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IGUANA

CONSERVATION, NATURAL HISTORY, AND HUSBANDRY OF REPTILES

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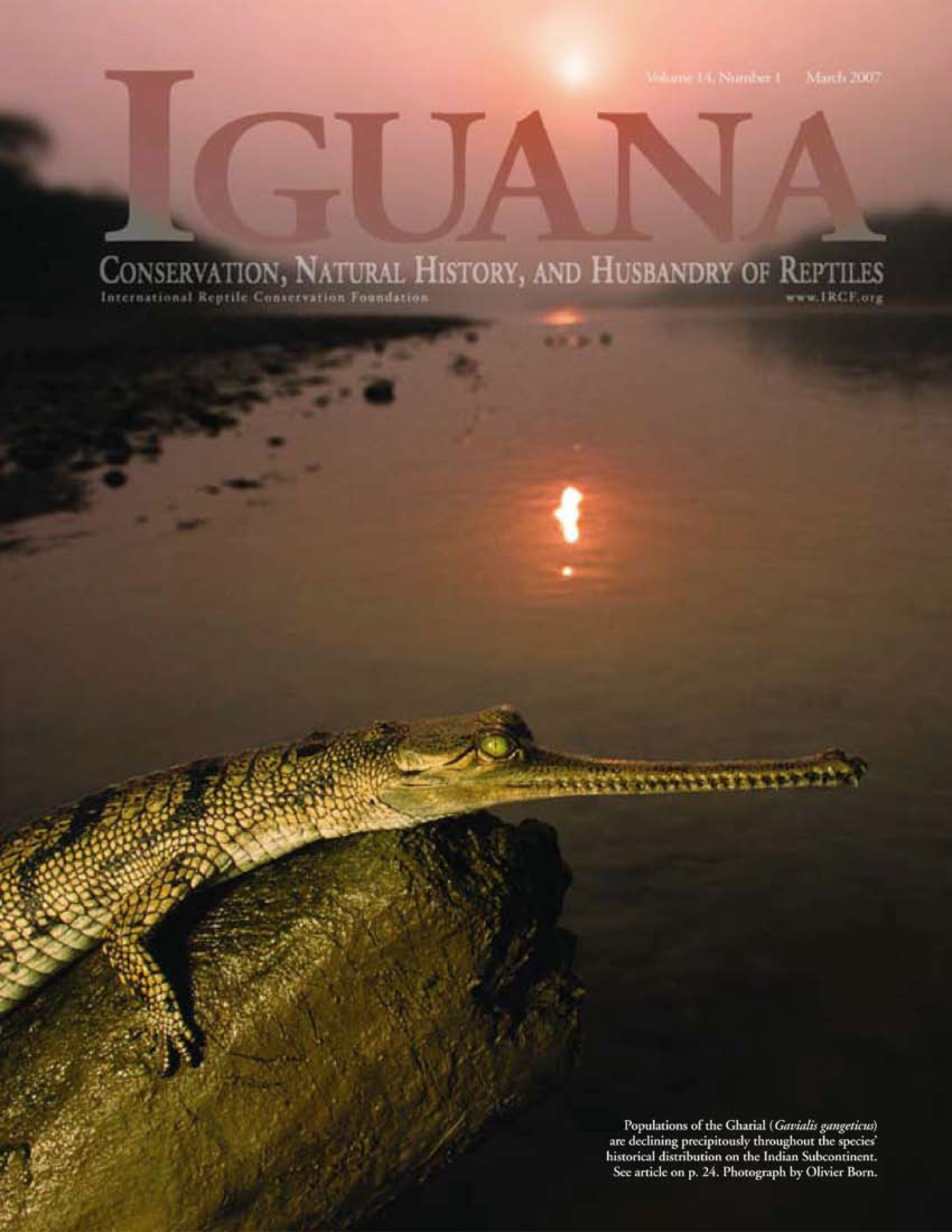

Populations of the Gharial (*Gavialis gangeticus*) are declining precipitously throughout the species' historical distribution on the Indian Subcontinent. See article on p. 24. Photograph by Olivier Born.

The Gharial (*Gavialis gangeticus*) is the focus of international conservation efforts determined to stem the decline of this large crocodilian (see article on p. 24).

A substantial portion of the range of critically endangered Ricord's Iguanas (*Cyclura ricordii*) has been removed from the Dominican protected areas system (see article on p. 2).

Proper lighting is essential for maintaining a healthy reptilian immune system: Proper lighting is a process, not a bulb (see article on p. 18).

A team of researchers is studying the Texas Horned Lizard (*Phrynosoma cornutum*) at Tinker Air Force Base in Oklahoma to learn more about the basic biology of this species (see article on p. 8).

Costa Rica is a naturalist's paradise. This Green Iguana (*Iguana iguana*) is resting on a branch overhanging a stream (see Travelogues on p. 38).

The distribution of the Guatemalan Black Iguana (*Ctenosaura palearis*) corresponds almost exactly with that of the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) (see Focus on Conservation on p. 64).

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BRIAN HORNE

Critically endangered Red-crowned Roofed Turtles (*Kachuga kachuga*) occur primarily in the watershed of the Ganges River, where they are affected by some of the same threats as the Gharial (*Gavialis gangeticus*; see story on p. 2).

Critically endangered Ricord's Iguanas (*Cyclura ricordii*) occur only in the Dominican Republic. A critical portion of the species' very restricted range has been removed from the Dominican protected areas system.

Preliminary Report on the Distribution and Status of *Cyclura ricordii* along the Southern Shore of Lago Enriquillo

Ernst Rupp, Sixto Incháustegui, and Yvonne Arias

Grupo Jaragua Inc., El Vergel # 33, Santo Domingo, Dominican Republic

Photographs by the authors except where indicated.

Ricord's Iguana (*Cyclura ricordii*) is endemic to Hispaniola, where it is one of two species of Rock Iguanas on the island. Ricord's Iguana is critically endangered according to the current IUCN Red List. The population is divided into two isolated areas in the southwest of the Dominican Republic. One area is in the Neyba Valley: on Isla Cabritos in Lago Enriquillo and some adjacent habitats on the southern shore of the Lake. Effective management is in place for the Isla Cabritos Lago Enriquillo Ramsar site, which is also a National Park. The southern shore of the lake, however, is not legally protected at this time. In fact, law 202-04 (2004) eliminated this region from the Dominican protected areas system. The present study examines the distribution of the species along the southern shore of Lago Enriquillo and assesses the conservation status of that population.

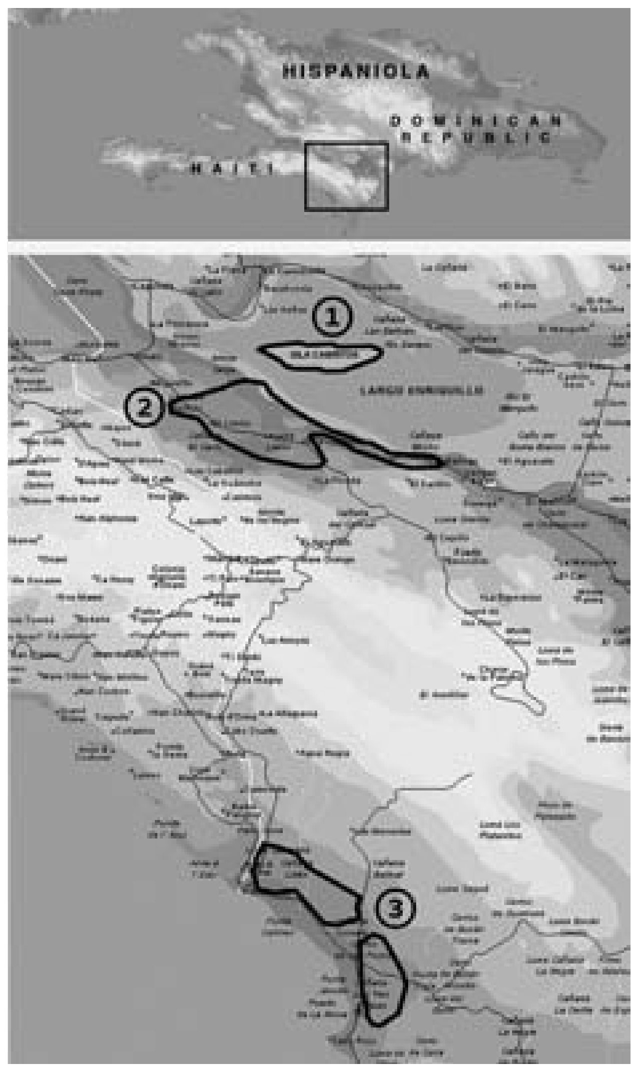
Methods

In order to localize *Cyclura ricordii* habitats and populations along the southern shore of Lago Enriquillo, key informants were contacted and interviewed about their knowledge of *C. ricordii*. Photographs of *C. cornuta* and *C. ricordii* were used to determine if the persons interviewed were able to discriminate between the two species. In addition, field trips were undertaken to the locations mentioned by informants and Landsat satellite photographs were examined in order to identify further potential *C. ricordii* habitat. The presence or absence of *C. ricordii* was determined by: (1) Direct sightings (clear identification of animals as being *C. ricordii*), (2) dead animals (identification of carcasses or parts of dead animals as being *C. ricordii*), (3) tracks (given conditions of fine soil substrate, tracks of *C. ricordii* and *C. cornuta* can be differentiated by their width and form), and (4) retreats (*C. ricordii* tends to occupy sites close to retreats for basking; knowing locations of retreats facilitates identification of basking animals and tracks leading to active burrows can provide an indication of the species occupying the specific retreat). Coordinates of locations where the presence of *C. ricordii* was verified were registered with GPS (UTM, map datum: NAD 27 of the Caribbean) and integrated into GIS.

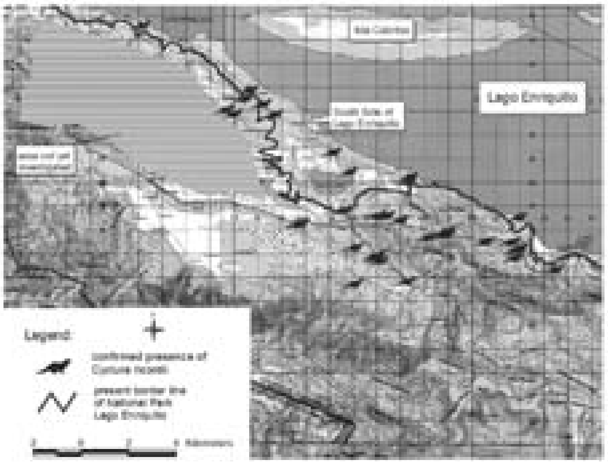
The extent of major threats to the species was defined and quantified by: (1) Interviewing local people; (2) fieldtrips to assess human impact on vegetation and iguanas; and (3) habitat changes evident in satellite images.

Results

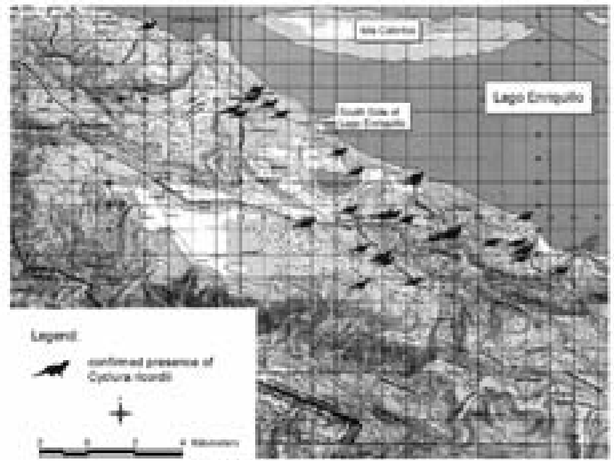
Status.—The presence of *C. ricordii* was verified in the following areas: (1) Along the main road from Duvergé to Jimaní



Distribution of *Cyclura ricordii* in the Dominican Republic. Numbered areas represent isolated populations: (1) Isla Cabritos in Lago Enriquillo, (2) southern shore of Lago Enriquillo, and (3) areas south of the Sierra de Bahoruco.



Present boundaries of Parque Nacional Lago Enriquillo and the nearby area not yet investigated for the presence of *Cyclura ricordii.*



Confirmed presence of *Cyclura ricordii* along the southern shore of Lago Enriquillo.

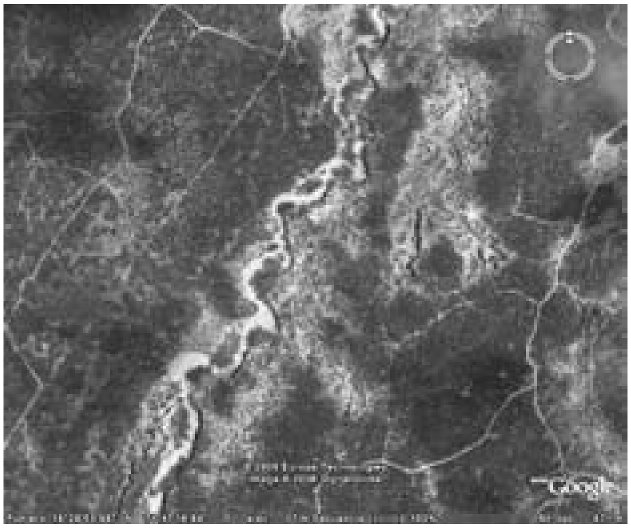
between the towns of Baitoa and El Limón; (2) in the area north and east of Laguna del Limón (called "La Florida"), (3) in the area north and east of Laguna en Medio (the lagoon actually has been drained); and (4) along the old road from Duvergé to Jimaní starting west of Baitoa and extending to Arroyo Aculadero about 5 km east of Jimaní. The occupied areas cover roughly 50 km^2, conforming largely to the historically known range identified by José A. Ottenwalder in 1999, but with the notable addition of extending substantially farther to the west along the old road to Jimaní.

Not all areas within this zone harbor the species. Dens are absent in areas covered by rock or gravel. The species is mainly present in sandy soil. A high concentration of dens was found in the banks of dry creek beds and ravines, which cut through the marine sediments, often of corals and shells. These sediments make up the major part of the geological layers of the zone. Most creeks have a south-north direction and drain into the southern shore of Lago Enriquillo. One area of apparently suitable habitat (dry creeks, open vegetation) remains to be investigated. It is an area of about 40 km^2, situated north of El Limón and east of Jimaní.

Cyclura ricordii is sympatric with *C. cornuta* in the region. A more detailed study is needed to define where *C. ricordii* appears to have a competitive advantage over *C. cornuta.* For

Bank of a dry streambed with two active dens.

Bank of a ravine with an adult male *Cyclura ricordii* in front of his den.



A satellite image of a dry streambed and surrounding area near Jimaní. Note the roads that lead to charcoal production areas. The small round circles are charcoal pits.

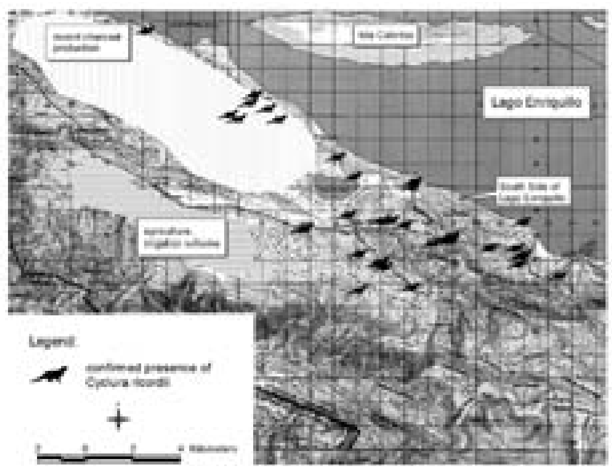
example, Thomas Wiewandt (unpublished field notes) visited one of the ravines ("Cañada de Guayabo") in 1975. He saw only *C. cornuta* (3 adults on 28 July and one adult and 3 juveniles the following day). We visited the same ravine on 25 May of this year and detected four adult and one juvenile *C. ricordii* and two adult *C. cornuta.*

The population structure of *C. ricordii* in this region seems to be healthy. Juveniles are seen regularly, indicating that successful recruitment is taking place and suggesting that nesting activities should also be plentiful. So far, we have only been able to detect one nest (12 eggs, all hatched). We assume that females do not move far from their dens to nest wherever suitable substrate is present. In the sandy soils of the area, they should have little trouble finding suitable sites.

Successful reproduction and a reasonable survival rate of juveniles may have been the key to the survival of the species in the zone to date. However, all of the adult animals can be quickly exterminated in a given area. Subsequent recruitment into such areas is therefore of vital importance.

Threats.—The major part of the zone where *C. ricordii* is present is not legally protected. It is not included in the Dominican national system of protected areas. Before law 202-04 was put into effect, all of the known distribution of these populations of *C. ricordii* was within the boundaries of Parque Nacional Lago Enriquillo. Law 202-04 reduced the protected habitat of *C. ricordii* to a small strip along the lakeshore, including the dry Laguna en Medio.

Intensive charcoal burning in the 1970s and 1980s practically eliminated all the original vegetation in the area, although Wiewandt noted relatively undisturbed vegetation in 1975. The main impact of charcoal production has been a reduction of plant species diversity combined with the introduction of aggressive species like mesquite (*Prosopis juliflora*) and a cholla-like cactus (*Cylindropuntia caribaea*). These two species and three other cacti (*Stenocereus histrix, Opuntia moniliformis, Neoabbotii*



Approximate extent of recent charcoal production and of an agricultural irrigation scheme.

A two-year-old juvenile *Cyclura ricordii* from the southern shores of Lago Enriquillo.

paniculata) dominate most of the current habitat of *C. ricordii* on the south side of Lago Enriquillo.

The effects of charcoal production on soil and ground conditions are not clear. We have found *C. cornuta* nesting in old charcoal pits in the area near Tres Charcos, which is close to Parque Nacional Jaragua, where animals seem to prefer the relatively open pits to the surrounding denser vegetation. We have not been able to verify the same situation along the southern shores of Lago Enriquillo.

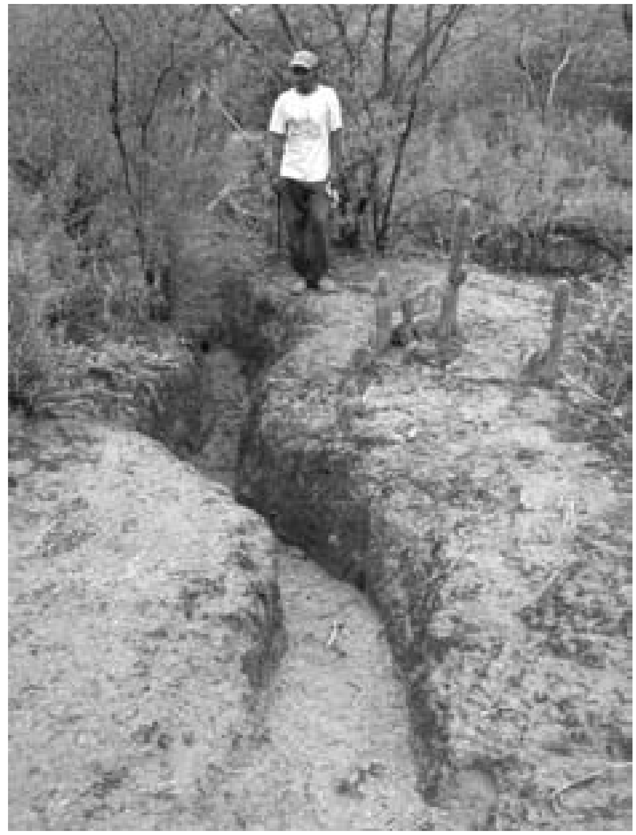
Iguana hunting is ongoing, involving an estimated 30 persons from the towns of Duvergé, Venganaver, and Baitoa. Hunters do not discriminate between *C. cornuta* and *C. ricordii* and, in fact, seem to possess little knowledge of iguanas. This is in sharp contrast to the situation in Pedernales, where persons with an excellent knowledge about iguanas can be found.

One method of catching iguanas consists of putting snares at the entrances of dens. Another method consists in closing the entrances of active dens with objects such as stones after iguanas have left their dens. The hunters then wait for the iguanas to return and hunt them with dogs. The most common practice is the excavation of dens. Some areas seem to have been "mined" for iguanas, with excavated dens nearly everywhere.

Recently, charcoal production has begun again in the region between the dry Laguna en Medio and the town of Duvergé, with most of the charcoal destined for Haiti. At present, little effort is being exerted to halt this illegal activity. Charcoal production and iguana hunting are closely tied. Whenever a charcoal pit is found, all dens in the area have been excavated, suggesting that charcoal production not only destroys valuable habitat, but that individuals engaged in such activities also engage in hunting iguanas.

Over the past few years, an agricultural irrigation scheme has been implemented southwest of El Limón, affecting an area where *C. ricordii* may have been present, although we lack the historical data necessary to confirm that assumption.

The concentration of dens in dry creek beds may constitute an additional threat to the species. Although creek beds may remain dry during many years, occasional floods can destroy dens because the marine sediments are only loosely cemented together and can easily be washed away. Effects of the flood that wiped out part of the town of Jimaní in 2004 illustrate the risk to dens in the region.



An excavated iguana den approximately 8 m in length.

A stand of cacti (*Stenocereus histrix*) surrounded by mesquite (*Prosopis juliflora*).

A gravid female *Cyclura ricordii* inside her den.

A recently abandoned charcoal pit.

Conservation Measures.—We had entered into a process with the local government (town hall) of Duvergé to delimit, declare, legalize, and administer the zone as a municipal protected area. A change in the political composition of the town council of Duvergé in August halted the process, which has yet to be reinitiated. Our studies on the distribution of the species have shown that a substantial part of Ricord's Iguana habitat lies within the jurisdiction of the town of Jimaní. This also is the portion of the range most affected by current charcoal production. A principal focus of our efforts will be to involve the town of Jimaní in conservation activities directed toward the designation of a municipal protected area. Corresponding regional and national authorities are being addressed regarding the illegal charcoal production in the Jimaní area.

A local group, "CIELO," in Duvergé has been actively supporting our efforts. With their help, we mounted a teachers' workshop in August. This program was developed in cooperation with the Indianapolis Zoo and ZooDom (the national zoo in Santo Domingo). Teachers have expressed considerable interest in units addressing the nation's natural heritage, of which Ricord's Iguana comprises an important element. Establishing a local support group in Jimaní and implementing additional workshops for teachers are critical if the local authorities are to become interested in conservation.

Acknowledgements

We thank the International Iguana Foundation for its support of this work.

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SPECIES PROFILE

Hispaniolan Lesser Racer (*Antillophis parvifrons*)

Robert W. Henderson

Milwaukee Public Museum, Milwaukee, Wisconsin

Certainly the most ubiquitous snake species on the Greater Antillean island of Hispaniola (including many of its satellite islands) is the colubrid *Antillophis parvifrons.* It is a slender snake with a maximum snout-vent length (SVL) of 530 mm. Dorsal ground color is variable (brown, black, gray, or bluish), and the dorsum may be patternless or with middorsal and dorsolateral stripes. The species occurs in habitats ranging from xeric scrub to rainforest. These snakes appear to be highly seasonal breeders in dry habitats, but may exhibit prolonged or even continuous breeding activity in moister situations at higher elevations.

A fast-moving, ground-dwelling, diurnally active snake, it can be found in orchard and plantation situations (e.g., banana, breadfruit, cacao, coconut, coffee), where it may be observed cruising through leaf litter or concealed in coconut or banana trash. It appears to do well in greatly altered habitats and is often encountered near human habitations.

Antillophis parvifrons is an active forager that feeds on a wide array of frogs (*Osteopilus*, *Eleutherodactylus*) and lizards (*Sphaerodactylus*, *Anolis*, *Leiocephalus*, *Celestus*, *Ameiva*), but *Anolis* accounted for nearly 71% of all prey items in a sample of almost 200 snakes. In contrast, frogs of the genus *Eleutherodactylus* accounted for only 12% of prey items. Although small mammals (*Mus musculus*) are occasionally taken, they are not typical fare (2.2% of the sample).

Groups of three to five individuals have been found together on Île-de-la-Gonâve (Haiti), perhaps in a breeding situation. Clutches of 2–15 eggs have been reported, and clutch size is positively correlated with female SVL. When threatened, some individuals will raise the forepart of the body and the neck will become flattened dorsoventrally, reminiscent of some species of West Indian racers (*Alsophis*).

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JAMES D. FORESTER

The Hispaniolan Lesser Racer (*Antillophis parvifrons*) occurs in habitats ranging from rainforest to xeric scrub, such as that found in the area around Lago Enriquillo.

A Texas Horned Lizard (*Phrynosoma cornutum*) in native grass at Tinker Air Force Base, Oklahoma.

Studying a Population of Texas Horned Lizards (*Phrynosoma cornutum*) in an Urban/Military Environment

Raymond W. Moody[1], Debora A. Endriss, Eric C. Hellgren, and Stanley F. Fox

[1] Biologist, Natural Resources Program
72nd ABW/CEVOE, 7701 Arnold St, RM 109
Tinker Air Force Base, Oklahoma, 73145-9100 USA
(raymond.moody@tinker.af.mil)

Photographs and graphics by the senior author.

Abstract.–University researchers from Southern Illinois (SIU), Oklahoma State (OSU), Virginia Tech (VT), and Federal agencies have come together as partners to learn more about the Texas Horned Lizard (*Phrynosoma cornutum*) at Tinker Air Force Base (AFB) in Oklahoma. Although listed as a state "Threatened" species in Texas, the lizard is a state "Species of Special Concern" in Oklahoma due to uncertainty regarding its status and lack of population data, making it a species of considerable conservation interest. Researchers at Tinker AFB are using tools such as handheld computers, passive integrated transponder (PIT) tags, global positioning systems (GPS), radio-telemetry, and geographic information systems (GIS) for gathering and interpreting biological data on Texas Horned Lizards. Over the last four years (2003–2006), 174 individual lizards have been captured and over 1700 capture locations and associated data have been recorded in the GIS lizard-tracking database. These data are beginning to reveal aspects of morphology, distribution, habitat requirements, home ranges, and hibernation characteristics as well as details of its myrmecophagous (primarily ants) diet. Population sizes (± 1 SE) within Tinker AFB's urban wildlife reserve are estimated to be 53 ± 11 individuals with a density of 5.0 ± 1.0 lizards/ha. Utilization of these tools opens the door for different ways of studying horned lizard habitat requirements and population trends. They also provide powerful insights for better managing a sensitive species on a busy military installation as well as in an ever-changing urban setting.

A great wealth of knowledge is beginning to unfold about the Texas Horned Lizard (*Phrynosoma cornutum*) through partnerships and contributions from many agencies, universities, and conservation groups. On the frontline of this research is the United States Air Force!

Tinker Air Force Base (AFB) is the largest single-site employer in the State of Oklahoma and home to large-bodied aircraft such as the E-3 Sentry, E-6A, and the KC-135 refueling

Texas Horned Lizard (*Phrynosoma cornutum*), a Species of Special Concern in Oklahoma.

Military training on a busy Air Base. Both the lizard and the military require access to the base's resources.

tanker. It is one of the world's largest aircraft depot maintenance facilities — but it is also home to the Texas Horned Lizard, an Oklahoma State Species of Special Concern and a Threatened species in Texas (ODWC 2006, TPW 2006).

The lizard is experiencing declines throughout its range, particularly in Texas (Price 1990) but also in Oklahoma (Carpenter et al. 1993). How then is it possible for a highly industrialized air force base nestled within a major metropolitan area to have a population of Texas Horned Lizards? A frequent comment heard in Oklahoma is: "I used to see them all the time." Is this just a reflection of people not getting out these days? That seems unlikely, however, considering the increasing popularity of outdoor activities such as wildlife watching.

