana pine snake.....	Page 21
Eastern massasauga.....	Page 26
Eastern indigo.....	Page 31
Armenian viper.....	Page 36
Jamaican boa.....	Page 41
Mexican lance-headed rattlesnake.....	Page 45
Bushmaster.....	Page 49
Candidate Species Accounts	
Santa Catalina rattlesnake.....	Page 53
Green anaconda.....	Page 57
Reticulated python.....	Page 62
Mangshan pit viper.....	Page 67
Eastern diamondback rattlesnake.....	Page 71
King cobra.....	Page 76

Guidelines & Recommendations

Managing Venomous Snakes..... [Page 81](#)
Enclosure Sizes for Snakes..... [Page 87](#)
Quarantine and pre-shipment diagnostic testing..... [Page 88](#)
Snakes in Outreach..... [Page 91](#)
Sample forms for vetting non-AZA facilities..... [Page 93](#)

Appendices

Appendix I: AZA Animal Program Management Levels Defined..... [Page 96](#)
Appendix II: Management Update Table..... [Page 97](#)
Appendix III: Animal Program Essential Roles, Goals & Actions Table..... [Page 98](#)

2016 TAG Steering Committee Contacts

Officers

- Chair: Chad Peeling, Clyde Peeling's Reptiland
chad@reptiland.com; (570) 538-1869
- Vice Chair: Chris Baker, Memphis Zoo
- Secretary: Penny Felski, Buffalo Zoo

Steering Committee Contacts

(Terms Ending 2016)

- Diane Barber, Fort Worth Zoo
dbarber@fortworthzoo.org; (817) 759-7180
- Penny Felski, Buffalo Zoo
pfelski@buffalozoo.org; (716) 995-6155
- Andy Snider, Brookfield Zoo
andy.snider@czs.org; (708) 688-8458

(Terms Ending 2017)

- Craig Pelke, San Antonio Zoo
cpelke@sazoo.org; (210) 734-7184, x1340
- Ian Recchio, Los Angeles Zoo
ian.recchio@lacity.org; (323) 644-4248

(Terms Ending 2018)

- Chris Baker, Memphis Zoo
cbaker@memphiszoo.org; (901) 333-6707
- Andrew Lentini, Toronto Zoo
alentini@torontozoo.ca; (416) 392-5968
- Billie Harrison, Milwaukee County Zoo
Billie.Harrison@milwaukeecountywi.gov; (414) 771-3040

The Association of Zoos and Aquariums (AZA) formed the Snake Taxonomic Advisory Group (SAG) in 1989. Under the oversight of AZA's Wildlife Conservation and Management Committee, Taxon Advisory Groups (TAGs) provide informed advice on their specific taxonomic group of animals to guide collection management of North American zoological institutions. A Taxon Advisory Group's main purpose is to examine the conservation and exhibition needs of the entire taxa. Each TAG consists of AZA Species Survival Plan coordinators, studbook keepers, institutional representatives, and other individuals with special expertise on one or more of the species covered by the TAG.

Mission Statement

The SAG's mission is to guide AZA institutions in the selection of snake species that are of high priority for cooperative management and conservation, and to facilitate information exchange between AZA institutions. Its specific objectives are to:

- Identify snake species in greatest need of conservation action based on their status in the wild.
- Identify snake species that have high exhibit and educational value to AZA institutions.
- Create management programs to ensure sustainable captive populations of priority species. This includes creating and maintaining studbooks and implementing Species Survival Plans (SSPs).
- Document husbandry protocols through Animal Care Manuals (ACM) for selected species.
- Enhance cooperative interaction among zoos and aquariums and the private sector to increase the size of managed populations, pool information and focus conservation efforts.

Although the SAG's primary function is to identify species and manage captive populations that meet the objectives listed above, we recognize that there are many other snake species of interest to curators. We do not intend to stifle individuality in zoological collections and have not recommended against keeping particular species. For managed programs to succeed, however, it is critical that institutions dedicate space and resources long-term. This RCP is a menu of options for institutional participation and we encourage directors, curators, and collection managers to prioritize SAG program species in their collection plans. We will continue to promote, evaluate and revise these programs as needed to maximize their success and sustainability.



Photo by Ian Recchio, Los Angeles Zoo

Operating Structure

The SAG Steering Committee consists of a Chair, Vice Chair, and seven additional voting members (one of whom serves as Secretary). Committee member positions are elected for three-year terms, which are staggered into groups of two and three (the Chair is a standing position). Notices announcing vacant committee positions will be posted on the SAG List Server and any Institutional Representative may be nominated with their permission as a candidate for vacant positions. Only Institutional Representatives can serve on the committee and only IR's can vote for new committee members.

Taxonomic Purview & Conservation Status

The SAG is responsible for evaluating all snakes. Snakes comprise more than a third of the extant species of non-avian reptiles, with more than 3,500 described species as of this writing. Despite their ubiquity, the ecology, life history, and conservation status of most snake species are poorly known, but habitat loss, disease, and persecution have clearly led to declines in some areas. This Regional Collection Plan (RCP) focuses on a small number of snake taxa for which cooperative population management would directly benefit conservation in the wild or ensure future exhibit/education animals for zoo and aquarium collections. A list of the species included in this RCP, along with their conservation status as known, is provided in [Table 2](#) (below).



Photo by Ian Recchio, Los Angeles Zoo

Conservation & SSPs

SSPs are, by definition, cooperatively managed captive populations. Where captive populations can provide meaningful support for conservation, it makes sense to deploy SSPs for the purpose. But lasting conservation must occur in a species' natural range and an ex-situ population is not always necessary to enhance the cause.

We consider conservation work and SSP programs as independent entities that sometimes collaborate. Both are vital, but they will not always be concerned with the same species (conservation programs don't have to

be SSPs and vice-versa). The Snake TAG supports myriad conservation efforts, whether or not a program qualifies as an SSP. These include basic field research, head-start programs, breeding/release programs, capacity building, community outreach, and habitat restoration/enhancement.

Conservation takes many forms and opportunities to contribute go well beyond SSP participation. We include a conservation program primer below and invite interested parties to contact the TAG for additional help or guidance.

Snake Conservation Primer

Long-term species conservation depends upon many factors—adequate habitat, appropriate legal protection, functional ecology, and the support of local human communities. Developing a conservation program takes work in the species' native range and collaboration with a variety of stakeholders.

Key to the success of any program is a dedicated, energetic, and capable champion. There is no magic formula for creating a successful initiative. It takes creative thinking, perseverance, and a willingness to change approach mid-stream if things aren't working. Most of all, it takes a commitment of time and energy. Conservation champions often dedicate years or decades to successful projects, but the results of this work are among the most rewarding professional accomplishments.

Although the Snake TAG supports conservation globally, we encourage projects that focus on our own “backyards.” Nobody is better equipped to conserve snakes in North America than local communities, and there are many endangered ecosystems in the US alone (e.g. longleaf pine forest, pine barrens, scrub oak forest, eastern hardwood forest, prairies, southwest deserts, numerous riparian and wetland habitats). Snake diversity and human development frequently collide in North America to the detriment of species. Persecution of snakes also remains a significant threat in some regions.

If you have an idea for a conservation program, the first step is to talk with colleagues who have managed similar projects, and the Snake TAG steering committee can help facilitate introductions. A viable plan generally involves multiple stakeholders—national and local government agencies, land owners, academic biologists, legislators—so communicating with potential collaborators is key. We encourage anyone interested in initiating or contributing to a snake conservation program to use the TAG steering committee as a resource.

We have described several successful programs below that showcase diverse approaches to enhancing snake conservation.

Public education campaigns - Traditional rattlesnake roundups throughout Appalachia and the desert Southwest have taken a heavy toll on rattlesnake populations. They often include barbaric treatment of animals and perpetuate anti-rattlesnake sentiment among local people. AZA institutions have helped convert roundup events in Georgia and Texas into no-kill wildlife festivals, contributing staff time and outreach exhibits. These festivals now provide communities with equal or greater revenue and carry a sustainable environmental message. Collaboration with community leaders, herpetological societies, and natural history museums helps broaden community support.



Photo by Joel Sartore, Photo Ark

AZA institutions, in coordination with Southwest Partners for Amphibian and Reptile Conservation, are currently developing educational materials and training programs for safe and humane techniques to remove and relocate rattlesnakes for utility companies, mine workers, wind farm staff, and federal agencies. This information will be available online through the PARC website (www.swparc.org). In addition to these zoo-supported activities, there are many more ongoing programs at the local, state, and national level. Zoos have a plethora of resources that may be utilized to spread the word and promote change through public education campaigns.

Large-scale ecosystem preservation - Aruba Island rattlesnakes, endemic to one Caribbean island, are threatened by human development, feral grazing animals, and direct persecution. In 1982 the Species Survival Plan—the first for a snake—was created to ensure long-term existence of the species. Over three decades, the program has conducted field monitoring and ecological research, an extensive public education campaign, and invasive species control measures on Aruba. A genetically diverse captive assurance colony has also been maintained in AZA institutions. In collaboration with the Aruba government, the program helped launch The First National Congress for Preservation of Aruba Wildlife (WildAruba), which aims to protect the island’s natural heritage holistically. The SSP and WildAruba (see WildAruba.org) have created collaborative synergy, changed the way local people view native wildlife, and inspired a movement toward ecologically sustainable development.

Breed and release program - Louisiana pine snakes are critically endangered by habitat loss and degradation. In 1984, wild snakes were taken into captivity to build a captive breeding program which developed into the SSP. In 2003 the SSP began a coordinated effort with US Fish & Wildlife Service, and other partners to protect and enhance remaining habitat. Beginning in 2010, zoo-bred pine snakes have been released and monitored on a tract of restored habitat. The coordinated efforts of a wide variety of stakeholders, including private timber companies, have inspired positive steps in conserving the Louisiana pine snake and created an opportunity for a meaningful contribution from zoos. In 2014, the program leader and primary collaborators examined the conservation trajectory of the species and decided to dramatically change the program’s approach to produce far more captive snakes for release. This new strategy meant consolidating the entire captive populations into four primary breeding facilities. This kind of results-oriented flexibility is essential for long-term conservation programs.



Photo by Penny Felski, Buffalo Zoo

Collaborative field research and public engagement - The eastern massasauga rattlesnake is a diminutive species originally distributed throughout shallow wetlands of the upper Midwest and northeastern parts of the U.S. and southern Canada. Habitat destruction, fragmentation, and degradation and persecution have left the species in desperate conservation need. An emerging fungal disease poses possible additional threats. By collaborating with state and federal conservation agencies, academic biologists, and private land owners, the SSP has engaged in field research, diet studies, and a ground-breaking public education campaign with novel outreach initiatives. Zoos

are also working out the reproductive biology of the species so that, ultimately, animals in zoos can form an assurance colony for this threatened snake.

Conservation Agency & Non-governmental Organization (NGO) Resources

It is important to consult government listings and NGO programs for a species before going too far with an idea. Often federal, state, or local wildlife or land protection agencies have existing programs or valuable knowledge. NGO's may have local connections and innovative ideas. Failure to collaborate with these entities risks duplicating efforts or squandering potential partnerships. The following lists some of the most important agency and NGO resources.

International Union for Conservation of Nature (IUCN) www.iucnredlist.org

Established in 1948, IUCN is an international organization of governments and NGOs. Scientists and other experts participate in evaluating the status of species, which is compiled to create the IUCN Red List.

United States Fish and Wildlife Service (USFWS) www.fws.gov

USFWS is an agency of the federal government, operating within the Department of the Interior, which is responsible for regulatory management of fish, wildlife, and natural habitats. USFWS is divided into eight regions (below), each regional website describes conservation priorities and species of concern within its respective area.

- Region 1- Pacific Region www.fws.gov/pacific (Hawaii, Idaho, Oregon and Washington)
- Region 2- Southwest Region www.fws.gov/southwest (Arizona, New Mexico, Texas and Oklahoma)
- Region 3- Midwest Region www.fws.gov/midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin)
- Region 4- Southeast Region www.fws.gov/southeast (Kentucky, Arkansas, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Florida, Commonwealth of Puerto Rico and the Virgin Islands)
- Region 5- Northeast Region www.fws.gov/northeast (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, New Jersey, Pennsylvania, Rhode Island, Vermont, Virginia and West Virginia)
- Region 6- Mountain-Prairie Region www.fws.gov/mountain-prairie (Montana, North Dakota, South Dakota, Wyoming, Nebraska, Utah, Colorado and Kansas)
- Region 7- Alaska Region www.fws.gov/alaska
- Region 8- Pacific Southwest Region www.fws.gov/cno (California and Nevada)

State Wildlife Action Plans

Each state is legally required to develop a wildlife action plan to assess the condition of wildlife and habitats within its borders and outline actions needed to conserve them. Search state government websites.

United States Geological Survey (USGS) www.usgs.gov

USGS is a research agency of the federal government, operating under the Department of the Interior, which is tasked with studying the biology, hydrology, geography, and geology of the United States. USGS conducts many in situ monitoring and research programs and can provide opportunities for collaborative conservation projects.

Association of Fish and Wildlife Agencies (AFWA) www.fishwildlife.org

This organization represents government wildlife agencies as well as non-governmental conservation groups. Its website includes links to all of the state fish and wildlife agencies and other partner organizations.

Partners in Amphibian and Reptile Conservation (PARC) www.parcplace.org

PARC's mission is "To conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public-private partnerships." PARC is divided into five regional working groups (below).

- Midwest (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin)
- Southeast (Alabama, Arkansas, Florida, Georgia, Kansas, Louisiana, Michigan, North Carolina, South Carolina and Tennessee)
- Southwest (Arizona, California, Colorado, Hawaii, New Mexico, Nevada, Oklahoma, Texas and Utah)
- Northeast (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia and West Virginia)
- Northwest (Alaska, Idaho, Montana, Oregon, Washington and Wyoming)

Our Limitations

Space is clearly *the* limiting factor in captive population management and AZA institutions simply cannot manage sustainable populations for the majority of taxa represented in our living collections (Conway, 2011; Murphy, 2014; Long, Dorsey and Boyle, 2011). The number of species under threat in the wild also vastly outstrips our resources for maintaining ex situ assurance colonies. It is essential that we acknowledge this limitation and focus efforts on a small number of species for which we can make a difference.

It is also important that species selected for cooperative management remain attractive and relevant to a significant proportion of zoological institutions over time. As curatorial staff changes, living collections naturally evolve and there is a tendency for species to fall out of fashion. Cooperatively managed species must address the needs and goals of multiple institutions, rather than depending entirely on the interests and efforts of individual institutions or champions.

Our Needs

Acquisition / Disposition Flexibility

Population management requires a means to deal with surplus offspring, and the trend toward restrictive institutional disposition policies threatens to cripple our collective sustainability. AZA institutions cannot manage populations in complete isolation, because successful populations inevitably produce surplus offspring that saturate available space with limited genetic diversity (this is particularly true of live-bearing snakes). Decision makers at institutions must allow population managers reasonable flexibility to cull and/or disperse surplus animals outside AZA through responsible disposition policies.

The SAG steering committee recognizes that animal disposition is laden with ethical, legal, and public relations implications, but we encourage institutions to approach these issues rationally and balance risk aversion with constraining the ability of collection managers to function. Exchanging surplus animals with non-AZA facilities, while exercising due diligence to ensure animal welfare and public safety, is in line with AZA's published acquisition/disposition policies. We have included a sample document used for vetting non-AZA entities prior to animal disposition ([see page 93](#)).

Dedicated Holding Space

The SAG steering committee is sensitive to the economic realities faced by zoos and aquariums and we have attempted to select species that fit within average-sized facilities. However, sustainable populations require dedicated off-exhibit space and this is sorely lacking for snakes in most zoos and aquariums. In most cases snakes have modest needs, and we have outlined off-display holding requirements for each managed species below as a planning tool. Additional space may also be available in the private sector, and non-AZA partners who have cooperated in Red or Yellow SSP programs are encouraged to apply to become approved Sustainability Partners by the WCMC when a program qualifies to become Green.

Why Bother?

Future availability of some key exhibit and education species is in doubt. If we are not able to maintain sustainable populations of these species, they may disappear from zoo and aquarium collections in the foreseeable future, limiting our opportunities to engage and educate visitors. We also have an ethical responsibility to limit our take from the wild wherever possible, to avoid detriment to free-ranging populations. Where captive populations can make a bona fide contribution to *in situ* snake conservation we must be able to respond.

To address the realities outlined above (see “Sustainability in Snake Collections”), the SAG steering committee used population sustainability as *the limiting principle* in the program species selection process. We established two narrow criteria that justify cooperative captive population management: direct support of field conservation programs and ensuring future availability of flagship exhibit/educational species in zoological collections.

Species managed for support of field conservation programs must have a direct and realistic link to enhancing the survival of the wild population. This requires a demonstrable conservation need, an active conservation program in the species’ range, and a realistic probability of success. Assurance colonies without a direct link to wild populations, or lacking a realistic plan, do not qualify for management as conservation programs because the number of species under threat in the wild far outstrips our ability to maintain sustainable assurance populations.

Species managed to ensure availability of flagship exhibit/educational populations must be used in exhibition/education programs by a significant proportion of zoos and aquariums; considered keystone species for zoo and aquarium exhibit and/or educational programming; and are not reliably available through other legal and ethical sources. This excludes species that are of narrow exhibit or research interest, those which are widely bred in the private sector, and species with stable wild populations where specimens may be sustainably taken into captivity legally.

All taxa in the RCP were evaluated against these criteria by asking a series of poignant questions:

Evaluating Species Managed for Support of Field Conservation Programs

- Is there a clear conservation need?
- Will conservation action be supported by government agencies?
- Is adequate habitat protected or available for protection?
- If needed, can the species be returned to the wild in the foreseeable future?
- Is an assurance colony warranted and practical?
- Are there an adequate number of potential founders?
- Can a sufficient number of institutions dedicate adequate space to meet population goals?
- Is a broad consortium needed or can work be handled by one or several regional institutions?
- Is the species indigenous to North America (regional focus)?

Evaluating Species Managed to Ensure Availability of Exhibit/Educational Populations

- Is there widespread institutional interest adequate to support a managed population?
- Is the husbandry of the species known and do specimens remain visible on exhibit?
- Is there adequate reproduction in zoos/aquariums?
- Is the species likely to be available from the private sector?
- Does the species have visitor appeal?
- Is there a compelling story, broadly significant to AZA institutions?
- Is there substantial morphological/behavioral distinctiveness?
- Does the species fulfill common institutional exhibit, zoogeographic, or taxonomic needs?
- Is the species useful as an outreach/program animal?

Many of these evaluation questions are subjective and answering them requires the experience and opinions of experts. A dichotomous decision tree does not accurately represent the process involved because answers are often not clear-cut. Extensive research, discussion among steering committee members, and consultation with population managers and academic biologists is required. Ultimately the evaluations remain subjective, but they represent the best judgment of the steering committee, a body of professional zoo herpetologists elected to represent the AZA community.

Evaluating more than 3,000 species of snakes individually is a practical impossibility. We narrowed our evaluations to those species currently held in captivity and those for which bona fide field conservation efforts are underway or likely in the foreseeable future. Many species were quickly eliminated from consideration based on their widespread reproduction and availability in the private sector. Other large groups were eliminated based on paucity of data about their status in the wild or lack of foreseeable restoration of protected habitat. Absence of adequate husbandry knowledge and inability to acquire specimens were also disqualifiers.

Legacy Commitments

Existing RCP programs were evaluated with the criteria described above, with one important caveat. Established programs that are effectively managed, making progress toward stated goals, and have ongoing commitments to government agencies or other stakeholders (e.g. Aruba Island rattlesnake, Armenian viper), were not subject to changes in program status even if they do not meet current selection criteria. Continuity is essential to program success, and the credibility of future programs hinges on honoring legacy commitments.

The results of our evaluation are summarized in table 1. Detailed information and justifications for each species selected are included in the Managed Population Accounts section below.

Table 1: Species Selected for Cooperative Management		
Managed to Support Field Conservation Programs		
Family	English Name	Taxon
Viperidae	Aruba Island rattlesnake	<i>Crotalus unicolor</i>
Colubridae	Louisiana pine snake	<i>Pituophis ruthveni</i>
Viperidae	Eastern massasauga rattlesnake	<i>Sistrurus catenatus</i>
Colubridae	Eastern indigo	<i>Drymarchon couperi</i>
Viperidae	Armenian viper	<i>Montivipera raddei</i>
Boidae	Jamaican boa	<i>Chilabothrus subflavus</i>
Managed for Exhibit & Education Programs		
Family	English Name	Taxon
Viperidae	Mexican lance-headed rattlesnake	<i>Crotalus polystictus</i>
Viperidae	Santa Catalina rattlesnake	<i>Crotalus catalinensis</i>
Viperidae	Bushmaster	<i>Lachesis muta</i>
Boidae	Green anaconda	<i>Eunectes murinus</i>
Boidae	Reticulated python	<i>Malayopython reticulatus</i>
Viperidae	Mangshan pit viper	<i>Protobothrops mangshanensis</i>
Viperidae	Eastern diamondback rattlesnake	<i>Crotalus adamanteus</i>
Elapidae	King cobra	<i>Ophiophagus hannah</i>

Sustainability Scores

Each selected species was assigned to one of four AZA population management levels: Green SSP, Yellow SSP, Red SSP, or Candidate Species (see Appendix III for definitions). These designations describe the overall sustainability of the population and delineate the policies under which the population must be managed (see [Appendix I](#) for AZA Program Policies Overview).