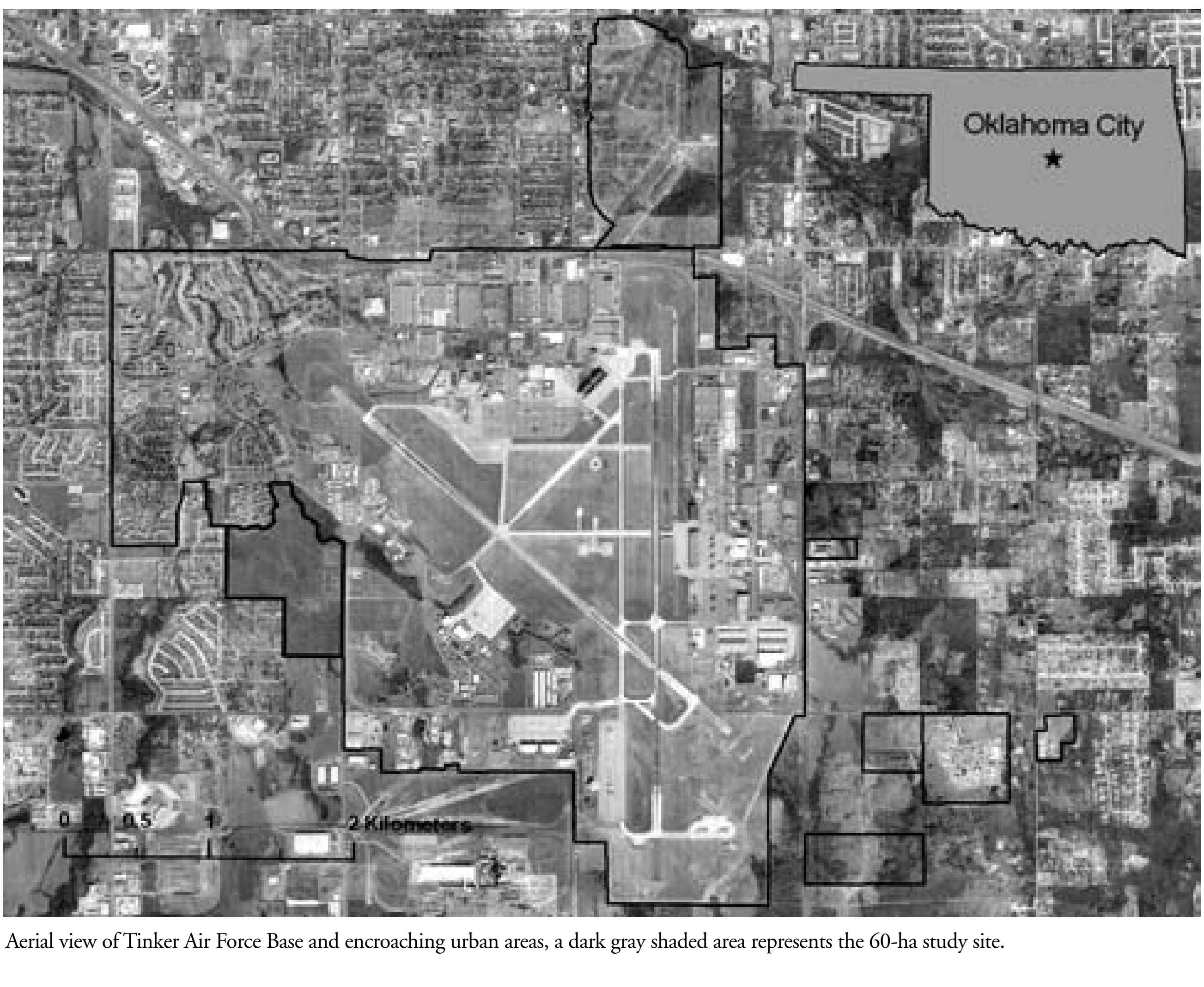
U.S. Fish and Wildlife Service (1999) surveys indicate that wildlife-related activities doubled between 1980 and 1995. From 1991–2001, no significant statistical change occurred in these types of activities (USFWS 2001). So, could habitat loss and alteration from development be a more likely cause? Carpenter et al. (1993) surveyed new landowners who reported seeing horned lizards when they first moved into a new housing development followed by quick disappearance of the lizards. Or is the decline in populations a combination of other factors? Many authors have suggested that insecticides (direct effects and prey base alteration), agricultural practices, irrigation, mowing, tilling, over-collection for the pet trade, increased predation, and roadkill (Price 1990, Carpenter et al. 1993, Donaldson et al. 1994) are reasons for declines. Interestingly, all of these factors are connected to urban development, which seems to be the common link.

These factors and the fact that Tinker AFB has a healthy population of lizards raise many other questions for a natural resources biologist managing land resources on a busy military installation. That's part of what the research at Tinker is about — how can the lizard and the military mission coexist in harmony.

Study Site and Objectives

The 2,000-ha Tinker AFB is situated in a transition area between Oklahoma City and rural settings, with major metropolitan areas immediately north and suburban/rural areas to the south. This also is reflected on the base, with industrial and community settings concentrated in the north fading into airfield and fragments of developed and undeveloped land plots and relatively undisturbed greenways to the south. The focal point of the study is within and around a 15-ha Wildlife Reserve, part of the base's Urban Greenway.

The approximately 60-ha study site is characterized by prairie, patches of riparian vegetation, shrubs, and transitional woodlands. Dominant native species at the site include Little



Aerial view of Tinker Air Force Base and encroaching urban areas, a dark gray shaded area represents the 60-ha study site.

Bluestem (*Schizachyrium scoparium*), Big Bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and Maximilian Sunflower (*Helianthus maximiliani*). Other native species include Side Oats Grama (*Bouteloua curtipendula*), Eastern Red Cedar (*Juniperus virginiana*), and American Elm (*Ulmus americana*). Prominent non-native species include Oldworld Bluestem (*Bothriochloa ischaemum*) and Tall Fescue (*Lolium* sp.), with some small patches of Chinese Lespedeza (*Lespedeza cuneata*) usually associated with Maximilian Sunflower (Dorr et al. 2003).

Measuring the total body length of a Texas Horned Lizard.

Texas Horned Lizard in hand showing an elastic collar and transmitter mounted on its back.

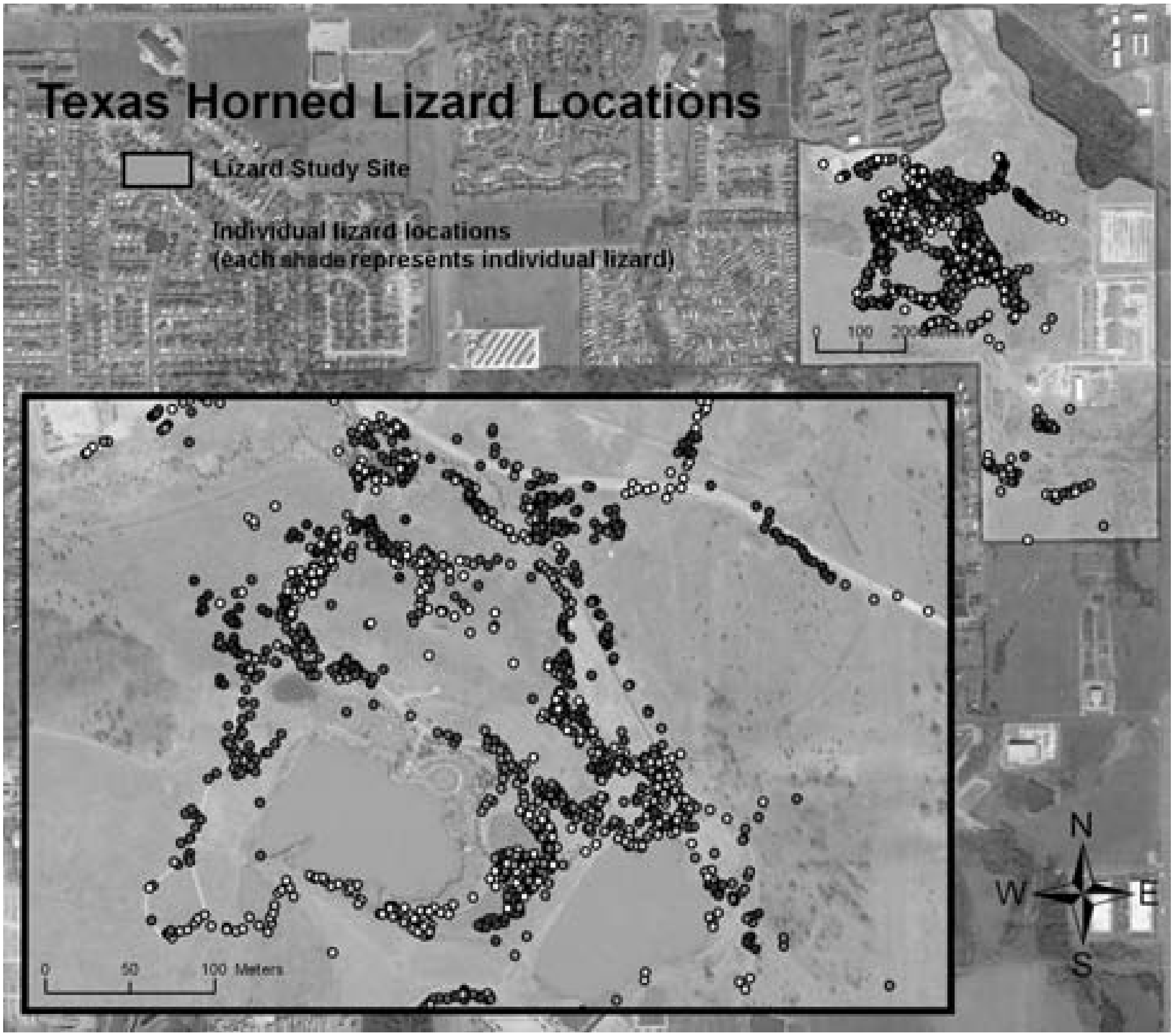
Biologist Ray Moody with Debora Endriss locates a Texas Horned Lizard within Wildlife Reserve 3 using radiotelemetry.

The major focus of the study was to better understand the ecology of the Texas Horned Lizard, particularly in fragmented urban type habitat. Specific objectives of the study included: (1) Determination of distribution, (2) determination of habitat requirements, (3) understanding behavior and demography, and (4) determination of population status and trends.

Materials and Methods

Horned lizards were captured by hand during fortuitous encounters on trails, roads, along areas of bare ground and in the brush. Morphological (sex, body mass, snout-vent length, and total length) and various habitat measurements were taken and if large enough, lizards were taken back to the lab for processing with tags and radio transmitters. Passive integrated transponder (PIT) tags were implanted for identification of individual lizards. One of two different sizes of transmitters (Holohil Inc., Model: BD-2, 1.8 and 1.3 g) was mounted on the lizard's back with superglue and an elastic collar (Hellgren et al. 2004). Over the last year silicone was substituted for superglue which seems to be less abrasive to the lizards and much easier to remove when exchanging transmitters. Select lizards that were too small for transmitters were tracked using fluorescent powder.

Debora Endriss records microhabitat data and GPS coordinates for lizard locations.



Expanded view of individual lizard locations at the study site; dots of different shades represent localities for individual lizards. Many lizard locations are stacked on top of one another at this scale, which maps over 1700 locations.

Movements of individual lizards were monitored through radiotelemetry. Lizards were relocated 1–5 times per week during the summer months and once per week or less during the fall until they entered hibernation. Global Positioning System (GPS) coordinates and microhabitat characteristics (%–grass, forb, shrub, tree, bare ground, rock, litter) for each lizard location were determined and entered into the GIS lizard tracking database. Hibernation sites were also marked and data recorded for site characteristics (e.g., depth, soil type, slope, aspect). Data were recorded using hand-held computers (IPAQ and GeoXT) equipped with GPS (Trimble GPS Pathfinder Pocket Receiver) and customized ArcPad 6.02 software. Data were differentially corrected and imported into ArcMap 9.1 (ArcGIS Version 9), which was used to develop a GIS layer for the lizards at Tinker. Once lizards entered and stayed in hibernation sites, wire mesh cages were placed above them for capture and release with new transmitters when they emerged from hibernation in the spring (Endriss 2006).

Results and Discussion

Researchers collected data over four years starting in the summer of 2003, focusing on the active summer months and also tracking lizards into the fall and start of the hibernation period. Population sizes (± 1 SE) within Tinker AFB's urban wildlife reserve are estimated to be 53 ± 11 individuals with a density of 5.0 ± 1.0 lizards/ha. The lizard GIS layer has 174 individual lizards with over 1700 capture/relocation points, which readily portray macrohabitat use, home ranges, nesting and hibernation sites on high-resolution digital ortho-quad color aerial photographs (9 cm/pixel resolution).

Some observations that have potential management implications are starting to emerge. For instance, lizards at Tinker were much smaller (average snout vent length for females was 68.4 mm; for males 59.4 mm) than those that have been studied farther south (Hellgren et al. 2004). These findings contradict Bergmann's rule, which proposes an increase in animal body sizes with an increase in latitude (Ashton and Feldman 2003).

Texas Horned Lizard cooling itself on gravel nature trail.

Texas Horned Lizard peering over Oldworld Bluestem.

Texas Horned Lizard just prior to emergence from hibernation.

Texas Horned Lizard peering through native Bluestem.

Texas Horned Lizard resting in small tree.

Five Texas Horned Lizards sluggish after removal from hibernacula on a cool spring morning.

Texas Horned Lizard with an old-style transmitter and pack at nest entrance.

Hatchling Texas Horned Lizards emerging from nest site.

Stark (2000) and Burrows et al. (2001) found lizards to utilize a mosaic of vegetation types from bare ground to areas densely vegetated with forbs and grasses. Fair and Henke (1998) and Burrows et al. (2001) indicated that Texas Horned Lizards require a mixture of open and vegetated habitats to meet thermoregulatory requirements. This was apparent in our study, with lizards using grasses, forbs, shrubs/small trees, and bare ground. When lizard locations where compared with GIS vegetation layers, no preference was shown regarding vegetation type, other than an apparent avoidance of Red Cedar shrubland. In addition, some areas that were known to be more densely vegetated and isolated from bare ground and trails were lacking in lizard locations. GIS layers also showed home ranges to be closely associated with graveled nature trails and paved walking/jogging trails (Endriss 2006). Vegetation structure and availability of bare ground seems to be more important to lizards than the vegetation species type (i.e., whether native or not). Therefore, gravel and paved trails within the study site are likely very important for thermoregulation and movement between habitat resources.

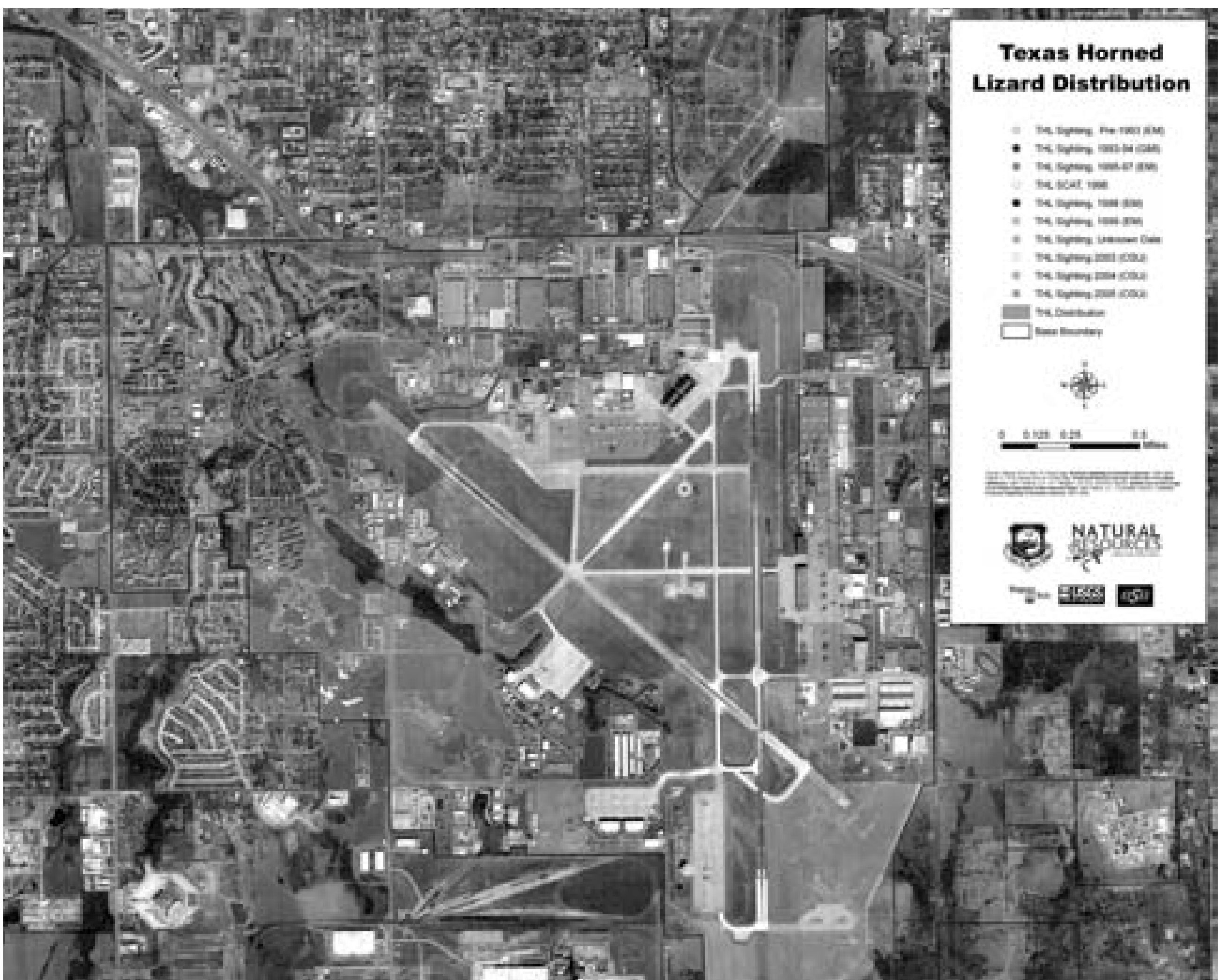
Lizard home ranges were determined with the aid of the GIS layer. They averaged 0.84 ha for adult females and 0.90 ha for adult males (95% fixed kernel method, Arc View 3.3 extension). Sixteen lizards were tracked to hibernation sites, where characteristics such as hibernation period (5.5–7.0 months), slope aspects (facing south-southwest), and soil depths (2–12 mm) were recorded. Ten lizards were tracked to nesting locations, where nest depths of 5.0–7.5 cm were found (Endriss 2006). Characteristics such as these are important factors to consider for planning land management activities such as prairie restoration efforts (e.g., spraying, mowing, tilling, disking, and prescribed burning).

Land managers often use prescribed burning for prairie management. Timing of these events is very important for Texas Horned Lizard management.

Capture locations and other documented historical sighting locations were used to construct a distribution layer for lizards. This was accomplished with the buffer tool in ArcMap, creating 360-m (maximum home range length) buffers around all lizard locations, and then eliminating known unfavorable habitat. Knowing distribution and potential habitat areas for the lizards allows for consideration in planning of base development, as well as the ability to prescribe mitigation when conflicts arise. Populations of Texas Horned Lizards often have a localized distribution, and thus can survive in protected areas within an urban environment (Endriss 2006). For example, populations of horned lizards often are found in small city parks and vacant lots (Carpenter et al. 1993, Donaldson et al. 1994, Stark 2000). Military bases often find themselves with islands of relatively undisturbed habitat as urban development encroaches upon them. Apparently, on Tinker, all the right natural resources, including habitat and prey, are available to sustain a viable population of Texas Horned Lizards.

Spraying herbicide on turf to restore the area to native grass.

Learning more about horned lizards and other sensitive species is important, and knowledge garnered is vital to proper management of these species, especially in highly dynamic environments such as an industrialized military installation. This unfolding of Texas Horned Lizards life history and ecology at Tinker AFB may be key to understanding the lizard in other



Texas Horned Lizard distribution on Tinker AFB showing historical and recent survey locations. Isolated sightings within potentially favorable habitat have occurred outside the main study area.

The white middorsal line of the Texas Horned Lizard is cryptic, providing excellent camouflage in a native grass environment where the stripe mimics dead plant stems.

environments. We hope that this knowledge will foster informed management and decision-making regarding the species across its range. Such management in return would promote more robust and stable populations. This would lessen the potential for federal or state listing as threatened or endangered species, thereby precluding potential land use and other restrictions on the military and private landowners. In this scenario, both humans and nature win.

Acknowledgements

Work on this study could not have been accomplished without the help of many partners. Special thanks go to colleagues who have worked so hard in the field: Joe Hackler, Vic Bogosian, and Matt Johnson. Jessica Dorr and Jennifer McCanne provided GIS support and Clark Baker arranged field housing facilities.

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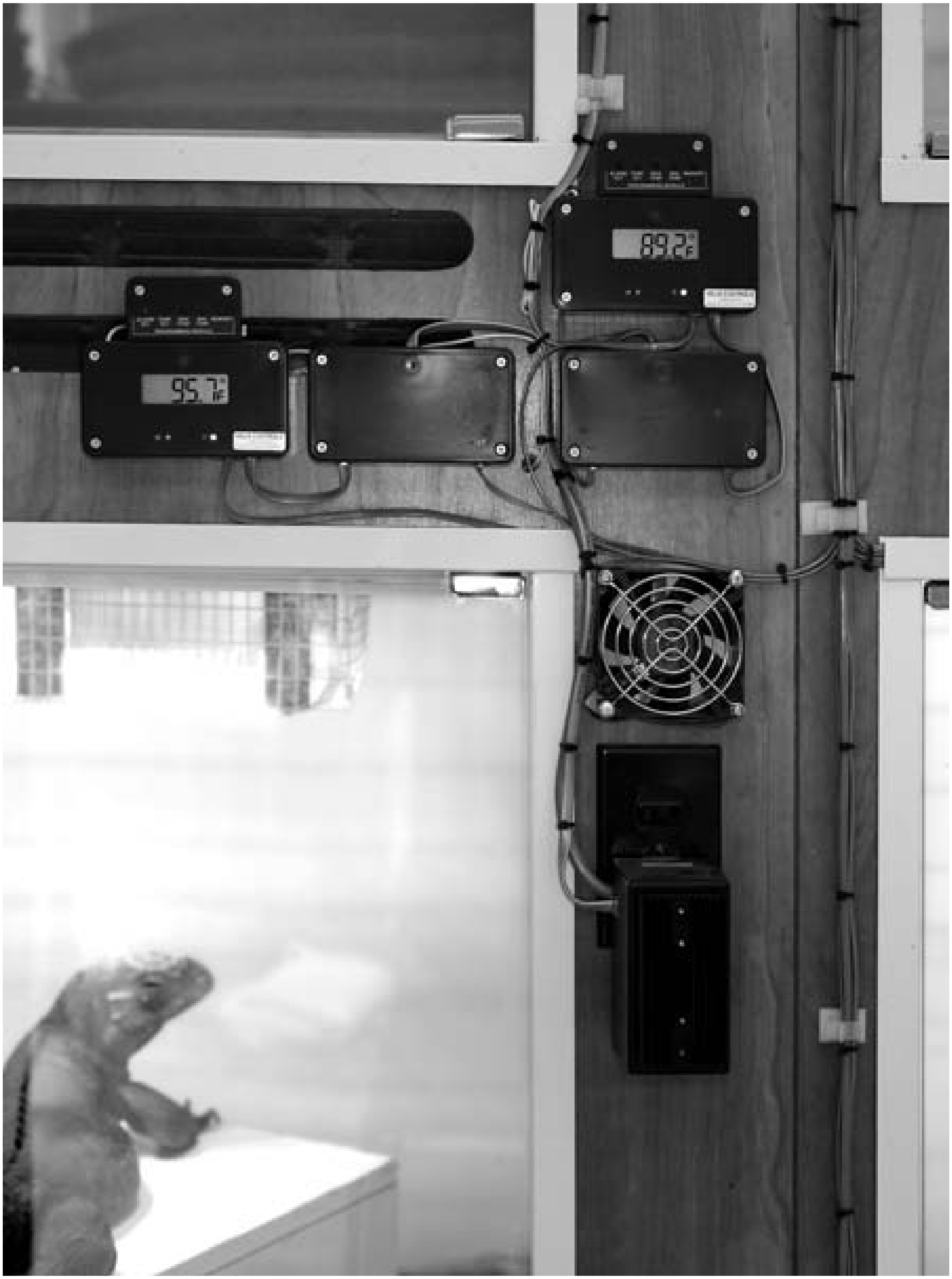
United States Fish and Wildlife Service (USFWS). 2001. *National Survey of Fishing, Hunting, and Wildlife Associated Recreation – National Overview.* USFWS Report, May 2001. Department of the Interior, Washington, D.C.

Educational signs alert humans to lizards on the base.



Full-spectrum lighting and heat in the Sandy and John Binns vivaria are controlled electronically and equipped with safeguard alarms. The system above simulates three periods of light: morning sunrise, day, and sunset (moonlight is optional). Temperature is electronically controlled to maintain two periods of a diurnal cycle that correspond to day and night. A ventilation system continually refreshes air quality. Should the system fail and go into thermal-overload, a sensor kills lighting and heating and activates a fan to ventilate the enclosure. Any system failure activates an audible alarm, and sends a coded message to a beeper or telephone.

HUSBANDRY

Aspects of Light and Reptilian Immunity

Henry Brames

Reptile Clinic, Munich, Germany

Effective reptilian husbandry is important to hobbyists and zoos, where many species are raised in captivity as a component of conservation projects, but also because reptiles are used as laboratory models in bioscience research and even in farming ventures that raise them for pets, food, and raw materials. Reptilian biology and physiology are very different than those of endothermic vertebrates (birds and mammals). Preventive reptilian medicine means improving human-reptile relationships and supporting a well-regulated reptilian immune system. Light is an important factor in this effort, and light means something different to reptiles than to us humans. To illuminate the effects of light on reptilian immunity, we must examine the reptilian immune system, the properties of light, and reptilian light perception.

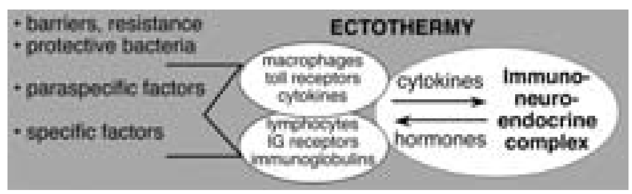
The Reptilian Immune System

Reptiles are positioned phylogenetically between higher and lower vertebrates and, in terms of evolutionary development, their immune systems are similarly intermediate. Immunologists distinguish between nonspecific defense mechanisms, such as barriers (skin and gut mucosa), protective bacterial flora, and natural resistance, and the complex immune system (IS), within which we distinguish between paraspecific (innate) and specific components. The cellular/molecular agents of the paraspecific IS include macrophages, cytokines, and toll-like receptors (which facilitate the recognition of a wide range of microbial molecules), whereas the specific IS utilizes lymphocytes, immunoglobulins, and immunoglobulin-superfamily-receptors. "Immunity" is much more than just antibodies (= immunoglobulins). The modern specific IS is functionally based on the ancient paraspecific IS; life without the paraspecific IS is impossible. The reptilian paraspecific IS is very well-developed, whereas their specific IS is handicapped by the lack of lymph nodes and germinal centers, and by having a reduced variety of immunoglobulins that, in turn, have some functional limitations. Furthermore, constraints imposed by reptilian ectothermy places a heavy reliance on the paraspecific IS alone.

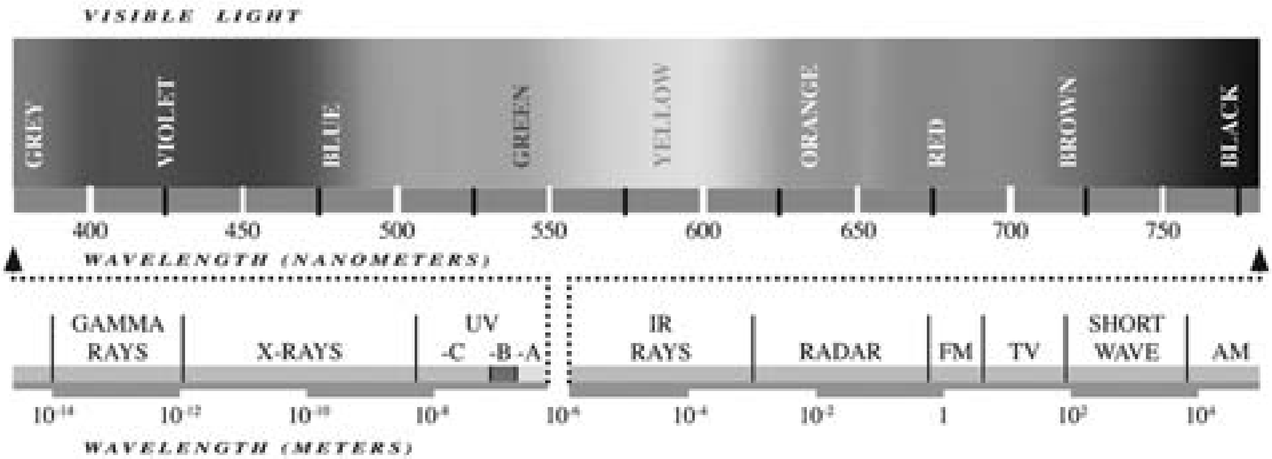
In conclusion, the reptilian IS is heavily paraspecific. Overall, the reptilian IS acts to permanently monitor the body's integrity. It communicates with and regulates other functions, such as metabolism and neural and endocrine activities, and is affected by them in turn. These systems together form the immuno-neuro-endocrine network. For example, immune-cell cytokines trigger the hypothalamus, which responds by releasing hormones that regulate the immune cells. This scenario provides some idea of how light may influence the reptilian IS.

Light

Light on earth is a continuous spectrum of electromagnetic radiation from the sun that has been filtered through kilometers of atmosphere. Conceptually, we divide the "light" portion of this spectrum (= the photo-environment) into bands of different wavelengths (measured in nanometers = nm) that range from infrared to ultraviolet, with the portion of the spectrum visible to humans limited to red, green, blue, and the wavelengths in between (i.e., we see only red, green, and blue, and all other colors are mixed in our brain depending on wavelength composition and intensity). This view is heavily anthropocentric and based solely on human photoreceptor design (eyes, retina) and human information processing (brain). The infrared wavelengths that are invisible to us are perceived as heat, and the equally invisible UV-A spectrum tans our skin, while UV-B helps synthesize vitamin D3 within our bodies. The portions of the spectrum visible to humans supply color and contrast for habitat orientation. The hue that humans perceive depends on



A variety of environmental and biological factors modulate an effective reptilian immune system. Barriers include structures like skin and gut mucosa that prevent entry and retention of invasive pathogens. In addition to barriers, natural resistance against specific pathogens (an alligator, for example, is resistant to tetanus toxins) and defensive surface flora comprise the three parts of the unspecific defense system. The body's paraspecific (innate) and specific (acquired) immune systems enable it to attack various dangerous substances, infectious pathogens, toxins, and transformed cells of the organism itself. These components form what we call the complex immune system. Innate, inherited paraspecific components include macrophages (a type of white blood cell that consumes foreign material and releases substances that stimulate other cells of the immune system), their toll-like receptors (proteins sensitive to exposure to molecular substances that are associated with some pathogens), and cytokines (small proteins released by cells that affect interactions between cells; cytokines include a variety of agents that, among other things, trigger inflammation and respond to infections). Specific components are cloned or activated only after exposure to a foreign dangerous substance (an antigen); these include lymphocytes (small white blood cells that produce antibodies [= immunoglobulins] that recognize and attach to bacteria and toxins or body cells that have been taken over by viruses or have become cancerous). These customized receptors are part of the body's immunoglobulin-superfamily-receptors and enable lymphocytes to attack dangerous materials. Hormones are chemical messengers secreted into blood by endocrine organs and transported to specific target cells, the functions of which are regulated in various ways. Hormonal (endocrine) activities and neural and immune functions correspond closely and interact within the immuno-neuro-endocrine network. Ectothermy is the ability to regulate internal body temperature behaviorally by exploiting environmental sources of heat.



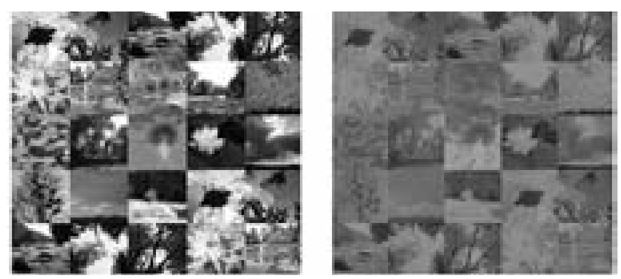
Light visible by humans is but a very small region of the entire spectrum. Note that humans see only three colors (red, green, blue) and all other visible colors are mixed in our brain depending on wavelength composition and intensity. However, reptiles apparently see four colors, the same three that we see plus at least some wavelengths of ultraviolet (UV) light, and pitvipers and at least some boas and pythons can see five, those seen by other reptiles plus infrared (IR) light. Consequently, the reptilian perception of the visible world is quite different from our own, something that must be considered when designing lighting systems capable of sustaining healthy animals.

the "color temperature" of light (usually expressed in degrees Kelvin [° K]), and that, in turn, depends on which wavelengths are filtered out by the atmosphere. "Warm" reddish hues dominate when blue is filtered (about 3000° K) and reds are emphasized, such as at sunrise and sunset, when the sun is low on the horizon and light must travel a greater distance through the atmosphere. "Cool' bluish hues prevail when the red spectrum is filtered (to ~10000° K) by, for instance, cloud cover, and the blue spectrum is favored. Sunny daylight lies at ~6000° K. Another aspect of light is the intensity received (illuminance). Illuminance depends on latitude, season, time of day, and degree of cloud cover, and is measured in lux, calculated as "adjusted watts"/m^2 = lumens/m^2 (watts weighted at human spectral sensitivity).

Is this the same for reptiles? How do reptiles see the world? What do reptiles perceive of the electromagnetic spectrum, the photo-environment? Reptiles see hues and lux that we hardly can imagine. Let's take a "reptocentric" look at the "visible" spectrum to clarify some anthropocentric misunderstandings.

Reptilian Light Perception

Microanatomical studies of lateral eyes show that most mammals are dichromats (have two different types of cones [= receptor cells that respond to different wavelengths of light]). Humans and Old World primates are trichromats (three cone types with peak sensitivities in red, green, and blue, covering 400–700 nm). Reptiles are tetrachromats with a fourth cone type for UV-A below 400 nm. Additionally, the peak sensitivities of the red, green, and blue cones are shifted slightly when compared to those of humans. Reptiles see in the UV-A range and use spectra differently. Behavioral studies show that UV-spectra and reptile-correct color rendering of artificial light settings is not only necessary for conspecific, interspecific, and intersexual recognition, but that brightness and contrast also are critical for motion perception and foraging, and probably also for maintaining a sense of well-being ("happiness") in reptiles.



The problem of providing an optimal reptilian photo-habitat with artificial light (non-continuous spectrum or lacking UV-A) is that they are optimized for human sensitivities rather than for those of reptiles. To illustrate what insufficient light might be doing to reptiles, notice the difference in the quality of this image (even in grayscale) when one of the three primary colors (in this case, blue) is deleted from digitized photographic images.

MARK DE SILVA

The parietal eye is a photosensory organ connected to the pineal body, active in triggering hormone production (including reproductive hormones) and thermoregulatory behaviors. It is sensitive to changes in light and dark, but does not form images, having only a rudimentary retina and lens. It is visible as an opalescent gray spot on the top of some lizard's heads; the parietal eye also is referred to as a "pineal eye" or "third eye." Although the parietal eye of this Grenada Bush Anole (*Anolis aeneus*) is quite prominent, those of many lizards are difficult to see.

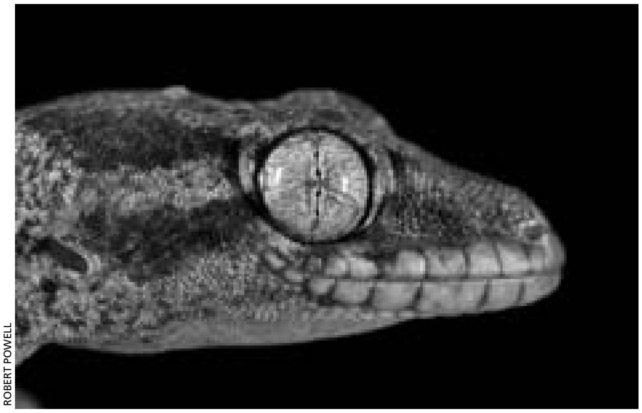
This illustrates the difficulty of providing an optimal reptilian photo-habitat with artificial light. Light fixtures providing a non-continuous spectrum or one lacking UV-A do not bother humans, but may dramatically affect reptiles. Artificial lighting has been optimized for human sensitivities rather than reptilian demands.

Another photoreceptor present in reptiles is the so-called "third" or pineal eye and the associated pineal gland. Pineal cells show the highest sensitivity to wavelengths of 600–750 nm, and are an effective light dosimeter with resulting thermal, immune, and reproductive regulatory consequences.

Additionally, some reptiles can see precisely even at night by exploiting the infrared portion of the spectrum. Pit vipers and boid and pythonid snakes use infrared sensors and sophisticated signal processing that operates like an image-improvement algorithm to precisely monitor their surroundings from emitted infrared in the dark.

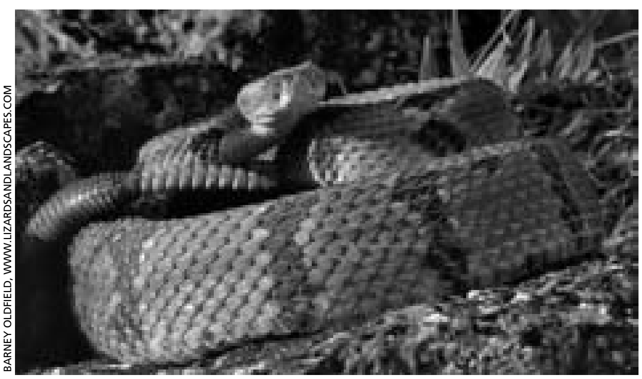
Humans use rods (receptor cells that are very sensitive to low light intensities) rather than cones for black and white vision under dim conditions. Surprisingly, geckos, most of which are nocturnal, lack rods, but have instead very sensitive cones for night color vision.

We do not know precisely nor can we really appreciate how reptiles see their environments, but we definitely know that the reptilian immune system can "see" the world. Where is the connection between light and the immune system?



ROBERT POWELL

Most geckos are nocturnal, but surprisingly lack rods (which are most active in mammalian night vision), instead having extremely sensitive cones that also allow color vision. The series of pinholes visible in the eye of a Turnip-tailed Gecko (*Thecadactylus rapicauda*) from St. Vincent come into play only when the vertically slit pupil constricts when exposed to bright light. Slit pupils, found in many nocturnally active animals, allow a greater range of light entry than a round pupil, because they are able to expand greatly in dim light. Slit pupils are particularly useful in combination with aspherical lenses, as they allow an image to be focused properly regardless of width. When light is bright, the pinholes block out more light than even a very slender simple pupil, while still allowing the eye to focus effectively.



BARNEY OLDFIELD, WWW.LIZARDSANDLANDSCAPES.COM

JOSEPH M. POLANCO

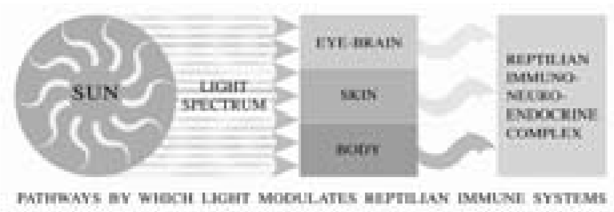
Pitvipers, such as this Timber Rattlesnake (*Crotalus horridus*, top), and boas and pythons, such as this Emerald Treeboa (*Corallus caninus*), have heat-sensitive pits that extend vision into the infrared spectrum. Although usually associated with targeting homeothermic prey, they also may function in precise predator shape detection and evaluation of habitats suitable for ambushing prey or use as refugia.

Light and Its Immune Effects

Whole-body-mediated light immune effects.—Reptiles are solar powered. As ectotherms, reptiles maintain their optimal body temperatures behaviorally. They depend directly on the infrared portion of the light spectrum as a source of heat (via basking) and indirectly on convection (from warm substrates and warm or cool burrows). Warming light is a pivotal factor in regulating reptile microclimates and microhabitats. This solar energy is a critical underpinning for well-functioning reptilian immune metabolism. The specific IS is more susceptible to temperature changes than the paraspecific IS, due to simple chemical and more complex biochemical reasons (the hypothalamo-pituitary-adrenal axis and the hormone corticosterone). During winter and in other unfavorable conditions, when specific antibodies are depleted, reptiles have to rely solely on the paraspecific IS.

Light also serves to dry the skin, providing a less comfortable surface for the growth of bacterial pathogens while promoting the growth of defensive bacterial flora. Finally, UV light itself has a direct disinfectant action. Body movements and gut peristalsis to prevent bacterial overgrowth are dependant on appropriate body temperatures and, last but not least, in combination with vision, light allows foraging and digestion to take place in order to supply the reptilian immune system with nutrients.

Eye-brain–mediated light immune effects.—In addition to the nonspecific radiation support to the reptilian defense system, other more sophisticated light effects influence reptiles' complex immune systems. The lateral eyes transduce light signals to the brain vision center and, via an alternate pathway, to the hypo-



Full-spectrum light, monitored by eyes (paired and parietal) and infrared sensors (pit organs and heat receptors on the surface and in the interior of the body), can dramatically affect the efficacy of reptilian immune systems.

thalamo-pituitary axis. From there, modified hormone patterns are created. These have a dramatic influence on reptilian immune systems. The pineal eye regulates serotonin and melatonin synthesis in the pineal gland depending on the degree and rhythm (daily or seasonal) of light exposure. Both neuro-hormones modulate the reptilian immune system.

Skin-mediated light immune effects.—Immune cells under the skin react directly to the deep-penetrating (red) portion of the spectrum and modify immune function. Further, UV-B regulates vitamin D3 endosynthesis in the skin (the primary source of D3 in many reptiles), which then is hydroxylated to bioactive calcitriol (1,25-hydroxy-cholecalciferol). Cytokines, such as interferons, trigger immune cells to D3 hydroxylation and immune cell populations (macrophages) are upregulated via calcitriol receptors. Calcitriol also attaches to immune cells to stimulate production of antibacterial agents. That might also explain the anticarcinogenic side effects of D3. Whereas calcitriol's regulating capacity on calcium metabolism is often mentioned, the direct D3 immune effects are overlooked. Also noteworthy is the fact that calcium itself plays an important role in long-distance immune cell communication via nanotubules.

Conclusions and Summary

For decades, herpetoculturalists have discussed the need for proper heating and lighting. Preventative reptilian medicine emphasizes the importance of a well-regulated immune system, and has found a strong link to proper lighting. Improving reptilian photo-environments (a combination of lamps, position, reflectors, control, and maintenance) is still and will continue to be a critical factor in the creation of appropriate habitats for captive reptiles. Proper lighting is a process not a bulb!

Veterinarians engaged in preventative reptilian medicine are aware and appreciate the technological advances in reptilian lighting. The movement has been from incandescent and halogen lamps to fluorescent full-spectrum tubes, compact lamps, metal halide lamps, self and external ballasted mercury vapor lamps, or combinations thereof. The latter are capable of providing reliable UV-B, UV-A, visible light intensities, and color temperatures. LED-lamps may hold promise for the future.

Properly controlled lighting systems and maintenance are necessary for reptilian enrichment, which should be a major concern for responsible herpetoculturists. Given that over 9,000 rep-

JOHN BINNS

PROPER LIGHTING IS A PROCESS, not a bulb. Establishing lighting systems necessary for maintaining optimally regulated reptilian immune systems (= healthy reptiles) is a complex network of several processes involving initial choices, extensive planning, effective implementation, and ongoing monitoring, maintenance, adjustments, and improvements.

JOHN BINNS

Lighting necessary for the maintenance of healthy reptiles involves a sequence of processes that only begins with the choice of lights. Not only must lighting provide the proper spectral range for vision, but intensities and photoperiods play important roles in regulating reptilian immune and endocrine systems. Well-designed lighting systems, such as these in the Sandy and John Binns vivarium, require research, experimentation, and constant monitoring. Proper lighting is a process, not a bulb!

tilian species occupy almost as many varied microhabitats, no single form of illumination will address all needs. An upcoming topic of concern is the misinterpretation of geographic climate data versus microhabitat demands and the ensuing chronic overradiation.

Reptiles perceive light differently than humans and other mammals. They are tetrachromats with additional perception in the UV-A range below 400 nm and their red, green, and blue cones have shifted peak sensitivities when compared to those of humans. Due to ectothermy and a consequent heavy reliance on the paraspecific immune system, light not only modulates but also provides pivotal support for reptilian immuno-neuro-endocrine networks. Endosynthesis of vitamin D3 via UV-B is important for mineral metabolism and also for immune regulation. Veterinarians, technicians, scientists, and hobbyists must be aware of the many different aspects of light-dependent reptilian physiology, and they and their reptiles will benefit tremendously from further investigations in this area. Proper lighting is a process not a bulb.

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Gharials (*Gavialis gangeticus*) are massive crocodilians with long, slender snouts equipped with sharp teeth ideally suited for capturing fish in deepwater portions of riverine systems on the Indian Subcontinent.

The Gharial: Going Extinct Again[1]

Romulus Whitaker
and Members of the GMTF

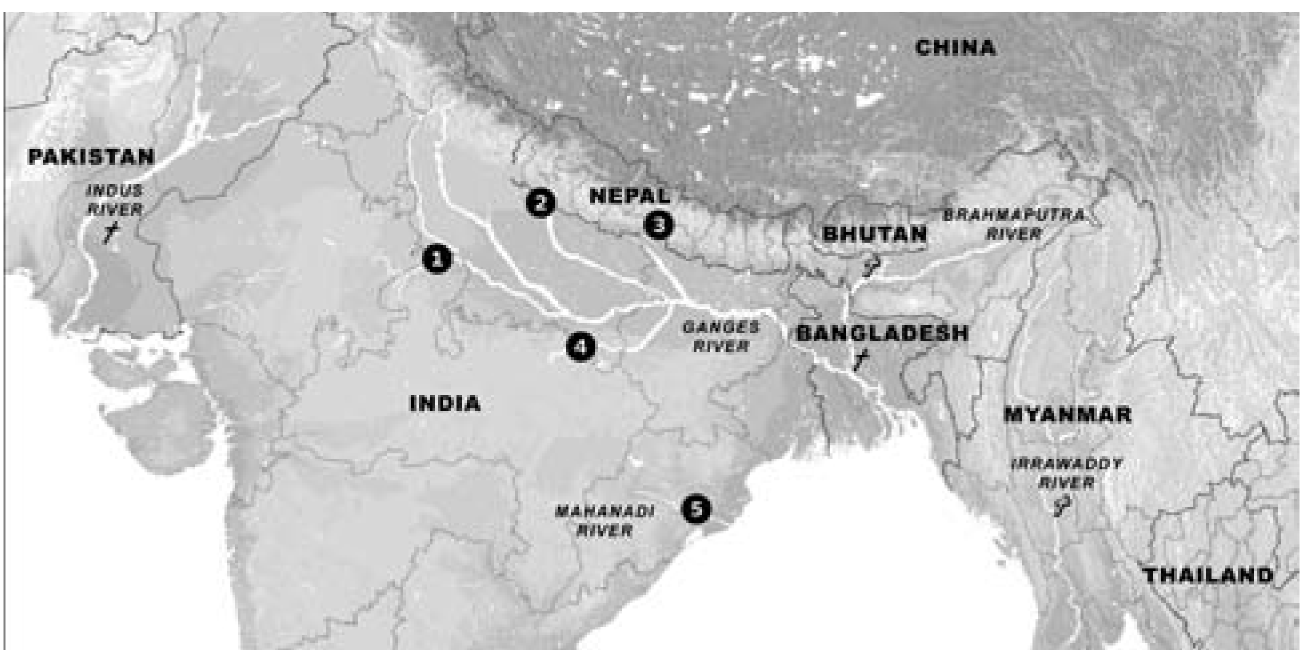
Gharial Multi-Task Force, Madras Crocodile Bank

The Gharial (*Gavialis gangeticus*) is a massive crocodilian, exceeded in size only by the Saltwater Crocodile (*Crocodylus porosus*). Historically, male Gharials of up to 6 m (nearly 20 ft) were commonly encountered, but such large individuals are unknown today. The species is characterized by its elongated, narrow snout, which varies in shape as an animal ages, becoming proportionally shorter and thicker over time. The bulbous growth on the tip of a male's snout, called "ghara" after the Indian word meaning "pot," is present in mature individuals, which utilize the structure to to modify and amplify "hisses" snorted through the underlying nostrils. The resultant sound can be heard for nearly a kilometer on a still day. The ghara also renders Gharials the only visibly sexually dimorphic crocodilian.

The well-developed laterally flattened tail and webbed rear feet provide tremendous maneuverability in the Gharials' deep-water habitat, where their diet consists primarily of fish. On land, however, an adult Gharial can do little more than push itself forward and slide on its belly, and it will leave the water only to bask or to nest on sandy beaches. Males will guard a territory in which several females live. Mating usually occurs during December and January and nesting from March to May, which corresponds to the dry, low water season. Females will excavate an egg chamber in the sandy banks above the flood line, depositing up to 60 eggs and carefully covering them. The eggs are the largest of any crocodilian species, weighing an average of 160 g. Eggs hatch after 83–94 days. Female Gharials dig up the young in response to hatching chirps, but, unlike many other crocodilians, do not assist the hatchlings to the water. They will, however, guard the hatchlings for some time. Although this remarkably gentle animal once thrived in the deep rivers of India, Nepal, Pakistan, Bangladesh, Bhutan, and Myanmar, it is now virtually extinct in all but the first two of these countries, where it is limited to 2% of its former range.

F. WILLIAM ZEIGLER

Gharials basking on sand banks at the Katerniaghat Sanctuary.



JOHN BINNS

Gharials were once distributed across approximately 20,000 km^2 of riverine habitat of the Indus, Ganges, Brahmaputra, and Irrawady river systems. Today populations are limited to a few refuges: (1) National Chambal Sanctuary; (2) Katerniaghat Sanctuary; (3) Chitawan National Park; (4) Son River Sanctuary; (5) Satkosia Gorge Sanctuary. No breeding is occurring in the Satkosia Gorge Sanctuary. Scattered individuals are known to occur along other rivers in India and Nepal, but no reproduction has been documented in decades. Solid crosses indicate that populations are presumed to be extirpated, and outlined crosses mark populations that are extirpated.

Early Records

Early records for the Gharial are mainly anecdotal. Old references indicate the Gharial's abundance: common in the Indus River in Pakistan (Francis 1910, Rao 1933); Gandak River in Nepal (I.A.K. 1921); Jumuna River in Uttar Pradesh (Hornaday 1885), and Kosi River in Bihar (Shortt 1921). Several authors mentioned seeing groups basking together. In 1885, Hornaday wrote that he had counted 64 Gharial in two hours on the banks of the Jamuna. Adams (1867) wrote: the Gharial "abounds in all the great rivers of Northern India … Ten or twenty may be frequently seen together. Hundreds of Gharial were observed on the Narayani River (Nepal) prior to the construction of the Gandak barrage … in 1964 and in the early 1950s about 235 Gharial were counted along the Narayani River between Narayanghat and Tribeni" (Maskey 1999). With a historic range of thousands of river kilometers of habitat over an area of about 20,000 km^2, from the Indus to the Irrawady, the Gharial had an inferred population of 5,000 to ≥ 10,000.

Many large males were killed by hunters from Nepal or Europe well into the 20th Century. This hunt was in what was to become the Royal Chitwan National Park and occurred just before the protected area was created. Today, only four large, mature males like that in the photograph remain in the Narayani and Rapti rivers around the park. Photograph courtesy of Olivier Born.

Current Status

By 1976, the estimated total population of wild Gharials had declined from an inferred 5,000–10,000 animals in the 1940s and throughout its huge former range (spanning the rivers of the northern part of the Indian Subcontinent from the Indus in present-day Pakistan 3000 km eastward across the Gangetic floodplain to the Irrawady in Myanmar) to fewer than 200 (Whitaker 1974), a decline of about 96%.

The Indian government subsequently accorded protection to the Gharial under the Wildlife Protection Act (WPA) of 1972. Project Crocodile began in 1975 under the auspices of the Government of India with the aid of the United Nations Development Fund (UNDP) and Food and Agriculture Organization (FAO). The project included an intensive captive-breeding and rearing program intended to restock habitats with low numbers of Gharials. An acute shortage of Gharial eggs was overcome by their purchase from Nepal. A male Gharial was flown in from the zoo in Frankfurt, Germany, to become one of the founding animals of the breeding program.

Sixteen crocodile rehabilitation centers and five crocodile sanctuaries (National Chambal Sanctuary (NCS), Katerniaghat Wildlife Sanctuary (KWS), Satkosia Gorge Wildlife Sanctuary, Son Gharial Sanctuary, and Ken Gharial Sanctuary) were established in India between 1975 and 1982. By 2004, 12,000 Gharial eggs had been collected from wild and captive-breeding nests, and over 5,000 Gharials reared to about a meter or more in length (roughly three years of age) and released into the wild. Over 3,500 of these were released in NCS, the largest Gharial reserve in the country, sprawling across 425 km^2 in the states of Uttar Pradesh, Madhya Pradesh, and Rajasthan.

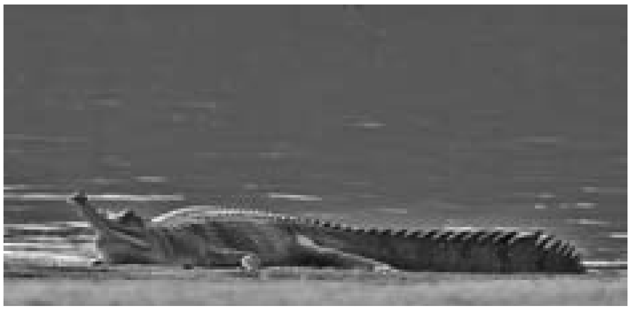
In 1982, a report by a wildlife biologist for the FAO/UNDP listed Project Crocodile among the most successful conservation projects in the world. However, in 1991, the Union Ministry of Environment and Forests felt that the project had served its purpose, and stopped funds for its captive-breeding program. Funds were also withdrawn for the egg-collection program. The thousands of crocodiles seen in various rearing stations and captive breeding centers clearly attested to the success of the project. However, little had been done to

MATT VAUGHAN, FORT WORTH ZOO

The very sharp interdigitated teeth are well adapted for capturing fish, which are Gharials' primary prey.