Sustainability scores were not formally tabulated for all species, because the size of the captive populations was the determining metric in assigning management levels. A list of current AZA holdings for each species, target population sizes (where determined), specific goals, and the management levels assigned are listed in Table 2 below. Program objectives and challenges are described in each Managed Population Account.

Space Assessment

We did not conduct a formal space survey, because experience with previous surveys has shown them to be of little value in determining how much space will *actually* be dedicated to managed populations. Instead, we assessed the space currently given to each taxa in AZA facilities, historical curatorial interest in the species, and how well the species fits with existing facilities in North American zoos and aquariums.

Table 2: Animal Program Summary												
Common name (taxon)	Last Breeding/ Transfer Plan	Current Population	Participating Institutions	Sustainability Score	Program Designation	Target Population Size	Target Sustainability Score	Space Needed (target - current)	5-year Population Trend	USFWS / IUCN / CITES	Goals (1-3)	
Aruba Island rattlesnake (<i>Crotalus unicolor</i>)	2015	27.25.1	21	>90%	Green SSP	150	90%	~100	Decreasing, but recent import	Threatened Critical CITES III	- Continue field research on impact of invasive <i>Boa constrictor</i> . - Finish diet study of invasive <i>B. constrictor</i> - Support development of National Park on Aruba	
Louisiana pine snake (<i>Pituophis ruthveni</i>)	2013	52.54.0	24	76.3%	Yellow SSP	200	84.5%	94	Increasing	Candidate Endangered Not Listed	- Securing final funding for consolidation - Consolidate the SSP - Increase reproductive output to amplify reintroduction.	
Eastern massasauga rattlesnake (<i>Sistrurus catenatus</i>)	2015	33.34.9	16	59.6%	Yellow SSP	100	78.4%	24	Increasing	Proposed Threatened Least concern Not Listed	- Increase participating institutions - Develop standard reproductive protocols - Develop education/outreach kit	
Eastern indigo (<i>Drymarchon couperi</i>)	2013	31.31.2	26	Not assessed	Yellow SSP	150	N/A	45	Stable	Threatened Least concern Not listed	- New program leader attend AZA Pop-1 course - Acquire more founders & build population - Continue re-introduction in Conecuh National Forest & establish 2nd site in 2016	
Armenian viper (<i>Montivipera raddei</i>)	2009	18.24.10	9	Not assessed	Red SSP	100	N/A	48	Increasing	Not listed Near threatened Not listed	- Encourage holding institutions to breed - Conduct next breeding/transfer plan in 2016 - Continue fieldwork in Armenia & construct conservation breeding center	
Bushmaster (<i>Lachesis muta</i>)	2014	74	27	42% / 100 yrs	Yellow SSP	100	78% / 15 yrs	26	Decreasing	Not listed Not listed Not listed	- Add holding/rearing spaces - Acquire additional founders - Move offspring to institutions for exhibit	
Jamaican boa (<i>Chilabothrus subflavus</i>)	2012	26.21.15	12	31%	Yellow SSP	100- 150	N/A	38-88	Increasing (primarily private sector breeding)	Endangered Vulnerable CITES I	- Publish new breeding/transfer plan in 2016 - Add at least 3 new participating institutions - Complete updated studbook in 2016	

Table 2: Animal Program Summary												
Common name (taxon)	Last Breeding/ Transfer Plan	Current Population	Participating Institutions	Sustainability Score	Program Designation	Target Population Size	Target Sustainability Score	Space Needed (target - current)	5-year Population Trend	USFWS / IUCN / CITES	Goals (1-3)	
Mexican lance-headed rattlesnake (<i>Crotalus polystictus</i>)	2013	22.28.19	18	40.29	Yellow SSP	100	69.94	~31	Decreasing	Not listed Least concern Not Listed	- Breed potential founders in population - Improve reproductive success - Complete Animal Care Manual	
Santa Catalina rattlesnake (<i>Crotalus catalinensis</i>)	N/A	25.27.0	9	Not assessed	Candidate	75- 100	N/A	~10 institutions	Increasing	Not listed Critical Not Listed	- Publish studbook - Recruit additional institutional partners - Introduce new wild bloodlines into the population via field collection and studies.	
Mangshan pit viper (<i>Protobothrops mangshanensis</i>)	N/A	62	12	Not assessed	Candidate	80- 100	N/A	~10 institutions	Unknown	Not listed Endangered Not listed	- Publish studbook - Acquire additional founders - Breed potential founders/improve reproduction.	
Reticulated python (<i>Malayopython reticulatus</i>)	N/A	00.00	??	Not assessed	Candidate	N/A	N/A	Not assessed	Unknown	Not listed Not listed CITES II	- Publish studbook - Select program leader - Acquire additional holding/rearing space	
Green anaconda (<i>Eunectes murinus</i>)	N/A	00.00	??	Not assessed	Candidate	N/A	N/A	Not assessed	Unknown	Not listed Not listed CITES II	- Publish studbook - Select program leader - Acquire additional holding/rearing space	
King cobra (<i>Ophiophagus hannah</i>)	N/A	00.00	??	Not assessed	Candidate	N/A	N/A	Not assessed	Unknown	Not listed Vulnerable CITES II	- Publish studbook - Select program leader - Acquire additional holding/rearing space	
Eastern diamondback rattlesnake (<i>Crotalus adamanteus</i>)	N/A	00.00	??	Not assessed	Candidate	N/A	N/A	Not assessed	Unknown	Under review Least concern Not listed	- Publish studbook - Select program leader - Acquire additional holding/rearing space	

Aruba Island Rattlesnake

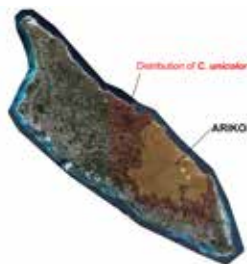
Crotalus unicolor

SSP



Aruba Island Rattlesnake

Crotalus unicolor



Green SSP

(written by R. Andrew Odum,
Toledo Zoo)

Species Summary:

The Aruba Island rattlesnake is a small endemic species closely related to the Neotropical rattlesnake, *Crotalus durissus*, but distinctive in size, pattern, and coloration. The entire range of the species is limited to 76km² (~43% of Aruba's land area), and it is considered one of the rarest snakes in the world (Reinert et al. 2002). It was first described by Van Lidth de Jeude (1887), and its taxonomic status was investigated in more detail by Gloyd (1936) and Kauffeld and Gloyd (1939), who included detailed observations of behavior and a litter



Photo by R. Andrew Odum, Toledo Zoo

of young born at the Staten Island Zoo. Some investigators believe that *C. unicolor* should be considered sub-specific (Campbell and Lamar 2004). However there is little dispute that the snake is a distinct and isolated breeding population with distinguishing physical characteristics, occupies a specific ecological niche, and is on an independent evolutionary trajectory. Given these biological factors, the SSP considers the Aruba Island rattlesnake a unique species worthy of conservation efforts.

Program Purposes: Assurance Population, Education/Exhibit Needs, and Research

The Aruba Island rattlesnake SSP was established in 1982 and is AZA's longest functioning snake conservation effort. The captive population has been maintained as a sustainable assurance colony, but the program has made extensive strides preserving the species on Aruba. This balanced approach has provided AZA institutions with display specimens that represent a broad conservation success story, while directly impacting the preservation of the snake and its ecosystem in situ (Odum and Reinert 2015).

Recent program achievements include:

- Importation of seven wild-caught potential founders to the Toledo Zoo to increase genetic diversity in the SSP population. These snakes have been distributed to four AZA institutions for breeding.
- Completion of a five-year study on Aruba to determine the impact of the invasive *Boa constrictor* on the rattlesnake.
- Data collection for a one-year diet study of the invasive *Boa constrictor*.
- Initiation of a study of the ecology of the rattlesnake's principle prey, the Aruba whiptail lizard (*Cnemidophorus arubensis*).
- Providing supportive training and consultation to Arikok National Park and the Government of Aruba.

Exhibit Qualities:

The Aruba Island rattlesnake is a small species, well suited to modest exhibit spaces. It inhabits xeric hilly areas of southeastern Aruba (Reinert et al. 2002) and is a perfect example of a species adapted to desert. Specimens may be maintained individually, in pairs, or in small groups. Exhibits should include rock piles or small logs to provide the snakes refugia while still remaining visible. To recreate the wild habitat, include sand or sand/gravel substrate, with medium sized limestone rocks. "Honeycomb limestone" is a common substrate on Aruba and is easily obtained in the U.S. Although introduced on Aruba, aloe (*Aloe vera*) is found island-wide and may be used as a live plant in rattlesnake exhibits.



Photo by R. Andrew Odum, Toledo Zoo

Educational Qualities:

The Aruba Island rattlesnake is an “underdog” species that became the foundation of a holistic conservation effort, benefitting all terrestrial wildlife on Aruba. Odum and Reinert (2015) provide a complete overview of its history, including background for education materials. Learning to live with wildlife is an important lesson for people everywhere. The success of this program is remarkable because Aruba is a major tourist destination, is relatively small, and has a potentially dangerous venomous snake resident.



Photo by R. Andrew Odum, Toledo Zoo

Interpretive Messages:

- Desert biomes
- Insular Biology
- Importance of venomous snakes
- Conservation of an umbrella species and its ecosystem
- Conservation partnerships

Care and Facilities:

Aruba Island rattlesnake care is similar to that of most dry climate rattlesnakes (e.g. those found in the southwestern United States). The thermal environment is key to maintaining healthy specimens in captivity, and the base temperature should be ~78-82°F during the day, dropping to ~70-72°F at night. A basking area during the day is crucial and should be ~92-95°F to support appropriate thermoregulation, digestion, vitellogenesis, embryonic development, and immune response to pathogens. For snakes in good health and feeding on a regular basis, it is only necessary to provide water about once a week. It is common for these snakes to live without water for many months in the wild, and fresh water usually elicits a drinking response. Animals that are in compromised health or condition should be provided with water continuously.

An important issue for population management is that captive animals are significantly heavier than their wild counterparts, due to overfeeding and lack of exercise. Analysis has shown that the fecundity and mortality rates for captive-born snakes are worse than for wild-caught snakes brought into captivity (Odum 2010). Avoid overfeeding and provide the rattlesnakes adequate space to encourage movement. Young animals should be fed every 10-14 days; adults should be fed every 3-4 weeks. Mice are the preferred diet in captivity, although in the wild, the Aruba whiptail lizard is the largest proportion of their diet (Reinert et al. 2008).

The breeding season is usually January through February. This corresponds to the end of the rainy season on Aruba and a slight cooling trend of a few degrees Celsius during the winter months. Breeding animals should be maintained separately and introduced in early January as the daytime temperature is dropped a few degrees. Misting with cold water often elicits a courtship response from males. In the wild, mate attendance has been documented,

and males may spend weeks in close proximity to a female (Reinert et al. 2008). It is probably prudent to allow males to remain with females for at least several months even if copulation has been observed.

Other Notes:

As the longest continuous snake conservation program (33 years as of this writing) under the AZA umbrella, the Aruba Island rattlesnake SSP is a model for zoo based conservation programs. The SSP was the driving force behind the First National Congress for the Preservation of Aruban Wildlife (Wild Aruba) in 2008, which developed an overall conservation action plan for the island (see WildAruba.org). Many of the recommendations in the Wild Aruba report have been realized, including establishment of an island-wide governmental authority to oversee conservation issues

Program Goals: ([Appendix III](#))

- Maintain an AZA assurance population with at least 90% gene diversity for at least 100 years.
- Continue to monitor the rattlesnake population and critical habitat on Aruba.
- Perform an ecological and behavioral study of the Aruba whiptail lizard, the primary prey for the rattlesnake from 2015-2018.
- Support the Aruba National Park, Arikok, to help it manage the rattlesnake on Aruba.



Photo by R. Andrew Odum, Toledo Zoo

Program Contact: ([Appendix II](#))

R. Andrew Odum, SSP Coordinator
Toledo Zoo
andrew.odum@Toledozoo.org
(419) 385-5721 x2113

References:

- Campbell, J. and W. Lamar (2004). *Venomous reptiles of the Western Hemisphere*. Ithaca, Cornell University Press.
- Gloyd, H. (1936). "The status of *Crotalus unicolor* van Lidth de Jeude and *Crotalus pulvis* Ditmars." *Herpetologica*: 65-68.
- Kauffeld, C. and H. Gloyd (1939). "Notes on the Aruba Rattlesnake, *Crotalus unicolor*." *Herpetologica*: 156-160.
- Odum, R. A. (2010). *Aruba Island Rattlesnake SSP Update*. AZA Snake Advisory Group. Fort Worth, TX.
- Odum, R. A. and H. K. Reinert (2015). "The Aruba Island rattlesnake *Crotalus unicolor* Species Survival Plan: a case history in ex situ and in situ conservation." *International Zoo Yearbook*: n/a-n/a.
- Reinert, H., L. Bushar, et al. (2002). "Distribution of the Aruba Island Rattlesnake, *Crotalus unicolor*, on Aruba, Dutch West Indies." *Caribbean Journal of Science* 38(1/2): 126-128.
- Reinert, H. K., L. M. Bushar, et al. (2008). *Ecology of the Aruba Island Rattlesnake, Crotalus durissus unicolor*. The Biology of Rattlesnakes. W. K. Hayes, K. R. Beaman, M. D. Cardwell and P. Bush. Loma Linda, California, Loma Linda University Press: 335-352.
- Van Lidth de Jeude, T. W. (1887). "On a collection of reptiles and fishes from the West Indies." *Notes Leyden Mus.* 9(129-139).

Louisiana Pine Snake

Pituophis ruthveni



PHOTOARK
JOEL SARTORE

SSP

Yellow SSP

Louisiana Pine Snake

*Pituophis ruthveni**(written by Steve Reichling, PhD, Memphis Zoo)*

Species Summary:

The Louisiana pine snake is an endemic of the decimated longleaf pine ecosystem west of the Mississippi River. Adult pine snakes—their scales dull and rough like pine cones, richly colored but somber in blacks, browns, and russet, and carrying the scars from years of subterranean battles with prey—are a clear reflection of life in the southern piney woods. This is the rarest species of snake in North America and the most imperiled native snake

*Photo by USFWS*

not listed as an Endangered Species. It is known from a mere 223 wild specimens recorded between 1927-2013. The pine snake was extirpated from most of its historic range during the first half of the 20th century, due to habitat alteration and ecosystem perversion. Today it persists on four tiny parcels of marginally suitable habitat (seven years ago there were six parcels). Within the past five years it has become apparent that the species is extirpated in Texas. Ongoing research reveals a continuing rapid decline in all the remaining populations. Conserving these sites and relict populations, alone, will not be sufficient to recover the Louisiana pine snake.

Program Purposes: *Conservation Action, Education/Exhibit Needs, and Research*

The AZA Species Survival Plan (SSP) for the Louisiana Pine Snake was implemented in 2000 to manage the zoo population that had been established in 1984. Currently, 109 specimens, representing 17 wild-caught founders, reside among 24 zoos. The primary goal of the SSP is to support in situ conservation. In recent decades the U.S. Forest Service (USFS) and state agencies in Louisiana and Texas have implemented active burning regimens and longleaf pine replanting programs, which have been very successful in returning degraded sites to longleaf forest. Sizeable tracts of excellent pine snake habitat now exist in Louisiana. These areas lie within the historic range of the pine snake, but have been without the species for many decades. A golden opportunity is now at hand to repatriate these restored landscapes using captive-bred specimens.



Photo by Carrie Thompson, USFWS

Since 2010, the SSP has been a partner in a modest release program of surplus captive snakes in Kisatchie National Forest, Grant Parish, Louisiana, in cooperation with the U.S. Fish and Wildlife Service (USFWS), USFS, and Louisiana Department of Wildlife and Fisheries. Encouraging data from post-release monitoring has shown that released snakes are surviving, growing, and maintaining fidelity to the release site.

Given the size and demographics of the captive population, it should be possible to produce 80-90 hatchlings per year, but the actual number of hatchlings produced since the reintroduction effort was started in 2010 has ranged from 1-17. This shortfall has been mainly due to a low reproductive rate of females and, while adequate for captive population maintenance, this level of reproduction is not sufficient to support a robust release program. Space limitations in zoos also present an obstacle to robust reproduction, as the SSP is already near capacity.

To meet the goal of creating a new and secure wild population and subsequent additional populations to recover the species, bold action to strengthen the captive component must be implemented without

delay. To address this need, the USFWS conducted a Structured Decision-Making Workshop in 2014 to develop a plan to significantly increase reproductive output. Representatives from the USFWS, USFS, LDW&F, the SSP, and the AZA Population Management Center (PMC) participated in these discussions. A series of models was generated showing the predicted population growth and numbers of available release snakes under various management scenarios. Only one option was deemed capable of achieving our goal: consolidation of the 109 SSP snakes into a small number of dedicated facilities and temporary suspension of release until each facility houses 70-100 specimens, whereupon releases are resumed with several hundred specimens per year.

The LPS is an ideal candidate for recovery by a release program. Extirpated over the vast majority of its former range, many sites are now restored and once again suitable for supporting the species. A consortium of experts and stakeholders is firmly established to guide this effort. An SSP assurance colony is well established and ready to put its full force into supporting a large scale release program. The single absent component in this formula for success is the limitation on reproductive output of the SSP population.

Exhibit Qualities:

Although this population is managed to support in situ conservation, genetically surplus animals make good

exhibit specimens. Although Louisiana pine snakes are almost exclusively fossorial in the wild, they adapt well to being fully exposed and on display. Exhibiting the species is no different from any other large North American colubrid and presents no special challenges.

Educational Qualities:

The Louisiana pine snake represents one of the most interesting ecological interconnections of any North American snake, making it an unparalleled example of the web of interrelationships in ecology and a perfect answer to the common questions, “Why should we conserve this animal? What purpose does it serve?” The answer is that every organism affects some other organism in some way, and if one animal is removed from the web, the whole system may collapse. The Louisiana pine snake is a critical example.

It all starts with fire—natural wildfires under which xeric pine upland fauna and flora evolved, and the deliberately set fires by Native Americans and by the timber industry in the first half of the 20th century. Fires sweep away midstory plants, allowing sunlight to reach the ground. This provides a perfect environment for grasses to dominate. In the trans-Mississippi Sandhills, pocket gophers (*Geomys bairdi*) have evolved to feed almost exclusively on the roots and young shoots of grasses and other understory vegetation, and adult Louisiana pine snakes feed primarily on pocket gophers.

Since the 1960s, a fire suppression campaign (Smokey Bear) and a shift from prescribed fire to use of herbicides in silviculture has eliminated the grassy understory, causing the loss of pocket gophers, and eliminating the main prey base of the Louisiana pine snake.

Interpretive Messages:

- Longleaf pine ecosystem conservation
- Silviculture and habitat conservation



Photo by Steve Reichling, Memphis Zoo

Care and Facilities:

Substrate consisting of a bedding material in which the snakes can partially burrow is preferable to bare newspaper, although specimens that are being frequently fed for reproductive conditioning may be maintained on paper in order to sustain proper hygiene levels. Providing a loose substrate will help reduce nose-rubbing and chronic corner probing to which some specimens are prone. Dry Aspen bedding, cypress mulch, pine bark nuggets, or pine shavings work well for this purpose. Refugia (hide boxes) are utilized by LPS and should be provided. A top-dressing of dried pine needles is used as a partial hide by the snakes, and provides naturalistic substrate that is aesthetically pleasing for exhibits. Breeding is straightforward and stimulated by the



Photo courtesy J. Kevin Bowler

techniques of photoperiod manipulation and artificial hibernation known to most herpetoculturists.