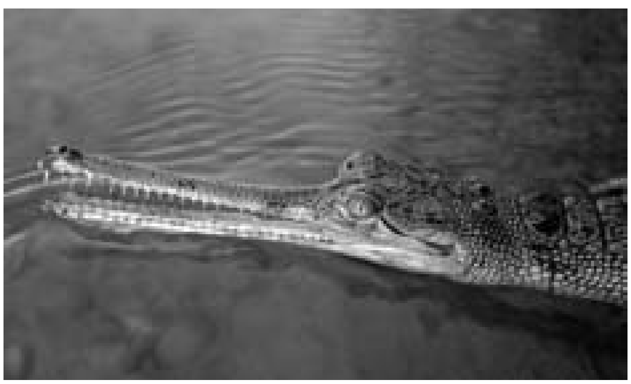
Table 1. Past and present numbers of adult Gharials in the major river systems of the Indian Subcontinent.

Subpopulation (river systems)	**Three Generations Ago (1946 – inferred)**	**Present (2006 – inferred)**	**Estimated Reduction**
Indus River		Nil	
Ganges River		< 200	
Mahanadi River		2	
Irrawady River		Nil	
Totals	**5,000–10,000**	**< 200**	**96%**



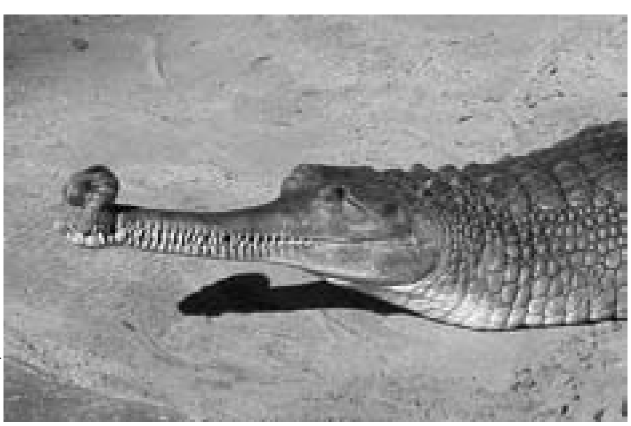
OLIVIER BORN

Gharials, such as this adult female, are powerful swimmers but graceless on land. The laterally compressed tail serves both to propel the animal and as a base from which to strike at prey.



OLIVIER BORN

The elongated, narrow snout reduces resistance as Gharials snag fish. It varies in shape as an animal ages, becoming proportionally shorter and thicker over time.



DON BOYER, SAN DIEGO ZOO

The ghara, a bulbous growth on the tips of snouts of mature males, is used to amplify the hiss produced by compressing the underlying nostrils.

involve the local communities in conservation, and that has been the key failure in securing the future of the species in nature. In 1997–1998, monitoring exercises by the forest departments of Madhya Pradesh, Rajasthan, and Uttar Pradesh located over 1,200 gharials and over 75 nests in NCS — but no surveys occurred between 1999 and 2003.

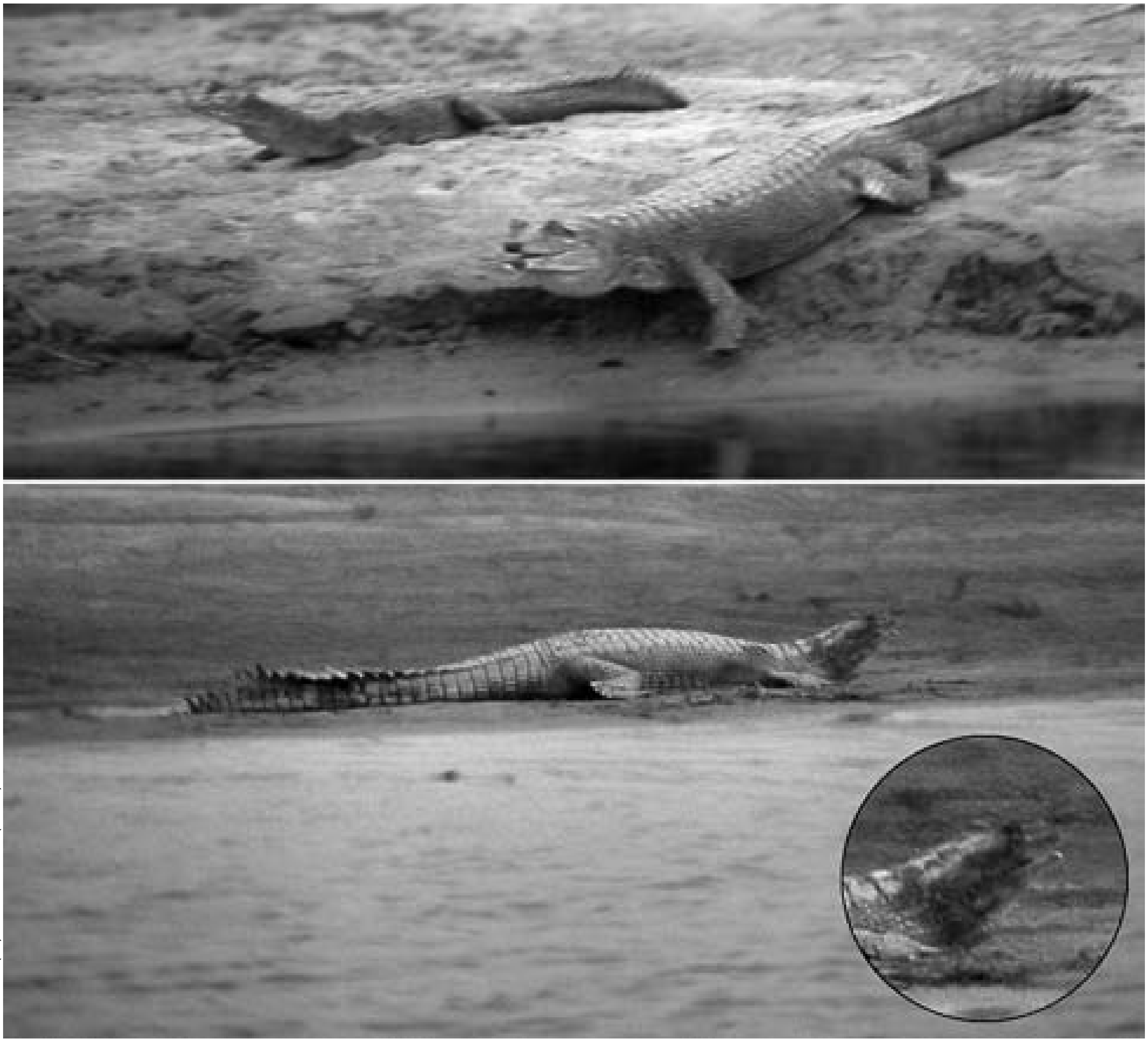
By 2006, the inferred mature gharial population in India had plummeted to fewer than 200 adult individuals (Andrews 2006, Sharma and Basu 2004) and fewer than 35 adults in Nepal (Maskey 2006). The species is virtually extinct in Pakistan (Whitaker and Basu 1983), Bangladesh (Whitaker 1976, Khan 1979, Faizuddin 1983), and Bhutan (Singh 1991). Only two records for the species were recorded from Myanmar in 1927, and it is presumed to be extinct in that nation.

Reasons for Decline

The drastic decline in the Gharial population over the last 60 years (three Gharial generations) can be attributed to over-hunting for skins and trophies, egg-collection for consumption, killing for indigenous medicine, and killing by fishermen. In addition, dams, barrages, irrigation canals, siltation, changes in river course, artificial embankments, sand-mining, riparian agriculture, and land-use changes to accommodate domestic and feral livestock have combined to limit the range of Gharials as a consequence of excessive, irreversible loss of riverine habitat. These threats have not ceased, indeed have increased and continue to compromise the survival of the species. The misguided megaplan to interlink the major Indian rivers will be the final nail in the coffin. Gharial declines have gone hand-in-hand with declines of other riverine taxa once reportedly abundant and now endangered. These include the Ganges River Dolphin (*Platanista gangetica*), Smooth-coated Otter (*Lutrogale perspicillata*), and the Mugger

ROM WHITAKER

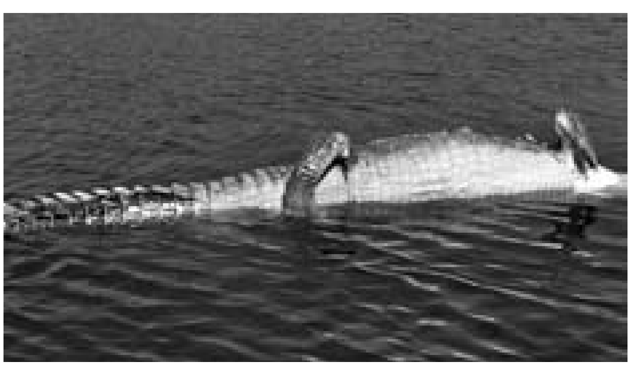
Illegal sand-mining operations have contributed to the irreversible loss of Gharial habitat at the National Chambal Sanctuary.



RAJIV CHAUHAN (TOP) AND HARRY ANDREWS (BOTTOM)

Fishermen, who illegally set nets in the National Chambal Sanctuary, will cut off Gharials' snouts, leaving them to starve.

Crocodile (*Crocodylus palustris*), in addition to numerous waterfowl and well-known game and edible fish species such as the Mahseer (*Tor* sp.) and Hilsa (*Hilsa illisha*). GMTF is collaborating with WWF-India to form "Riverwatch," which will monitor all of these endangered river taxa.



RAJIV CHAUHAN

Gharials quickly drown when they become enmeshed in illegal fishing nets at the National Chambal Sanctuary.

Nest Counts

The mature Gharial population was estimated by using nest counts, as they are easily visible and counted at well-known locations that have been monitored for decades. This is likely to be an accurate assessment for numbers of mature animals, because of the unknown number of immature males that are routinely counted as "adults," before they grow a ghara at 12–15 years of age. Females reach sexual maturity when they are around seven years old and about 2.4–2.7 m in total length. Males do not mature until they are about 4 m in length at 15–18 years of age. Using the only published data on ratios of males in the mature Gharial population (14%) (Hussain 1999), we inferred that a proportion of all 'adults' reported in censuses are actually subadult males.

NICK BAKER

This female Gharial has a fishing net tangled around her snout. If she cannot rid herself of the net, she will slowly starve to death over a period as long as a year.

Breeding Populations

The Chambal River supports the largest breeding subpopulation and is the largest remaining Protected Area for Gharials, with an estimated 48% of the total population. The total number of nests found in the National Chambal Sanctuary in 2006 was 68. The other large breeding population of Gharials in India is in the Katerniaghat Wildlife Sanctuary (KWS), where 20 nests were found in 2006. The only other known breeding population in India is the Son River Sanctuary, where two nests were found in 2006 (for the first time in 30 years; Andrews 2006).

Since many female Gharials nest every year in captivity, the assumption that the above-cited nest counts indicate the presence of 90 reproducing female Gharial in India is reasonable. Consequently, the reported paucity of mature males (with their very conspicuous gharas) on the Chambal in the surveys of 2005 and 2006 and the resulting drastically low estimate of mature males are likely to be accurate for that river (Andrews 2006, Rao, pers. comm.). However, a total of 20 nesting females and six mature males were counted in the KWS by independent observers in 2006 (B.C. Choudhury, H.V. Andrews, R. Whitaker, pers. obs.). The total inferred number of mature Gharials in the three remaining wild breeding subpopulations in India is therefore 107, based on observed nest numbers and inferred numbers of mature males.

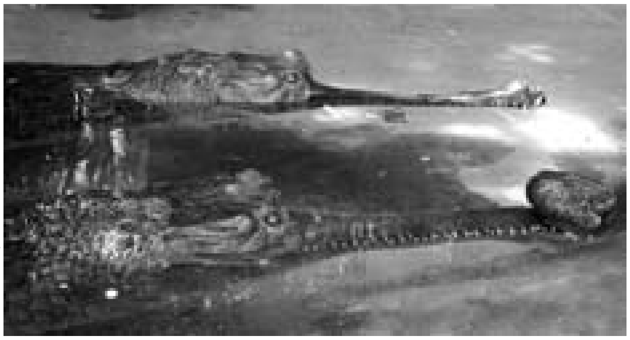
Other Subpopulations

Two other small, non-reproducing populations of Gharials are known to exist in India (Ken River in Madhya Pradesh and Mahanadi River in Orissa). These have been supplemented by the reintroduction of captive-bred stock (as in all present Gharial locations). A few scattered Gharials may also remain in the Brahmaputra River of northeastern India, but confirmed sightings date to 1993 (Choudhury 1997). These other subpopulations in India contain a total estimated 40 mature animals (no mature males nor any breeding have been reported). The Gharial is undoubtedly extinct in the Indus (Pakistan/India) and Irrawady (Myanmar) river systems.

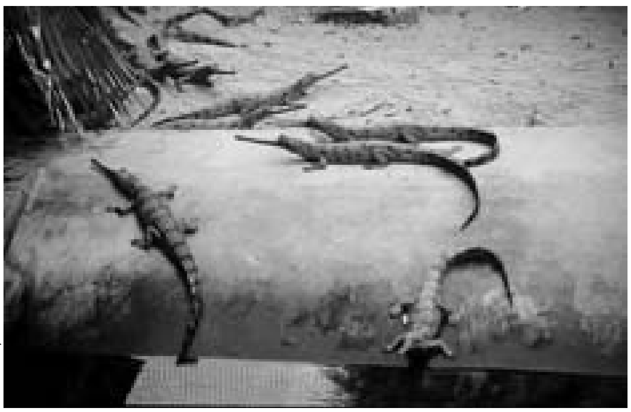
F. WILLIAM ZEIGLER

SUSHANT DEY, DOLPHIN CONSERVATION PROJECT

Gharial declines have gone hand-in-hand with declines of other riverine taxa, such as the Ganges River Dolphin (*Platanista gangetica*; above) and the Mugger Crocodile (*Crocodylus palustris*; top right). The latter was photographed at the Katerniaghat Sanctuary along one of the Ganges River tributaries.


MATT VAUGHAN, FORT WORTH ZOO

Sexual dimorphism in Gharials is readily apparent. Only males develop the protuberance at the tip of the snout, the "ghara," from which the species derives its name.


DON BOYER, SAN DIEGO ZOO

Gharials have been successfully bred in captivity; this group of hatchlings were produced at Kukrail, India.


COLIN STEVENSON

A captive Gharial from St. Augustine's in Florida.

U.S. Institutions with Gharials

Busch Gardens, Tampa
Cleveland Metroparks
Ft. Worth Zoo
Honolulu Zoo
National Zoo, Washington, DC
St. Augustine Alligator Farm
San Antonio Zoo
San Diego Zoo

U.S. Efforts to Aid Gharial Conservation

Although the critical work to protect Gharials from extinction in the wild is most needed in their native habitat, zoos in the United States support these efforts wherever possible. In 2004, the Cleveland Zoo and the San Diego Zoo started a fund to help support *in-situ* conservation. Since then, the two zoos have contributed $26,000 to the Gharial Multi-Task Force (GMTF). These funds are used for Gharial surveys, ongoing monitoring of known populations, and operational expenditures by the local associates of the GMTF. Although they do not keep Gharials, the Dallas Zoo recognized the precarious position of the wild population and recently joined in contributing to the fund. A plea has been extended to other AZA institutions to contribute to this important endeavor.

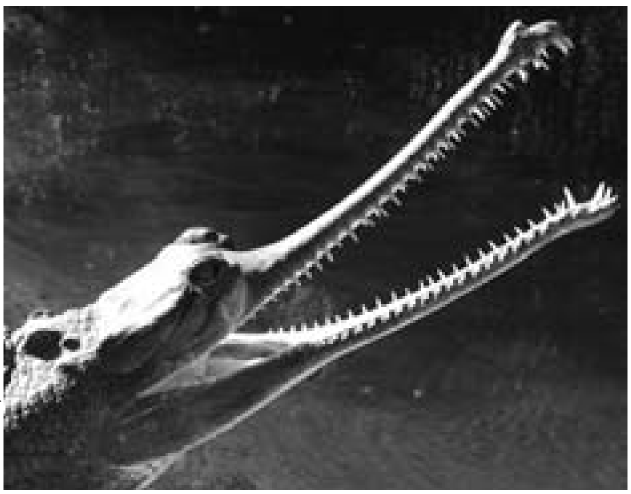
Another objective is to create a self-sustaining population to serve as a genetic reservoir for the species. To accomplish this, the current U.S. population of 21 animals would have to be supplemented by captive-reared animals from India. Although no Gharials have been born in captivity in the United States (possibly due to the fact that the potential breeders have yet to reach sexual maturity), over 4,500 animals have been raised in captivity and returned to the wild in India, proving that a self-sustaining captive population is attainable.

A self-sustaining population of Gharials in the United States would have the additional benefit of increasing the number of institutions that keep these alluring animals. This would help to raise awareness and funds for Gharial conservation and create a broader base of support for pressuring the Indian and other governments to act decisively to protect Gharials in the wild.

Also, the actions of some conservation organizations that focus on species other than Gharials have contributed to their conservation. One example is the Turtle Survival Alliance. This coalition of zoos, institutions, and individuals with divisions in the United States, Europe, and Austral-Asia, supports the protection of critical habitat for turtles such as the Red-crowned Roofed Turtle (*Kachuga kachuga*), which is sympatric with Gharials in part of their range. Asian turtles and Gharials both are faced with the threats of habitat destruction, poaching, and high mortality due to illegal fish-netting practices. While the alliance focuses on turtles, other endangered species, such as Gharials and the Indus River Dolphin, benefit from efforts to protect habitat and enforce laws that protect wildlife.

Lee Pagni and Don Boyer
Zoological Society of San Diego

The proportionally shorter snout and large ghara are apparent in this adult male.



One hundred and ten sharp teeth line the slender snouts of Gharials.

Gharials in Nepal

Six nests were counted in 2006 in Nepal in Chitawan National Park (Rapti/Narayani River) and three other small, non-reproducing subpopulations are known (Kosi, Karnali, and Babai rivers). The total number of mature Gharials in all subpopulations in Nepal is inferred to be 35 animals (Maskey 1999, pers. comm.).

How Many Gharials?

Unless additional research tells us otherwise, we have to assume that the maximum number of wild, mature Gharials across the entire remaining range of the species (presently only India and Nepal) is 182 in about eight non-contiguous, fragmented habitats.

Gharial Declines in the Past Decade

In 1997, the peak year with the highest numbers of wild mature Gharials and nests recorded in the last 30 years, 226 mature animals and 81 nests were recorded in the Chambal (Sharma and Basu 2004). Although no nests were found in the Son, about 10 mature individuals occurred there. We had no nest data for Katerniaghat, where an estimated 30 mature animals were present. No nesting data from Nepal exist for this period, with an estimated 36 mature Gharials reported (Maskey 1999).

Based on the available data (Sharma and Basu 2004, Maskey 1999) and adding the 2006 estimated numbers of nonbreeding mature animals (in small subpopulations outside the three Indian and one Nepali breeding subpopulations — a total of 40 animals), the estimated total mature Gharial population throughout its present range (India and Nepal) in 1997 was 342.

The decline from an estimated 342 adult Gharials in 1997 to 182 in 2006 represents a 47% decline across the species' range. This drastic decline occurred within a period of nine years, well within the span of one generation, qualifying the Gharial, under criterion C1 of the IUCN Red List, to be listed as Critically Endangered, although the current status is listed as endangered (Crocodile Specialist Group 1996).

Present Distribution of the Gharial

The total extent of occurrence of the Gharial was once on the order of about 20,000 km^2 (including suitable areas of the Indus, Ganges, Brahmaputra, and Irrawady river systems). Rao and Singh (1995) reported a figure of 2,986 km^2 (in India). In Nepal, the total area of occupancy is now under 100 km^2, whereas it once could have been close to 1,000 km^2 (Maskey, pers. comm.). Current total area occupied in India and Nepal is less than 250 km^2, based on river length x width and occurrence of Gharials within Protected Areas.

Table 2. Adult Gharial estimated population reduction within one generation.

Subpopulation	Past	Present	Estimated Decline in One Generation
Chambal	226 (1997)	78 (2006)	65%
		68F/10M	
Katerniaghat	30 (1997)	26 (2006)	13%
		20F/6M	
Son	10 (1997)	3 (2006)	66%
Others (India)	50 (2003)	40 (2006)	20%
Chitawan (Nepal)	20 (1999)	8 (2006)	80%
Others (Nepal)	100 (1994)	27 (2006)	73%
Totals	**436**	**182**	**58%**

Table 3. Rivers in India and Nepal with suitable habitat harboring breeding and non-breeding Gharial populations (habitat length x width = square kilometers of habitat; 0.3 km refers to overall average river width of 300 m). Total Gharial habitat (with Gharials) remaining in India and Nepal in 2006 is 240 km^2.

India

Chambal (National Chambal Sanctuary)	425 x 0.3 km = 128.0 km^2
Girwa (Katerniaghat Wildlife Sanctuary)	5 x 0.3 km = 1.5 km^2
Ken (Ken Gharial Sanctuary)	45 x 0.3 km = 13.5 km^2
Son (Son River Sanctuary)	200 x 0.3 km = 60.0 km^2
Mahanadi (Satkosia Gorge Wildlife Sanctuary)	14 x 0.3 km = 4.2 km^2
Ramganga (Corbett National Park)	20 x 0.3 km = 6.0 km^2

Nepal

Rapti/Narayani (Chitawan National Park)	60 x 0.3 km = 18.0 km^2
Karnali (Royal Bardia National Park)	10 x 0.3 km = 3.0 km^2
Babai (Royal Bardia National Park)	10 x 0.3 km = 3.0 km^2
Kosi	10 x 0.3 km = 3.0 km^2

Summary of Gharial Restocking Programs

One perspective suggests that little has been accomplished other than throwing over 5,000 juvenile Gharials into largely inhospitable habitats in Indian and Nepali rivers and leaving them to their fate. Little was done to secure the habitat. Banned from fishing in sanctuaries created for Gharials, local communities were not offered alternative employment. Combined with the lack of enforcement, Gharials are at the mercy of embittered and disempowered local people.

In Chitawan National Park (Nepal), where 457 Gharials were released, 16 nests were counted in 1977 and only six in 2006. Reintroduction was not successful there (although one argument states that at least total extinction was averted by supplementation). The principal reasons for failure was growing and uncontrolled anthropogenic pressures, including the depletion of fish resources.

In the Girwa River (Katerniaghat Sanctuary), where 909 Gharials were released (including 112 in 2006), four nests were recorded in 1977 and 20 in 2006, so 16 nesting females (2% of the total pre-2006 releases) comprised the result of 30 years of reintroductions. This seemingly poor achievement, considering the money and effort spent, suggests that enforcement is the key to Gharial survival (although some argue that the carrying capacity may have been reached).

In the third and most important remaining Gharial breeding habitat, the Chambal River (the tri-state National Chambal Sanctuary), where 3,552 Gharials were released (Whitaker and Andrews 2003) (plus 224 in 2006), 12 nests were recorded in 1978 and 68 in 2006. While nesting has apparently increased by over 500%, these recruited mature, reproducing females represent only about 2% of the total number released. The linear, riverine habitat of the Gharial presents a potentially insurmountable challenge with annual monsoonal flooding, when the newly hatched young are especially prone to being flushed downstream and out of the Protected Areas.


OLIVIER BORN

Large scales are used to weigh Gharials prior to release.


OLIVIER BORN

Animals are measured and scales are removed for individual identification prior to release.


OLIVIER BORN

Thousands of Gharials were hatched and raised in captivity before being released into the wild. Only a small number is thought to have survived.


OLIVIER BORN

Nursery facilities at Kasara Gharial Breeding Center (Royal Chitwan National Park, Nepal). Dr. Antoine Cadi (Noé Conservation) and Dr. Samuel Martin (SOS Crocodiles) check the hatchlings.

Note: Vol 14 Number 1 contained a color centerfold (11x17 inches). Due to Adobe PDF restrictions, the centerfold needed to be reduced to fit the 8.5x11 inch format.

The diet of Gharials consists almost exclusively of fish.

When Gharials dive, a transparent membrane covers and protects the eye.

Fishing nets, in which Gharials become entangled and drown, have contributed to population declines.

Like other crocodilians, Gharials have dorsally displaced eyes and nostrils.

OLIVIER BORN

Hatchling Gharials are weighed and individually marked before release into the Narayani River, a tributary of the Ganges River.

With recruitment or retention of reintroduced Gharials (plus natural recruitment) over the last 30 years as low as 0.02% (Mahanadi River, Orissa) and averaging 3–10% elsewhere, the entire reintroduction strategy needs to reassessed. Scarce conservation funds and human resources need to be focused on habitat assessments, studies of Gharial 'migration,' fisheries assessment/enhancement, and conflict mitigation. The latter, basically recruiting support of the river people, may be particularly critical if we are to improve the survival odds of Gharial in their few remaining refuges. However, the four sites where Gharials are still breeding all had residual populations when the restocking programs began. Nowhere has restocking re-established a viable Gharial population.

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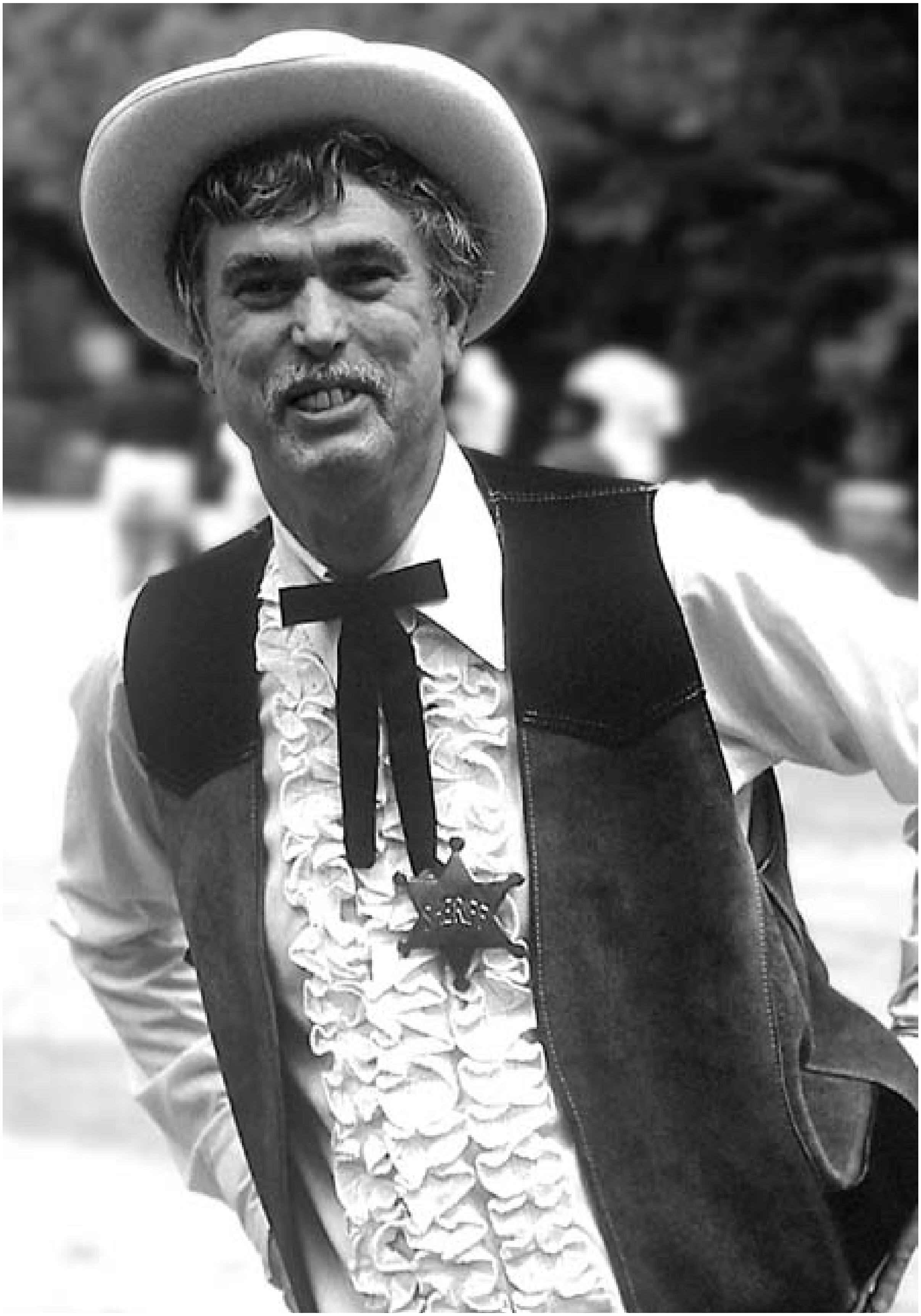
The Situation is Not Futile

Follow these three "-fuses" to help save the Gharial: **Infuse** yourself with more information. Learn more about Gharials (www.nationalzoo.si.edu, www.flmnh.ufl.edu/cnhc/csp_ggan.htm, www.ircf.org, www.gavialis.org). To stay current, sign up to receive updates from the Gharial Multi-Task Force through IRCF. **Diffuse** what you learn to your friends. A colleague recently saw a Gharial while touring India, but had no idea they were so close to extinction. Make sure everyone you know realizes that we are close to losing the few Gharials remaining in the wild. **Effuse** cash to funds that support Gharial conservation. The IRCF website allows you to donate online with 100% of the funds going directly to the Gharial Multi-Task Force. You also can support other conservation funds that protect Asian turtles, Indus River Dolphins, and even tigers, because all of them need the same riparian habitat as Gharials.