Program Goals: ([Appendix III](#))

- Establish dedicated breeding facilities for SSP
- Consolidate SSP population/boost reproductive output
- Produce ~300 hatchling LPS annually for release

Program Contact: ([Appendix II](#))

Steve Reichling PhD, SSP Coordinator

Memphis Zoo

sreichling@memphiszoo.org

(901) 333-6711

References:

- Henley, G. 1985. Pine snake hatched. AAZPA Newsletter 26:16.
- Himes, J.G. 2000. Burrowing ecology of the rare and elusive Louisiana pine snake, *Pituophis ruthveni* (Serpentes: Colubridae). *Amphibia-Reptilia* 22:91-1-1.
- ----. 1998. Activity patterns, habitat selection. Excavation, behavior, growth rates, and conservation of the Louisiana pine snake (*Pituophis melanoleucus ruthveni*). Shreveport, Louisiana State Univ., Master of Science Thesis.
- Reichling, S.B. 2008. Reptiles and Amphibians of the Southern Pine Woods. University of Florida Press, Tallahassee.
- ----. 2005. Pine snakes, pocket gophers, and partnerships. *AZA Communique* 5:6-9.
- ----. 1988b. Louisiana's rare and elusive snakes. *Louisiana Conservationist* 40:12-14.
- ----. 1988c. Reproduction in captive Louisiana pine snakes, *Pituophis melanoleucus ruthveni*. *Herpetological Review* 19:77-78.
- ----. 1990. Reproductive traits of the Louisiana pine snake, *Pituophis melanoleucus ruthveni* (Serpentes: Colubridae). *Southwestern Naturalist* 35:221-222.
- ----. 1995. The taxonomic status of the Louisiana pine snake (*Pituophis melanoleucus ruthveni*) and its relevance to the evolutionary species concept. *Journal of Herpetology* 29:186-198.
- ---- and Marti, K. 2013. Louisiana pine snake population management plan. AZA Population Management Center, Lincoln Park Zoo, Chicago.
- Rudolph, D.C. and Burgdorf, S.J. 1997. Timber rattlesnakes and Louisiana pine snakes of the west gulf coastal plain: hypothesis of decline. *Texas Journal of Science* 49:111-122.
- ----, ----, Conner, R.N., Collins, C.S., Duran, C.M., Ealy, M., Himes, J.G., Saenz, D., Schaefer, R.R.,
- Trees, T. Prey handling and prey composition of Louisiana pine snakes (*Pituophis ruthveni*) and black pine snakes (*Pituophis melanoleucus lodingi*). *Herpetological Natural History* 9:57-62.
- ----, Conner, R.N., Parker, M. 1995. Final Report: radio-telemetry study of Louisiana pine snakes in Louisiana. Agreement No. 19-94-059, State of Louisiana.
- Stull, O.G. 1929. The description of a new subspecies of *Pituophis melanoleucus* from Louisiana. *Occasional Papers of the Museum of Zoology of the University of Michigan* 205:1-3.
- U.S. Fish and Wildlife Service. 2013. Candidate Conservation Agreement for the Louisiana pine snake (*Pituophis ruthveni*).



PHOTOARK
JOEL SARTORE

Eastern Massasauga

Sistrurus catenatus

SSP



PHOTOARK
JOEL SARTORE

Yellow SSP

Eastern Massasauga

*Sistrurus catenatus**(written by Andrew Lentini, PhD, Toronto Zoo)*

Species Summary:

The massasauga is a rare and attractive North American pit viper that typically inhabits wetlands and associated uplands. Its familiarity to residents in the Great Lakes region of the USA and Canada helps to create a connection with visitors that live or vacation near this animal's habitat.

Program Purposes: Assurance Population, Education/Exhibit Needs, and Research

Massasauga rattlesnakes are recognized as a Candidate Species for federal listing in the United States and a Threatened Species at Risk in Canada, being protected throughout its range by state, provincial or federal laws. Shrinking natural spaces and expanding human infrastructure are leading to increased reported encounters with this elusive reptile, despite its overall decrease in numbers. Along with the usual factors leading to many species declines (habitat loss, illegal trade, pollution, etc.), the eastern massasauga is additionally impacted because it is a venomous snake, a fact that drives many to purposefully harm this species or damage its habitat out of misguided fear. Captive populations can be managed according to genetically defined subpopulations, allowing for future repatriation of locally extirpated populations using genetically appropriate individuals.

Conservation programs for this species are varied and widespread throughout its range including long-term mark recapture studies, radio telemetry projects, habitat modeling, population augmentation, and numerous landowner education and outreach initiatives.



Photo by Crystal Robertson

Exhibit Qualities:

Massasaugas are boldly patterned attractive snakes with a wide range of individual variation in color. They lend themselves well to a variety of exhibit habitats ranging from wetland to prairie. They are relatively small snakes and may be housed in smaller exhibits than would be required for larger rattlesnakes. Massasaugas have been successfully housed in a variety of social configurations. Individual animals, mixed sex, and single sex groups may be housed for long periods without apparent problems, and these snakes appear very tolerant of conspecifics. Massasauga rattlesnakes have been successfully housed with other snake species including bull snakes, fox snakes, hognose snakes, and milk snakes. Massasaugas will bask readily in open areas during the day, making them easily visible. Enrichment items may also prompt the snakes to move and explore their exhibits regularly.



Photo by Andrew Lentini, Toronto Zoo

Educational Qualities:

Within the range of the massasauga, there are opportunities to learn about living safely with local wildlife and to foster appreciation for the role this venomous species plays in the ecosystem. Unique physical and behavioral characteristics, including the rattle itself, may be highlighted in graphics and interpretive programs as unique features found only in the Americas. Such topics also fit well with common curriculum topics about animal adaptations and defense. Current and historic massasauga distribution maps help illustrate these animals as a disappearing part of our natural heritage and open the door to messaging about stewardship opportunities to protect habitat and species.

Interpretive Messages:

- Living with wildlife
- Wildlife safety
- Respect for the environment
- Stewardship

Care and Facilities:

Eastern massasauga is a small, stout rattlesnake, making it appropriate for exhibits that may be too small for many other North American pit vipers. Depending on the size of the enclosure, several snakes of mixed sexes and ages may be kept together. For example, an exhibit with 32 square feet (3 m²) of floor space can accommodate up to 6 adult massasaugas, while a 40-gallon tank with floor space of 4.5 square feet (0.4 m²) is enough space for a pair of massasaugas, on exhibit or in a holding area.



Photo by Andrew Lentini, Toronto Zoo

As with other venomous species, enclosures housing eastern massasaugas should be properly labelled, secure, and accessible only by authorized trained staff. A secure holding area should also be available in the event that separation for medical treatment or housing of neonates becomes necessary. A variety of exhibit layouts and furnishings may be used to mimic the local landscape. Institutions within the range of the eastern massasauga should strive to recreate a habitat with which local visitors are familiar. Natural substrates including sand, soil, mulch, coconut husks, and leaf litter are often used in exhibits. Live or artificial plants may be used and should be selected to represent the local habitat. Shelter or hide boxes can be placed throughout the exhibit, being mindful of the number of individuals that will be accessing them and their placement within the thermal gradient. An ambient temperature range of 22–32 °C (71–90 °F) should be offered, with a specific hot spot (34–40 °C [93–104 °F]). This will provide a thermal gradient that allows the snake to select desired temperatures for proper behavior thermoregulation. Exhibit lighting may be used to provide good quality light, heat, and UV. Basking sites may be provided using incandescent lamps, ceramic heat emitters or substrate heaters. UV lighting selection should be based on the size of the exhibit and the distance the lamps are from the animals, and can be evaluated using a UV meter. Relative humidity of 50–70% is desirable, and natural substrates help maintain appropriate moisture, which is important for ecdysis. Large water bowls or pools that allow the snake to fully submerge should be available at all times and cleaned regularly. Seasonal changes in photoperiod for exhibits and holding should mirror those seen in the wild.

Snakes should be offered a thawed, previously frozen mouse every other week. The food item should be thawed in a refrigerator and can be warmed slightly (surface temperature to 35 °C [95 °F]) in order to give it the thermal profile of a live prey item. Appropriately sized avian prey may also be offered.

Other Notes:

The eastern massasauga SSP is a dynamic and active program with many opportunities to become involved in research and conservation activities with zoo and wild populations. Future research needs of note include nutrition and reproductive studies. The SSP also has an active outreach and education committee that will support zoos in efforts to reach local stakeholders and zoo guests with positive messaging and experiences with this special snake.



Photo by Crystal Robertson

Program Goals: ([Appendix III](#))

- Add participating institutions
- Develop standard reproductive protocols
- Develop/distribute education/outreach kit

Program Contact: ([Appendix II](#))

Jeff Jundt, SSP Coordinator
Detroit Zoological Society
jjundt@dtz.org
(248) 336-5859

References:

AZA Eastern Massasauga Rattlesnake SSP (2013). Eastern Massasauga Rattlesnake (*Sistrurus catenatus catenatus*) Care Manual. Association of Zoos and Aquariums, Silver Spring: MD.

Eastern Indigo Snake

Drymarchon couperi



PHOTOARK
JOEL SARTORE

SSP

Yellow SSP

Eastern Indigo Snake

*Drymarchon couperi**(written by Chad Peeling, Reptiland)***Species Summary:**

Eastern indigos are among the longest species of snakes in North America, sometimes exceeding 7 feet in length. Gunmetal black skin, stocky build, and generally even temperament make these snakes wonderful exhibit and education animals, highlighting endangered upland habitats of the Southeastern US.

Program Purposes:

*Conservation Action, Education/
Exhibit Needs, and Research*

Drymarchon couperi is not listed by CITES and is categorized as least concern on the IUCN red data list. However it is listed as Threatened under the U.S. Endangered Species Act and has been protected by all in-range state wildlife agencies and USFWS since the mid-1970s. Indigos once inhabited five states in the southeastern coastal plain, but are now limited to southern Georgia and peninsular Florida. They are dependent on the presence of gopher tortoise burrows for winter refugia in the northern part of their range. Remaining populations are threatened by habitat destruction and fragmentation, decline in gopher tortoise populations, declining prey base, human persecution, and new predation and disturbance pressures (coyote, hogs, armadillo, fire ants).



Public domain image

Long-term conservation of this species depends on protecting large tracts of land needed to support its foraging lifestyle. Currently an indigo reintroduction program is in progress in Conecuh National Forest in Alabama, and a second site will be initiated in the Florida panhandle in 2016. These release specimens are derived from



Photo by Vicky Poole, Fort Worth Zoo

captive-hatched individuals, with Central Florida Zoo's Orianne Center for Indigo Conservation being the only source for captive-bred indigos from known localities. The US captive population is a critical resource for repatriation of indigos throughout its range. Currently eastern indigo snakes are not available from the wild. Captive-hatched animals are available from private breeders, but their pedigree may be in doubt. The AZA captive population is essential for ensuring availability of genetically managed animals to support educational exhibits, outreach, and ongoing repatriation efforts.

Exhibit Qualities:

Indigos are large, active, and beautiful snakes. They are typically alert on exhibit and make engaging subjects for visitors. This species forages actively in the wild and needs large enclosures (24 square feet minimum). Because they are sometimes cannibalistic *Drymarchon* are typically housed individually, except for breeding encounters. Adult eastern diamondback rattlesnakes and gopher tortoises have been successfully maintained with indigos as long as there are visual barriers and topographic complexity in the habitat. Indigos are indiscriminate, generalist predators leaving few other safe options for multi-species exhibits. Successful exhibit themes include

replicated longleaf pine ecosystem with fallen limbs and coastal scrub habitat with sand dunes.

Educational Qualities:

As conservation education animals, indigos are outstanding. Most specimens are calm enough for presenters to handle during programming, and adult snakes are truly impressive subjects. They are alert and physically active, often reaching up from the handler's hold while tongue flicking. The deep blue sheen for which indigos are named is easy to see as the animal shifts positions, changing the angle of reflected light. Some specimens may be appropriate for public touching, offering visitors a memorable wildlife encounter.

Interpretive Messages:

- Life-giving fire (importance of burns in longleaf pine habitat)
- Symbiosis (gopher tortoises, indigos, and eastern diamondback rattlesnakes)
- Long-range hunter (among the largest home range of any North American snake)
- Brute force (subdue prey by pinning to the ground and swallowing alive)
- Immunity (evolved resistance to rattlesnake venom)
- Threatened habitats of the southeast (coastal sand hills, longleaf pine forest, etc)

Care and Facilities:

With few exceptions, indigos are hardy captives. They require spacious enclosures and benefit from some degree of physical complexity (e.g. small logs, branches, rocks). Enclosures should be horizontally oriented for maximum floor space, and surfaces should be smooth to prevent rubbing. Indigos are powerful and exploratory; doors, screen tops, and removable panels should be securely fastened to prevent escape.



Public domain image

Enclosures should be maintained at approximately 80°F or offer a thermal mosaic from approximately 74-82°F during the day. Nighttime temperatures should drop by 5-10°F. Winter temperature drops are utilized for breeding preparation. Indigos are bold predators that eat virtually any small animal, including fish, amphibians, reptiles, birds, and mammals. Captive snakes are typically fed rodents. An ongoing challenge with this species is declining reproductive fitness of females. The cause(s) of egg retention and reduced fertility are not well known, but may be related to lack of exercise or diet in captivity. Overfeeding should be avoided to keep captive snakes lean.



Photo by Fred Antonio, Orianne Center

Program Goals: ([Appendix III](#))

- Increase captive population and founder base.
- Continue indigo reintroduction in Conecuh National Forest in southern Alabama.
- Establish 2nd introduction site at Nature Conservancy's Apalachicola Bluffs and Ravines Preserve in 2016.

Program Contact: ([Appendix II](#))

Michelle Hoffman, SSP Coordinator
Central Florida Zoo & Botanical
Gardens

michelles@centralfloridazoo.org

(407) 323-4450 ext. 143



Photo by Fred Antonio, Orianne Center

References:

- Antonio, F. Eastern Indigo Snake Studbook. Association of Zoos and Aquariums Regional Studbook. 2010.
- The IUCN Red List of Threatened Species. Version 2015.2. <www.iucnredlist.org>
- Snake TAG 2011. Eastern Indigo Snake (*Drymarchon couperi*) Care Manual. Association of Zoos and Aquariums, Silver Spring, MD.



Photo by Fred Antonio, Orianne Center

Armenian Viper

Montivipera raddei



PHOTOARK
JOEL SARTORE

SSP

Armenian Viper

Montivipera raddei



Red SSP

(written by Jeff Ettling, PhD, St. Louis Zoo)

Species Summary:

The Armenian viper is endemic to the Armenian Highlands and has a distribution that includes the countries of Armenia, eastern Turkey, western Azerbaijan, and northwestern Iran. The species inhabits mountain steppe, xeric forests, and sparsely vegetated rocky hillsides at elevations ranging between 1,100 – 2,700 m. Vipers inhabiting forested regions tend to have a dark ground color and contrasting dorsal pattern compared to those from mountain steppe areas that are lighter colored with an indistinct dorsal pattern. The diet is mainly comprised of rodents and lizards, but nestling birds and orthopteran insects are also eaten.

Program Purposes: Assurance Population, Education/Exhibit Needs, and Research

Armenian vipers are listed as Near Threatened by the International Union for the Conservation of Nature (IUCN) and Vulnerable by the Republic of Armenia. Populations have declined by 80% over the past 40 years as a result of habitat alteration, in the form of overgrazing and conversion to cropland, as well as over-collection for the pet trade. Armenian vipers occur in two of Conservation International's biodiversity hotspots and may be used as an ambassador for conservation efforts in those regions. Zoos exhibiting and breeding the species have the opportunity to use it as a fund raising tool for the field program and the conservation breeding center that is being developed in Armenia. Due to the steady decline in Armenian viper populations augmentation using captive-produced



Photo by Mark Wanner, St. Louis Zoo

offspring will be implemented in the near future. While the majority of the breeding (for augmentation releases) will take place in Armenia, it is likely that valuable genetic stock will be held in AZA institutions as assurance populations at some point in the future.



Photo by Jeff Ettling, St. Louis Zoo

Exhibit Qualities:

The Armenian viper is a medium-sized species (31–42” as adults, with males being larger than females) and does not require considerable space to successfully exhibit and breed. It is primarily terrestrial, but will climb if provided with sturdy plantings, such as bushes. Armenian vipers are diurnal and have a beautiful dorsal pattern of orange, yellow, yellowish-orange, or reddish blotches, making them easily visible. In large exhibit enclosures provided with a variety of temperature zones, the snakes will regularly move between the zones throughout the course of the day.

Educational Qualities:

The Armenian viper may be used in educational materials/programming to discuss illegal poaching, habitat alteration (overgrazing and agriculture), biodiversity hotspots, endemism, and climate change.

The mountain viper (*Montivipera*) complex is comprised of nine species inhabiting western Asia, with the majority having isolated and restricted distributions in remote mountain habitats. As such, Armenian vipers provide a perfect opportunity to talk about “Sky Islands” and the impact that climate change may have on their distribution and continued existence.



Interpretive Messages:

- Habitat alteration/degradation
- Over-collection for pet trade
- Biodiversity hotspots
- Sky islands and endemism
- Speciation
- Climate change
- The role of venom in the development of new pharmaceuticals

Care and Facilities:

The Armenian viper has been maintained successfully in typical terrestrial enclosures, but will occasionally climb if provided with rock ledges, branches, or appropriate plantings. An enclosure that measures 34" x 48" x 42" (LxWxH) is adequate for a pair or trio of adult specimens, while larger enclosures (i.e. 120" x 48" x 48") will allow groups to be kept together. Ambient temperature generally ranges from 74-76°F during the day and may be dropped to 68-70°F at night. A hotspot of 95-100°F should be provided for basking purposes. Due to the vipers' occurrence in open, rocky, steppe habitat at high elevations it is advisable to provide access to a UV light source. Photoperiod should vary seasonally with 8-9 hours of light during the winter (no basking lights) with an increase up to 15-16 hours of light during the summer. A three month brumation (December – March) at 39-45°F is important for stimulating breeding activity. Many types of substrates have been used successfully with this species. In off-exhibit enclosures, newspaper, indented craft paper, aspen shavings, and reclaimed cellulose fiber bedding all work well. Natural substrate consisting of coconut fiber, hardwood mulch, sand, gravel, and mixtures thereof may be used in exhibit enclosures. To simulate morning dew, the enclosure should



Photo by Aram Aghasyan

be misted daily. Vipers will often drink water off their own bodies while being misted. A water bowl should be provided at all times. Rock formations should be provided and will be used regularly for basking and retreats. Neonates are typically good feeders on pinkies, but the occasional reluctant feeder is often induced to feed by offering crickets. Neonates and juveniles should be fed an appropriate sized rodent every 7-10 days. Adults should be fed once every 3-4 weeks. Post-parturient females should be fed more frequently until at optimum weight. It is important to prevent obesity and associated problems of articular gout.

Program Goals: (Appendix III)

- Encourage institutions with proper sex ratios to attempt breeding.
- Conduct next SSP breeding and transfer plan in 2016.
- Continue field work in Armenia with potential breeding facility being established in country—part of Saint Louis Zoo's WildCare Institute, Center for Conservation in Western Asia.



Photo by Mark Wanner, St. Louis Zoo

Program Contact: (Appendix II)

Mark Wanner, SSP Coordinator

Saint Louis Zoo

wanner@stlzoo.org

(314) 646-4785



Photo by Mark Wanner, St. Louis Zoo

References:

- Aghasyan, A. and Kalashyan, M. (eds.). (2010), The Red Book of Animals of the Republic of Armenia. Yerevan. Zangak Press. 367 pp.
- Darevsky, I. S. (1966), Ecology of rock-viper (*Vipera xanthina raddei* Boettger) in the natural surroundings of Armenia. *Memorias Instituto Butantan Simposio Internacional* 33, 81–83.
- Ettling, J. A., Aghasyan, L. A., Aghasyan, A. L., and Parker, P. G. (2013), Spatial ecology of Armenian vipers, *Montivipera raddei*, in a human-modified landscape. *Copeia* 2013, 64–71.
- Mallow, D., Ludwig, D., and Nilson, G. (2003), True Vipers: Natural History and Toxinology of Old World Vipers. Krieger Pub. Co., Malabar, FL.
- Nilson, G. and Andrén, C. (1986), The mountain vipers of the Middle East – the *Vipera xanthina* complex (Reptilia: Viperidae). *Bonn. Zool. Monogr.* 20, 1–90.
- Nilson, G., Tuniyev, B. S., Andrén, C., and Orlov, N. (1999), Vipers of the Caucasus: taxonomic considerations. *Kaupia* 8, 103–106.
- Nilson, G., Andrén, C., Avci, A., and Akarsu, F. (2008), *Montivipera raddei*. In IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. www.iucnredlist.org. Downloaded 11 May 2011.
- Rajabizadeh, M., Nilson, G., and Kami, H. G. (2011), A new species of mountain viper (Ophidia: Viperidae) from the Central Zagros Mountains, Iran. *Russian Journal of Herpetology* 18(3), 235–240.
- Sochurek, E. (1984), Die giftschlangen der Türkei – eine Übersicht. *Elaphe, Aquarium-Terrarium Beiträge* 8(1), 1.



Jamaican Boa
Chilabothrus subflavus

SSP

Yellow SSP

Jamaican Boa

Chilabothrus subflavus

(written by Andy Snider, Brookfield Zoo)

Species Summary:

The Jamaican boa is the largest of the seven snake species found on Jamaica, and is its largest terrestrial predator. It is endemic to the island; although it can be found throughout much of the island, it is most prominent in the central Cockpit Country area, in moist limestone forest. As with many snakes, this species is often killed on sight, primarily due to the mistaken belief that it is “poisonous” (venomous). It is often found in coffee and banana farms established within the Cockpit Country—these farms are often surrounded by forest, and rats are attracted to the maturing fruit. Rats, and in some cases bats and parrots, make up a significant portion of the prey base for this species.

Program Purposes: *Assurance Population, Education/Exhibit Needs, and Research*



Photo by T. Vickers

This species is listed in CITES Appendix I, and as “Vulnerable” in the IUCN Red List of Threatened Species. Captive-bred animals are sometimes available from specialist breeders in the US and zoos in Europe, although the CITES I designation makes it very difficult to import specimens from Europe. This is a long-lived species, with relatively large litters of young—a managed program should be able to provide adequate numbers for future zoo needs in the US. This species could easily be piggy-backed with the Jamaican Iguana SSP if needed for fund raising and visibility purposes.

Exhibit Qualities:

The Jamaican boa is a medium-sized species (~ 6-7 feet is typical as adults, with females being larger than males) and, as such, doesn’t require huge amounts of space to successfully exhibit and breed. It is highly arboreal, although it will also spend varying amounts of time on the substrate of the enclosure. Although often beautifully patterned and nocturnal (or crepuscular), the species is still easily visible on public display.

Educational Qualities:

The Jamaican boa easily fits into programs discussing predators, island endemism, deforestation, and habitat loss. Because several of the Caribbean Islands host related species of *Chilabothrus* or *Epicrates*, the concept of island speciation can also be discussed. Some specimens may tolerate limited handling for educational opportunities, while others remain less tolerant of any handling.



Photo by T. Vickers

Interpretive Messages:

- Island Endemism
- Speciation
- Predator/Prey Relationships
- Deforestation/Habitat Loss
- Snake Phobias or Intolerance

Care and Facilities:

Although this species has been maintained successfully in typical terrestrial enclosures, it really needs the ability to climb and properly thermoregulate to thrive long-term. An enclosure that measures 4' x 4' x 6' (LxWxH) is adequate for an adult specimen, while a larger enclosure will allow pairs or even groups to be established successfully. Temperatures generally range from 84-86°F during the day, dropping to the low 70s°F at night. A hotspot of 90-95°F may be provided for basking purposes. A temperature drop during the winter months, combined with a shortened day length (from 14-16 hours in the summer to 8-10 hours in the winter) will often spur breeding behaviors in the late winter to early spring. Many types of substrates have been used successfully, including potting soil, mulch, gravel, or other natural substrates—whichever is used should be capable of holding moisture, since this species prefers relative humidity in the 70% or higher range. Because of this humidity requirement, a cool-mist humidifier or spray-mist system is beneficial. A water bowl should be



Photo by Jim Skene, Toronto Zoo

provided and, if large enough, the animals may soak in it as well – this may be especially beneficial prior to shedding. Climbing branches should be provided and will be used regularly. Feeding is usually every 1-2 weeks, and consists of pre-killed rodents and/or chicks. Particularly stubborn feeders may often be tempted with chicks as a food source. Neonates are often finicky in the beginning and may sometimes be encouraged to eat pre-killed pinkies by rubbing with chick scent or the scent of lizards or frogs.

Other Notes:

Program numbers were boosted several years ago, when a sizeable number of animals was imported from Europe from several different bloodlines. These animals, when old enough and big enough to reproduce, will assist greatly in the breeding potential of the US population.

Program Goals: ([Appendix III](#))

- Acquire additional potential founders
- Re-establish contact with Windsor Research Centre in Jamaica to determine how the SSP can assist with future research efforts
- Next SSP breeding and transfer plan to be published in 2016



Photo by Dino Ferri

Program Contact: ([Appendix II](#))

Andy Snider, SSP Coordinator
Chicago Zoological Society/
Brookfield Zoo

Andy.snider@czs.org

(708) 688-8458

References:

- www.cockpitcountry.com/yellowboa.php
- www.iucnredlist.org/details/7826/0

Mexican Lance-headed Rattlesnake

Crotalus polystictus

SSP



Yellow SSP

Mexican Lance-headed Rattlesnake

*Crotalus polystictus**(written by Penny Felski, Buffalo Zoo)*

Species Summary:

This spectacular spotted rattlesnake is a perfect pick for your South of the Border species exhibit! Their beautiful brown spots outlined in black pop out against their golden brown background color. Their unique spotted patterns make these snakes easily individually identifiable. The head is somewhat elongated and less triangular than many rattlesnake species each with unique brown blotches on top. This is a medium sized rattlesnake, with adults averaging 70-80 cm, some specimens may approach 100 cm. This snake is found in montane habitat in the center of Mexico, and therefore has adapted to colder temperatures. Distributed along the southern portion of the Mexican Plateau, this snake competes for space with the largest city in the world, Mexico City.

Program Purposes:

*Assurance Population,
Education/Exhibit Needs,
and Research*

The status of this species in the wild is currently listed as Least Concern (IUCN Red List of Threatened Species) with the population trend listed as decreasing. Future availability of this snake from the wild is in doubt and the captive population is managed to ensure exhibit animals long-term. Continued captive management and improved husbandry are necessary to ensure this population's sustainability. Understanding specific nuances needed to cycle and breed this species take some effort. Institutions that agree to hold breeders must consider the environmental controls required, such as brumation. A successful captive breeding program will help alleviate pressures of habitat change from human encroachment and persecution. Currently no conservation programs are planned for this species and re-introduction is unlikely for the foreseeable future.



Photo by Ian Recchio, Los Angeles Zoo

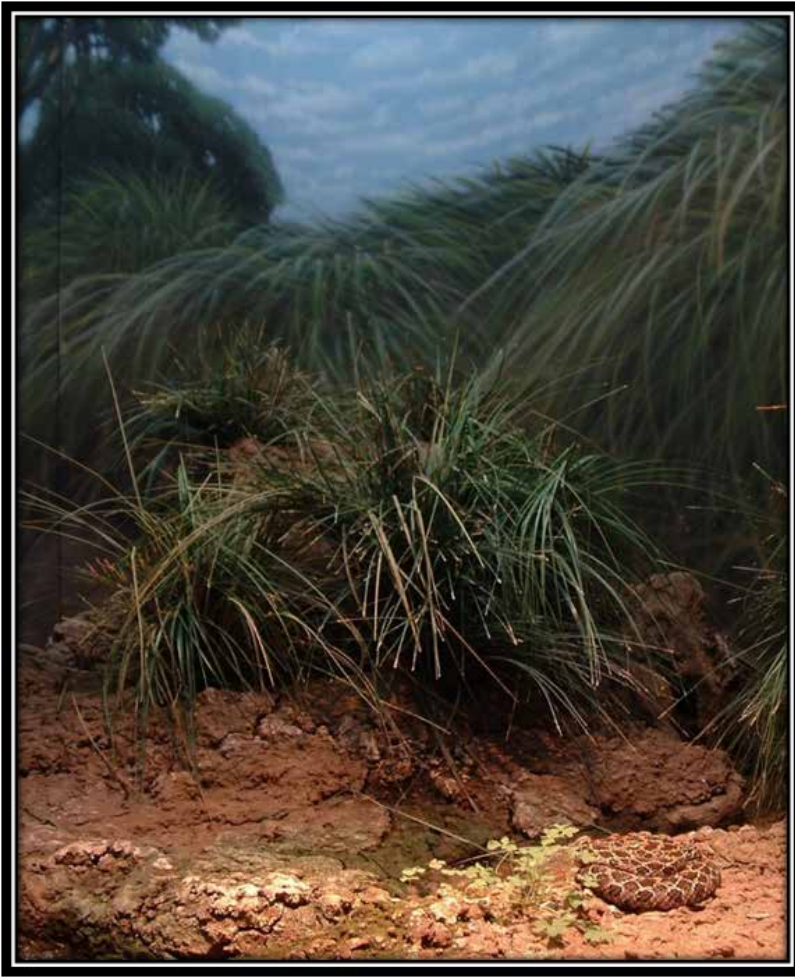


Photo by Penny Felski, Buffalo Zoo

Exhibit Qualities:

Mexican lance-headed rattlesnakes make attractive and active exhibit snakes. They often cruise around tongue-flicking and exploring their habitat. To increase exhibit densities, males may be displayed together. They often will use the same hide at the same time. They also will exhibit male to male combat during breeding season, which is a fascinating behavior rarely witnessed.

Educational Qualities:

Rattlesnakes are endemic to the Americas, belonging to a unique clade of snakes (crotalids). Audiences are intrigued by up-close viewing (through the glass) of crotalids features, including the rattle at the end of the tail and the heat sensing pits on the face. The complexity of venom and its uses is also a fascinating subject. Because they are small and beautifully patterned, lance-headed rattlesnakes are an ideal species for teaching people about respect for wildlife and its role in the natural world.

Interpretive Messages:

- Camouflage
- Persecution of venomous snakes
- Snake venom as a subject of medical research and drug development
- Human expansion and habitat alteration
- Ambush predator
- Convergent Evolution (Russell's Viper)

Care and Facilities:

Lance-headed rattlesnakes exhibit well in a standard terrestrial desert or grassland habitat. Grasses can act as nice natural looking hiding spots. The species is not known for climbing,



Photo by Penny Felski, Buffalo Zoo

but providing topography gives snakes opportunity for exercise. Humidity is important to these snakes and they should be misted in the morning as needed. Substrate should remain humid until the next day, but not wet on the surface. They will readily accept adult mice or rat pups. Feed gravid females weekly and non-breeding adults less often. Temperatures may vary seasonally from daytime ambients of 68-74°F and a basking site surface temperature of 95-110°F. Feed schedules, photo period, ambient temperatures, and basking temperatures must be adjusted for breeding purposes. Brumation is necessary for reproduction of this species and typically involves a cool period of at least three months beginning in November. Breeding takes place primarily in the fall, but may also occur in spring. Juveniles may be housed together and separated during feeding.

Program Goals: ([Appendix III](#))

- Acquire more founders
- Breed potential founders in current population
- Improve ability to reproduce this species
- Enhance sustainability of captive population

Program Contact: ([Appendix II](#))

Penny Felski, SSP Coordinator

Buffalo Zoo

pfelski@buffalozoo.org

(716) 995-6155

References:

- Armstrong, B.L. & Murphy, J.B. (1979). The natural history of Mexican rattlesnakes. Lawrence: University of Kansas Museum of Natural History.
- Bryson, R.W., de la Rosa-Lozano, G.U. & Lazcano, D. (2003). Observations on a population of Mexican lanceheaded rattlesnakes (*Crotalus polystictus*) from an agricultural area in the Mexican state of Me´xico. *Herpetol. Rev.*34, 313–314.
- Klauber, L.M. (1972). Rattlesnakes: their habits, life histories, and influence on mankind, two volumes, 2nd edn. Berkeley:University of California Press.
- Mocinˆ o-Deloya, E., Setser, K., Pleguezuelos, J.M., Kardon, A. & Lazcano, D. (2009). Cannibalism of nonviable offspring by postparturient Mexican lance-headed rattlesnakes, *Crotalus polystictus*. *Anim. Behav.* 77, 145–150.
- K. Setser, E. Mocinˆ o-Deloya, J. M. Pleguezuelos, D. Lazcano2 & A. Kardon. (2010). Reproductive ecology of female Mexican lance-headed rattlesnakes. *Journal of Zoology*. 1-8.



Photo by Ian Recchio, Los Angeles Zoo

South American Bushmaster

Lachesis muta

SSP



Yellow SSP

South American Bushmaster

Lachesis muta

(written by Brett Baldwin, San Diego Zoo)

Species Summary:

The South American bushmaster is the largest pit viper in the world and the longest venomous snake in the Americas, reaching 8' in length. The bushmaster also has long fangs, rivaling those of the gaboon viper. It is an apex predator and iconic symbol of the rainforest along with the jaguar and harpy eagle. There are 5 species of bushmaster (*L. muta*, *L. steonphrys*, *L. melanocephala*, *L. rhombeata*, and *L. achrochorda*) and these are the only viperid snakes in the New World that lay eggs. The South American bushmaster is found in Colombia,

Venezuela, Trinidad, Guyana, Suriname, French Guiana, Ecuador, Peru, Brazil, and Bolivia. Despite its broad range, it is not common. It is predominantly nocturnal and very secretive. Bushmasters are occasionally encountered during the day, particularly during breeding season. Very little is known about their behavior in the wild.



Photo by Ian Recchio, Los Angeles Zoo

Program Purposes: Education/Exhibit Needs and Research

The South American bushmaster, *Lachesis muta*, is not listed by CITES but *L. rhombeata* is CITES II, vulnerable. Although the South American bushmaster has the largest range and a stable captive population in North America, it is under the same pressures as other species—deforestation, agricultural conversion of land, and wanton killing. *Lachesis* have proven delicate to keep and reproduce in captivity. They are rarely imported and few founders exist in the captive population. This population needs to be managed to ensure future availability for education and exhibits.

An ongoing field project, spearheaded by The Orianne Society and supported by several AZA institutions, is working in Panama and Costa Rica to better understand the natural history of *Lachesis* in the wild.

Exhibit Qualities:

Bushmasters are undeniably impressive exhibit animals. They require large enclosures and prefer some cover. The snakes often frequent the buttresses of large trees that can be fabricated into beautiful rainforest exhibits with live plants, leaf litter and sphagnum moss. San Diego Zoo has housed plumed basilisks with them. Audubon Zoo has successfully exhibited bushmasters with *Phyllomedusa bicolor*, *Anolis roquet*, and *Plica plica*. A well-designed exhibit with plants, logs, vines, branching and artificial tree buttresses makes a spectacular showcase.

Interpretive Messages:

- Largest pit viper in the Americas
- Lays eggs with average clutch size of 10
- Among the longest fangs of any snake
- They are not strike-and-release vipers, they strike, bite down and hold on to their prey
- Highly elusive predator with very little known about its natural history

Care and Facilities:

Groups of three animals may be housed together (larger numbers could present safety issues for keepers) and housing males together may stimulate courtship. Terrestrial space is very important for this species and exhibits should be 5-10' long by 3-5' tall by 3-5' deep. Daytime basking sites should be 90-95°F with relatively uniform ambient temperatures in the rest of the habitat to mimic tropical rainforest (surface temperatures 75-80°F). Daytime temperatures for animals at San Diego Zoo during the spring and summer average 79-83°F with overnight temperatures of 77-80°F. Fall and winter temperatures range from 77-80°F by day and 74-77°F at night. There are two skylights 33" x 33" placed 60" from the top of the habitat screen.

Exhibit floors should be plumbed for drainage, and many institutions install raised grates covered in mesh. Bedding is typically river rock (or other fast-draining base), sphagnum moss, and leaf litter. It is critical to have excellent drainage as this species is a terrestrial ambush predator and may sit in one spot for extended periods of time. This habit coupled with a humid environment can cause small ventral lesions that easily go unnoticed and develop into larger ones, eventually causing septicemia. They are known to develop skin issues and shedding problems if proper heat and humidity are not accommodated. Ideal humidity is 70-80% and they



Photo by Vicky Poole, Fort Worth Zoo



Photo by David Tetzlaff, Central Florida Zoo

should be misted or rained on 1-2 times per week. Ventilation is important to prevent mold growth and small fans circulating air above exhibit are advised. In the wild, bushmasters spend most of the day hidden in mammal burrows, logs, or at the bases of large tree buttress, so it is important to keep enclosures humid while maintaining dry bellies specifically where they hide.

Off-exhibit animals may be housed in cages, 4' x 2' x 16" (LxWxH) with a hide box, 12" water bowl, and aspen bedding (ASPEN

BEDDING, Harlan/TEKLAB, Madison, WI) or bark mulch. The bedding should not be moist as it will mold quickly. These animals are typically soaked in plastic shift containers about once a week for 2-3 hours, and they may need to be soaked for 24 hours prior to ecdysis. Adult bushmasters are capable of consuming large mammalian prey items, but in captivity tend to prefer small rats.

Program Goals: ([Appendix III](#))

- Acquire additional founders
- Add holding and rearing space
- Place offspring with institutions that need only exhibit animals

Program Contact: ([Appendix II](#))

Brett Baldwin, SSP Coordinator
San Diego Zoo
bbaldwin@sandiegozoo.org
(619) 685-3282



Photo by Don Boyer, courtesy Dallas Zoo

References:

- Campbell, J.A. & Lamar, W.W. The Venomous Reptiles Of The Western Hemisphere, Vol I & II. Cornell University Press, 2004

Catalina Island Rattlesnake

Crotalus catalinensis

SSP



Santa Catalina Rattlesnake

Crotalus catalinensis



Candidate

(written by Chris Rodriguez,
Los Angeles Zoo)



Photo by Chris Rodriguez, Los Angeles Zoo

Species Summary:

The Santa Catalina Island rattlesnake is a pit viper endemic to the small Island of Santa Catalina in the Sea of Cortez, Mexico. This rattlesnake is unique in that it has evolved the loss of its rattle, presumably due to hindrance in capturing arboreal prey. Two distinct color phases of this rattlesnake occur naturally. The dominant phase is an overall brownish-red color and a smaller portion of the population is a silvery ash color that lacks brown pigment. On the island, this rare viper is concentrated in wash areas among dense shrubs and sparse,

low-lying trees; they are crepuscular to nocturnal in this hot, arid environment. Local human populations avoid the island largely due to the rattlesnake's unwarranted bad reputation.

Program Purposes: Assurance Population and Education/Exhibit Needs

This species is listed as Critically Endangered on the IUCN Red List and is at high risk of extinction due to the small size of the island, a continued decline in the number of mature specimens, and pressure from exotic species such as feral cats. Rising sea levels resulting from global climate change is another possible threat due to the island's low topographical relief. Along with other natural disasters, periodic years of drought threaten the prey base, which consists of native mice and lizards. Illegal collecting pressures have been a threat for many decades. The captive population should be managed as a resource for field conservation.



Photo by Ian Recchio, Los Angeles Zoo

Exhibit Qualities:

Santa Catalina Island rattlesnakes have been successfully housed in multiple types of exhibits. This species requires xeric conditions and exhibit substrate that consists of a mixture of sand, gravel, and rock. It is necessary to provide one or more pieces of driftwood or hide boxes, which are utilized heavily by these rattlesnakes. Keep in mind when setting up any perching in the exhibit that these snakes have arboreal tendencies, especially while foraging.

Interpretive Messages:

- Island endemism and adaptations
- Evolutionary reversals (rattle loss)
- Camouflage and natural variations (two distinct color morphs)
- Global climate change and possible threats to island endemics

Care and Facilities:

This species requires ambient daytime temperatures of 80–90°F and a mid day basking site reaching 100–110°F. Off-display substrates include finely ground pine chips or shredded pine. Holding enclosures range in size from 5-gallon terrariums for neonates to 40-gallon tanks for adults. Adult pairs may be housed together, however, care must be taken around feeding time, as these snakes are very jumpy and prone to biting one another. Santa Catalina Island rattlesnakes can be housed in group settings, permitting that only a single male is matched with multiple females. Male rattlesnakes are quick to bite other males when housed together. It is essential to separate paired snakes when feeding. These rattlesnakes feed aggressively on rodents from the time they are neonates and become frenzied when food is present. Due to their voracious nature it is easy to overfeed them. The female's food intake is limited only during the non-breeding months while the males are kept on the lean side throughout the year. Increased breeding behavior and higher birth rates have been observed from leaner males as opposed to obese males.



Photo by Ian Recchio, Los Angeles Zoo

Santa Catalina Island rattlesnakes are active year round in the wild and in captivity; however a 10–15°F decrease in temperature during the winter months is required to stimulate breeding in the spring. These snakes reach maturity at a minimum of three years of age both in captive and wild populations. Parturition occurs during the rainy season from July through August and litter size ranges from one to six offspring. Females are able to produce healthy litters for consecutive years given optimal conditions. Unlike most rattlesnake species, Santa Catalina Island rattlesnakes do not display any sexual dimorphism. Sexing is carried out via probe or by counting subcaudal scales. The subcaudal database contains 50+ specimens and their corresponding genders, establishing baseline counts for this species.



Photo by Ian Recchio, Los Angeles Zoo

Other Notes:

Collection trips in 2009 and 2011 secured 12 wild-caught individuals as the foundation of all the breeding stock in North American zoos as well as the studbook. As of 2015 more than 50 living specimens represented in the studbook are now part of a Yellow SSP Program. The permitting and collection of this species was part of a collaborative study between the Los Angeles Zoo and Botanical Gardens, the San Diego Zoo, and the Universidad Autónoma de Nuevo León, Mexico.

Program Goals: ([Appendix III](#))

- Name program leader
- Publish formal studbook
- Program leader attend Population Management I course

Contact: ([Appendix II](#))

Vacant

References:

- The IUCN Red List of Threatened Species. Version 2015.2. <www.iucnredlist.org>
- Martins_etal_2012. Juvenile Recruitment, Early Growth, and Morphological Variation in the Endangered Santa Catalina Island Rattlesnake, *Crotalus Catalinensis*. *Herpetological Conservation and Biology* 7(3):376–382
- Recchio, I.M., and D. Lazcano. 2010. *Crotalus catalinensis* (Santa Catalina Island Rattlesnake).
- Reproduction. *Herpetological Review* 41:500–501.
- Grismer, L. Lee. 2002. *Amphibians and Reptiles of Baja California Including Its Pacific Islands and the Islands in the Sea of Cortes*. University of California Press 1-398.