Deirdre Ballou and Lee Pagni
Zoological Society of San Diego


DAVID T. ROBERTS

Jim Murphy as the defender of rattlesnakes in a 1989 Dallas Zoo conservation day skit.

PROFILE

Been There, Done That: A Profile of James B. Murphy

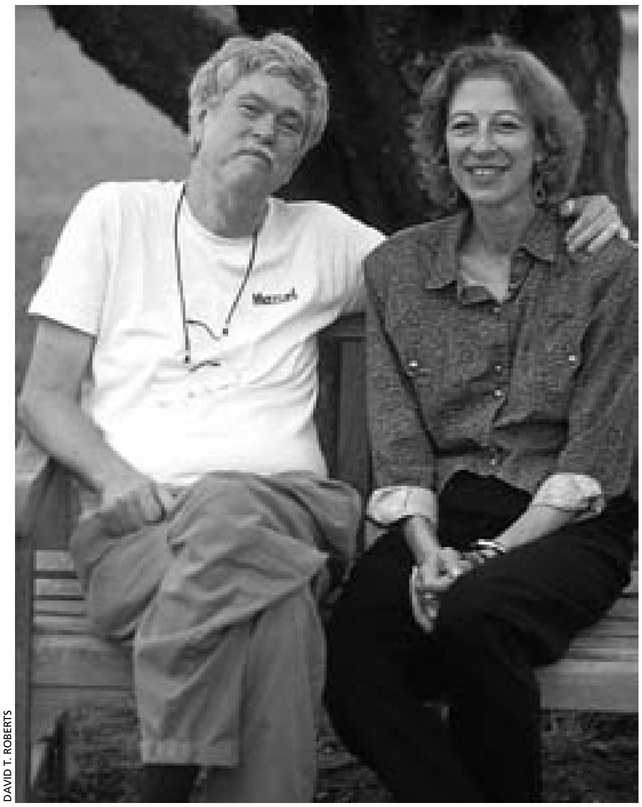
David T. Roberts

Dallas Zoo

James B. Murphy was born in Oak Park, Illinois. During his youth, he developed an interest in reptiles and amphibians. Throughout high school, he associated with herpetologists both at zoos and museums in Chicago. His parents, who had never been exposed to these creatures, had, as Jim puts it, "a considerable period of adjustment" while he filled his bedroom with his collection of reptiles and amphibians.

After graduating from high school, Jim decided to major in philosophy at Xavier University in Cincinnati, Ohio with the intention of becoming a college professor in that discipline. According to Jim, he later came to his senses and embarked on a zoo career. Since that time, Jim has not only become one of the most respected curators in the zoological park field, but also in the academic communities of herpetology and conservation.

Jim's first zoo position was as a keeper in the herpetology department at the Atlanta Zoo. He acquired this position shortly after graduating with his B.S. in Philosophy in 1965. From there, Jim moved west and accepted a keeper position in the newly formed herpetology department at the Dallas Zoo, which had just constructed a bird and reptile building. Later that year, Jim was promoted to supervisor of the department. From this point, Murphy started to become professionally entrenched in the herpetological community. He became program chair for the International Herpetological Society (IHS) that same year and put together a group of speakers and developed a symposium. Since then, Jim has chaired the IHS program two other times. In 1998, he developed a symposium on the differences between captive and wild snakes. Today, Jim is an Honorary Advisor of the IHS.



DAVID T. ROBERTS

Jim and his wife Judith near their home in Washington, D.C. in 1995.

Jim Murphy and Jack Joy in the field.

Murphy's career led to many professional affiliations, including the Herpetologists' League (HL), Society for the Study of Amphibians and Reptiles (SSAR), British Herpetological Society, American Society of Ichthyologists and Herpetologists (ASIH), Texas Herpetological Society, and the American Zoo and Aquarium Association (AZA). He has served those organizations in a variety of positions, including president, chairperson, editor, member of the board of directors, advisor, and professional fellow. Jim also has been a member of numerous foreign and regional societies.

During his career at the Dallas Zoo, Jim worked with myriad people from many different disciplines. He invited experts from other zoos, universities, and conservation organizations from around the world to visit the Dallas Zoo's collection. He would lead these individuals through the collection, introducing his staff and allowing them to discuss their interests and expertise with the visitors. These introductions were Jim's way

DAVID T. ROBERTS

Jim in his office at the Dallas Zoo Herpetarium in 1990.

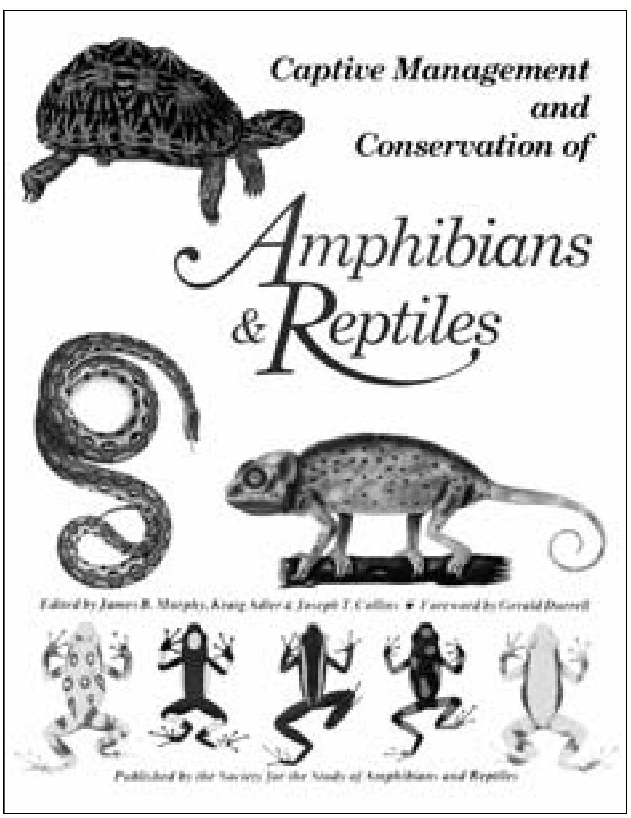
of encouraging collaborative relationships with his staff and other organizations.

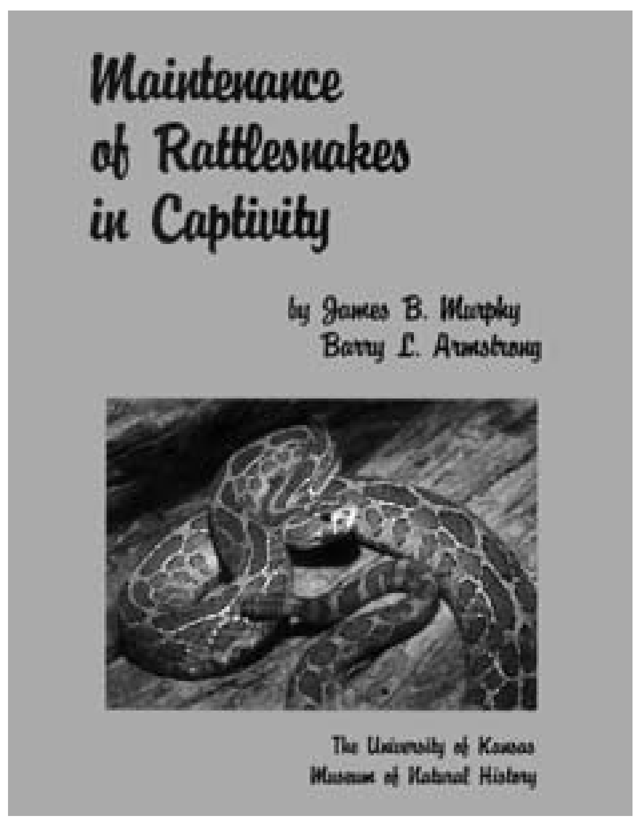
Murphy has a wonderful philosophy for managing people. He encourages his staff's interests, guides their learning, helps forge relationships with individuals who share similar interests, and allows his employees to "run with the ball." In other words, he provides his staff with the necessary tools they need to spark their own interests and reach goals they set for themselves.

I came to know Murphy through my love of reptiles and amphibians. As a youngster in the late 60s, I too had a strong interest in capturing and keeping native reptiles and amphibians — a common thread among herpetologists. I had a particularly strong interest in rattlesnakes, and was given a copy of *Maintenance of Rattlesnakes in Captivity*, by J.B. Murphy and B.L. Armstrong. That summer of 1979 was the first time I had ever heard of Jim Murphy. The publication was full of information about more species of rattlesnakes than I knew existed. It was also the first publication to spark my interest in learning the formal taxonomic names of animals. The little book was full of them, and of references to other publications revolving around every aspect of captive rattlesnake husbandry. That book changed my life. I knew then that having a career working with reptiles and amphibians was possible.

In 1982, I literally packed up everything I owned and moved to the Dallas area from upstate New York in an attempt to garner a position at the Dallas Zoo. In April 1986, I was hired as a keeper for the Dallas herpetology department. That was more than 20 years ago, and today I still am deeply involved in herpetological conservation and research.

Under Jim's guidance, I was privileged to work with one of the most dynamic groups of herpers for more than 15 years. During Jim's leadership as curator of the department, we had the opportunity to work with some of the top researchers in our field, including such academic experts as Carl Gans, Hobart Smith, Joe Collins, Jonathan Campbell, and Harry Greene, as well as peers from other zoos, such as Joe Laszlo, Bill Lamar, Rick Hudson, Dave Barker, Bern Tryon, and Charlie Radcliffe, just to name a few. The list is too extensive to account for every





Books like these, co-authored or co-edited by Murphy, served as valuable resources at a time when captive maintenance was considerably less sophisticated than it has since become. By sparking interest and providing valuable references, both books effectively promoted the possibility that careers in herpetological conservation and research were realistic goals of young enthusiasts.

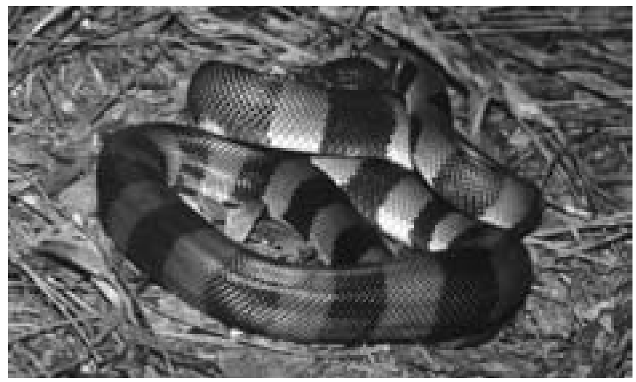
1987 Edward H. Bean Award Certificate for Captive Reproduction of Bushmasters (front left: Donal Boyer; front right: Ardell Mitchell; back, left to right: David Roberts, Clay Garrett, Steve Hammack, and Jim Murphy).

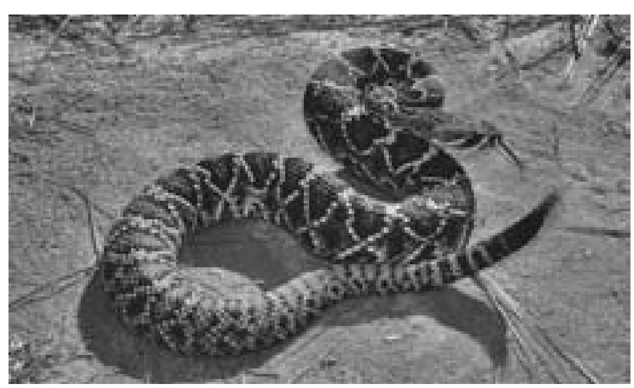
influential person who came to discuss ideas, philosophies, and techniques to tease out aspects of the biology, reproduction, and behavior of reptiles and amphibians. Many of these people were close friends of Murphy's, and most took the opportunity to put Jim on the spot with the kinds of embarrassing stories to which those of us in herpetology invariably are burdened. Jim has a wonderful sense of humor and would laugh aloud during these memory-jogging sessions.

Through his career, Jim has served as a reviewer for many scientific journals including *Copeia*, *Herpetologica*, *Transactions of Kansas Academy of Sciences*, *Journal of Herpetology*, *Southwestern Naturalist*, *Texas Journal of Science*, *Science*, *Herpetological Review*, *Hormones and Behavior*, *Acta Zoologica et Pathologica Antverpiensia*, and *Zoo Biology*. Murphy also served as editor for his department. He would jokingly get out a large red marker whenever one of us would hand him our latest manuscript for his perusal. During his tenure, the department produced more than 50 publications exclusive of Murphy, with his own numbering more than 110, including articles, book chapters, and books. The department also received two Edward H. Bean Awards for reproduction (in Bismarck Ringed Pythons and Bushmasters), four significant achievement awards for reproduction (in Eastern Diamondback Rattlesnakes, Tancitaran Rattlesnakes, Coahuilan Box Turtles, and rattlesnake reproduction programs), 21 First Captive Breeding awards, and a Silver and Gold Propagator's Certificate (for the American Milksnake) from the AZA. Jim also was instrumental in coordinating the Dallas Zoo's receipt of a National Science Foundation grant totaling more than half a million dollars to investigate improved visitor education techniques concerning amphibians and reptiles in a zoological garden.

Murphy's accomplishments in herpetology were acknowledged by the University of Colorado-Boulder when they honored him with an Honorary Doctor of Science Degree in 1989. This was a great moment in Jim's life, and much of the recognition for this honor was organized by Murphy's long-time colleagues David Chiszar and Hobart Smith.

After more than 30 years at the Dallas Zoo, Jim retired from his position as curator and moved to Washington, D.C. in 1994. He is currently a Smithsonian Research Associate in the Department of Herpetology at the Smithsonian's National Zoological Park, and he stays involved with many organizations, including the IUCN/SSC Declining Amphibian Populations Task Force and the IUCN/SSC Captive Breeding Specialist Group, and is the Section Editor of the "Zoo View" column in *Herpetological Review*. His research interests are now centered on developing quantitative methods for assessing the competence of animals raised in captivity, zoo history, the behavior of pitvipers and other reptiles, and the evolution of herpetological illustrations.





Under Murphy's guidance, the herpetology department at the Dallas Zoo received Edward H. Bean Awards for reproduction in Bismark Ringed Pythons (*Bothrochilus boa*; top) and Bushmasters (*Lachesis muta*; middle) and significant achievement awards for reproduction in Eastern Diamondback Rattlesnakes (*Crotalus adamanteus*; bottom), among others.

Costa Rican Scarlet Macaws (*Ara macao*) squawk and litter the ground beneath the high trees in which they perch with rotting fruit and molted feathers.

TRAVELOGUES

A Costa Rican Adventure

Janelle M. Pansza

Department of Biology, Avila University, Kansas City, Missouri

During winter break 2005/2006, my sister and I traveled to Costa Rica. We were undergraduates in a class intended to experience three ecosystems: dry forest, cloud forest, and rain forest. Our journey into this phenomenally biodiverse country began at the very small airport in Liberia. Open to the elements, humidity covered us like a thick blanket — but I could hear calls of exotic birds in the open rafters of the airport roof, and they reminded me why I was here. The drive to our first destination was bumpy and slow. The driver informed us that some of the locations we would visit had been inaccessible except by horseback or ATV until the last few years. The scenery was spectacular, although patches had obviously been clear-cut; much cultivated land is devoted to tropical plants, especially bromeliads, which are exported to Europe and the U.S.

With a very pro-environmental democratic government, and a highly literate (including computer-literate!) populace, the standard of living in Costa Rica is among the highest in Latin America. Nevertheless, Costa Rica still has a relatively impoverished underclass. I observed houses made of pieces of tin and surrounded by naked children and livestock. Alongside poverty, we also observed some large haciendas, mostly associated with cattle ranches, the primary cause for deforestation in Costa Rica.

We first stayed at the base of the Rincon de la Viejo volcano, and had a terrific view of the crater on one side and unspoiled dry forest on the other. After dark, the croaking serenades of House Geckos (*Hemidactylus frenatus*) and Cane Toads (*Bufo marinus*) were common. These species have adapted well to human-altered environments, and many a hotel pool in Costa Rica hosts toad parties well into the wee hours. A pre-sunrise concert of birds, interrupted periodically by raucous parrots, preceded zip-lining in the canopy. A huge male Black Iguana (*Ctenosaura similis*) basking on a rock made the trip back worthwhile. Black Iguanas, known locally as "Garrobos," also seem surprisingly well adapted to human presence. These animals were abundant in many of the sites that we visited. An afternoon hike along the Pailas Trail was enlivened by Black-handed Spider Monkeys (*Ateles geoffroyi*) and our first close encounter with massive Strangler Figs (*Matapalo ficus*), Coatis (*Nasua narica*), and an Agouti (*Dasyprocta punctata*).

JANELLE M. PANSZA

In areas frequented by ecotourists, wildlife, such as this female White-collared Manakin (*Manacus candei*) lose their fear of humans.

JANELLE M. PANSZA

Anoles (*Anolis* sp.) were ubiquitous along the edges of forests.

JANELLE M. PANSZA

Cattle ranching is the principal cause of deforestation in Costa Rica.

JANELLE M. PANSZA

Green Iguanas (*Iguana iguana*) often bask on branches overhanging forest waterways.

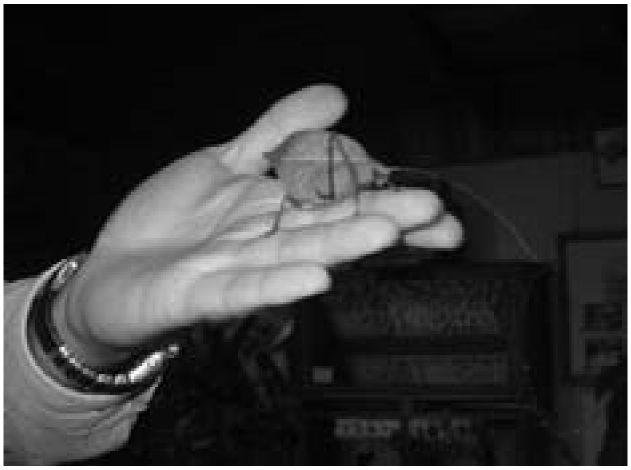
At the Santa Marta Ranger station in Guanacaste National Park, we saw our first snake, a beautiful Green Vine Snake (*Oxybelis fulgidus*) drinking at a rainwater pool.

The next ecosystem we visited was the cloud forest at Monteverde. The hills were green to the very top of the mountains, and you could see all the way to the ocean. Green Iguanas (*Iguana iguana*) were common in roadside trees. When we reached our lodge, the weather was rainy, cool, and windy. Investigating munching noises in a nearby tree, we spotted a Two-toed Sloth (*Choloepus didactylus*) mere meters from our bal-

JANELLE M. PANSZA

Coati Mundis (*Nasua narica*) have become proficient panhandlers.

Zip-lining through the canopy provides a totally different perspective of the forest.



JANELLE M. PANSZA

Insects, such as this katydid, often exhibit remarkable cryptic patterns and colors, in this instance, looking just like a leaf, scars and all.

cony. Our final day in the cloud forest was spent touring a reptile farm, the serpentarium, and the frog house. Of 135 species of snakes found in Costa Rica, 17 are venomous. This information was not entirely academic. A girl on the same trip the year before was bitten by a Fer-de-lance (*Bothrops asper*) and had to spend several weeks in the hospital.

During the rainforest portion of our trip, we saw a Green and Black Dart Frog (*Dendrobates auratus*) and a smaller "Blue Jeans" Dart Frog (*Dendrobates pumillio*). At the La Selva Biological Station, we spotted several species of anoles (*Anolis* spp.), more large Green Iguanas, and, down by the river, American Crocodiles (*Crocodylus acutus*) and Spectacled Caimans (*Caiman crocodilus*). Near the Pacure River, we shared our cabins with many little geckos. Anoles were all over the front porch, Ground Lizards (*Ameiva festiva*) were common on the grounds, and basilisks (*Basiliscus* spp.) basked on rocks along the riverbanks. We did see some individuals running on their hindlimbs but never saw one running on water, a skill for which they received the common name "Jesus Christ Lizard."

Our last stop was in San Jose. Half a day in the large, busy city was quite a culture shock after passing the previous few weeks in the green serenity of the forests. Costa Rica was an experience of a lifetime. Although I had been forewarned, I was amazed to see such biodiversity in such a small geographical area. I recommend a visit to anyone with even a casual interest in nature — but make sure you bring a good camera. PURA VIDA!!!

From Here It's Possible: A Texan Visits the Tropics

Kaela E. Champlin

Department of Natural Resource Management, Texas Tech University, Lubbock, Texas

Clinging to the front seat of the "turismo" bus for dear life, I anxiously awaited certain death as the bus squeezed past cars on the winding, narrow road leading to the small town of Atenas near San Jose. I wanted to close my eyes but couldn't sacrifice the view. Within a half hour, the landscape had changed from crowded city to meandering emerald green hills and slopes. Tropical trees draped over the serpentine road, and small houses littered the roadside, their occupants busy in the fields beyond.

We spent some time at the School for Field Studies in Atenas. Drifting through town, I gazed into store windows and savored the sweet aroma of baking breads and empañadas. Uniformed school children sat on the steps of a whitewashed church, and people were quietly strolling and relaxing on benches in a park that seemed to blend naturally into the greenery encompassing the town.

Three days later, we drove through mountain slopes patterned by a mosaic of coffee plantations, arriving at Poás National Park by mid-morning. Fortunately, clouds had not yet risen over the crater, so the chamber was clearly visible. Water gurgled and bubbled while sulphurous gases seeped out of the sides and a biting wind tried to steal my hat. Within minutes, clouds wafted over the crater, covering it like a blanket. While walking up a trail to a crater lake, a Poás Squirrel (*Syntheosciurus poasensis*), endemic to the park, tried to charm us in exchange for food. The lake's deep blue water contrasted sharply with the tangled dark green forest around us.

The next day, during an eight-hour drive over the central mountain range, we pulled off the road. The air was crisp, thin, and chilly. Anxious to stretch our legs, we piled out of the bus and attacked a hill covered with sub-alpine páramo vegetation. Huffing and puffing, I reached the top, almost 11,000 feet high and above the clouds. Below me lay richly verdant mountain slopes and birds soaring in the distance. The view will be a snapshot in my memory forever.

Several hours of pouring rain and narrow, bumpy roads later, we arrived in the swampy town of Sierpe, from were we were to visit the Osa Peninsula and Corcovado National Park, traveling through mangroves and out into the ocean. A three-hour ride, weather permitting, would take us to Sirena Station. Soon, the narrow river view opened to an endless vista of ocean stretching into an azure sky. The water turned from murky brown to a deep, transparent blue. The boat pulled into a cove where a waterfall cascaded into the ocean, and the boulders housed an array of tropical birds. Later, a school of dolphins accompanied our boat. Our arrival was abrupt. The refreshing breeze was replaced by intense humidity. We quickly disembarked. As the boat pulled away, I realized how isolated we were. I felt a surge of excitement and heard the first of many mysterious howls, hoots, and screeches emanating from the jungle.

After the initial shock of the heat wore off, the Osa Peninsula became a paradise. Sirena Station consisted of a kitchen, screened rooms with bunk beds, and a lab frequented by researchers. Surrounded by forest, you can sit on the porch and watch the wildlife pass. Howler Monkeys (*Alouatta* sp.) served as alarm clocks, hooting and screaming as if they were right in the room.

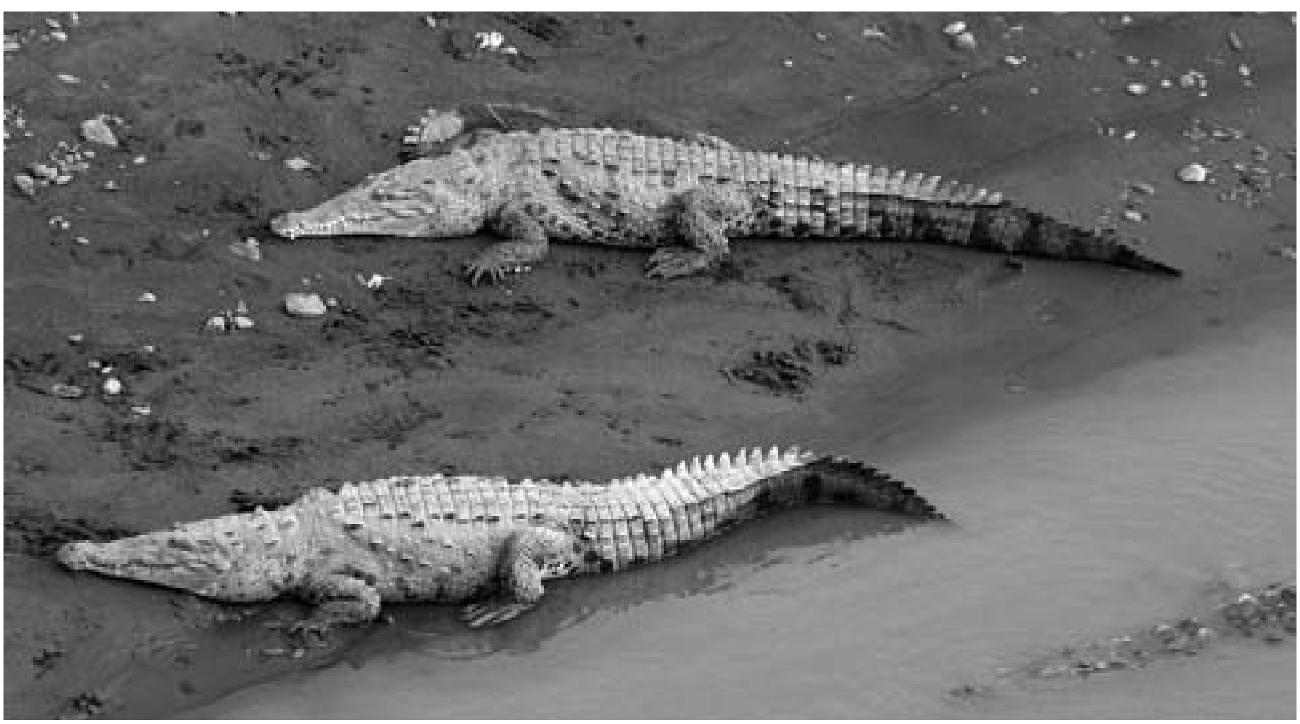
If you enter as a quiet visitor, the diversity is amazing. Once my eyes adjusted, I saw Leaf-cutter Ants (*Atta* sp.) hauling leaves to their massive mounds. Bulging Strangler Figs (*Ficus* sp.) eventually smothering the trees on which they grow. One cool morning on the bank of the Río Claro, I was sitting on a tree trunk watching a Tiger Heron (*Tigrisoma mexicanum*), when a sudden

JANELLE M. PANSZA

Hot vents in the forest provide ample evidence of Central America's volcanic origins.