PHOTO^{ARK}
JOEL SARTORE

Green Anaconda

Eunectes murinus

Candidate Program

Candidate

Green Anaconda

Eunectes murinus

(written by Craig Pelke, San Antonio Zoo)

Species Summary:

This large constrictor is considered the largest (but not longest) species of snake on record due to its vast potential girth and weight. One of the largest green anacondas ever measured was almost 28' (8.53 m) with a girth of 44" (1.12 m). This individual was not weighed, but based on measured dimensions she was estimated to weigh over 500 lbs (226.80 kg). Females achieve much larger sizes than males, which rarely exceed 12' (3.66 m). Green anacondas are iconic species of Amazonian South America, although their wild range is not limited to the rainforests. Few animals have the name recognition and universal public appeal of this keystone exhibit species.



Photo by Chad Peeling, Reptiland

Program Purposes: Education/Exhibit Needs

Green anacondas are listed on Appendix II of CITES, limiting commercial trade from South America. The skin trade and habitat degradation are believed to have resulted in sharp declines in anaconda populations where the species is not protected. However, wild populations have not been well studied with the exception of the Venezuelan llanos. Like many species of snake, the green anaconda falls victim to human prejudice and ignorance resulting in unnecessary killing.

Once easily available through collection and importations, or from captive born animals in the private sector, exhibit-sized (large) adults are now increasingly scarce. This is due largely to new regulations limiting the transport of green anacondas across state lines without a federal permit. These regulations have effectively ended private sector breeding of the species and made importation by zoological institutions very difficult. A captive population must be managed to ensure future availability of exhibit animals. This will require institutions to work together to not only create exhibits that can hold large specimens, but also incorporate groups for breeding as well as holding space for juveniles to meet future needs.

Exhibit Qualities:

The green anaconda is always a popular exhibit animal that all zoo and aquarium visitors can easily identify and enjoy due to its famous history—both real and fictitious. These giant snakes are highly aquatic, becoming increasingly so as they mature in size. Despite their highly aquatic lifestyle as mature adults, they still require adequate land space for hauling out. While a large exhibit is required to meet their amphibious requirements, this space can be used efficiently by creating mixed-species exhibits with compatible terrestrial and aquatic wildlife. Terrestrial amphibians (anurans), lizards, and other snakes may be exhibited with anacondas and, in an appropriate water volume, an incredible variety of fish species mix beautifully with green anacondas. Species that have been associated with green anaconda exhibits include (but are not limited to) dart frogs (*Dendrobates* sp., *Phylllobates*, sp.), common iguanas (*Iguana iguana*), basilisks (*Basiliscus* sp.), common boa (*Boa constrictor*), Brazilian rainbow boa (*Epicrates c. cenchria*), false water cobra (*Hydrodynastes gigas*), miscellaneous freshwater rays (*Potamotrygon* sp.), long-whiskered catfish (*pimelodid* sp.), and various South American cichlids (oscar, chocolate, convicts, acara, etc.) and tetras. Turtle species should be avoided due to health issues (protozoan and bacterial) along with predation issues. While these mixes are beautiful, it is important to maintain a green anaconda on an adequate diet to avoid the snake from preying on the exhibit animals.

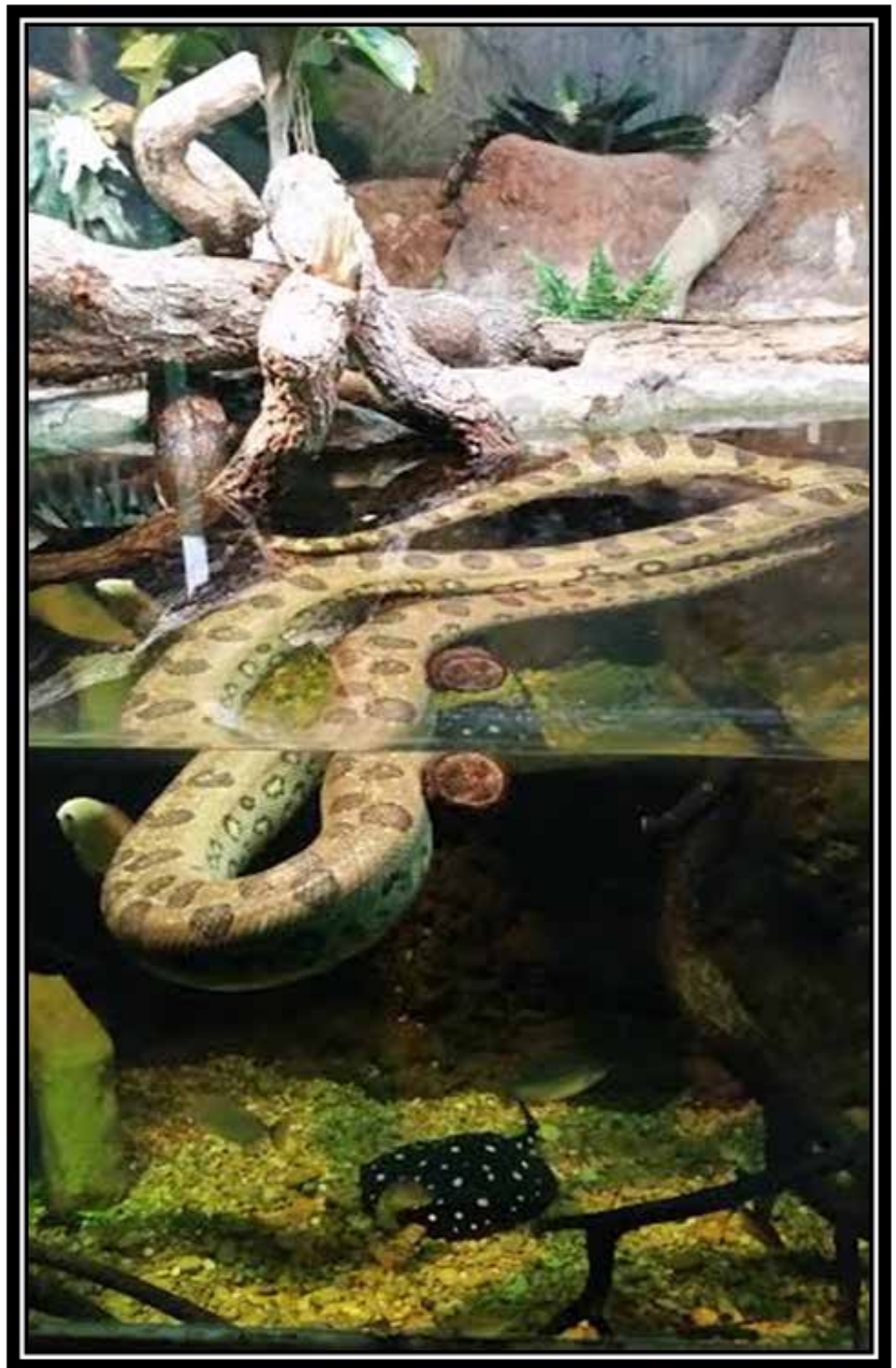


Photo by Craig Pelke, San Antonio Zoo

Educational Qualities:

Neonate/juvenile green anacondas that may not satisfy exhibit needs due to their immature size can play a role in outreach programs. Adult males can be long-term program animals pending their individual demeanors as well as the physical abilities of program staff. Individuals that are tolerant of handling will have a great impact due to their iconic status and offer a platform to discuss rainforest conservation, dispel myths about snakes in general, as well as promote species-level education on true size of neonates and juveniles.

Interpretive Messages:

- Rainforest Conservation
- True nature of large constricting snakes
- Viviporous snakes (live birth)
- South American ecosystems
- General snake conservation

Care and Facilities:

Unlike other large constrictors that require a minimalistic terrestrial enclosure with a water body/pool large enough for them to soak in, green anacondas thrive in semi aquatic exhibits with large pools and land haulouts.

Ideally, an enclosure of proper size would display a mature, full-sized adult

with a land-to-water surface ratio of roughly 1:2. Total enclosure space should not only consider the green anaconda's needs, but space for the staff to work with or around the snake safely. Ambient air temperatures should range from 78-86°F during the day with a nighttime drop no lower than 70°F. Basking spots should range from 88-95°F, and ideally are placed near the water's edge or over low branches at water's edge, allowing the snakes to thermoregulate naturally. Water temperatures should be similar to those required for Amazonian fish, with a range of 78-84°F; stable water temperatures are helpful in maintaining ambient temperatures as well as humidity. Green anacondas are sensitive to cooler temperatures, which may result in health issues such as enteritis or respiratory disease.

The pool should slope gently from the water's edge to the deepest section, with an ideal depth of 3-4'. If the pool has a steep drop off, provide stout perching branches into the water at the pool's edge to provide areas for the snake to hold on and support itself. Without these submerged "perches," anacondas are often uncomfortable as they reside in the water. Life support equipment is important for maintaining the health of this highly aquatic species, along with proper water quality. Adequate filtration is necessary due to the production of copious amounts of feces and urates. Proper filtration through sand filters and pumps is best assessed and installed after the volume of water is known, and should be accompanied with an appropriately sized UV sterilization unit to limit the build up of suspended microbes. A water heater designed for aquatic animal life support should be installed to maintain stable water temperatures. These aquatic life support components also lend themselves to



Photo by Clyde Peeling, Reptiland



appropriate fish care for mixed species exhibits.

In the wild, green anacondas are incredibly opportunistic predators, feeding on fish, amphibians, reptiles (including chelonians and crocodilians), birds, and mammals. Captive diets generally consist of appropriately sized birds or mammals, and may include chicken, quail, mice, rats, guinea pigs, and rabbits. Truly large individuals could eat even larger food items such as small pigs. Food animals should be appropriately sized for the snake and, unless a finicky eater requires live food, prey animals

should be pre-killed (frozen/thawed, fresh/humanely dispatched). While struggling with live prey is normal in the wild, food animals can inflict serious injury, often requiring veterinary care in captivity. A balance is required to satiate the appetite of a green anaconda without overfeeding. Underfeeding in a mixed species exhibit may lead to predation on other species being displayed. Overfeeding leads to obesity and causes a myriad of health problems including poor reproduction and early death.

Other Notes:

Acquisition of green anacondas (and other regulated constrictors) requires adequate planning and time to acquire Injurious Wildlife permits from the US Fish & Wildlife Service. These permits often take several months or more to process and require information about housing and transport. Contact SAG steering committee members for examples of successful applications previously submitted.

Program Goals: ([Appendix III](#))

- Name program leader
- Publish formal studbook

Program Contact: ([Appendix II](#))

Vacant

References:

- "Biggest Snake: Giant Anaconda." Biggest Snake. Extreme Science, n.d. Web. 22 June 2015.
- Gray, Irina. "Green Anaconda The Largest Snake In The World." Green Anaconda, The Largest Snake In The World
- Rainforest Animals. Tropical-Rainforest-Animals.com, Nov. 2007. Web. 08 June 2015.
- O'Shea, Mark. "Anacondas/Green Anacondas." Boas and Pythons of the World. Princeton, NJ: Princeton UP, 2007. 53-55.
- Parramore, Laury. "Service Lists Four Nonnative, Large Constrictor Snakes as Injurious Wildlife." Fish and Wildlife Service News Release System. N.p., Mar. 2015. Web. 22 June 2015.
- USA. US Fish & Wildlife Service. Ecological Services | Southeast Region. N.p., 6 Mar. 2015. Web. 22 June 2015



PHOTOARK
JOEL SARTORE

Reticulated Python

Malayopython reticulatus

Candidate Species

Candidate

Reticulated Python

Malayopython reticulatus

(written by Craig Pelke, San Antonio Zoo)

Species Summary:

This large and exceptionally beautiful constrictor is considered the longest (but not the largest) species of snake on record. Captive specimens have occasionally been measured at more than 20' in length, but 16-18' is typical. Females achieve much larger sizes than males. Reticulated pythons are oviparous, laying 25-100 eggs with an incubation of roughly 84 days. The species ranges across much of Southeast Asia, eastward to the Philippines and southward just west of New Guinea. They are heavily exploited for the commercial skin trade.

Program Purposes: *Education/Exhibit Needs*

Reticulated pythons are listed on Appendix II of CITES, limiting commercial trade from range countries in Southeast Asia. However, the commercial skin trade and habitat exploitation are believed to adversely affect the wild populations resulting in sharp declines. Wild populations have not been well studied due to the vast range of the species. Like many snake species, the reticulated python falls victim to human prejudice and ignorance resulting in unnecessary killing.

Once readily available through importation of wild reticulated pythons or from captive-produced animals, availability of exhibit-sized (large) adults that are normal/wild phase (in coloration and/or pattern) are increasingly scarce. Large snakes available from the private sector are mostly “designer” (non-normal/wild) color morphs. New regulations limiting the transport of reticulated pythons across state lines without a federal permit have exacerbated acquisition problems. These regulations have drastically decreased private sector breeding of the species and made importation by zoological institutions difficult. A captive population must be managed to ensure future availability of exhibit animals. This will require institutions to create exhibits that can hold large specimens and incorporate groups for breeding, and dedicate holding/rearing space for juveniles.



Photo by Ian Recchio, Los Angeles Zoo

Exhibit Qualities:

Reticulated pythons are always a popular exhibit animal at zoos and aquariums due to their size and beautifully patterned/iridescent skin. Despite their large size, they are often physically active and alert on exhibit, compared with other large boid species. Large exhibits are necessary to accommodate the needs of the species and to permit staff to safely move around the snake(s) while maintaining the exhibit. Reticulated pythons also display arboreal habits. Enclosure furnishings that allow for climbing and perching add to the quality and excitement of an exhibit and help maintain a healthy, fit animal. Mixed species exhibits are possible, primarily with other species of snakes such as blood pythons (*Python curtus* or *P. brongersmai*), amethystine pythons (*Morelia amethystina*), and Burmese pythons (*Python m. bivittatus*). Arboreal lizards, like tokay geckos (*Gecko gecko*) have also been used successfully. Other species combinations may be possible, but consideration should be made for safely and appropriately feeding all specimens on exhibit. Turtle species should be avoided due to health issues (protozoan and bacterial).

Educational Qualities:

Neonate/juvenile reticulated pythons that may not satisfy exhibit needs due to their immature size may be used in outreach programs. Adult males, which are drastically smaller than females, may be long-term program animals, pending the snake's individual demeanor and the physical abilities of program staff. Individual pythons that are tolerant of handling will have a great impact due to their iconic status and incredible beauty, and offer



Photo by Chad Peeling, Reptiland

a platform to discuss rainforest conservation, effects of commercial skin trade, opportunities to dispel myths about snakes in general, and species-level education about true size of neonates and juveniles.

Interpretive Messages:

- Rainforest conservation in Asia
- True nature of large constricting snakes
- Thermal incubation by female pythons (shivering to produce heat)
- Iridescent skin
- Asian ecosystems
- Snake conservation & effects of the commercial skin trade

Care and Facilities:

Reticulated python enclosures should be a terrestrial/arboreal mix with enough aquatic volume to allow the snake(s) to completely soak themselves. Pools should be designed to accommodate the elevated water level caused by displacement when an adult snake is submerged. Arboreal furnishings need to be sturdy enough to withstand the weight and strength of an adult python, and elevated perches should be nearly horizontal if possible. If plants (live or artificial) are desired, they should be placed out of the snake's reach or sturdy enough to stand up to physical abuse.

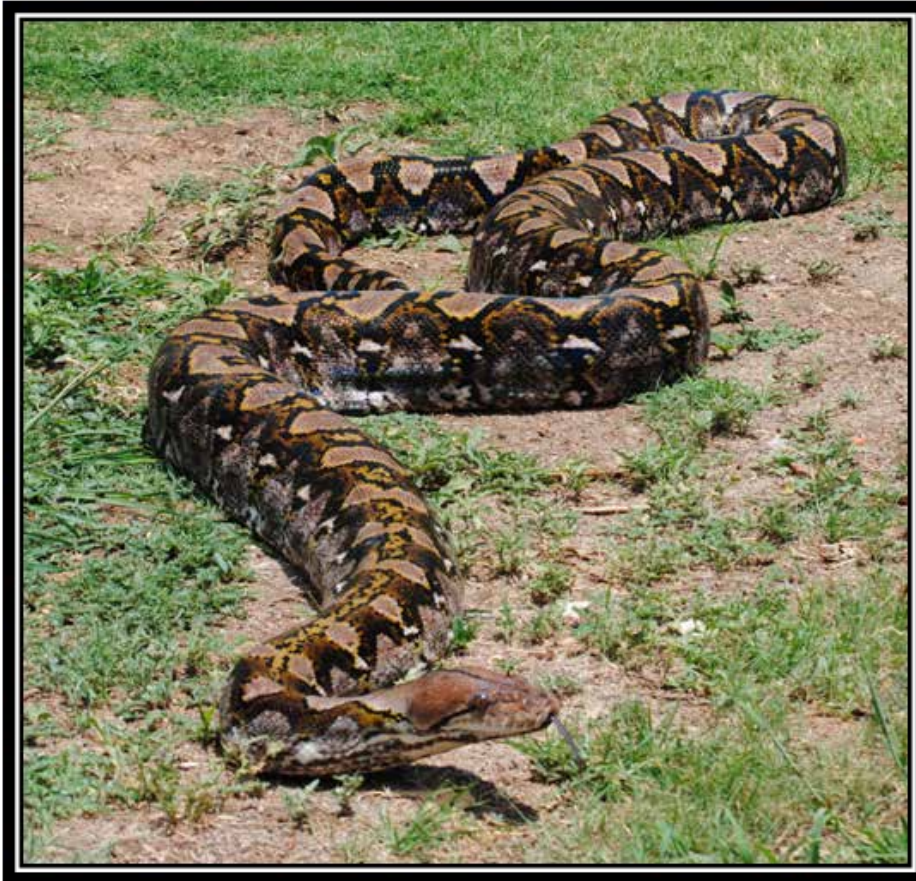


Photo by David Brothers, Zoo Atlanta

Enclosure sizes should take into consideration the activity level of the species (relative to other large boids) and provide adequate room for staff to safely care for the snake and maintain the enclosure. Ambient air temperatures may range from 78-90°F with a nighttime drop not lower than the low 60's°F. Basking areas may be set up to 95°F, and the overall temperature gradient should allow for the python to thermoregulate and choose its preferred temperature. Relative humidity should be 70% or higher to ensure proper shedding.

In the wild, reticulated pythons are opportunistic predators, feeding on mammals, birds, and other reptiles. Barone (2006) noted reticulated pythons preying upon tigers, panthers (leopards), and crocodiles in the wild. In captivity, diets are typically limited to mammals and birds that are readily available, ranging from medium-sized mice for neonates to appropriately sized pigs or goats for large adults. Unless the python is a finicky eater that requires live food, all prey items should be pre-killed (frozen/thawed, fresh/humanely dispatched). While struggling with live prey is normal in the wild, food animals can inflict serious injury, often requiring veterinary

care in captivity and unwanted handling by keeper staff. A balance is required to satiate the appetite of a reticulated python without overfeeding. Underfeeding may result in a very excitable food response from a large and, deceptively quick, snake when food is offered. Overfeeding leads to obesity and causes a myriad of health problems including poor reproduction and early death.



Courtesy Abilene Zoo

Other Notes:

Acquisition of reticulated pythons (and other regulated constrictors) requires adequate planning and time to acquire Injurious Wildlife permits from the US Fish & Wildlife Service. These permits often take several months or more to process and require information about housing and transport. Contact SAG steering committee members for copies of successful applications previously submitted.

Program Goals: ([Appendix III](#))

- Name program manager
- Publish formal studbook

Contact:

([Appendix II](#))

Vacant

References:

- Barone, S. "Python vs. Tiger! Incredible but True Attacks by Giant Snakes." *Reptilia* 46 (2006): 71-76. The Reptile Database. Web. 3 Nov. 2015.
- Clark, Bob. "Reticulated Python Care Tips." *Reticulated Python Care Tips*. *Reptiles Magazine*, n.d. Web. 22 June 2015.
- O'Shea, Mark. "Asian Pythons." *Boas and Pythons of the World*. Princeton, NJ: Princeton UP, 2007. 88-91. Print.
- Parramore, Laury. "Ecological Services | Southeast Region." *Ecological Services | Southeast Region*. N.p., 6 Mar. 2015. Web. 22 June 2015.
- "Service Lists Four Nonnative, Large Constrictor Snakes as Injurious Wildlife." *Fish and Wildlife Service News Release System*. N.p., 6 Mar. 2015. Web. 22 June 2015.
- Uetz, Peter, and Jakob Hallermann. "Malayopython Reticulatus." *The Reptile Database*. N.p., n.d. Web. 22 June 2015.

Mangshan Pit Viper

Protobothrops mangshanensis

Candidate Program



Candidate

Mangshan Pit Viper

Protobothrops mangshanensis

(written by Tommy Owens, San Diego Zoo)

Species Summary:

A beautifully colored and patterned snake, the Mangshan pit viper or Mang Mountain viper is a large and heavy bodied snake endemic to high elevation forest (700-1300 m) in southeast China. Sometimes referred to as the “ironhead” pitviper, this species has a colossal head with substantially long fangs. Reaching lengths of over 7 feet, adults of this species are capable of producing copious amounts of venom. Young Mangshan pit vipers have a light blue to whitish colored tail tip used to lure prey. This distinctly colored tail tip is retained through adulthood, though it darkens slightly in color.