GAD PERRY

Costa Rican wildlife, such as this Lesser Anteater (*Tamandua tetradactyla*), has become quite accustomed to humans.



CLINT BOAL

American Crocodiles (*Crocodylus acutus*) basking along rivers are a common sight in conservation-minded Costa Rica.

commotion in the nearby brush turned out to be a Kinkajou (*Potos flavus*), rarely seen by day. Once, we stumbled onto a pack of Javelinas or Collared Peccaries (*Tayassu tajacu*) sifting through a mud pile. Most of the activity during the day is in the canopy, where Keel-billed Toucans (*Ramphastos sulfuratus*) call and Spider Monkeys (*Ateles* sp.) swing. At night, the rainforest truly comes to life. Insects come out in full throttle, and the bats soon follow. The Catch-22 of walking at night was the choice of stumbling blindly through blackness or sacrificing my flesh to the hordes of mosquitoes and other bloodthirsty insects attracted to my flashlight. The hollow clicks of Red-eyed Treefrogs (*Agalychnis callidryas*) echo from above, and tiny fluorescent-yellow Palm Treefrogs (*Hyla ebraccata*) chirp happily on waxy leaves. Wading through a swampy pond, we found sleeping Basilisks (*Basiliscus* sp.), Cat-eyed Snakes (*Leptodeira septentrionalis*), a caiman (*Caiman crocodilus*), and a treeboa (*Corallus ruschenbergerii*).

GAD PERRY

Seventeen of Costa Rica's 135 species of snakes are venomous. This is a light-brown Eyelash Viper (*Bothriechis schlegelii*), named for the scales that protrude over the eyes.

When not in the forest, I ventured onto the beach. At low tide, perfect conch shells washed ashore and melted into the black sand. Although I longed to cool off in the water, the prospect of encountering a Bull Shark (*Carcharhinus leucas*) restrained me. Scarlet Macaws (*Ara macao*) flew overhead, squawking and littering the ground beneath the high tree in which they perched with rotting fruit and molted feathers. American Crocodiles (*Crocodilus acutus*) floated where the river met the ocean.

Eventually, we had to leave. Coming back was a shock. Tropical forest was replaced by small town, then by big city. From walking, cold showers, and occasional power, we went back to cars, electricity, and hot water. Clothing could once again be washed, and we had options for food. Eventually, we got on a plane and came back to the dry, flat landscape that surrounds Lubbock, Texas. I don't miss the mosquitoes, but I do miss Costa Rica. I'll be back...

CLINT BOAL

Black Iguanas (*Ctenosaura similis*), locally known as "Garrobos," are abundant and amazingly tolerant of close approaches by humans.

HISTORICAL PERSPECTIVE

Notes on Iguanids and Varanids in a Mixed Exhibit at Dallas Zoo[1]

James B. Murphy

Supervisor of Reptiles, Dallas Zoo, Dallas, Texas, USA

Numerous attempts are made by zoological gardens to display resident populations of iguanids and varanids, but often these meet with little success. Many species of the two families are imported annually; yet surprisingly, few exhibit the characteristic alertness and activity associated with wild specimens. After a few months in captivity, their lethargy and obvious lack of health is depressing even to the casual zoo visitor.

Since November 1966, we have maintained an exhibit centred around these two families. Rhinoceros Iguanas *Cyclura cornuta*, Andros Island Iguanas *Cyclura b. baealopha* [*Cyclura cychlura cychlura*], Exuma Island Iguanas *Cyclura b. figginsi* [*Cyclura cychlura figginsi*], Cayman Island Iguanas *Cyclura macleayi caymanensis* [*Cyclura nubila caymanensis*], Green Iguanas *Iguana i. iguana*[2], and the Mexican False Iguana *Ctenosaura hemilopha* live in complete harmony with a large Water Monitor *Varanus salvator* and a Lace Monitor *Varanus varius.* They are exhibited in a large glass-fronted display area, measuring 4.6 x 2.4 x 3 m, the top being screened with wire. A concrete pool, 2.4 x 1.2 m, is in the centre of the cage. The monitors are often seen swimming or resting in the water.

Because the natural temperature of the area is only 27 °C (80 °F), an auxiliary heat source is needed so that normal metabolic functions can proceed. A bank of six 250-W/11O-V Infrared Heat Lamps (Ken-Rad) and two 275-W/11O-V 'Sun Lamps' (Ken-Rad) are directed to a 'hot spot' at the front of the cage where the temperature reaches 41 °C (106 °F). The value of these lamps cannot be underestimated, for the lizards are most healthy when they are in operation. Common or Green Iguanas *Iguana iguana* with paralysed hindlimbs and in generally poor health are often brought in as donations. In many cases, their condition has improved after a few months under the sun lamps.

For a natural effect, plastic foliage, rocks, and tree limbs are used. The plants must be chosen carefully to withstand the constant prowling and climbing of the lizards. The limbs are arranged at an angle one meter from the ground, so the lizards may retire to them during the heat of the day. Gravel that will pass through a 1-cm screen is used for the substratum, as this tends to hold the warmth well. It also gives a firm footing for the constantly scurrying lizards, which seem to feel insecure if placed on material that gives way under their weight.

To ensure the health of the saurians, a proper diet must be offered and they are fed three times a week. Two large aluminium trays are filled with diced fruits and vegetables. Oranges, apples, bananas, grapes, lettuce, spinach, kale, tomatoes, beets, carrots, papaya, and cantaloupe are used according to season. Once a week, strips of lean horsemeat and freshly killed mice are included in the tray. A multiple vitamin preparation (Pervinal) and steamed bone meal or oyster shell flour are the only additives. Care is taken to avoid overfeeding, and we judge this by observing the girth of the hind limbs and proximal portion of the tail.

The photoperiod and temperature remain relatively constant day by day and the relative humidity is about 40%. The lights are turned on at 0800 hours, and the lizards begin to emerge almost immediately. Usually, after basking in the heat for the first 30 minutes or so, they begin to leave the 'hot spot' and return only periodically to maintain their temperature level. They are fed between 1500 and 1600 hours. After the meal they return to the 'hot spot' and remain there for some time. This apparently aids digestion. The lights are turned off at 1700 hours, and this is the period of greatest activity. Flattening themselves dorsoventrally, they remain on the 'hot spot' area until it cools. During this time, the sunlight that shines through the sky-

[1] This article is adapted with the kind permission of the *International Zoo Yearbook* (*International Zoo Yearbook* 9: 39–41; 1969), which is published by the Zoological Society of London. Additional information about the IZY can be found at http://www.blackwellpublishing.com/journal.asp?ref=0074-9664&site=1.

[2] Note that subspecies of Green or Common Iguanas (*Iguana iguana*) are, for the most part, not currently recognized. Extensive studies of genetic relationships among populations from different regions are underway (e.g., see "ISG Reports" in *Iguana* 13(2): 127–128).

Editor's Remarks

This is the complete, edited text (e.g., capitalized formal common names, insertion of current scientific names when they differ from the original) of the first major publication by James Murphy of the Dallas Zoo, whose profile appears elsewhere in this issue. Although relatively recent compared to other studies we have highlighted in this section, this article was an important milestone.

Zoos used to be dismal places. They began as places of entertainment, and animal welfare, conservation, and research were not a part of their missions. That eventually began changing, but reptile departments were not at the forefront of this process. The 9th issue of the International Zoo Yearbook (IZY), in which this article appeared, was the first to have a herpetological focus. Other articles examined thermal requirements of captive reptiles (following on the work of Cowles and Bogert, which we featured in *Iguana* 13(1): 53–61), reported on lighting and humidity, and described captive reproduction and incubation techniques. Species covered were primarily large: crocodilians, tortoises, constrictors, iguanas, and monitor lizards. Most articles were shorter than Murphy's, and few had references. Zoos were beginning to emphasize scholarship, and Murphy was a leader in applying this to herpetological collections.

Things have changed dramatically over the ensuing decades. The IZY has had a number of herpetologically themed issues over the years, and these reflect the increasing sophistication of zoo research. Some leading zoos (including the Dallas Zoo, whose herpetological publications can be seen at http://www.dallaszoo.com/oth/oth.asp?page=spubs#reptiles), now include studies of natural habitats and their conservation in their mission. This modest paper led that change.

Gad Perry
Texas Tech University

light above the cage gradually fades. The only variation in this routine is during the introduction of new animals when, if they are shy and feeding diffidently, the lights will be left burning after visiting hours so they will emerge and feed.

Newly acquired animals are quarantined in fibreglass holding cages for at least 30 days. Upon arrival, they are washed in a prophylactic solution of oxytetracycline hydrochloride (Cosa-terramycin) for 24 hours. Food is presented daily until a pattern of feeding can be determined.

Maintenance of the exhibit is remarkably uncomplicated considering the number of reptiles involved. Daily, the keeper enters the cage before the lights are turned on, drains the pool and scrubs it with a disinfectant (Roccal), cleans faecal matter from the gravel, and polishes the glass. The cage is completely dismantled bi-monthly and the gravel and walls are thoroughly disinfected. The plastic plants, rocks, and gravel are also cleaned and disinfected.

Rudimentary 'grooming' by the Exuma Island Iguana has been observed. As the lizards shed their superficial epidermis in fragments, pieces adhere to the body. Individuals of the same species will investigate the body of the shedding lizard and consume the skin whenever possible. Not only are the dorsal and lateral areas checked, but the shedding iguana will lift its leg and allow the others to pull the skin from beneath the leg. Occasionally, more than one 'grooming' lizard will be involved in this process.

Hopes for future successful breeding with this arrangement are based on the numerous copulations we have observed; although, unfortunately, the only eggs discovered were broken. The male iguanas display vigorously in typical head bobbing fashion and territories are rigorously defended. For such a large and varied population, the mortality in the cage has been remarkably low. Since its inception, only one Nile Monitor *Varanus niloticus* has died.

Readers should recognize that combining different species in one enclosure is a risky proposition. Behavioral triggers that cannot be anticipated may result in aggression leading to injury or death of some animals. With very few exceptions, such practices are not recommended.

Products mentioned in the text: Ken-Rad, Owensboro, Kentucky, USA; Pervinal, US Vitamin and Pharmaceutical Corporation, Veterinary Products Division, New York, USA; Cosa-terramycin, Charles Pfizer and Company Inc., New York, USA; Roccal, Winthrop Laboratories, New York, USA.

COMMENTARY

Collecting Animals from Nature

Robert Powell

Department of Biology, Avila University, Kansas City, Missouri

"Could we be going in the direction that eventually zoos and researchers will be denied access to wildlife?"

Al Winstel
Naturalist and Environmental Educator,
Cincinnati, Ohio

The deleterious effects of wholesale destruction of populations and habitats as a consequence of development have been amply documented (e.g., Tilman et al., 2002), as have those of uncontrolled collection (e.g., COSAEWIC, 2004). Here I focus on efforts to govern personal, educational, and scientific collection. My discussion is based on personal experiences, exchanges with colleagues, postings over the past several years on the PARC (Partners in Amphibian and Reptile Conservation: www.parcplace.org) listserver, and comments by responsible hobbyists. Individuals in each of those categories will see comments below that reflect their input and sometimes their very words.

Personal Collection

Young people love to collect. Although an early enthusiasm for reptiles may be responsible for the development of many professional herpetologists, many others become hobbyists or merely pass through such a stage. Nearly every coveted salamander, frog, turtle, lizard, or snake they encounter makes its way into a cage. This can be a learning experience leading to an increased awareness of nature and the myriad interactions that keep it going. However, the mortality of captured animals, many of them not well suited to captivity, is almost invariably high, especially during early attempts at husbandry.

THOMAS WIEWANDT, WILD HORIZONS

JOHN BINNS

Despite better and more frequently enforced regulations and a burgeoning captive-breeding industry, the sale of wild-caught animals persists. Locals in the Dominican Republic offering for sale wild-caught male and female Rhinoceros Iguanas (*Cyclura cornuta*) to a tourist in 1975. The snouts of the Iguanas were tied with wire or rope to prevent biting. International and domestic laws now help protect iguanas in the Dominican Republic and many other nations. Large expos offer for sale both captive-bred and some wild-caught animals. Sellers are required to have permits, a regulation that is strictly enforced by responsible organizers of reputable expos and the U.S. Fish and Wildlife Service (vendor names are intentionally blurred in this photograph).


BRIAN S. EDMOND

Catching and keeping wild-caught animals has been responsible for the development of many budding herpetologists.

Such losses might be accepted as the price that must be paid to attract the next generation of herpetologists, except that the number of people engaged in personal collection has increased dramatically in recent years. For evidence, one need only to look at the phenomenally profitable business that provides housing, lighting, food, supplements, and more for captive reptiles and amphibians. Some of that increase has been met by captive breeding, but the sale of wild-caught animals persists. Even if only a tiny fraction of enthusiasts buy or collect wild animals, some populations, especially in and around dense human concentrations, will inevitably become depleted. As the numbers of people engaged in such activities increase, even casual collecting can become significant.

On the other hand, discouraging children from collecting animals may alienate them from the natural world. Richard Louv, in his recent book (*Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder*), argued that sensationalist media coverage and paranoid parents have "scared children straight out of the woods and fields," while promoting a litigious culture of fear that favors "safe," regimented sports over imaginative play and exploration. Well-meaning elementary school curricula may teach students everything they need to know about the Amazonian rainforest and DNA, but do little to encourage personal relationships with the world outside their own doors.

Educational Collection

A dearth of knowledge on the part of most people about amphibians and reptiles is a considerable deficiency in promoting reasonable and effective herpetological conservation. Those of us with experience, especially we who bill ourselves as "professionals," have a vested responsibility to teach others — and that requires access to live animals.

Scientific Collection

Scientific collection has not been implicated directly in the extinction of any species. Although historically common meth-


PHOTOGRAPH COURTESY OF GEORGE C. GORMAN.

Although scientists historically used "markets," in which locals catch and offer animals for a small fee, the number of specimens taken are invariably limited to those needed to address specific questions. This stands in stark contrast to actions of indiscriminate commercial collectors, who often take every animal hoping that enough survive to ensure a profit. Here, children bring lizards caught with grass nooses to a researcher studying inter-island evolution in the Lesser Antilles.


ALLISON C. ALBERTS, ZOOLOGICAL SOCIETY OF SAN DIEGO.

Educating the public about amphibians and reptiles is most effective when live animals are used. Here, a Cuban Iguana is featured in a program for military and civilian personnel and their families at the U.S. Naval Base at Guantanamo Bay.


PHOTOGRAPH COURTESY OF ELLEN J. CENSKY.

Researchers today rarely collect large numbers of animals from any one population. More and more studies involve mark-and-release methods. Here, a scientist weighs an animal in the field prior to releasing it at the original site of capture.

ods (e.g., "markets) may well have caused declines of some populations, most scientists now seek to minimize the numbers of individuals taken. Unfortunately, attitudes of agencies and current regulations frequently reflect abuses of the past instead of today's reality. Instances of "scientific imperialism" (e.g., removal of important materials from the nation of origin, failure to share results with local agencies, and a lack of willingness to collaborate with resident scientists or students) by North Americans or Europeans may be cited by governmental agencies in developing nations to deny or restrict collection of specimens by scientists from those regions. Although the events are real, very few are recent. Almost all cases of exploitative collection within the past 50 years are attributable to collectors feeding the ever-growing commercial trade in amphibians and reptiles.

Regulatory issues

The acquisition of animals from the wild for personal, educational, and scientific purposes is subject to a plethora of regulations governing collection. Attempts to abide by these rules are frequently rendered difficult by fees or procedures that appear to exist primarily in order to discourage such activities. In sharp contrast, few regulations effectively address wholesale destruction of entire populations or even habitats as a consequence of economic development, which is responsible for the decline or disappearance of most populations. Often further complicating this issue is the lack of regulatory distinction between commercial collectors, whose activities are often driven solely by a desire for short-term profits, and those who are motivated by a sincere interest in animals, such as hobbyists, educators, and scientists.

Regulations prohibiting personal collection of native wildlife often exclude "game" animals (e.g., Bullfrogs, Snapping Turtles, Green Iguanas) that are covered by hunting or fishing permits. This inevitably leads to situations in which possession of an animal as a pet is illegal, yet thousands can be legally "harvested," kept in inhumane conditions, killed, and sold as food when "in season." Complicating matters even more is the fact that "snake hunting" can create revenue. Local businesses in west Texas for example, love snake hunters, who stay in their motels, buy their gas, eat at their restaurants, and pay Texas taxes.

Snake hunting can create revenue. Local businesses in west Texas, for example, love snake hunters, who stay in their motels, buy their gas, eat at their restaurants, and pay Texas taxes. Photograph courtesy of APNM.org

Educational collecting in some states requires a permit to keep and display native wildlife, often imposing additional restrictions on dangerous species such as venomous snakes or large constrictors. Some governmental agencies limit animals used in education to non-releasable, rehabbed individuals or those confiscated from illegal keepers. Such constraints would, for example, preclude individual teachers from collecting tadpoles for their classrooms, forcing them to rely instead on scientific supply houses that provide such resources by collecting and shipping large numbers of animals — with inevitably high levels of mortality. Similarly impacted are individuals, often associated with local or regional herpetological societies, who are knowledgeable and willing to conduct educational programs for the public, but are discouraged from using native species that might be most effective in developing an environmental ethic in their audience.

Restricting scientific collections of animals that are threatened or potentially threatened in the wild can lead to lack of sufficient knowledge to develop effective management programs or develop appropriate protocols for rearing them in captivity. The latter may make the difference between extinction and survival. For example, isolation and captive propagation of frogs with populations in nature that are vulnerable to the chytrid fungus may be the only way to salvage a species and the sole means of reestablishing a wild population should the risk ever be remediated. Without captive animals, refining husbandry and breeding techniques is impossible, and methods based on experiences with presumably similar species may or may not apply. Ironically, lack of information is frequently cited as justification for restricting collection. At the same time, some individuals have suggested that gaps in knowledge should not exist, considering the number of educational institutions and individuals who have been studying amphibians and reptiles for many years. Unfortunately, those who hold these views often rely on anecdotal observations, as opposed to reliable research, to support their contentions. In reality, we know far less than we should about most species and populations. The only way to address this deficiency is to encourage more research, even if this entails the collection of some animals. Restrictions that preclude accurate scientific assessments are shortsighted and ultimately place more populations and communities at risk of extirpation or extinction.

Common Themes

Three issues are relevant to all forms of collecting: (1) Collecting animals in the wild can and does affect the viability of populations and their habitats; (2) little or no information is available on the status of most populations; and (3) prohibition (or severe restriction) of all forms of collection is easier than regulating case-specific situations.

That all forms of collecting arguably cause less harm to animal populations than development is an unpleasant reality. I was once questioned about the number of several common species I sought to collect until the point was made that a 100-m extension of a planned road into the area would kill far more individuals than I sought to remove from the population. However, using the "bulldozer" justification for unregulated collecting is disingenuous. Developmental pressures on habitats and their inhabitants do not absolve commercial and casual or even scientific collectors from their collective share of the responsibility for

CRAIG PELKE

Isolation and captive propagation of frogs with populations in nature that are vulnerable to the chytrid fungus may be the only way to salvage a species and the sole means of reestablishing a wild population should the risk ever be remediated. Here, an *Eleutherodactylus euphronides* sits on eggs in the breeding facility of the Milwaukee County Zoo. One recent estimate of this endangered species' restricted distribution in the highlands of Grenada was only 18 km^2.

the many thousands of specimens that they remove purposefully from the wild gene pool. Even if such activities are legal, that does not mean that they should be.

Private collectors often argue that they are doing more good for species than bad. Once animals are bred in captivity in sufficient numbers, prices will drop until buying them from breeders or pet shops is cheaper than collecting them from the wild. Some breeders have also argued that occasional collection is necessary to get "new" blood into captive populations, needed as a safety net against extirpations and extinctions in the wild. Many are not convinced by these arguments. Does anyone really need 20 snakes of a single species from a single locality? Of course not — but too many individuals, especially those engaged in commercial operations, cannot seem to stop collecting. A recent article in the *Kansas City Star* (3 July 2006) featured Rodney Wittenberg, a graduate student studying Timber Rattlesnakes in an old quarry where efforts are in place to clean up discarded tires that had accumulated over many years. He is trying to keep workers and snakes from harming one another. The article did not reveal the actual site. Wittenberg said: "I don't want to alert rattlesnake poachers or even thrill-seekers. Next thing you know, you can kiss [the snakes] good-bye," noting that they could end up as somebody's hatband or in a rattlesnake roundup. As for captive breeding, private individuals allowed to breed endangered and threatened species should have to submit to regulation and inspection to assure compliance with the need to maintain breeding lines and proper use of husbandry techniques. Collection should be strictly regulated to conform to detailed breeding plans, not individual whim.

RODNEY D. WITTENBERG

A graduate student is studying Timber Rattlesnakes (*Crotalus horridus*) in an old quarry where efforts are in place to clean up discarded tires that had accumulated over many years. He is trying to keep workers and snakes from harming one another. He will not reveal the actual site, noting: "I don't want to alert rattlesnake poachers or even thrill-seekers. Next thing you know, you can kiss [the snakes] good-bye." Portrayed here is a rarely seen but apparently not particularly rare instance of arboreal activity in Timber Rattlesnakes.

Contentious Issues

One really important point divides those who engage in collection of animals from the wild. Many conservation biologists would favor bans on collection until hard data show that collecting causes "no real threat" for a given species, but many others would favor collection until data show that collecting poses a "real threat." Such extreme positions typically preclude compromise. Decisions based on data that are fragmentary or inconclusive might be acceptable in situations during which populations are being affected by other factors. For example, because development is ongoing and often inevitable, building permits should include provisions that require collection for scientific assessments, or even allow personal collection of species from the area destined to be altered. On the other hand, bans on all but responsible — and limited — scientific collection may be appropriate for species about which essentially nothing is known (on the presumption that lack of knowledge may be indicative of few opportunities to study the relevant species) or under circumstances involving fragile ecosystems (or even habitats) that deserve complete protection.

Because a deficiency of information is often responsible for conservative measures (e.g., protect until we have data that assures us that some collection is reasonable), investigations into the natural history of as many species (populations or even communities) as possible should be encouraged and funded. That would presumably lead to regulations based on reliable (rather than anecdotal) data and applicable specifically to targeted species and populations. Because the drawback to this approach is frequently fiscal, designated funds might be made available by charging substantial fees for collecting permits other than for scientific investigations. Individuals seeking to harvest animals for personal pleasure or profit would ultimately benefit if more data suggest that more species could be managed on a basis of sustained yields.

However, research capable of determining the effects of collection is inevitably difficult due to the many confounding factors (e.g., complexity of interactions and local effects that may or may not apply to other populations of even the same species). The implications of that reality have profound effects on management decisions. In the interim, then, until more and better data slowly accrue, such decisions must and undoubtedly should be made on the basis of factors that may merely reflect the sub-

STESHA PASACHNIK

Because development is ongoing and often inevitable, building permits should include provisions that require collection for scientific assessments, or even allow personal collection of species from the area destined to be altered.

jective judgment of "designated experts." I would have to think that anyone sincerely interested in amphibians and reptiles would prefer that over decisions made by uninformed bureaucrats and based largely on the financial interests of a few fiscally influential citizens.

Recommendations

Collection for personal use, whether by individual or commercial collectors, almost invariably diminishes population health or habitats. Private collectors should be restricted to small numbers of common species — those for which we have enough information to safely conclude that removal of a few individuals will not be deleterious. Although individuals enamored with rarities will object and may on occasion circumvent regulations, no justification exists for allowing unconstrained collection of any species for which we lack definitive information. Captive breeding should compensate for the imposition of restrictions on collecting. Taxon-specific caresheets and books are available for many species, often via the internet.

Collection for educational purposes should be similarly restricted. Developing a conservation ethic does not require the use of rare and threatened species. However, reason should prevail. Restrictions on the possession of wild-caught animals should not preclude the use of common native species (e.g., the afore-mentioned tadpoles) in classrooms or in presentations by conscientious educators, be they professionals or hobbyists.

In stark contrast, restrictions on scientific collection should be streamlined and limited to steps necessary to confirm the legitimacy and identities of scientists seeking to remove any animals from the wild. Numbers to be collected should be determined by circumstances unique to each situation and the needs of the investigation rather than any arbitrary limit established by bureaucrats, even those with the best of intentions. The apparent health of a population frequently is based on counts of organisms, which do not necessarily indicate whether a population is healthy. For example, do we know how many individuals are required to make the population viable? What is the level of mortality? Recruitment? Is this adequate for maintaining numbers? How vulnerable is the habitat to destructive effects of collection? Only by studying animals will we ever learn enough about natural populations to manage them effectively, much less relieve restrictions on collecting animals from nature for purposes other than research and conservation.

Finally, the loopholes that allow massive losses to habitat destruction must be closed. The fiction that natural areas can be "developed" without the loss of the animals dwelling there must be abandoned. Because development is ongoing and often inevitable, building permits should include provisions that require and fund collection for scientific assessments, or even allow personal collection.

Ultimately, any decision to restrict collection should be determined by considering all possible effects on populations of species affected. When data are insufficient for reasonable consideration, short-term bans should be implemented, but are to be accompanied by efforts to promote acquisition of necessary data by qualified individuals. In today's world, changes are occurring at such a rapid pace that laissez faire management of wild populations cannot be justified, lest we lose them forever.

Acknowledgements

Robert W. Henderson and Gad Perry commented on earlier drafts of this manuscript. S. Blair Hedges has voiced and published concerns about undue constraints on scientific collection, many of which I have incorporated into this commentary. A number of individuals posted relevant comments on the PARC listserver, including many whose views differ considerably from those expressed herein. I have shamelessly exploited their insights and expertise.

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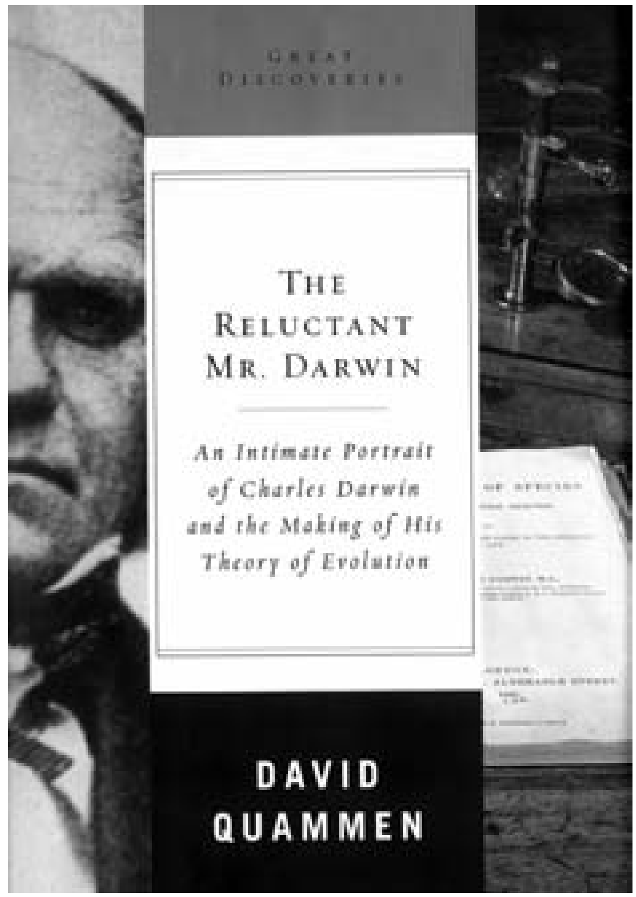
Tilman, D., R. M. May, C. L. Lehman, and M. A. Nowak[1]. 2002. Habitat destruction and the extinction debt. *Nature* 371:65–66.