Program Purposes: Assurance Population and Education/Exhibit Needs

The IUCN lists the Mangshan pit viper as Endangered and it is listed on CITES Appendix II. Decades of legal and illegal logging have restricted this species to its current small range (~100 km²) and small population size (~300-500 individuals based on survey work in 2000). Given its precarious status, over-harvesting is now the biggest threat. Habitat loss and modification outside of the 100 km² protected reserve habitat, extreme climate conditions, prolonged cold spells, and extreme snow events could influence the survival of this species due to loss of suitable refugia. Survey work also shows extremely low densities within protected areas, estimated at

3-5 individuals per km². But this work was published before this species started entering the U.S. and European markets for private collections and zoos—the overall population and density are expected to be even lower now.

The species now appears to exist primarily in two national parks, and the possibility of obtaining additional potential founders may be limited. The AZA captive population must be managed to ensure future availability for exhibits. It is also likely that captive animals could be used to support wild populations in China in the foreseeable future.



Photo by Ian Recchio, Los Angeles Zoo

Exhibit Qualities:

This is a striking species that attains a large adult size. Mangshan pit vipers often sit out in the open for most of the day in clear sight when on exhibit. Even though their coloration is incredibly cryptic, the immense size of the adults allows them to remain visible in most exhibit enclosures. Heavy misting will increase activity and natural behaviors. This species does well housed in pairs or groups. During the spring and early summer, it is common for visitors to observe courtship and even breeding behaviors in the evening hours.



Photo by Craig Pelke, San Antonio Zoo

Interpretive Messages:

- Habitat Loss
- Over-collection
- Legal and illegal logging
- Food and medicinal use by indigenous people
- Endemic to a very small, high elevation, range of mountains (only ~100 km²)
- A large, attractive, and impressive species that was not formally described until 1990

Care and Facilities:

Although a large, heavy bodied snake, *P. mangshanensis* is very agile and often climbs. This species does well in large enclosures, utilizing both floor space and height. Enclosures should have large perching and/or rock ledges for adults and subadults. A variety of plants may be added to the enclosure, including live or cut bamboo, ferns, and mosses. Because adult Mangshan pit vipers should be cooled for breeding, choosing plant species that are cold tolerant is prudent. This species requires high humidity and often has shedding problems when



Photo by Robert W. G. Jenkins

ambient humidity is not adequate. When possible, misters, foggers, and humidifiers should be used to raise the humidity. This can also be useful to stimulate breeding seasonally. Mangshan pit vipers may be housed individually, in pairs, or small groups. There have been no issues noted by housing multiple males.

Feeding captive-hatched animals is not usually a problem, and hatchlings typically start eating newborn mice after their first shed or within a couple months with minimal manipulation. Wild-caught individuals usually do not eat on their own immediately, but with a few months of assist feeding they generally start eating rodents on their own. Birds may be offered as prey items as well.

Adults of this species should be cooled for about 3 months to stimulate reproduction. A temperature regimen of 55°F daytime and night time lows of 45°F to 50°F appears to be cool enough to prepare the snakes for successful reproduction. Some fluctuation in winter temperatures, with warmer days during the cool period, does not appear to have a negative impact, and may be beneficial. Spring and fall temperatures

should range from 74°F during the day to the upper 60s°F at night. Summer (late June, July, and early August) temperatures may reach the mid to upper 80s°F with nighttime lows around 75°F.

Other Notes:

Although our ability to maintain and, more recently, reproduce *P. mangshanensis* successfully in captivity has improved over recent years, husbandry parameters are still being adjusted as our experience with this species increases.

Program Goals: ([Appendix III](#))

- Name program manager
- Publish formal studbook
- Acquire additional founders
- Breed potential founders/improve reproduction.

Contact:

([Appendix II](#))

Vacant



Photo by Robert W. G. Jenkins

Eastern Diamondback Rattlesnake

Crotalus adamanteus

Candidate Species



Candidate

Eastern Diamondback Rattlesnake

Crotalus adamanteus

(written by Fred Antonio, Central Florida Zoo's
Orianne Center for Indigo Conservation)

Species Summary:

Eastern diamondback rattlesnakes are the largest venomous snakes in the U.S. with adults regularly exceeding five feet in length and weighing more than 10 pounds. These imposing snakes have high, peaked bodies and dark diamond-shaped markings bordered in white or yellow down the length of the back. The historic range of the eastern diamondback rattlesnake includes the southeastern coastal plain from North Carolina south through Florida—including coastal islands and the Florida Keys—and westward to extreme southeastern Louisiana (Martin and Means, 2003). These rattlesnakes typically inhabit open-canopied, pine and wire grass flatlands, longleaf pine-turkey oak hills, rosemary scrub, and palmetto flatwoods. By appearance and reputation, this snake is a dramatic exhibit species.

Program Purposes:*Education/Exhibit Needs***The Snake**

Advisory Group first reviewed the eastern diamondback rattlesnake as a candidate for management in the early 1990s and approved a studbook to support in situ conservation concerns. Three editions of the North American Regional Studbook were published (Antonio, F. 1997; Antonio F., 2000; Antonio, F., 2004) along with two Population Management Plans.

However, most

institutions only wanted a single adult exhibit specimen, and salvage snakes were regularly accepted by Florida zoos at that time. The program was ultimately dropped from the RCP in 2004 due to lack of need and participation.



Photo by Mark Beshel, Jacksonville Zoo

Since then, the impact of habitat loss and fragmentation, pine silviculture, and direct persecution have resulted in population declines throughout the species' range (Means, 2009). Some states provide legal protection, but the species is not federally listed. A petition to list was published in the Federal Register in 2012, initiating a status review, and a USFWS Conservation Action Plan is nearing completion as of this writing (K. Stohlgren, pers. comm). Reluctance to list this species or regulate commercial harvest may be partly driven by southern cultural attitudes towards protecting a large venomous snake, rather than a lack of conservation merit.



Photo by Katie Govern, ZooAmerica

Availability of exhibit specimens has become more difficult in recent years, and we can no longer depend on wild populations as a sustainable source. Acclimation of large wild-caught specimens is also problematic, as they are stressed by captivity. Captive-born animals readily adjust to zoo environments. The captive population must be managed to ensure future availability of this flagship species for zoo and aquarium exhibits and educational programs.

Exhibit Qualities:

Eastern diamondback rattlesnakes have been a mainstay in North American zoological institutions since the late 19th century. Records submitted to the studbook include those from the Philadelphia Zoo that date to 1895, noting a litter of five born that year. They remain universally popular exhibit subjects, serving as prominent symbols of upland habitats in the Southeast.

Most exhibits recreate southeastern upland habitats. Sand or mulch substrates, large branches/logs positioned to provide tactile security, live or artificial plants (e.g. grass clumps resembling wire grass) to enhance aesthetics and offer visual security, and a hidden water bowl are common features. Enclosures should be simple as large specimens can displace props, and an unencumbered work space promotes safety when hooking out snakes.

Exhibit lighting should provide highlights in the environment, rather than a uniform glow. A basking light will be used by some specimens but preferred optimal body temps are not high—approximately 82-86°F (27-30°C). Although ultraviolet radiation may not be required for maintenance, specimens living in outdoor enclosures for even part of the year appear to be more vibrant in color and more physically vigorous (Nick Clark, pers. comm).



Photo by Scott Pfaff, Riverbanks Zoo

Mixed species exhibits with Eastern Diamondback Rattlesnakes have included canebrake (timber) rattlesnake, copperhead, cottonmouth, dusky pigmy rattlesnake, rat snakes, black pine snake, eastern indigo, broadhead skink, oak toad, southern toad, and squirrel treefrog.

Educational Qualities:

This species offers abundant educational opportunities, including the importance of preserving apex predators, responsible land use planning, and commensal relationships among species (i.e. rattlesnakes using gopher tortoise burrows). Eastern diamondbacks make spectacular program animals when handled by a presenter with extensive venomous experience under controlled conditions.

Interpretive Messages:

- Sit-and-wait predator (long periods without food and infrared labial pits)
- Prescribed burns and quality habitat management for wildlife
- The value of snake venom (mining for new pharmaceuticals)

Care and Facilities:

This species requires adequate floor space and safe access for staff. Most off-display enclosures for a single adult are at least 3' x 3' x 1' (LxWxH) with hinged or sliding access doors. Larger enclosures are needed for pairs and a hide box should be provided. Off-exhibit bedding may include newspaper, aspen shavings or cypress mulch. Ambient temperatures should range from 76-80°F with a thermal gradient for basking (hottest area 85-90°F) during the day to 68-70°F at night. A cooling period may be helpful prior to breeding.

Eastern diamondbacks generally feed willingly on appropriately sized rodents, and care must be taken to avoid overfeeding adults. Keeping adults lean appears to be among the most important captive considerations. Larger enclosures with a thermal mosaic may also encourage exercise.

Program Goals: ([Appendix III](#))

- Name program manager
- Publish formal studbook
- Support efforts to convert rattlesnake roundups to no-kill wildlife festivals.
- Develop a conservation education brochure.

Contact:

([Appendix II](#))

Vacant

References:

- Antonio, F. 1997. Eastern diamondback rattlesnake (*Crotalus adamanteus*): North American Regional Studbook (Third edition). Central Florida Zoological Park, Lake Monroe, Florida: 100 pp.
- Antonio, F. 2000. Eastern diamondback rattlesnake (*Crotalus adamanteus*): North American Regional Studbook (Third edition). Central Florida Zoological Park, Lake Monroe, Florida: 122 pp.
- Antonio, F. 2003. Eastern diamondback rattlesnake (*Crotalus adamanteus*): North American Regional Studbook (Third edition). Central Florida Zoological Park, Lake Monroe, Florida: 109 pp.
- Antonio, F. and C. Lynch. 2001. Eastern diamondback rattlesnake (*Crotalus adamanteus*), Population Management Plan. AZA Population Management Center, Chicago, IL.
- Antonio, F. and C. Lynch. 2003. Eastern diamondback rattlesnake (*Crotalus adamanteus*), Population Management Plan. AZA Population Management Center, Chicago, IL.
- Clark, N. and F. Antonio. 2008. Reproduction in the Eastern Diamondback Rattlesnake, *Crotalus adamanteus*, under optimal conditions in captivity. In: Hayes, W.K., Beaman, K.R., Cardwell, M.D. and S.P. Bush, editors. *The Biology of the Rattlesnakes*. Loma Linda University Press, Loma Linda, CA. Pp413-418.
- Beaman, K.R. and W.K. Hayes. 2008. Rattlesnakes: Research trends and annotated checklist. In: Hayes, W.K., Beaman, K.R., Cardwell, M.D. and S.P. Bush, editors. *The Biology of the Rattlesnakes*. Loma Linda University Press, Loma Linda, CA. Pp5-16.
- Green, H.W. 1997. *Snakes, the evolution of mystery in nature*. Univ. of California Press. 351p.
- Kain, P. 1995. Home range, seasonal movements, and behavior of the eastern diamondback rattlesnake (*Crotalus adamanteus*). Southeastern Louisiana University, Thesis. 1-113p.
- Martin, W.H. and D.B. Means. 2003. Distribution of the eastern diamondback rattlesnake (*Crotalus adamanteus*). Abs In: Timmerman, W.W. and W.H. Martin, eds. *Conservation guide to the eastern diamondback rattlesnake, Crotalus adamanteus*.



Photo by Tad Arensmeier

King Cobra

Ophiophagus hannah

Candidate
Program



Candidate

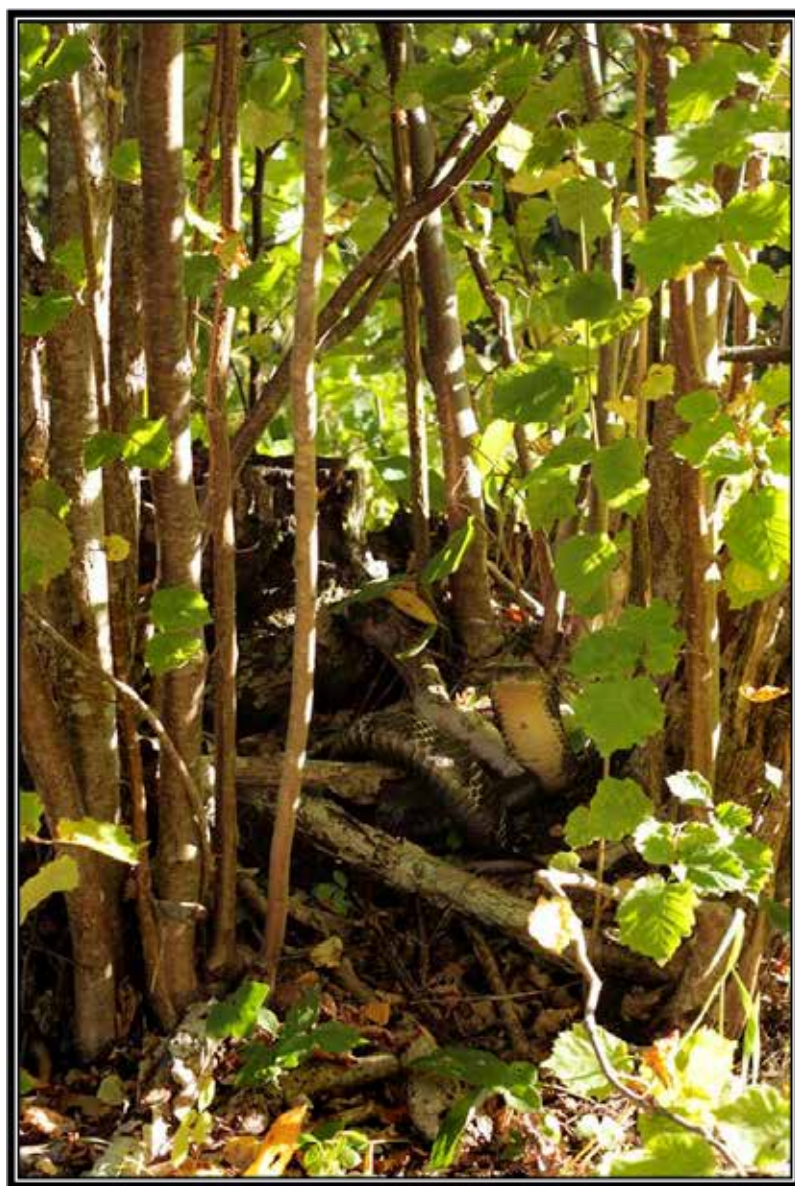
King Cobra

Ophiophagus hannah

(written by Chad Peeling, Reptiland)

Species Summary:

King cobras are the world's largest venomous snakes, carrying enough venom to kill an adult elephant. They are widely recognized by the public, long lived, and hearty in captivity, making them mainstays of reptile and tropical Asia exhibits.



Program Purposes: Education/Exhibit Needs

The king cobra is listed in CITES Appendix II, categorized as vulnerable on the IUCN red data list, and protected regionally in some parts of its range.

The taxonomy of king cobras is in flux and some researchers suggest there may be as many as seven species embedded in the genus. What is certain is that these snakes are distributed over an enormous range, from western India to the Philippines and southern China to Java and Bali. Significant morphological variation occurs between populations across this range, including differences in size and color/pattern. Most populations are sparse and under pressure from habitat loss and over-collection for the skin trade and traditional medicine. Direct persecution is also a problem in some areas.

Regional conservation and research efforts are being undertaken in some parts of the king cobra's range, and some captive breeding occurs in range-country facilities. It is unlikely that animals from the US population would be used for re-introduction in the foreseeable future. Although importation of wild king cobras is still possible from two range countries, the long-term availability of imports is uncertain. The only way to ensure availability of this keystone exhibit species is to manage the US captive population cooperatively.

Exhibit Qualities:

For more than 100 years king cobras have been iconic exhibit specimens in US zoos. They are large, alert, and imbued with almost universal name recognition. These active hunters benefit from spacious enclosures with varied topography and climbing opportunities. Successful exhibits have included bamboo forests, tropical buttress trees, and recreated temple ruins. The snakes thrive on a variety of substrates, including soil mix, leaf litter, and earthen-textured concrete/resins. Sturdy live or artificial plants may be included for aesthetics. A shallow water reservoir should be available for drinking, but king cobras are capable swimmers and deeper pools may be included.

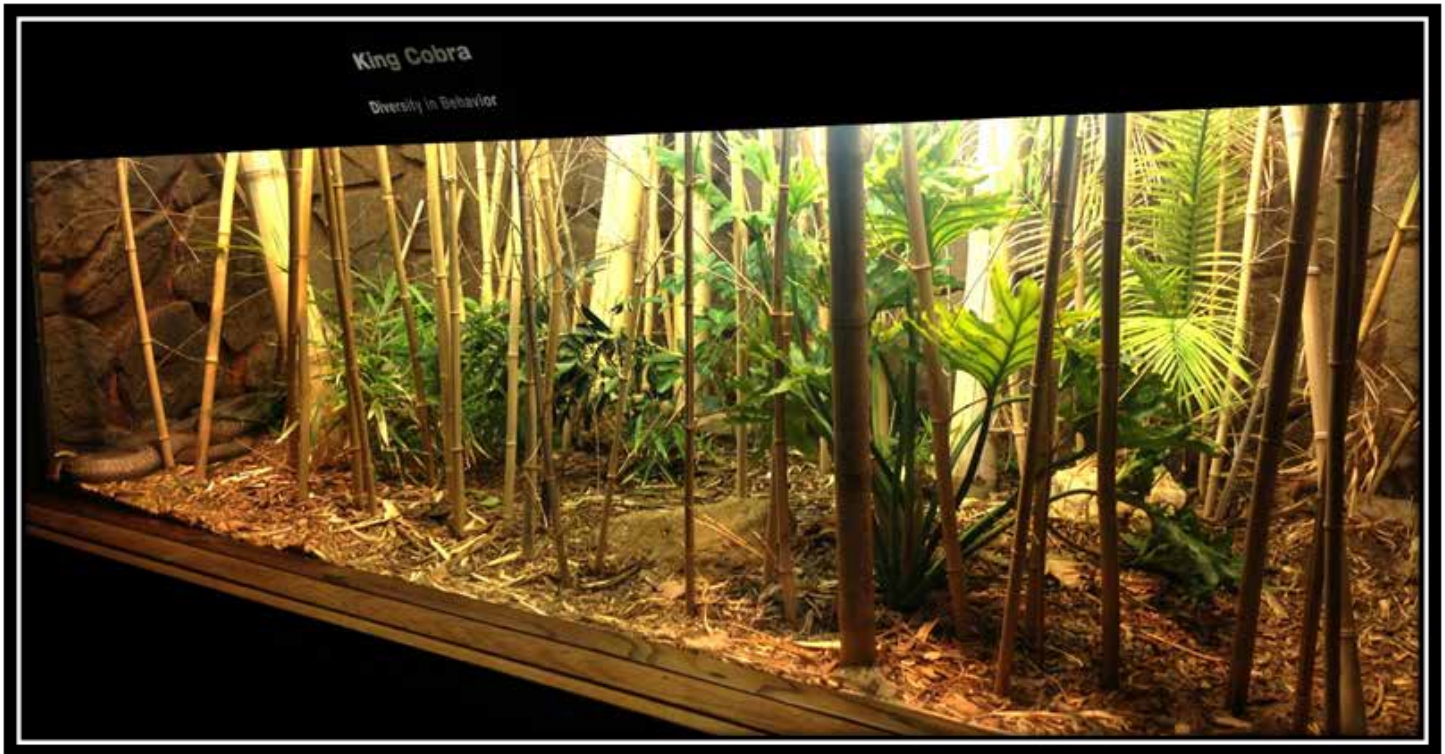


Photo by Nate Nelson, Sedgwick County Zoo

King cobra exhibits should be relatively large to allow the snake freedom of movement and permit safe keeper access. Two AZA institutions have successfully kept a breeding pair in an approximately 6' x 9' x 6' (LxWxH) exhibit. Enclosures should be designed to allow transfer of a large specimen, including adequate clearance behind the enclosure if the snake is meant to be removed manually. Hidden shift boxes are often used for this species and specimens may learn to use them or be coaxed in with hooks.

Interpretive Messages:

- Evolution of venom (predator/prey arms race)
- Tropical deforestation

- The cobra's hood
- Snake "charmers" (sight, not sound)
- Sacred snakes (revered in some Hindu cultures)
- Canopy hunters (climbing for better vantage)

Care and Facilities:

Staff competence with venomous snakes, a clear and practiced snakebite procedure, and a current supply of antivenom are prerequisites for managing this species. King cobras are undeniably dangerous, however most specimens are docile by nature. They typically exhibit curiosity, rather than aggression. This is one of the few venomous snake species where constricting bands should be considered as a first aid measure in bites.



Photo by Julie Larsen Maher, Bronx Zoo / WCS

The primary challenge in king cobra husbandry is diet: they are almost exclusively snake-eaters in the wild. If adequate supplies of feeder snakes are not available year-round (which is typically the case), most king cobras may be converted to eating rodents. A variety of techniques has been used to make this transition, but all involve scenting rodents with snakes (with snake musk, macerated snake carcasses, shed snake skins, sewing a chunk of dead snake to the front of a rodent, etc) and gradually omitting the scent over a series of feedings. This is best done early in life with captive-bred specimens, but adults are also sometimes compliant.

Because king cobras eat other snakes, they are generally exhibited as solitary animals (although this may not be strictly necessary). Males and females are brought together for brief breeding encounters, and otherwise maintained separately by most institutions. It is essential that off-display space be dedicated to keeping at least one adult to serve as an exhibit backup and for use in potential breeding. Obtaining replacement adult animals is difficult, so institutions should plan to raise juveniles for several years prior to reaching exhibit size.

King cobras require tropical temperatures year-round—80-85°F during the day; 70-75°F at night. They are primarily forest dwellers and require elevated humidity during shedding.

Other Notes:

This species is relatively easy to breed in captivity. Two limiting factors must be overcome to maintain a sustainable captive population: institutional space and willingness to keep large, venomous snakes. Although space requirements are modest compared with birds or mammals, king cobras need relatively large exhibits and a commitment to maintaining at least one adult specimen off display. Rearing these snakes to adult size is time-consuming and institutions should plan to raise young when adults reach advanced age. Because mortality in juveniles is relatively high, more hatchlings must be produced than are ultimately needed in the population. To avoid swamping available space with genetically surplus animals, a means of culling or responsibly placing surplus snakes must be considered. Venom labs are one possible outlet where surplus snakes may contribute to the greater good.

The number of AZA institutions exhibiting exotic venomous snakes has declined somewhat in recent decades. If this trend continues, it will be difficult to maintain a sustainable captive population of king cobras or other venomous species. It is essential that AZA institutions maintain competence with venomous species, which are perennially popular with visitors and represent an important part of life's diversity. The staff training and safety procedures required for venomous snakes are no more difficult or costly than for other dangerous animals.

Program Goals: ([Appendix III](#))

- Name program manager
- Publish formal studbook
- Acquire additional founders

Contact:

([Appendix II](#))

Vacant

References:

- The IUCN Red List of Threatened Species. Version 2015.2. <www.iucnredlist.org>
- C. Scott Pfaff, Riverbanks Zoo, personal communication.
- Snake TAG 2002. King Cobra (*Ophiophagus hannah*) Taxon Management Account. Association of Zoos and Aquariums, Silver Spring, MD



Photo by Scott Pfaff, Riverbanks Zoo

Managing Venomous Snakes

(written by Chad Peeling, Reptiland)

Over the last 20 years, there has been a decline in the number of AZA institutions keeping venomous snakes, constraining the resources available for population management. Much of the decline is attributable to management concerns about safety, liability risks, and the costs of maintaining antivenom. There is also a misconception among some decision makers that visitors are not interested in seeing snakes.

Decades of empirical surveys demonstrate that, while snakes and other reptiles are not widely loved, they are consistently among the most sought after exhibits in zoological parks (Balmford, 2000; Hanson, 2002; Krantz, 2013; B. Aucone, conference presentation). Retention time at reptile/amphibian exhibits has also been shown higher than for other taxa, offering institutions the opportunity to convey meaningful interpretive messages (Marcellini, 1988; B. Aucone, personal communication). Institutions that use venomous snakes in educational programming report that nothing captures an audience more reliably (J. Johnson, personal communication; A. Lentini, personal communication).



Photo courtesy Reptiland

While caring for venomous snakes certainly carries inherent risk, the dangers are manageable and far less challenging than those associated with many large mammals. There has not been a death from snakebite in an AZA institution since the 1960s. The costs of stocking antivenom depend upon the range of taxa maintained, but polyvalent antivenoms that cover multiple species offer cost effective coverage of many of the species in this RCP.

Venomous snakes are an important part of the natural world, with significant roles in their ecological systems, and figure prominently in indigenous cultures. They are inordinately persecuted and misunderstood, but they also inspire curiosity, awe, and respect. Nine species in this RCP are venomous—some are keystone exhibit species, others in desperate need of conservation help. If we are to achieve sustainability in these populations, we need institutions to commit space and resources.

The keys to safe management of venomous snakes are sound safety protocols and emergency procedures; staff training and interest; and access to appropriate antivenom and medical care. Because snakes need relatively little space, it is possible for institutions to create significant

conservation impact in a small footprint. The cost of implementing and maintaining safe venomous snake exhibits is modest, and the return on investment—both financially and in furthering the institutional mission—is robust.

This brief primer provides sample documents institutions should consider when managing venomous snakes. It is by no means exhaustive or definitive, and we recognize that there are multiple legitimate approaches. We invite you to contact the SAG steering committee or AZA Antivenom Advisors for additional guidance. A collaboration between AZA and the American Association of Poison Control Centers has created a wonderful database of information and access to snakebite experts, which is available to Poison Control Centers and AZA institutions.

Safety Protocols

Effective protocols should include a clear written policy about how, who, and when venomous snakes may be worked. It should be clear to all staff which tools and techniques are permitted and which are not. It is also critical to have a reliable means of communication with a second person in the event of bite, since in rare cases bite victims may become incapacitated quickly.



Photo by Ian Recchio, Los Angeles Zoo

A typical protocol might include the following:

- Venomous species may only be worked by venomous certified staff members. A second person must be present in the building during handling to initiate emergency protocols if needed.
- Non-certified personnel and personnel not in training are forbidden to work venomous reptiles.
- Venomous snakes should always be managed using appropriate equipment such as hooks, tubes, squeeze boxes, or shields. Under no circumstance should a venomous snake be “free handled.”
- Senior staff must approve pinning or other manual restraint for medical procedures.
- Tongs and hooks must be of adequate length and size for the individual snake. Bites have occurred when



Enclosure labels. Photo by Ian Recchio, Los Angeles Zoo

keepers misjudge striking distances or become overconfident in their ability to predict behaviors.

- If a venomous snakebite occurs immediately refer to the “Venomous Snakebite Emergency” protocol and follow the instructions.
- All venomous snake enclosures should be labeled with the English name, taxon, and appropriate antivenom for the species housed.

Emergency Procedures

Snakebite procedures should be clear, brief, and posted in work areas. It is important that staff members know and understand what to do in the event of a venomous bite and drills should be performed and recorded regularly in compliance with AZA accreditation standards. We also suggest routine testing of alarm or communication systems to ensure functionality. Emergency procedures should be customized for each institution to reflect its staff, venomous species, preferred hospital, and the opinions of its snakebite physician.

A typical snakebite procedure might include the following:

- Secure snake/lizard if possible.
 - Notify backup person to initiate emergency contact list (911, managers, etc).
 - Remove feed/identification card from the snake’s enclosure.
 - Collect antivenom and snakebite kit.
 - Perform appropriate first aid:
Remove rings, bracelets, etc. from affected limb before swelling becomes too great.
Splint the affected extremity to reduce mobility.
* If the bite is from an elapid with minimal cytolytic and necrotic toxins (list species in collection here), apply an Ace bandage to the entire length of the affected extremity starting furthest from the body and wrapping toward the body. Apply the bandage only as tightly as you would for a sprain injury. Do not apply the ace bandage for bites other than elapids with minimal cytolytic and necrotic toxins.
 - Transport the victim, antivenom, and snakebite kit to the designated hospital.
- OR
- Call 911 and tell them you need a direct ambulance transfer from (institution name) and where to meet the victim. If there is confusion with EMS personnel regarding First Aid Measures, tell them not to employ tourniquet, cut and suction, or cryotherapy.

Staff Training

Working venomous snakes requires keepers with strong interest in the subject and a motivation to learn. It does not lend itself to generalist training of staff that cover many taxa. A basic understanding of venom, its delivery apparatus, first aid, and medical treatment is important for a venomous snake keeper. Some institutions cover these subjects informally; others give a written test.

A sample outline for study might include the following:

- Introduction to venom—its evolution, components, and clinical effects.
- Introduction to the four medically significant families of venomous snakes, their fang/venom delivery systems, and their functional abilities.
- Basic process by which antivenom is produced, its function, and potential side-effects.
- How most bites occur in captivity.
- Basic first aid for the bites of various species/families.
- A summary of hospital care provided to snake bite victims.

There is no substitute for experience in the safe management of venomous snakes and hands-on training is essential. Most institutions conduct structured mentoring or certification programs in-house, where new staff members are introduced to safety techniques and practice under the guidance of an experienced handler. Trainees are typically certified or otherwise approved to work venomous snakes only when a member of management is confident in his/her abilities, knowledge, and judgment.



Shift boxes for exhibits. Photo by Ian Recchio, Los Angeles Zoo

A sample training checklist might include the following:

- Demonstrate competence using safety equipment (hooks, tubes, tongs, squeeze boxes, shifts, and transfer containers).
- Exercise good judgment by maintaining safe distances and choosing appropriately sized tools (hooks, tubes, and tongs).
- Demonstrate adequate strength and coordination in manipulating various species/sizes of venomous snakes.
- Maintaining a calm, level-headed demeanor at all times.
- Display full knowledge of emergency procedures and appropriate first aid.

Snakebite Physician & Antivenom

It is also important to forge a relationship with a local physician to serve as your primary medical advisor. Most North American medical facilities treat relatively few snake bites and it is important to have a medical advocate in the event of an emergency. It is typically not difficult to find a physician interested in filling this role and we recommend meeting with him/her at least annually to maintain the relationship and review protocols. Inviting your snakebite physician to your institution once a year makes this review fun and personal. Many institutions also volunteer to give snakebite talks to ER departments as a return courtesy.

If your institution maintains exotic venomous snakes, you will likely need access to foreign antivenoms. Most foreign antivenoms are not FDA-approved drugs and importing them requires obtaining federal permits and complying with regulatory requirements. All of this is doable and we recommend consulting the AZA Antivenom Index (www.aza.org/antivenom-index/) as a specific guide.



Antivenom refrigerator. Photo courtesy Reptiland

Here are the basic steps:

- Obtain an Investigational New Drug (BB-IND) permit from the US Food and Drug Administration Center for Biologic Research and Evaluation. This requires that you designate a physician as the “Principal Investigator,” provide details about the antivenoms to be imported, and agree to storage and transport stipulations.
- Obtain a permit to import biological material from the US Department of Agriculture Animal and Plant Health Inspection Service.
- Fax copies of the BB-IND and USDA import permits, along with your order, to the antivenom supplier. Most suppliers require you to wire money directly to their bank before shipping.
- These shipments usually require a bonded Customs broker for importation. Some couriers (DHL, FedEx, etc) include this service.
- Be prepared to get a call from US Customs Service or US Fish & Wildlife Services as these agencies sometimes hold up shipments at the port of entry. Customs clearance is not typically a lengthy process; if USFWS inquires about whether the antivenom contains any snake tissue, assure them that it does not.

Antivenom should be stored in a dedicated refrigerator and temperatures monitored regularly. Some institutions have devised inexpensive alarm systems that notify staff if there

is a malfunction. Clearly label all antivenom to indicate which species in the collection it covers and ensure staff have easy access to the refrigerator in the event of an emergency.

Ensure that your antivenom supply and emergency contact information is accurately listed on the AZA Antivenom Index. Accurate records must be kept for current and expired antivenoms to comply with FDA annual reporting requirements (a report template is available on the Antivenom Index website). Records should include an up-to-date inventory and the disposition details of any antivenom no longer on hand. If antivenom is used, the FDA requires the physician name, date and quantity used, the species of snake involved in the bite, and (if HIPPA rules allow) a summary of the treatment outcome.



Refrigerator alarm. Photo by Rick Haeffner, Denver Zoo



Off-display holding. Photo by Ian Recchio, Los Angeles Zoo

References:

- Aucone, Brian, "Making Smart Institutional Investments." AZA National Conference. Salt Lake City, UT. September 19, 2015. Conference presentation.
- Balmford, Andrew, Separating Fact from Artifact in Analyses of Zoo Visitor Preferences. 2000. *Conservation Biology*, 14:1193-1195.
- Hanson, Elizabeth, *Animal Attractions Nature on Display in American Zoos*. 2002. Princeton University Press.
- Krantz, Palmer "Satch" and Monique Blanchette Jacobs, *Riverbanks Zoo & Gardens 40 Wild Years*. 2013. University of South Carolina Press.
- Marcellini, Dale and Thomas Jenssen, *Visitor Behavior in the National Zoo's Reptile House*. 1988. *Zoo Biology* 7:329-338.
- Procedures for Importing Antivenom and Applying for Permits. 2015. Online Antivenom Index.

Enclosure Sizes for Snakes

(written by Chad Peeling, Reptiland)

It is impossible to make definitive statements about what constitutes minimum acceptable enclosure sizes for snakes, because there is no single “best” answer to the question. Snakes do not often exhibit stereotypic behaviors or other obvious confinement syndromes. Private breeders have shown that many snake species may be housed in very small enclosures throughout their life cycles with no regular exercise, but the long-term health effects of such high-density housing are not well known. It stands to reason that exercise is desirable and, all else being equal, more space is probably better. But other environmental factors (thermal mosaic, moisture levels, appropriate refugia) are more important to the health of snakes than raw space. The degree to which exercise is essential for the health or welfare of these animals is simply not known.

Most snakes do not require large spaces, and may be housed in small spaces temporarily. Species that hunt actively (e.g. indigos) are obvious exceptions to this, but all species benefit from extreme confinement during shipping or transport. A rule of thumb for enclosure size is to provide enough space for the snake to move about in a natural way (i.e. adopt normal body postures, feeding, and reproductive behaviors); easily thermoregulate by moving in and out of a hot spot; and avoid lying in wet or soiled bedding.

These goals may be accomplished in a variety of creative ways. Enclosures with a very small footprint may be appropriate for some species if vertical climbways or multiple horizontal tiers are provided. A thermal mosaic may be provided by placing heat emitters overhead, to the side, or beneath the enclosure. Appropriate refugia may be created with hides, natural cover (leaves, branches), or the design of the enclosure itself.

Designing snake enclosures requires consideration of the natural habits of each species and weighing those against the space available and whether it is intended as temporary or permanent housing. Consult others who have successfully maintained the species and think creatively. The following rules of thumb are meant only as general guidelines; not as minimum standards.

- **Terrestrial species:** Enclosures for species that primarily utilize floor space (e.g. pythons, rattlesnakes, pine snakes) typically provide at least ½ the length of the snake in the enclosure’s long horizontal dimension and ample floor space so that it may extend its body and exhibit natural feeding, resting and reproductive behaviors. For example, a 5.5’ Louisiana pine snake is generally provided an enclosure approximately 3’ long x 18” wide (standard 3’ commercially available plastic tank). As the number of snakes in an enclosure increases, floor space is increased proportionately.
- **Arboreal species:** Enclosures for species that spend the bulk of their time in trees or elevated shrubs (e.g. green mambas, emerald tree boas, mangrove snakes) should provide adequate space for climbing and perching. Relatively little floor space may be needed, but vertical or diagonal dimensions of the enclosure are typically at least 1/2 of the snake’s length.
- **Aquatic species:** Enclosures for sedentary species that spend the bulk of their time in water (e.g. tentacled snakes, elephant trunk snakes) typically have at least ½ the length of the snake in one dimension and provide enough space for the snake to adopt normal body postures and feeding behaviors.

Pre-ship Testing & Quarantine Recommendations

(written by Chad Peeling, Reptiland)

reviewed by

Bonnie Raphael, D.V.M., DACZM, Wildlife Conservation Society

Steve Klause, DVM, Los Angeles Zoo

Rob Coke, DVM, San Antonio Zoo

The Snake TAG Steering Committee recognizes the importance of preventive veterinary care in managing captive collections, but excessive or redundant procedures may undermine sustainable population management with unnecessary costs and delays. We offer the following guidelines as a reasonable compromise for zoo and aquarium snake collections.

Pre-ship testing

A pre-shipment physical examination, fecal smear and floatation, and sharing of medical records (if any) are reasonable preventive measures that incur little cost or delay. In general, we do not recommend extensive pre-shipment laboratory diagnostics for snakes. Most ophidian diseases are either apparent in a pre-ship physical exam or emerge with clinical symptoms during standard quarantine (see quarantine section below). We suggest that receiving institutions perform whatever tests they deem necessary during quarantine.

Paramyxovirus

Paramyxovirus (OPMV)—sometimes referred to by the genus *Ferlavirus*—is an important disease of viperid snakes; the first report of an outbreak was in 1979. It, or a similar virus, has since been found in a mamba, multiple species of rat snakes, diamond python, and rhinoceros viper. Some collections of snakes have suffered devastating losses of animals to this disease in the past. However, fewer outbreaks have been seen in the last 15 years, primarily due to more effective quarantine practices and improved husbandry measures overall. Appropriate thermal mosaics are probably among the most important husbandry practices which influence immunocompetence and possible susceptibility to the disease.

PCR testing for paramyxovirus consists of a tracheal wash with submission of the wash to a laboratory capable of performing PCR. It is a test for the presence of the virus or pieces of virus. Not to be confused with a titer, the value of the PCR is that it reflects whether the virus is present in the lungs at the time of sampling.

Serology, or titers, are tests of the blood which were more routinely conducted in the past. The tests measure antibodies, which indicate exposure, but not necessarily the presence of the virus. Ideally, two titers are measured at 45-60 day intervals. A difference between the level of the first and second titer would indicate a recent exposure, but doesn't give an indication of whether the animal has been successful in eliminating the virus from its body. It is important to use the same laboratory for serial testing to eliminate inconsistent results.

Paramyxovirus screening may be accomplished by PCR or serology (described above), but each test comes with costs (monetary, time, and stress associated with sample collection). Wild-caught snakes should probably be tested, but if the source of a captive snake is known and trusted to convey medical history (e.g. another AZA institution) and no clinical suspicions exist, we do not recommend blanket screening for OPMV. In the absence of laboratory testing, a strict quarantine of at least 90 days for new animals is highly recommended.

Inclusion body disease

Inclusion body disease (IBD) is a clinically devastating disorder that primarily affects boids. Symptoms vary, but may include regurgitation, pneumonia, oral and skin lesions, and central nervous system damage. Although there are now PCR tests for Reptarenavirus, which has been found in snakes with IBD, it is unclear how to interpret results in a clinically healthy specimen (i.e. PCR-positive snakes will not necessarily become ill, and may not be carriers). IBD-positive snakes with clinical symptoms should be euthanized, as there is no effective treatment. The mode(s) of transmission have also not been established, although direct contact between snakes is likely, and it is reasonable to suspect mites may act as vectors. There is still much to learn about this disease and we do not recommend pre-ship IBD testing at this time. Appropriate quarantine, staying alert for clinical symptoms, controlling mites, and maintaining hygienic husbandry practices appear to be the most practical approach for now.

Cryptosporidia

Cryptosporidiosis is a disease of the digestive tract, caused by a protozoan parasite. Clinical symptoms in snakes usually include regurgitation several days after feeding and, often, development of a firm mid-body swelling caused by thickening of the stomach wall. However, there are also strains of Cryptosporidia that primarily cause enteritis. Cryptosporium organisms may be identified microscopically via standard fecal exams, but the spores are shed intermittently and are very small and easy to miss. Acid-fast stains on direct fecal smears make identification easier.

Immunofluorescent antibody testing (IFA) can be done on feces during quarantine and if positive, followed up with PCR testing. IFA does not distinguish between mammalian and reptilian Cryptosporidia, but is much less expensive than PCR. PCR differentiating between the different types of *Cryptosporidium* is now available, making species-specific identification of the parasite possible. However, interpreting the results is problematic in clinically healthy animals. Many immunocompetent animals (including humans) appear to tolerate cryptosporidia as benign flora, but can serve as sources that could transmit the organisms to other species. Direct histologic examination of endoscopic stomach biopsies has been used successfully to diagnose clinical infections in living snakes (Cervený et al. 2012).

Even mild infections of *Cryptosporidium* can cause severe symptoms in hosts that are immune-compromised. There is currently no reliable way to eliminate cryptosporidia from infected snakes, and the parasite's oocysts are highly resistant to most disinfectants. Institutions wishing to maintain a crypto-free collection should test for this pathogen during quarantine and consider euthanasia or permanent isolation of carrier animals. Hygienic husbandry practices and thorough disinfection, during and after quarantine, are probably the most significant preventive measures.

Quarantine

We recommend snakes undergo a 90-day quarantine before being introduced into the main zoological collection. This period exceeds the incubation period of most known ophidian pathogens, allowing sub-clinical infections to express themselves fully. Quarantined specimens should be examined physically (skin, oral tissues, palpation), undergo at least two clear fecal examinations, be weighed (beginning and end of quarantine period), and treated for any parasites or infections deemed significant. Some snake species are delicate, particularly as juveniles, and require nuanced care. For these species it may be best for herpetology staff, rather than veterinary technicians, to provide quarantine care.

Quarantine area(s) should be separated from animals in the existing collection by physical barriers which prevent dissemination of pathogens. Ideally separate rooms are used for animals coming into quarantine. However, few snake diseases are capable of airborne transmission, so it is possible to quarantine animals with staggered entry/exit in the same room. The most significant vectors of infection are mites and inappropriate husbandry. Quarantine enclosures should be as sparsely decorated as possible and keepers should treat each enclosure as an independent quarantine space, changing gloves and disinfecting tools between them.