[1] Abstract of Tilman et al. (2002): Habitat destruction is the major cause of species extinctions. Dominant species often are considered to be free of this threat because they are abundant in the undisturbed fragments that remain after destruction. Here we describe a model that explains multispecies coexistence in patchy habitats and which predicts that their abundance may be fleeting. Even moderate habitat destruction is predicted to cause time-delayed but deterministic extinction of the dominant competitor in remnant patches. Further species are predicted to become extinct, in order from the best to the poorest competitors, as habitat destruction increases. Moreover, the more fragmented a habitat already is, the greater is the number of extinctions caused by added destruction. Because such extinctions occur generations after fragmentation, they represent a debt — a future ecological cost of current habitat destruction.

BOOK REVIEW

The Reluctant Mr. Darwin

The Reluctant Mr. Darwin: An Intimate Portrait of Charles Darwin and the Making of His Theory of Evolution. 2006. By David Quammen. W.W. Norton & Co., New York. 304 pp. Hardback – ISBN: 0-393-05981-2. $22.95.



As part of the landed gentry, Charles Darwin's family lived a sedate and sophisticated life in a large Georgian house in Shrewsbury. Darwin's father, a successful doctor and capitalist, had a large library, especially rich in natural history; a greenhouse was just off the morning room, and Darwin's mother kept fancy pigeons. After what is often described as an unremarkable childhood, Darwin left for Edinburgh to study medicine at the age of sixteen, but was appalled by the body trade and especially the brutality of surgery without anesthesia. After he abandoned that career, his father told him, "You care for nothing but shooting, dogs, and rat-catching, and you will be a disgrace to yourself and all your family." Darwin's next plan was to prepare himself for ordination at Cambridge and become a parson-naturalist.

But then it happened. In 1831, Darwin received an invitation to accompany Captain Fitzroy on the second *Beagle* expedition. Darwin wrote in his *Autobiography* that before leaving he "did not then in the least doubt the strict and literal truth of every word in the Bible." After nearly five years of collection, observation, and seasickness, he returned to England, and David Quammen's new biography *The Reluctant Mr. Darwin* begins with this return.

When considering the number of existing biographies of Darwin, one may wonder what is left to say. However, Quammen's biography, while not revisionist, is noteworthy for several reasons. At 250 pages, it is concise and manageable, especially compared to Adrian Desmond and James Moore's 800 pages or Janet Browne's 1000-page treatment. Also, more than a biography of the man, Quammen's lucid and engaging book is the history of an idea — the "marvelous and shocking and grim" idea of natural selection. Quammen provides just enough biographical detail to convey the birth of this idea in the context of a great deal of hesitation and reluctance on Darwin's part.

With his characteristic flair for metaphor, Quammen entitles the first chapter "The Fabric Falls," and writes that for two years after the *Beagle* voyage, Darwin "lived a strange double life, like a spy in the corridors of the British scientific establishment, which at that time was closely attuned to Anglican orthodoxy and grounded in the tradition of natural theology." In 1837, an important breakthrough occurred when John Gould examined the bird specimens from the Galápagos Archipelago. Darwin had thought that one group represented an assortment of wrens, grosbeaks, orioles, and finches, but they were all finches, thirteen species, closely related but distinct, and all unknown to science. Also, three distinct species of mockingbird were nestled in the collection, and, unlike the finches, the mockingbirds had been carefully tagged. Each species inhabited a different island.

Another breakthrough occurred in 1844, when Joseph Hooker examined the old plant specimens from the *Beagle* and found that their island-by-island diversity contradicted the preconceived notions of species radiating from a center. Darwin wrote, "At last gleams of light have come & I am almost convinced (quite contrary to opinion I started with) that species are not (it is like confessing a murder) immutable." Quammen writes that this was a daring admission, "cast in sheepish understatement and contradicting one of the fundamental tenets of British natural theology." At that time, Darwin completed a 189-page draft of his species theory, tucked it away, and seemed to stop.

In speculating on the reasons for what is referred to as "Darwin's Delay," Quammen continues to examine the tensions between Darwin's class and status and the political implications of his work. As a gentleman and patriarch, Darwin was part of the establishment working in a political climate in which Church and government feared the Chartists and street agitators bolstered by Lamarckism and other such subversive ideas. As the law of the land, Christianity helped to keep the lower orders in check; anything that challenged the Church was seditious. Darwin was not only afraid to publish, he wanted no part of this class warfare. The evolutionary radicals in the public arena were not his kind of people.

In 1846, Darwin began to dissect barnacles, and because of his reputation and vast network of contacts, he was able to obtain them from all over the world. In contrast to his former belief regarding the rarity of variation, he discovered that barnacles were highly variable, and Quammen writes, "Here they were, the minor differences on which natural selection works." After almost eight years of barnacle work, his volumes won the Royal Medal for Natural Science, providing even more scientific esteem and credibility from the establishment.

Darwin had sixteen years to refine the ideas he had outlined in 1842 and drafted in 1844. He had fathered nine children, buried two, and published eight books. Why not publish? Instead, he started to breed pigeons.

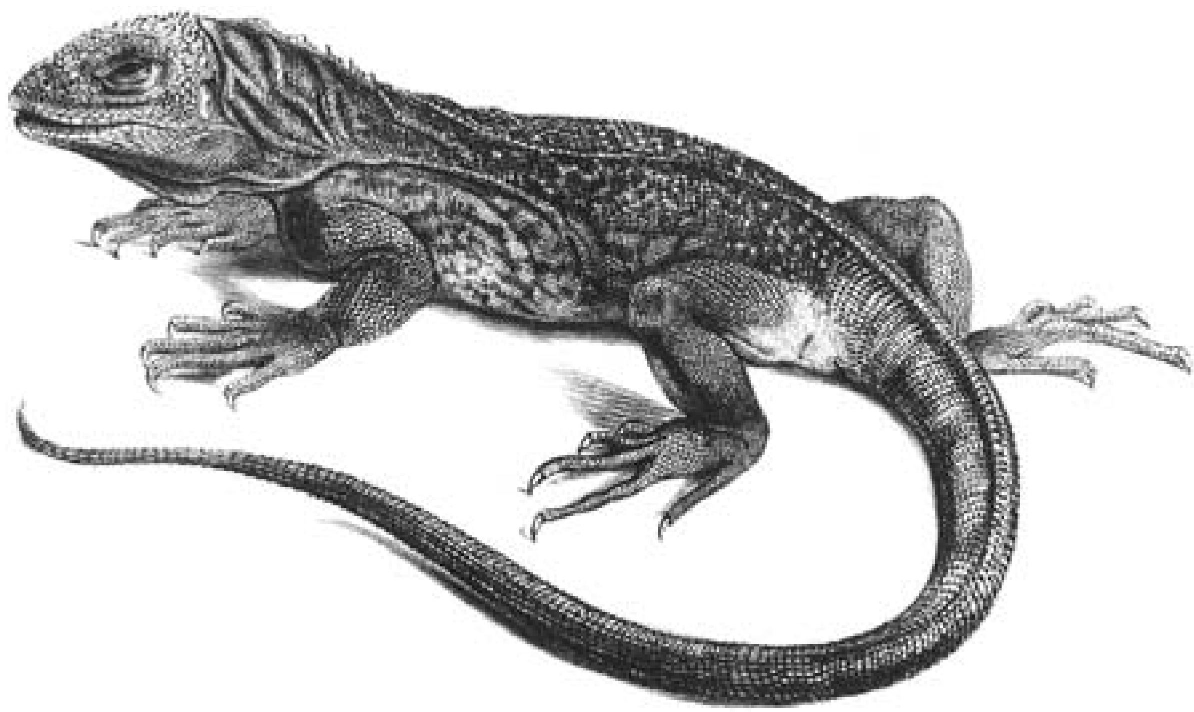
Quammen compares Darwin to a kiwi, a bird that lays a disproportionately large egg. Not only was it large, but Darwin postponed and delayed and then published only when forced to do so. When Alfred Russel Wallace independently developed the idea of evolution by natural selection, Quammen writes that Darwin responded with surprise, nausea, and despair. In 1858, the Darwin-Wallace material was read before the Linnean Society and published in the society's *Journal of Proceedings* two months later — and triggered no immediate reaction. In 1859, just ten months after the Wallace scare, Darwin published *Origins*, writing, "I am *infinitely* pleased & proud at the appearance of my child."

The idea of descent of species from common ancestors became widely accepted soon after *Origins*, but natural selection did not. Natural selection as the differential reproductive success resulting from small, undirected variations served as the chief mechanism of adaptation and divergence — but it lacked purpose or design and challenged not the existence of a Divine force, but the godliness of humans. The coinage of such words and phrases as "agnosticism" by Thomas Huxley and "survival of the fittest" by Herbert Spencer indicates what a profound shift was taking place in intellectual and scientific circles.

Throughout the biography Quammen discusses the incompatibility of Darwinian evolution and Christianity, writing that scientific insight and religious dogma "had never come more directly into conflict." In the introduction by way of comparison, he notes that a 2004 Gallup poll revealed that 45 percent of Americans interviewed were creationists; 38 percent theistic evolutionists, and only 13 percent materialistic evolutionists. These results remained virtually unchanged over the course of a generation, representing "an extreme level of skepticism and willful antipathy."

Although the majority seems slow to digest it, Quammen calls *Origins* one of the most influential books ever written, provoking the most cataclysmic change in human thinking in four hundred years. He also calls it "hastily composed" and "seriously flawed," and one wishes that his reasons for doing so were more convincing. One also wishes that Thomas Huxley were more a part of the story, but, overall, this perceptive and concise biography is well worth reading. Part narrative and part essay, it creates suspense, refuses to romanticize Darwin, and confronts the politics of evolution in matter-of-fact and explicit ways — and, after considering Darwin's torturous reluctance and delay, perhaps we can better understand the contemporary unwillingness and inability to accept such a well-established scientific discovery.

Nancy Cervetti
Department of English
Avila University, Kansas City, Missouri



This image of a Marine Iguana (*Amblyrhynchus cristatus*) is Plate 12 from C. R. Darwin (ed. 1843. *Reptiles, Part 5, No. 2 of The Zoology of the Voyage of H.M.S. Beagle* by Thomas Bell "edited and superintended by Charles Darwin." Smith Elder and Co., London). The original image was drawn at natural size from nature on stone by B. Waterhouse Hawkins, printed by C. Hallmandel, and labeled *Amblyrynchus Demarlii*, as the species was then known. Reproduced with permission from The Complete Work of Charles Darwin Online (http://darwin-online.org.uk/).

CONSERVATION RESEARCH REPORTS

Connectivity and Interpond Movements of Painted Turtles

Because of the importance of facilitating movement of plants and animals between habitats, protecting the connectivity of isolated habitat patches has become an essential component of conservation biology. For a corridor to be successful, it must allow for increased movement, compared to the unconnected state. BOWNE ET AL. (2006. *Conservation Biology* 20: 780–789) studied the relationship between connectivity and population density in Painted Turtles (*Chrysemys picta*) in northern Virginia. They examined movement rates and movement probabilities in an agricultural landscape in order to determine persistence over a four-year period. The study area consisted of nine ponds, with intervening distances ranging from 110–2300 m. On occasion, more distant surrounding ponds were sampled to check for emigrants from the focal area. Turtles were categorized into five classes: Adult male, adult female, subadult male, subadult female, and juvenile. Of those, adult females were the most sensitive to habitat quality, and would move to more distant ponds. Habitat patch quality was influenced by interpatch distance and patch size and shape. The authors found that connectivity is a function of the behavior of individuals in relation to landscape features and habitat quality. Thus, if the ecology of a species is not taken into account, structural connectivity by itself has little worth. For proper conservation planning, connectivity must consider known behavior of the target species as well as the quality of habitat.

JIM HARDING, WORLD CHELONIAN TRUST

Adult female Painted Turtles (*Chrysemys picta*) were more sensitive than adult males or subadults of either sex to habitat quality.

Rat Eradications

Using New Zealand as a case study, TOWNS ET AL. (2006. *Biological Invasions* 8:863–891) examined the effects of invasive Pacific Rats (*Rattus exulans*), a small South-East Asian species spread by Polynesians throughout the Pacific, and more recently introduced Norway Rats (*R. norvegicus*) and Ship (Roof) Rats (*R. rattus*) on native species. Rats suppress some forest plants, and are associated with extinctions or declines of flightless invertebrates, ground-dwelling reptiles, land birds, and burrowing seabirds. Globally, Ship Rats were associated with declines or extinctions of the largest number of indigenous vertebrate species. Effects of rats on forest trees and seabird populations are sufficiently pervasive to affect ecosystem structure and function. However, data are patchy, and deficiencies would be reduced by documenting distribution and abundance of indigenous species before and after eradications of rats on islands.

Introduced rats (*Rattus* spp.) suppress some forest plants, and are associated with extinctions or declines of flightless invertebrates, ground-dwelling reptiles, land birds, and burrowing seabirds.

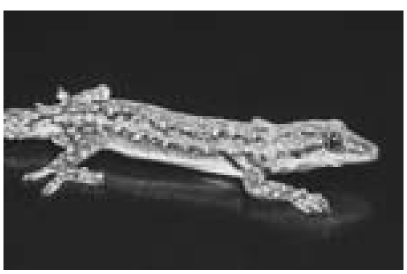
Conservation Implications of Sea Turtle Nesting Beach Loss

Historically, Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricata*) turtles nested in high densities throughout the Caribbean. Because of hunting by humans, turtle populations have been decimated and populations continue to decline. Population declines and ecological changes have occurred over many centuries and historical and archeological data provide information that can be used to estimate early geographic ranges and population sizes of sea turtles. MCCLENACHAN ET AL. (2006. *Frontiers in Ecology and the Environment* 4:290–296) used historical data on use of nesting beaches to determine changes in population sizes for both species in 20 regions of the Caribbean. Historic data show that nesting sites supported large populations in the past, but that those are now extremely depleted. Current Green and Hawksbill populations are 0.33% and 0.27% of their respective historic values, 20% of the historic nesting sites have been lost, and 50% of the remaining sites support very low populations. Because historic data have not been used previously, the magnitude of population declines has been underestimated. Protection efforts have resulted in increases in a few turtle populations, but long-term data are sparse. For successful conservation to occur, short-term data should not be used to infer long-term change. Without proper protection, the remaining nesting beaches could soon be lost. Protection and scientific research funding must be implemented in as many beaches as possible to help recover lost nesting beaches.

Historically, Green (*Chelonia mydas*; above) and Hawksbill (*Eretmochelys imbricata*) turtles nested in high densities throughout the Caribbean. Because of hunting by humans, turtle populations have been decimated and populations continue to decline.

Invasion and Displacement in Pacific Island Geckos

Growing international travel and trade have amplified the spread of invasive species, which causes significant ecological and economic damage. Invasives can alter successional patterns, mutualistic relationships, community dynamics, ecosystem function, and resource distributions. The Common House Gecko (*Hemidactylus frenatus*) continues to expand its range and is displacing many other species, such as the ecologically similar but all-female Indo-Pacific Gecko (*H. garnotii*) on a global scale. DAME AND PETREN (2006. *Animal Behaviour* 71:1165–1173) predicted that the presence of *H. frenatus* will cause *H. garnotii* to consume fewer resources and tested whether *H. frenatus* would respond to *H. garnotii* as they would to conspecific males or to conspecific females. The hypothesis that resource competition is the mechanism of displacement of *H. garnotii* received no support from the experiments. Although geckos consumed fewer resources when they were in pairs, resource consumption of *H. garnotii* was not negatively affected by *H. frenatus*. The hypothesis that male aggression toward *H. garnotii* is the primary mechanism of invasion of *H. frenatus* was also rejected. Male *H. frenatus* responded to *H. garnotii* as they did to conspecific females, and courted and copulated with them. However, male *H. frenatus* showed a preference for larger female *H. garnotii*, which suggested that sexual interference could be a mechanism for displacement of *H. garnotii*.

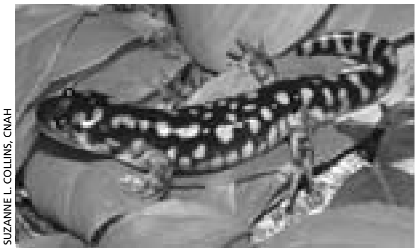


ROBERT POWELL

The Common House Gecko (*Hemidactylus frenatus*; above) continues to expand its range and is displacing many other species, such as the ecologically similar but all-female Indo-Pacific Gecko (*H. garnotii*) on a global scale.

Tiger Salamanders Disappear in Maryland: Is This the Fate of Other Non-game Species of Conservation Concern?

LEE (2006. *Bulletin of the Chicago Herpetological Society* 41:217–224) documented the demise of the last Maryland population of Eastern Tiger Salamanders (*Ambystoma tigrinum*) from a site that is owned and managed by the Maryland DNR. This site was purchased by The Nature Conservancy specifically to protect this species and was sold to the state



SUZANNE L. COLLINS, CNAH

The last known Maryland population of Eastern Tiger Salamanders (*Ambystoma tigrinum*) has disappeared from a site that is owned and managed by the Maryland Department of Natural Resources.

with the stipulation that this salamander be managed in perpetuity. The last breeding pond was not monitored, and, over time, silted in, pH and water depth changed, surrounding vegetation shaded the pond, and Bluegills were introduced. Despite warnings from people familiar with the needs of these salamanders and a decline documented by a private individual, the state refused to take action or listen to advice from local herpetologists.

An agency boasting "everything we do is based on the best available science" failed to maintain a viable population under their stewardship since the early 1970s. An agency with a forestry division, wetland specialists, wetland restoration teams, a legal mandate to protect state endangered species, and a state herpetologist, was unable to oversee the wellbeing of a forest-dwelling creature on lands it owns and manages. One can only imagine how well other locally rare and endangered reptiles, turtles, and amphibians are doing under their care. The article raises the obvious question as to how other states oversee non-game species of conservation concern.

Survival and Growth of Artificially Incubated American Alligators

TEMSIRIPONG ET AL. (2006. *Journal of Herpetology* 40:415–423) compared artificially incubated and repatriated American Alligator (*Alligator mississippiensis*) hatchlings released within and outside the maternal alligator's home range with naturally incubated hatchlings released within and outside the maternal alligator's home range at three lakes in central Florida. Artificially incubated hatchlings released outside the maternal alligator's home range had lower recapture probabilities than all other treatments, none of which differed significantly. Artificially incubated hatchlings were about 6% shorter than naturally incubated hatchlings at about nine months of age. The authors concluded that repatriation of hatchlings might be an economical alternative to repatriation of older juveniles in efforts to restore populations, but that location of release may affect subsequent survival and growth.

Repatriation of American Alligator (*Alligator mississippiensis*) hatchlings might be an economical alternative to repatriation of older juveniles in efforts to restore populations, but the location of release may affect subsequent survival and growth.

NATURAL HISTORY RESEARCH REPORTS

Physiology and Sociality: Why Banded Geckos Band

Aggregation may have important reproductive, ecological, and fitness implications. Although studies of aggregating behavior have been conducted for many species, few have measured the benefits of lizard aggregation. LANCASTER ET AL. (2006. *Animal Behaviour* 72:199–207) conducted a study to determine the benefit of aggregation in the desert-dwelling Banded Gecko (*Coleonyx variegatus*). Geckos from Borrego Springs, San Diego County, California were housed in groups of five and offered a surplus of retreats in an effort to test the hypothesis that geckos benefit from grouping by lowering rates of evaporative water loss. The authors also tested effects of humidity and scents of conspecifics and predators. Geckos avoided predator-scented areas, supporting past work on other species, but did not band together to avoid predators. Nor did lizards use conspecific scents to choose retreat sites, and no social or mating benefits were found. Instead, the study showed that Banded Geckos benefit from aggregation by lowering rates of evaporative water loss. Thus, aggregation provides physiological but no evident social benefits for *Coleonyx variegatus*.

JEFF LEMM

Tokay Geckos (*Gekko gecko*) are native to southeastern Asia, but have been widely introduced in tropical and subtropical areas. A study in Thailand indicated that adults of both sexes and juveniles were active at comparable times, used essentially similar foraging strategies, and ate the same types of prey.

Foraging Ecology of Tokay Geckos

Although individuals exhibited varied foraging behavior, AOWPHOL ET AL. (2006. *Amphibia-Reptilia* 27:491–503) found no significant differences in foraging parameters (foraging period, time spent moving, foraging attempts, foraging success, prey size consumed, and foraging distance) among male, female, or juvenile Tokay Geckos (*Gekko gecko*) in Thailand. Foraging occurred from 1800–0900 h, peak emergence was from 1800–2000 h, and peak retreat time from 0400–0700 h. Food items were insects, most in the orders Lepidoptera, Orthoptera, and Coleoptera. The lack of size differences in prey taken by geckos of different sizes reflected no prey size selection, possibly attributable to low insect availability. Geckos mostly used a sit-and-wait strategy, but foraged more widely when prey was relatively abundant.

Are Snakes with Narrow Distributions More Specialized?

The Italian Aesculapian Snake (*Zamenis lineatus*) has a narrow distribution in southern Italy and on Sicily. CAPULA ET AL. (2006. *Amphibia-Reptilia* 27:531–537) examined the diet of this snake to test the hypothesis that species with narrow distributions will be more ecologically specialized than wide-ranging relatives. The diet of adult *Z. lineatus* consisted of small mammals and birds, whereas that of juveniles was composed mainly of lizards. Diets of males and females did not differ. The authors concluded that the feeding ecology of *Z. lineatus* was very similar to that of the widespread ecological generalist, *Z. longissimus*, indicating that the assump-

JEFF LEMM

Desert-dwelling Banded Geckos (*Coleonyx variegatus*) benefit from aggregating in groups because that lowers rates of evaporative water loss.

STEFAN MOELLER, WWW.ELAPHE.INFO

The feeding ecology of the Italian Aesculapian Snake (*Zamenis lineatus*) was very similar to that of the widespread ecological generalist, *Z. longissimus*, indicating that narrowly distributed Mediterranean snakes are not more specialized than their widely distributed counterparts.

tion that narrowly distributed Mediterranean snakes are more specialized than their widely distributed counterparts does not apply to the dietary ecology of these snakes.

Jump Dispersal in Introduced Mediterranean Geckos

From 1962–1997, Mediterranean Geckos (*Hemidactylus turcicus*) were intentionally introduced multiple times into a science building at the University of Central Oklahoma in Edmond. In 2005, LOCEY AND STONE (2006. *Journal of Herpetology* 40:526–530) recorded 365 captures of 305 individuals and estimated the population size to be 1005 geckos with at density of 478 lizards/ha. The population had dispersed a maximum of 200 m from the point of introduction, a diffusion dispersal rate of 20 m/yr. The wide distribution of this species across the southern United States since their introduction in Key West, Florida was recorded in 1910 suggests that expansion of the species' range occurred as a consequence of multiple jump dispersal events instead of slow diffusion dispersal.

DAWSON/WIKIPEDIA.ORG

Slow rates of diffusion dispersal in introduced Mediterranean Geckos (*Hemidactylus turcicus*) suggest that the wide distribution of this species across the southern United States is a consequence of multiple jump dispersal events.

Population Structure and Density of Leopard Tortoises

Leopard Tortoises (*Geochelone pardalis*) are the largest tortoises in southern Africa, where they are widely distributed in a variety of habitats. MCMASTER AND DOWNS (2006. *Journal of Herpetology* 40: 495–502) studied Leopard Tortoises in semi-arid farmland in Nama-Karoo, central South Africa. The sex ratio of 92 tortoises did not differ significantly from 1:1. Adult females were larger than adult males, and adults were larger than conspecifics studied in more mesic habitats. A population estimate of 57.6 ± 4.0 tortoises translated to a very low density of 0.017 tortoises/ha, much lower than in more mesic situations.

ANDERS G.J. RHODIN, CHELONIAN RESEARCH FOUNDATION

The population density of Leopard Tortoises (*Geochelone pardalis*) was lower in dry South African habitat than in more mesic situations, but adults were larger.

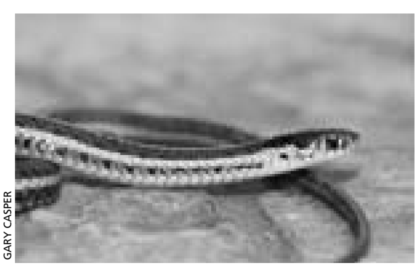
NEWSBRIEFS

Butler's Garter Snake Will Remain on Protected List

A legislative committee in Wisconsin that this summer had threatened to remove Butler's Garter Snake (*Thamnophis butleri*) from a protected list that stops developers from killing it, reversed course and decided to allow the snake to remain on a list of threatened species. The decision was praised by state Department of Natural Resources executive assistant Mary Schlaefer, who said protecting the endangered snake was vital to the overall health of the environment. Critical steps need to be taken when there is a species like this snake that is in danger of disappearing, she said.

With their habitat shrinking, the reptiles were placed on the threatened list in 1997 by the DNR, meaning that in most cases the snakes cannot be killed. The protected area encompasses about 405,000 acres in southeastern Wisconsin. Known for its colorful yellow stripes, the 1- to 2-foot-long snake is generally found in marshes, prairies and fields, as well as in roadside grassy areas and in vacant lots. In addition to southeastern Wisconsin, it can be found in Ohio, Indiana, Michigan, and in southern Canada.

The Republican-controlled Joint Committee for Review of Administrative Rules decided in July to remove the snake from the DNR's threatened list if the agency didn't soften its regulations.



GARY CASPER

A legislative committee in Wisconsin that this summer had threatened to remove Butler's Garter Snake (*Thamnophis butleri*) from a protected list that stops developers from killing it, reversed course and decided to allow the snake to remain on a list of threatened species.

The agency on Tuesday outlined a number of changes it had made and was in the process of implementing, including reducing the time of review of proposed projects from 27 to seven days and coming up with more funding to reduce costs for homeowners to get needed surveys. Those surveys can cost up to $10,000, said Andy Galvin, a consultation specialist in the DNR's bureau of endangered resources. The agency also reduced the number of acres in the protected area by 500. It is working to identify as many as 65 protected sites for the snake. Once those are established and stabilized, regulations on private landowners can be ended more quickly, Schlaefer said. "Our goal is to manage based on science, but in a way that minimizes impact on homeowners," she said.

The committee voted 7-2 not to take the snake off the protected list. One of the two no votes, state Rep. Debi Towns, R-Janesville, said she was concerned that the DNR was not setting a goal of how many snakes needed to be in the area before the protection is removed. "I just think the whole thing is so nebulous. ... There's no end game," Towns said. Also voting no was state Rep. Dan LeMahieu, R-Oostburg.

Developers had complained that the snake's presence was delaying, and sometimes halting, construction projects. The snake has been found in Fond du Lac, Milwaukee, Ozaukee, Sheboygan, Washington, and Waukesha counties.