Photo by Chad Peeling, Reptiland

References

- American Association of Zoo Veterinarians Infectious Disease Committee Manual. 2013.
- Cervený, S. N. S. D.V.M., M. M. Garner, D.V.M. Dipl. A.C.V.P., J. J. D'Agostino, D.V.M. Dipl. A.C.Z.M., S. R. Sekscienski, M. E. Payton, Ph.D., and M. R. Davis, D.V.M. Dipl. A.C.Z.M. Evaluation of Gastroscopic Biopsy for Diagnosis of *Cryptosporidium* sp. Infection in Snakes. *Journal of Zoo and Wildlife Medicine* 43(4): 864–871, 2012.
- Inclusion Body Disease of Boid Snakes. University of Florida College of Veterinary Medicine website. < <http://labs.vetmed.ufl.edu/sample-requirements/zoo-med-infections/boid-ibd/> >
- Stenglein, M.D., Sanders, C., Kistler, A.L., Ruby, J.G., Franco, J.Y., Reavill, D.R., Dunker, F., and DeRisi, J.L. Identification, Characterization, and In Vitro Culture of Highly Divergent Arenaviruses from Boa Constrictors and Annulated Tree Boas: Candidate Etiological Agents for Snake Inclusion Body Disease. *mBio*. 2012 Jul-Aug; 3(4): e00180-12. Published online 2012 August 14.

Snakes in Outreach

(written by Clyde Peeling, Reptiland)

Few taxa generate more excitement in live animal programs than snakes. Part of their appeal is that snakes are so widely hated, feared, and misunderstood; but snakes also evoke simple curiosity. They hold people's attention, offering interpreters the chance to communicate something meaningful. In the hands of a skilled presenter most audiences—even adults shaped by years of negative propaganda—may be transformed to appreciate, or at least tolerate, these animals. Many snakes make ideal outreach animals. Choosing species that tolerate repeated handling, properly transporting them, and ensuring safety of the presenter and audience are subjects that should be considered.

Choosing Species

This document should be used as a guide; not an all-inclusive list. Experience may prove that some individuals of a species reputed to be intractable are well-suited for handling, while individuals of other species said to be reliably gentle may be completely untrustworthy. Select specimens that have proven gentle and tolerant of handling and those that are hardy enough for transport. Many snakes from the families colubridae and boidae make excellent program animals, but species from other families may also do well.

Some examples of species used successfully include:

- New World rat snakes (*Pantherophis sp.*)
- king snakes/milk snakes (*Lampropeltis sp.*)
- Pine snakes / bull snakes (*Pituophis sp.*)
- Eastern indigo (*Drymarchon couperi*)
- Boa constrictor (*Boa constrictor*)
- Ball python (*Python regius*)
- Burmese python (*Python bivittatus*) *now listed as Injurious Wildlife*
- Yellow anaconda (*Eunectes notaeus*) *now listed as Injurious Wildlife*

Check wildlife regulations to ensure that each species may be used in the location of your venue. Venomous species or large snakes are regulated in some states and municipalities; native species may be protected by local wildlife laws; and some species of large boids are now listed as Injurious Wildlife, requiring double containment and interstate transport permits.

Handling

After removing a harmless snake from its transport container, it is generally best to let the snake hold you as opposed to you restraining the snake. Provide adequate support to give it a sense of security. Depending on the size of the snake, get your hands, arms, or torso under the animal to eliminate any risk of it falling. Very large, heavy-bodied constrictors are difficult program animals—it looks ungraceful to heft a massive snake from a container and improper handling may injure the snake. Boids in the neighborhood of 6 to 9 feet and up to 25-30 pounds are most comfortable both for the presenter and snake.

The opportunity to touch tractable specimens provides a memorable experience for audiences. Public contact with snakes comes with some degree of risk, but this is manageable with reasonable precautions. Touch animals should be clean, dry, and healthy to limit the possibility of zoonotic disease transmission, and audiences should be encouraged to wash or sanitize hands after touching. It is generally best to discourage people from touching the snake's head, and to conduct touching in a controlled environment (e.g. a line of people touching one at a time). Be sure to check local regulations, because public touching is prohibited by some states and municipalities.

Program snakes are typically rotated on a regular schedule to prevent excessive handling or disturbance during pre-shed, shedding, or feeding cycles. Program animals that display signs of stress or illness should be eliminated from the lineup until cleared by curatorial or veterinary staff.

Husbandry

When possible program animals should be treated as a separate population and kept isolated from the non-program living collection. Where complete isolation is impossible, they should be provided with dedicated caging and keepers must exercise caution to limit contact between the two populations.

Transport

Many snakes travel well with little apparent stress. Transport containers should be stout, secure, cleanable, and provide adequate ventilation. Commercial plastic restaurant bins have been used successfully for decades and are available in various sizes. Insulated picnic coolers and Styrofoam boxes provide greater protection from temperature extremes. Boxes should be bedded with an absorbent material (e.g. newspaper or non-toxic wood shavings) to absorb uric acid or feces. Cedar and other aromatic wood shavings should be avoided.

Disposable heat packs add a margin of safety on extended trips in cold weather, but it is best to keep transport containers in a temperature-controlled environment. Inexpensive digital thermometers that have an outdoor probe may be used to monitor one or more containers from the front of a transport vehicle. Overheating is a greater threat than under heating and containers should never be exposed to direct sunlight or left in an enclosed vehicle unattended.

The size of the container should in most cases keep the snake tightly confined to preclude sliding about during travel. Bags have been used extensively for shipping snakes inside containers but will prove awkward for a presenter doing outreach programs.

Venomous Snakes in Outreach

Viperid and Elapid snakes make dramatic program animals when used by handlers with extensive venomous training. Obviously, this requires a controlled environment and appropriate distance from an audience. While controversial among some herpetologists, venomductectomy surgery adds an additional layer of safety for some venomous snake species. Venomoid snakes should always be handled using the same protocols as unaltered snakes, as if they were fully capable of envenomation.

Vetting Non-AZA Entities for Responsible Disposition

(edited by Penny Felski, Buffalo Zoo)

Participating with non-AZA partners in sustaining captive populations is critical to the success of these programs. To aid institutions in vetting non-AZA partners, we have included a sample facility profile and reference questionnaire. The SAG encourages institutions to develop a vetting process and forge relationships with academics, private sector breeders, and other responsible entities. We refer policy makers to the AZA Policy on Responsible Population Management (www.aza.org/board-policies/) for additional guidance.

Sample Non AZA Facility Profile

Date: _____ Facility Contact Person: _____

Facility Name: _____

Address, City, State, Zip: _____

Phone: _____ Fax: _____ Years in Business: _____

Primary Operational Purpose: a) Zoo ☐ b) Private Breeding Facility ☐ c) Rehabilitator ☐ d) Dealer ☐

e) Other ☐ _____

List all federal/state permits held and attach a copy of each permit applicable to this and future transactions:

Questions:

Is there a full time veterinarian on site? Yes ☐ No ☐ If no, is there a consulting veterinarian? Yes ☐ No ☐

How often does the consulting veterinarian visit the premises? _____

Are new or sick animals quarantined from the main collection? Yes ☐ No ☐

Briefly describe the husbandry experience of the facility or its principals: _____

Briefly describe the record keeping system & means of identifying animals: _____

Does the facility use the International Species Information System or similar record-keeping? Yes ☐ No ☐

Does the facility donate, sell, or trade to other institutions or individuals for purposes of:

Exotic Wildlife Auctions? Yes ☐ No ☐

Terminal research? Yes ☐ No ☐

Commercial pet trade? Yes ☐ No ☐

If yes, please explain:

Has the facility or its principals ever been convicted of a violation of wildlife regulations such as the animal Welfare Act, Lacey Act, Marine Mammal Protection Act, Endangered Act, CITES., etc.? Yes ☐ No ☐

If yes, please explain:

Briefly describe how the facility avoids the acquisition of illegally collected specimens:

References (see reference questionnaire on following pages)

(Name)

(Address)

(Phone Number)

(Name)

(Address)

(Phone Number)

(Address)

(Phone Number)

Sample Reference Questionnaire

Facility/Dealer/Individual: _____

Name of Professional Reference: _____

- 1) How long have you dealt with facility/dealer/individual? _____
- 2) To your knowledge, does this dealer / individual exchange animals for auctions, hunting ranches, or the pet trade?
Yes ☐ No ☐ If yes, please explain: _____
- 3) Has the facility/dealer/individual been fair & ethical in their dealings with you? Yes ☐ No ☐
If not, please explain: _____
- 4) Has the facility/dealer/individual always provided you with healthy animals? Yes ☐ No ☐
If not, have they worked with you to remedy the problem in a timely manner? Yes ☐ No ☐
- 5) Do you receive all requested paperwork, including permits, health certificates and medical histories without a problem? Yes ☐ No ☐
Is individual data & diet information provided? Yes ☐ No ☐
- 6) Has the facility/dealer/individual been willing to give you information regarding the eventual disposition of animals sold to them? Yes ☐ No ☐
- 7) Are animals picked up and delivered when promised? Yes ☐ No ☐
If not, are you notified promptly about changes? Yes ☐ No ☐
- 8) Is this party prompt in paying bills? Yes ☐ No ☐
- 9) Do you have any knowledge of complaints regarding this party? Yes ☐ No ☐
If so, please explain: _____
- 10) Have you inspected the facility personally? Yes ☐ No ☐ If yes:
Are animals held in a safe and humane manner? Yes ☐ No ☐
Are exhibit and holding areas maintained in acceptable condition? Yes ☐ No ☐
How do you rate the professionalism of the staff?
Is adequate veterinary care provided?
- 11) Additional Comments: _____

Form completed by: _____ Date: _____

Appendix I

AZA Animal Program Management Levels Defined

Green SSP Program - Populations that are most sustainable for the long-term. The criteria to be met are:

- At least 50 individuals held among at least three AZA institutions
- Projected to retain at least 90% gene diversity for 100 years or 10 generations
- Current published studbook
- Compliance with Green SSP recommendations is mandatory.
- Only AZA member institutions and WCMC approved Sustainability Partners may participate.

Yellow SSP Program

- At least 50 individuals held among at least three AZA institutions
- Projected to retain less than 90% gene diversity for 100 years or 10 generations
- Current published studbook
- Participation in Red SSPs is voluntary.
- Non-AZA entities may participate without becoming approved Sustainability Partners.

Red SSP Program

- 20-49 individuals held among at least three AZA institutions
- Projected to retain less than 90% gene diversity for 100 years or 10 generations
- Current published studbook
- Participation in Red SSPs is voluntary
- Non-AZA entities may participate without becoming approved Sustainability Partners.

Candidate Program

- Less than 20 individuals held among at less than three AZA institutions
or
- Lack a published studbook

TAG Monitored Population

- Species not recommended for formal management, but commonly kept by AZA member institutions.
- The TAG may choose to monitor these species informally and recommend them later for management.

Appendix II Management Update Table

Common name / (taxon)	Date Initiated	Previous Designation	Current Designation	Program Leader Change	Program Leader / Species Contact	Studbook Keeper / Contact
Aruba Island rattlesnake (<i>Crotalus unicolor</i>)	1982	SSP	Green SSP	N/A	R. Andrew Odum, Toledo Zoological Society (419) 395-5721 x2113 andrew.odum@ToledoZoo.org	Stan Mays, Houston Zoo (713) 533-6527 smays@houstonzoo.org
Louisiana pine snake (<i>Pituophis ruthveni</i>)	1984	SSP	Yellow SSP	N/A	Steve Reichling PhD, Memphis Zoo (901) 333-6711 sreichling@memphiszoo.org	C. Drew Foster, Phoenix Zoo 602.286.3800 x 7638 dfoster@phoenixzoo.org
Eastern massasauga rattlesnake (<i>Sistrurus catenatus</i>)	2007	SSP	Yellow SSP	2013	Jeff Jundt, Detroit Zoological Society (248) 336-5859 jjundt@dzs.org	Daine Mulkerin, Lincoln Park Zoo (312) 742-2376; dmulkerin@lpzoo.org
Eastern indigo (<i>Drymarchon couperi</i>)	2002	PMP	Yellow SSP	2014	Michelle Hoffman, Central Florida Zoo's Orianne Center for Indigo Conservation (386) 785-5468 michelles@centralfloridazoo.org	Michelle Hoffman, Central Florida Zoo's Orianne Center for Indigo Conservation (386) 785-5468 michelles@centralfloridazoo.org
Armenian viper (<i>Montivipera raddei</i>)	2006	PMP	Red SSP	N/A	Mark Wanner, St. Louis Zoo (314) 646-4785 Wanner@stlzoo.org	Mark Wanner, St. Louis Zoo (314) 646-4785 Wanner@stlzoo.org
Jamaican boa (<i>Chilabothrus subflavus</i>)	1993	PMP	Yellow SSP	2014	Andrew Snider, Chicago Zoological Society (708) 688-8458 andy.snider@czs.org	Andrew Snider, Chicago Zoological Society (708) 688-8458 andy.snider@czs.org
Mexican lance-headed rattlesnake (<i>Crotalus polystictus</i>)	2002	PMP	Yellow SSP	2012	Penny Felski, Buffalo Zoo (716) 995-6155 pfelski@buffalozoo.org	Chris Baker, Memphis Zoo (901) 333-6707 cbaker@memphiszoo.org
Bushmaster (<i>Lachesis muta</i>)	1992	PMP	Yellow SSP	2003	Brett Baldwin, San Diego Zoo (619) 685-3282 bbaldwin@sandiegozoo.org	Brett Baldwin, San Diego Zoo (619) 685-3282 bbaldwin@sandiegozoo.org
Santa Catalina rattlesnake (<i>Crotalus catalinensis</i>)		N/A	Candidate	2013	Vacant	Chris Rodriguez, Los Angeles Zoo (909) 821-6406 Sleepingbird@aol.com
Green anaconda (<i>Eunectes murinus</i>)		N/A	Candidate	N/A	Vacant	Vacant
Reticulated python (<i>Malayopython reticulatus</i>)		N/A	Candidate	N/A	Vacant	Vacant
Mangshan pit viper (<i>Protobothrops mangshanensis</i>)		N/A	Candidate	N/A	Vacant	Vacant
Eastern diamondback rattlesnake (<i>Crotalus adamanteus</i>)		N/A	Candidate	N/A	Vacant	Vacant
King cobra (<i>Ophiophagus hannah</i>)		N/A	Candidate	N/A	Vacant	Vacant
Virgin Island boas (<i>Epicrates monensis</i>)	1990	SSP/ Candidate	Eliminated from RCP	N/A	N/A	N/A
Ocellate Mountain viper (<i>Montivipera wagneri</i>)		PMP	Eliminated from RCP	N/A	N/A	N/A
Philippine palm viper (<i>Bothriechis mcgregori</i>)	2000	PMP	Eliminated from RCP	N/A	N/A	N/A
San Francisco garter snake (<i>Thamnophis sirtalis tetrataenia</i>)		PMP	Eliminated from RCP	N/A	N/A	N/A

Appendix III

Animal Program Roles, Goals & Essential Actions Table

English name / Taxon	Aruba Island rattlesnake (<i>Crotalus unicolor</i>)
Program Designation	Green SSP
Primary Role	Assurance population, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Continue field research project to determine the impact of the introduced Boa constrictor on the rattlesnake and other native fauna of Aruba using condition indices.
Goal #2 / Essential Action	Complete diet study for the invasive <i>Boa constrictor</i> on Aruba.
Goal #3 / Essential Action	Continue supporting the development of the National Park, Arikok, on Aruba. Program leader will remain in contact with officials and offer assistance as needed.
English name / Taxon	Louisiana pine snake (<i>Pituophis ruthveni</i>)
Program Designation	Yellow SSP
Primary Role	Conservation Action, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Finalize securing funding for consolidation of the SSP. This involves completing grant cycles with USFWS.
Goal #2 / Essential Action	Consolidate the SSP population geographically to create four breeding centers. This will involve significant logistics and time moving animals and preparing space.
Goal #3 / Essential Action	Increase reproductive output to amplify reintroduction. Surveys have been sent to all holders of the species regarding husbandry/breeding circumstances and outcomes. These will be evaluated to look for significant patterns.
English name / Taxon	Eastern massasauga rattlesnake (<i>Sistrurus catenatus</i>)
Program Designation	Yellow SSP
Primary Role	Assurance population, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Increase the number of participating institutions by promoting involvement at TAG meetings.
Goal #2 / Essential Action	Develop standard reproductive protocols to boost success among participating institutions. This involves communicating with all participants and cataloging the conditions under which snakes are kept and have reproduced.
Goal #3 / Essential Action	Develop education/outreach kit for use by participating institutions by making materials available on the new eastern massasauga rattlesnake SSP website.
English name / Taxon	Eastern indigo (<i>Drymarchon couperi</i>)
Program Designation	Yellow SSP
Primary Role	Conservation action, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	New program leader to attend AZA course Population Management I.
Goal #2 / Essential Action	Acquire additional founders as opportunities present themselves and build the current population by experimenting with husbandry/breeding techniques developed at the Orianne Center for Indigo Conservation.
Goal #3 / Essential Action	Continue indigo reintroduction in Conecuh National Forest in southern Alabama and establish 2nd introduction site at the Nature Conservancy's Apalachicola Bluffs and Ravines Preserve in 2016.
English name / Taxon	Armenian viper (<i>Montivipera raddei</i>)
Program Designation	Red SSP
Primary Role	Assurance population, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Encourage institutions with proper sex ratios to attempt breeding. Breeding is occurring at two institutions thus far.
Goal #2 / Essential Action	Conduct next SSP breeding and transfer plan in 2016.
Goal #3 / Essential Action	Continue fieldwork in Armenia and construct conservation breeding center.

Appendix III

Animal Program Roles, Goals & Essential Actions Table

English name / Taxon Program Designation Primary Role	Jamaican boa (<i>Chilabothrus subflavus</i>) Yellow SSP Assurance population, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Publish new breeding/transfer plan in 2016.
Goal #2 / Essential Action	Recruit at least three more institutions to hold specimens anticipated from future breedings by promoting the species at herp TAG meetings and making personal contact.
Goal #3 / Essential Action	Complete studbook update in 2016.
English name / Taxon Program Designation Primary Role	Mexican lance-headed rattlesnake (<i>Crotalus polystictus</i>) Yellow SSP Assurance population, Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Breed potential founders in existing population.
Goal #2 / Essential Action	Improve reproductive success with the species by collecting data from previous successful breedings and looking for significant patterns.
Goal #3 / Essential Action	Publish updated breeding & transfer plan in 2016.
English name / Taxon Program Designation Primary Role	Bushmaster (<i>Lachesis muta</i>) Yellow SSP Education/Exhibit Needs, and Research
Goal #1 / Essential Action	Acquire additional founders by looking for legally/ethically sourced imports.
Goal #2 / Essential Action	Add holding and rearing space by promoting the species and needs at herp TAG meetings and making personal contact.
Goal #3 / Essential Action	Place current offspring with institutions that only need exhibit animals to free up rearing space at existing breeding centers.
English name / Taxon Program Designation Primary Role	Santa Catalina rattlesnake (<i>Crotalus catalinensis</i>) Candidate Assurance population and Education/Exhibit Needs
Goal #1 / Essential Action	Designate a program leader.
Goal #2 / Essential Action	Publish formal studbook.
Goal #3 / Essential Action	Designated population manager take AZA Population Management 1.
English name / Taxon Program Designation Primary Role	Green anaconda (<i>Eunectes murinus</i>) Candidate species Education/Exhibit Needs
Goal #1 / Essential Action	Designate a program leader.
Goal #2 / Essential Action	Publish formal studbook.
Goal #3 / Essential Action	Add holding and rearing space by promoting the species at herp TAG meetings.
English name / Taxon Program Designation Primary Role	Reticulated python (<i>Malayopython reticulatus</i>) Candidate species Education/Exhibit Needs
Goal #1 / Essential Action	Designate a program leader.
Goal #2 / Essential Action	Publish formal studbook.
Goal #3 / Essential Action	Add holding and rearing space by promoting the species at herp TAG meetings.

Appendix III

Animal Program Roles, Goals & Essential Actions Table

English name / Taxon	Mangshan pit viper (<i>Protobothrops mangshenensis</i>)
Program Designation	Candidate species
Primary Role	Assurance population and Education/Exhibit Needs
Goal #1 / Essential Action	Designate a program leader.
Goal #2 / Essential Action	Publish formal studbook.
Goal #3 / Essential Action	Add potential founders to the population as opportunities present themselves.
English name / Taxon	Eastern diamondback rattlesnake (<i>Crotalus adamanteus</i>)
Program Designation	Candidate species
Primary Role	Education/Exhibit Needs
Goal #1 / Essential Action	Designate a program leader.
Goal #2 / Essential Action	Publish formal studbook.
Goal #3 / Essential Action	Add potential founders to the population as opportunities present themselves.
English name / Taxon	King cobra (<i>Ophiophagus hannah</i>)
Program Designation	Candidate species
Primary Role	Education/Exhibit Needs
Goal #1 / Essential Action	Designate a program leader.
Goal #2 / Essential Action	Publish formal studbook.
Goal #3 / Essential Action	Add holding and rearing space by promoting the species at herp TAG meetings.