Scott Bauer
Associated Press

Database Details Pesticide Effects on Reptiles and Amphibians

The citizens group Californians for Alternatives to Toxics (CATs) has created a user-friendly database of the most recent international research about the effects of pesticide use on amphibians and reptiles. "By bringing together current research on beleaguered amphibians and reptiles, we have made this global information readily accessible to academics, neighborhood activists, and students," said Patty Clary, CATs programs director. The Reptile, Amphibian, and Pesticides database (RAP) builds on an earlier version that covered the literature to 1998 and was assembled by the Canadian Wildlife Service.

"The value of this database is that biologists and other users can easily access information about the effects of pesticides on amphibians and reptiles drawn from a variety of sources," said Marlon Gil, a biologist who compiled the database for CATs. Gil, whose frog research has taken him as far afield as West Africa, said, "Hopefully this will enhance efforts to prevent losses of these species worldwide." The updated research is searchable by species and genus, location of research, pesticide studied, and toxicological effect. It includes a list of 327 scientific papers published since 1999 on the effects of pesticides on amphibians and 128 research papers on the impact of pesticides on reptiles. Clary said that CATs will update the database as new information becomes available.

The database specializes in field studies from California that are meshed with findings from the unique pesticide-use database of the state's Department of Pesticide Regulation. California is one of the "hot spots" in the global decline of amphibian populations, and native aquatic frog and toad species have been disappearing for two decades. For example, research by the U.S. Geological Survey since 1997 has revealed dangerous levels of pesticides in both the bodies of frogs and in their aquatic habitats in pristine areas of the Sierra Nevada. Entire populations of native frogs have vanished, and research has pinpointed pesticide sprays that have drifted hundreds of miles from the Central Valley to settle in wilderness areas.

Founded in 1982, CATs was a major player in a suit that won increased protection from pesticides for the Red-legged Frog (*Rana aurora draytonii*), made famous by Mark Twain in his story "The Celebrated Jumping Frog of Calaveras County." The new database is available at the CATs website at: http://www.alternatives2toxics.org.

Environment News Service
22 December 2006

Python Patrol Plies the 'Glades: Crews Aim to Stem Voracious Non-native Species Imperiling the Fragile Ecosystem

"SNAKE!" Hearing this shout, Skip Snow slammed on the brakes. When the off-roader plowed to a halt, he and his partner, Lori Oberhofer, leapt out and took off toward two snakes — 10-foot Burmese Pythons (*Python molurus bivittatus*) lying on a levee, sunning themselves. After slipping, sliding and tumbling down a rocky embankment, Snow, a wildlife biologist, grabbed one of the creatures by the tail. The python, Oberhofer says, did not care much for that. "It made a sound like Darth Vader breathing," she said, "and then its head swung around and I saw this white mouth flying through the air." Snow saw the mouth too — jaws open 180 degrees, needle-sharp teeth bared in an almost devilish grin. He let out a shriek, then blinked. When his eyes opened, the python's head was hanging in midair, a foot from his own. Oberhofer, with a ninja-like thrust, had snared the python in midstrike. In the end, the humans were victorious: Both snakes were bagged, trucked off to the Everglades Research and Education Center, euthanized and necropsied for the benefit of science.

So goes python control in the Everglades, a painstaking, around-the-clock slog against a voracious, foreign snake species that has established a stronghold in this wilderness and put native wildlife at risk. Scientists also worry that these slithery giants may soon start to feast on native species whose survival is in doubt. "The Everglades doesn't work by itself anymore," says Leon Howell, who has been associated with the park for 21 years and now is a park ranger. "This whole landscape has to be managed today: water, fire, exotics — you name it." Which explains the evolution of Snow and Oberhofer into a human firewall against non-native species. Without them, Howell figures, "there'd be pythons all over the place."

The pythons began turning up here in the late 1990s. Pet owners were releasing their unwanted snakes in and around the park. Convincing the public that the pythons are a danger to the Everglades is a tough sell. As vast as these wetlands may appear, they have been so drained and abused by humans in the last century that a population of pythons, if left unchallenged, could take down this fragile web of life within a generation. "It's a now-or-never thing," Oberhofer said. "We still have a chance, with the python's numbers being so limited, to do something. But if we let this go, we don't know how far the pythons will migrate, how much they will reproduce."

Native to southeastern Asia, the Burmese Python has come to the

ORLANDO COY

KENNETH L. KRYSKO

Burmese Pythons (*Python molurus bivittatus*) have become established in the Everglades and efforts to control them and other invasive species may be a last-ditch effort to protect native wildlife.

LORI OBERHOFER

As Burmese Pythons (*Python molurus bivittatus*) become more common in the Everglades, so do encounters with native wildlife, such as this American Alligator (*Alligator mississippiensis*). Although large 'gators eat pythons, large snakes eat small alligators. Long-term effects on either species are unknown.

Everglades by way of the burgeoning global trade in exotic pets, creatures shipped to America legally and distributed via pet shops and flea markets. Since 2000, about 1 million pythons have been imported to the U.S. for commercial sale.

Todd Lewan
Associated Press
20 December 2006

Tighter Rules Urged as Exotic Pets Adapt to Florida's Wild

With giant snakes battling alligators in the Everglades, the state wildlife commission has proposed sharp restrictions on the owners of Burmese Pythons (*Python molurus bivittatus*) and four other non-native reptiles, including a requirement to implant their slithery pets with computer identification chips.

Florida's climate has made the state a congenial home for species from Africa, Asia, and South America let loose by their owners after they become too big or too high maintenance. A breeding population of Burmese Pythons has been discovered in Everglades National Park, where the constrictors have been killing native birds, mammals, and, in one notorious incident, an alligator. Elsewhere in the state, trappers routinely catch pythons and other large non-native snakes.

The new rules would limit sales of constricting snakes that grow to at least 12 feet, specifically Burmese Pythons, Reticulated Pythons (*P. reticulatus*), African Rock Pythons (*P. sebae* and *P. natalensis*), Amethystine or Scrub Pythons (*Morelia amethystina*), and Green Anacondas (*Eunectes murinus*). The rules also would restrict sales of Nile Monitors (*Varanus niloticus*), carnivorous lizards that can grow as long as 6 feet and already have established a breeding population in the Cape Coral area on Florida's Gulf Coast.

At the moment, anyone can walk into a pet shop and walk out with a python. Under the new rules, buyers would have to be 18 years old, complete a questionnaire, apply for a state permit, submit a plan for keeping the animal secure in case of a hurricane or other disaster, and have the reptile implanted with a computer chip. The rules would go into effect 1 January 2008. They would be retroactive, although owners would have until 1 July 2008 to comply with the chip requirement. Assuming — and hoping — that many owners of the big snakes would find these rules too onerous, the state plans to set up amnesty programs that would allow people to drop off unwanted reptiles at sites yet to be determined — no questions asked. "We don't know how many are out there," West said. "We have a suspicion it's a high number. We're hoping a lot of people will say they don't want to do this and turn them in." The restrictions would have to be approved by the wildlife commission, a seven-member board appointed by the governor. The commission initially will consider the proposals in February.

David Fleshler
South Florida Sun Sentinel
1 January 2007

Court Grants Protection for Recently Discovered Salamander

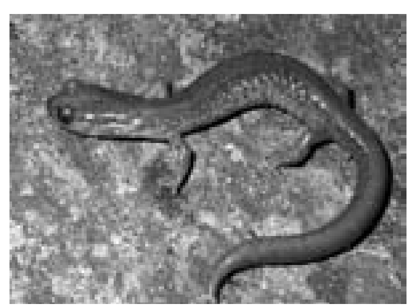
In response to a suit brought by the Environmental Protection Information Center, Klamath-Siskiyou Wildlands Center, and Center for Biological Diversity, Superior Court Judge Peter Busch ruled today that the Department of Fish and Game (DFG) cannot lawfully strip protection for the Scott Bar Salamander (*Plethodon asupak*) under the California Endangered Species Act.

Formerly considered a subpopulation of the Siskiyou Mountains Salamander (*P. stormi*), which is listed as a threatened species under the California Endangered Species Act, the Scott Bar Salamander was described as a new species in May 2005. Rather than herald the discovery of new species, DFG immediately informed forestry officials and timber companies that the salamander had lost protection, which allowed several logging projects to destroy salamander habitat. At least one private logging plan is currently proposed in Scott Bar Salamander habitat and likely will be affected by today's decision.

"DFG's move to allow logging in the Scott Bar Salamander's habitat runs counter to their mission to protect the state's fish and wildlife," said Joseph Vaile, campaign director of the Klamath-Siskiyou Wildlands Center (KS Wild). "The court today made it clear that DFG lacks the authority to remove protections from rare species just because they were described as a new species."

The court's decision was important because it clarifies that only the Fish and Game Commission, and not DFG, can remove protection for species under the California Endangered Species Act. Because advances in genetic analyses allow detection of previously undetectable species, it is quite likely that other new species will be separated from already protected species. Today's decision ensures that these species will continue to receive protection until the Fish and Game Commission has a chance to review their status in light of the thorough scientific review and public comment required under the law.

16 January 2007



ALAN BARRON

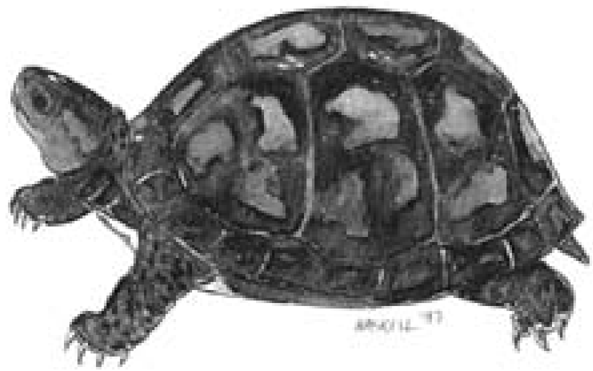
A court ruling clearly stated that the California Department of Fish and Game cannot remove protection from rare species, such as the Scott Bar Salamander (*Plethodon asupak*), just because they were described as new species.

OBITUARY

Alison Haskell
(1956–2006)

The Fish and Wildlife Service family and conservation community lost a very special friend. Alison Haskell died peacefully at her home in Ashfield, Massachusetts in the company of her husband John Rosseel and family and friends.

Alison was born on 26 December 26 1956 in Berkeley, California, and grew up on the coast of Massachusetts. She received a B.S. and M.S. in wildlife biology from the universities of New Hampshire and Massachusetts, respectively. Her master's thesis focused on population ecology of the Plymouth Redbelly Turtle (*Pseudemys rubriventris*). She studied at Tufts University Veterinary School, where she also worked as the chief veterinary technician at the Wildlife Clinic for five years, and became noted for her exceptional ability in handling raptors. In 1993, she joined the Fish and Wildlife Service as a Wildlife Research Specialist in the Division of Federal Aid. Alison's unique and extraordinary blend of skills, ranging from wildlife health to population viability analyses, suited her extremely well in administering a wide variety of grant programs, including Section 6 Endangered Species, Wildlife Restoration, Partnerships For Wildlife, Wildlife Conservation and Restoration Program, and State Wildlife Grants. Alison's passion for wildlife may have been exceeded only by her compassion for her fellow humans, and she channeled that professionally by becoming adept at conflict resolution and facilitation. She assisted many Service and State fish and wildlife agency programs as a trainer and facilitator. She left Federal Aid in 2002 to become the national coordinator for Partnerships in Amphibian and Reptile Conservation (PARC).



An Eastern Box Turtle (*Terrapene carolina carolina*): Watercolor by Alison Haskell.

FRED SNYDER, NEW JERSEY DIVISION OF FISH AND WILDLIFE

Alison Haskell in the field with a bear cub.

Alison was diagnosed with stage-4 ovarian cancer in late 2002, and on the insistence of her physicians, took a medical retirement from the Service to focus on treatment and recovery. Despite an unbelievably grueling regimen of surgeries and chemotherapy, Alison formed a non-profit organization, Cures for Ovarian Cancer, to advocate for early detection screening, which is not currently a part of routine physical examinations for women or provided for in health care plans. Her campaign took her far and wide speaking to audiences to increase awareness.

An accomplished artist specializing in water color, Alison also formed the non-profit Northeast Wildlife Heritage to raise funds for conservation efforts in the northeast through sales of her art and other crafts.

Alison is survived by her husband John, her parents, two sisters and a brother, and many nieces and nephews, and her two Corgis, Ursa and Ry, named for two of her favorite constellations, Ursa Minor (the little dipper) and Orion (the hunter). She leaves a network of friends, whom she touched deeply with her ability to make others feel good. Alison's spirit will be with us on starry nights when Ursa Minor and Orion grace the sky, but those who knew her well will feel her presence when the planet Venus rises, the diminutive planet that burns the brightest.

PARC has established the Alison Haskell Excellence in Herpetofaunal Research and Conservation Award. Donations for the first award can be made to: The New England Chapter, TWS, Attn: A Haskell Herp Award, c/o Doug Blodgett, VT Fish and Wildlife, 271 North Main Street, Suite 215, Rutland, VT 05701.

John F. Organ
Chief, Division of Wildlife and Sport Fish Restoration
U.S. Fish and Wildlife Service
Hadley, Massachusetts

IRCF ON THE MOVE

Endangered Blue Iguana Population Doubles

The Blue Iguana Recovery Programme, on the small Caribbean island of Grand Cayman, has just doubled the wild population of the critically endangered Grand Cayman Blue Iguana (*Cyclura lewisi*).

A giant, turquoise blue lizard unique to a single island, the Grand Cayman Blue Iguana skirted with extinction in 2002 when its wild population sank to between 10 and 25 individuals. Habitat loss and road kills are still compounding long-established pressures from feral cats and roaming dogs that attack and kill hatchling and adult iguanas, respectively. This magnificent reptile was once the Cayman Islands' largest land animal, but has been in decline since the first years of human colonization.

The Blue Iguana Recovery Programme has embarked on a large-scale population restoration effort for the iguanas, in Grand Cayman's Salina Reserve. By 2006, two major releases of captive-reared Blue Iguanas had brought the Reserve's iguana population to 92 individuals, aged three and four years. Some of the four-year-olds began to breed in the summer of 2006, when researchers documented three successfully hatched nests, and observed the first hatchling to be seen wild in the Salina Reserve for well over a decade.

A group of international volunteers converged on Grand Cayman in late 2006, to help the Programme's staff release 103 more Blue Iguanas, which were available thanks to the Programme's highly successful captive-breeding and head-starting operation. Dubbed "*Team Blue 2007*," the volunteer team is the latest in a series that is coordinated by the Programme's main U.S. partner, the International Reptile Conservation Foundation, which also underwrote a portion of the operation's cost through a generous grant from a donor through the Maine Community Foundation. Primary funding for the release effort has come from the Programme's main British partner, the Durrell Wildlife Conservation Trust.

Team Blue 2007 began work in late November, building artificial retreats based on a Programme-developed design, which encourages the iguanas to stay in the areas in which they are released. Made variously from wood and lightweight concrete, and weighing up to 35 lbs. each, the retreats were backpacked into the Salina Reserve, placed strategically in predetermined positions, and mapped precisely using GPS.

Simultaneously, a team of veterinarians from the Wildlife Conservation Society in New York, examined the 103 iguanas scheduled for release, checking blood smears, droppings, and growth rates, to ensure that no parasites or other diseases were being introduced from the captive population to the wild.

MICHAEL KERN

Some of the TeamBlue volunteers (from left): Doug Bell, Fred Burton, Raffi (last name unknown), Molly Cavanaugh, Andrew McAffee, Nick Louis, Memory Mays, Lorraine Scotson, Jude Bryja, and Kadie Frasier.

JOHN MAROTTA

HRH Prince Edward, Earl of Wessex, visited the Salina Reserve trailhead on 4 February to see three young Blue Iguanas about to be released. Here he responds to an adult Blue ("Pedro") as BIRP Director Fred Burton explains the threats that Blue Iguanas face in the wild.

By mid-December, the first retreats were ready for occupancy, and the iguanas were certified fit to go free. Team Blue then expanded into a local community affair, as Christmas and New Year holidays freed environmentally concerned residents from their day-to-day jobs. School students, staff from the Department of Environment, and staff from the National Trust for the Cayman Islands were among those who risked the extraordinarily harsh terrain of the Salina Reserve to release the young Blue Iguanas into their designated retreats. As the release reached a peak, the Governor of the Cayman Islands, Mr. Stuart Jack, with his family and later his staff, also joined the team.

By New Year's Day 2007, the population of Blue Iguanas in the Salina Reserve had risen from 92 to 195. Combined with the smaller numbers of Blue Iguanas the Programme has released into the QE II Botanic Park, the total wild population of Blue Iguanas now stands at approximately 214 individuals, an order of magnitude greater than only five years ago.

The Blue Iguana Recovery Programme, which operates under the auspices of the National Trust for the Cayman Islands, has a goal of restoring and maintaining at least 1,000 Blue Iguanas in the wild. That target will require acquisition and protection of additional dry shrubland habitat in eastern Grand Cayman, and will require the Programme to develop ways to sustain itself financially for the long term.

For more information, see the following websites: www.BlueIguana.ky, www.nationaltrust.org.ky, www.ircf.org, and www.durrell.org.

Project Palearis

The initial phase of Project Palearis (see the Focus on Conservation, p. 64), which the IRCF is undertaking in partnership with Zootropic and Zoo Atlanta, will begin in May 2007. The IRCF has purchased a vehicle and provided seed money for research investigating the distribution, ecology, and conservation status of the Guatemalan Black Iguana, *Ctenosaura palearis.* Zootropic's Daniel Ariano and an undergraduate student, Paola Coti, will bead-tag and release all animals that are captured. Five males and two females are already under observation at the research site in the Motagua Valley of Guatemala. Thanks to the efforts of Zootropic, *C. palearis* has been granted protection under Guatemalan law, and animals may no longer be exported from the country.

DANIEL ARIANO

The IRCF purchased this vehicle for use by personnel involved in Projects Palearis and Heloderma.

DANIEL ARIANO

Guatemalan Black Iguana (*Ctenosaura palearis*).

Project Heloderma

A proposal to transfer the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) from CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) Appendix II to Appendix I has been submitted, with a decision scheduled for the Fourteenth Meeting of the Conference of the Parties to the CITES Agreement on 3–15 June 2007 in The Hague, Netherlands. If ratified, the transfer will confer a much higher degree of protection on this critically endangered species. Project Heloderma, the conservation program on behalf of *H. h. charlesbogerti*, is a joint undertaking of the IRCF, Zootropic, and Zoo Atlanta (see also *IGUANA* 13(2), p. 176 and 13(3), pp. 178–191).

DANIEL ARIANO

Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*).

Argentine Sand Dune Lizard

The IRCF is providing equipment and funds for a research project on behalf of the Argentine Sand Dune Lizard (*Liolaemus multimaculatus*). This small reptile is uniquely adapted to its sand dune habitat, able to "swim" in the sand in search of its insect prey and perfectly camouflaged by its matching coloration. The Sand Dune Lizard and many other inhabitants of this fragile ecosystem in Buenos Aires Province of Argentina are endangered by habitat destruction. *Liolaemus multimaculatus* will be featured in an article in the June issue of *IGUANA.*

FEDERICO KACOLIRIS

Argentine Sand Dune Lizard (*Liolaemus multimaculatus*).

IRCF
International Reptile Conservation Foundation

Editors' Remarks

In addition to feature articles and regular pieces that address responsible husbandry of reptiles, profiles of herpetologists and conservationists, travelogues to herpetologically fascinating destinations, historical perspectives, commentaries on issues relevant to reptilian biology and conservation, and book reviews, *IGUANA* has presented short summaries of news items ("Newsbriefs") that feature reptiles and efforts to conserve them and their habitats. With Volume 12 in 2005, we also included summaries of research articles concerning the conservation of reptiles ("Conservation Research Reports"). In this issue, in light of our other focus on natural history, we inaugurate a new section devoted to summaries of research articles dealing with reptilian natural history ("Natural History Research Reports").

The purpose of these short summaries is to create and maintain an awareness of current events and ongoing research addressing issues that readers of *IGUANA* should find interesting and educational. The research reports in particular are usually extracted from technical journals written with other researchers in mind. However, the investigations represent the cutting edge of our knowledge about conservation and natural history of reptiles, and often present critical information that can lead to new insights and additional research.

We have been approached about the possibility of expanding the scope of *IGUANA* to include amphibians. As a rule, we have resisted those temptations in spite of the reality that global amphibian declines may very well represent the results of events that affect reptiles and other animals in an equally dramatic fashion. However, we frequently do include amphibians in herpetofaunal surveys or travelogues. On occasion, we also may include newsbriefs or research reports about amphibians if the topic is relevant to reptilian natural history or conservation.

IRCF members represent a vast cross-section of persons with an interest in reptiles. Included are perspectives from throughout the world, interests in many different kinds of reptiles, and experiences that may range from occasional encounters with animals in nature and concerns about a treasured pet to lives dedicated to developing a better understanding of the world around us. Consequently, we eagerly solicit input from subscribers who have found items in the news or in journals that they think may be of broad interest to other readers. If you find such a piece, please submit a copy to an editor or alert us to a source (publication or link).

The Editors of *IGUANA*

Statement of Purpose

The International Reptile Conservation Foundation works to conserve reptiles and the natural habitats and ecosystems that support them.

The International Reptile Conservation Foundation, Inc. is a non-profit 501 c(3) California corporation.

Membership Information

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Additional copies are available upon request at $6.00 each plus postage.

*The Adobe PDF is optimized for web publishing and does not provide the quality and resolution of the archival printed version, especially noticeable in photographs and complex graphics.

www.IRCF.org
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Email: info@IRCF.org, or contact AJ at 860-236-8203, or write to: IRCF, 3010 Magnum Drive, San Jose, CA 95135

Solicitations

The IRCF encourages contribution of articles, letters to the Editor, news items, and announcements for publication in IGUANA. General articles can deal with any aspect of reptilian biology, including conservation, behavior, ecology, physiology, systematics, or husbandry. Submission of photographs to accompany articles is encouraged. Manuscripts may be submitted via e-mail (send to AJ@IRCF.org). Authors of one page or more of print will receive a free copy of the journal in which their contribution appears, and will receive a PDF file of their article for distribution.

Donations

For any donations, please include your name, address, phone number, and e-mail address.

Advertising Policy

We advertise only non-living products (except feeder insects). For advertising rates and options contact Sandy Binns, Advertising Director, at SB@IRCF.org or 3010 Magnum Drive, San Jose, CA 95135.

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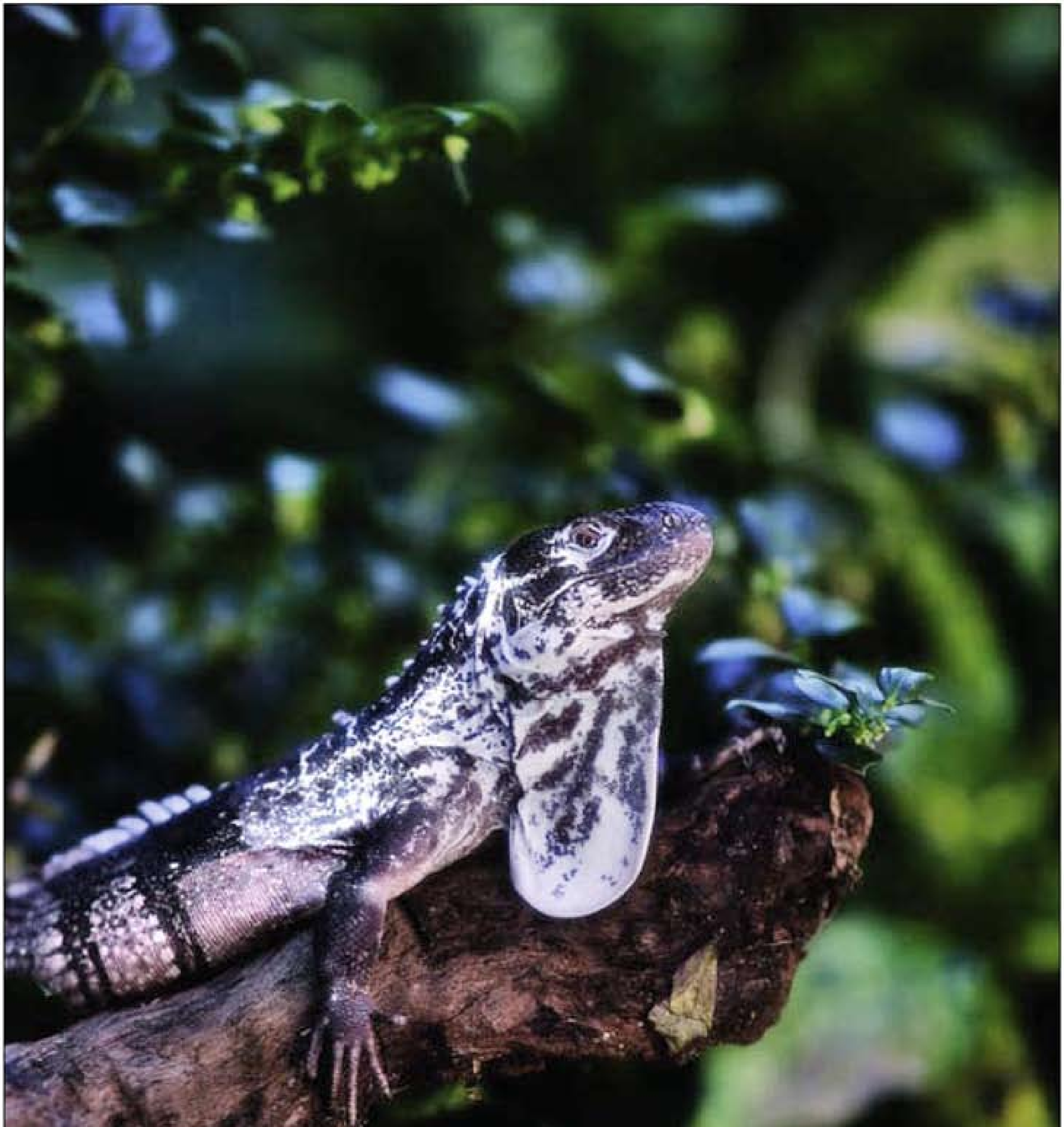
The Guatemalan Black Iguana: Critically Endangered

DANIEL ARIANO

The Guatemalan Black Iguana (*Ctenosaura palearis*), with a distribution limited to the Motagua Valley of Guatemala, is categorized as "Critically Endangered" on the IUCN Red List. The actual number remaining in the wild is unknown. The IRCF, in partnership with Zootropic and Zoo Atlanta, has established "Project Palearis" in order to develop and implement a recovery action plan for this species. Given that its distribution coincides with that of the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*), many of the concerns about *Ctenosaura palearis* can be addressed in the recovery plan for "Project Heloderma." Specifically, *C. palearis* can be included in current environmental education programs for local communities, where citizens have hunted this reptile for food. The proposed captive-breeding facility for the Beaded Lizard also can be used to breed *C. palearis* for return to the wild.

Funding is urgently needed to provide equipment for investigations of distribution, behavior, general ecology, and reproductive biology of the species, as well as for educational programs, construction of the breeding facility, and for the purchase of land intended for the establishment of a conservation reserve for both species. For more information on the Guatemalan Black Iguana and to make donations, please see www.IRCF.org/palearis.



JOHN BINNS, ANIMAL COURTESY OF WEST COAST IGUANA RESEARCH

Almost nothing is known about the distribution and natural history of the Guatemalan Black Iguana (*Ctenosaura palearis*). See the Focus on Conservation (facing page).

Populations of critically endangered Ricord's Iguanas (*Cyclura ricordii*) along the southern shore of Lago Enriquillo in the Dominican Republic are threated by removal of their habitat from the Dominican protected areas system. See article on p. 2.

JOHN BINNS