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IGUANA

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Adult male Grand Cayman Blue Iguanas (*Cyclura lewisi*) battle for dominance.

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Distribution and Habitat Utilization of *Ctenosaura bakeri* on Utila

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Photographs by the author except where indicated.

Abstract.—*Ctenosaura bakeri*, endemic to Utila (Honduran Bay Islands), is one of only two reptiles that are exclusive mangrove dwellers. With a total distribution of 1091 ha, the total size of the three mangrove areas on Utila, this species has the smallest range of any in the genus. Distribution of three species of mangroves is not homogenous in any of the three areas. Also, effects of tides and salt content vary substantially over place and time. I collected and marked 171 iguanas at three study sites. The most animals (107) were caught at the Iron Bound site, fewer than half that many (40) were caught at Big Bight Pond, and only 24 iguanas were caught at Blue Bayou. Adult iguanas totaled 125, 2.7 times the number of subadults (46). Population densities were 63 adults per ha or 103 iguanas (adults + subadults) per ha (Iron Bound), 37 adults or 39 iguanas per ha (Big Bight Pond), and 20 adults or 24 iguanas per ha (Blue Bayou). Recaptures of marked iguanas numbered from 1–14 and generated 123 distances moved involving 52 individuals (25 females and 27 males). Five animals were recaptured exclusively at initial capture sites and most (56 %) moved < 20 m from the site of initial capture. Distances moved were greater in males than females. Time between first capture and last recapture ranged from 10–323 days. Sex specific differences were not evident. The primary factor controlling population density was the abundance of tree hollows, used as retreats and found primarily in larger Black Mangroves (*Avicennia germinans*). These were inhabited for at least four years, regarded as territory year-round, and aggressively defended. Estimates, made using two different models, of total adult population size for the entire island were 21,820–73,097 and 38,185–85,098.

Key Words: *Ctenosaura bakeri*, Utila, Honduras, Bay Islands, Mangroves, Population size, Habitat association

The utilization of mangroves as preferred habitat has a certain exclusivity within the Iguanidae and also (as far as we know) within the class Reptilia. Certain reptiles appear frequently in mangrove habitat, but these are typically temporary visitors from marine (e.g., *Crocodylus acutus*) or terrestrial habitats (e.g., *Boa constrictor*). Even species often designated as mangrove specialists, such as the Mangrove Skink (*Emoia atrocostrata*), the Mangrove Monitor (*Varanus indicus*), and the Mangrove Snake (*Boiga dendrophila*), also inhabit terrestrial habitats such as rocky coastlines and tropical rainforest (Alcala 1986, Manthey and Grossmann 1997). In contrast, the Utila endemics *Ctenosaura bakeri* (commonly known as the "Swamper")and *Norops utilensis* are exclusively mangrove-dwelling lizards (Gutsche et al. 2004, Köhler 1996). From evolutionary and ecological perspectives, inhabiting mangroves entails some very specific adaptations of diet, behavior, and resource utilization.

Male *Ctenosaura bakeri* reach a total length of over 800 mm, snout-vent length (SVL) of 315 mm, and a weight around 900 g. Females are about 30% smaller. Adult males have a well-developed dewlap (up to 30 mm long) and a prominent dorsal crest consisting of up to 56 dorsal spines (each to 25 mm in height); both are less developed in females. Body coloration of adults varies from an inconspicuous grey-brown to bright turquoise blue. The body is generally patternless, and dark shading and dark lateral crossbands are only rarely distinguishable. In contrast, the tail has distinct dark crossbands. The dorsal crest of males consists of white and black spines arranged in alternating groups of two or three of the same color. Juvenile *C. bakeri* are uniformly blackish brown to grey-brown in color with dark brown crossbands on the dorsum and dorsal surface of the tail. This juvenile coloration varies notably from that of many other Spiny-tailed Iguana species, whose young display green or yellow-green pattern elements or are entirely green in color (Köhler 2002).

Isla de Utila belongs to the small Caribbean island group known as the Islas de la Bahia and lies in the Gulf of Honduras,

Swamper habitat in a Black Mangrove (*Avicennia germinans*) stand near Iron Bound Lake. Note the finger-like aerial roots emerging from the water in the foreground.

Adult males are impressive. They can grow to a total length of 80 cm and weigh more than 900 g. Dorsal spines are not always held erect like those of Green Iguanas, but they can be erected for advertisement or aggressive displays.

about 30 km off the Honduran coast. The maximum length of the 41.4-km^2 island is 13 km, the maximum width is 4.6 km. Utila is of coralline origin and lies on a base of metamorphic rock. The island has very little relief, rising only slightly from west to east. Large portions of the island are flat and lie only a few meters (or in the case of the mangrove swamp areas, only a few centimeters) above sea level. The only two areas with more substantial topography are both in the eastern region. The remainder of the erstwhile volcanic crater, Pumpkin Hill, at 74 m above sea level, is the highest elevation on Utila, although it covers only a small area. The considerably larger area of the 51-m high Stuart Hill extends as a hilly landscape from the settlement at East Harbor (Utila Town) and runs about two kilometers to the north. Also significant to the makeup of the island is the canal, which was excavated in the 1950s as a connection between the south (Oyster Bed Lagoon) and north coasts (Rock Harbor) for small fishing boats and to provide easier access to the north side.

The climate of Utila has relatively constant temperatures throughout the year and distinct rainy and dry seasons. The rainy season begins around the end of August and extends to the end of February. The rainiest months are October and November, in which more than half (58%) of the annual precipitation falls. At this time, the northeast trade winds can form hurricanes over the central Caribbean, and these are known to pass over the island at irregular intervals (e.g., Hurricane Marco, November 1996; Hurricane Mitch, October 1998). The dry season, with monthly precipitation < 100 mm/m^2, starts in early March and lasts until the end of July, sometimes to mid-August. The months of March and April are driest.

The average monthly temperature is relatively constant with a mean annual temperature of 26.3 ± 1.9 °C. The lowest temperatures occur during the rainy season. The absolute daily temperatures during this period vary between 19 (night) and 29 °C (day). Starting in March, the weather conditions change. As the frequency of precipitation decreases, the mean daily temperature increases slightly, fluctuating between 23 and 32 °C, with the highest monthly mean in August (28.6 °C). The relative constancy of Utila temperatures can be attributed to its location in the tropics and the moderating effect of the surrounding Caribbean Sea.

Utila lies in the range of semi-evergreen, tropical tradewind forest. Leaf loss and blossoming of the uppermost canopy layers are tied to the summer dry season, whereas the lower levels remain largely evergreen (Walter and Breckle 1999). The vegetation of Utila is remarkably diverse, considering the small size of the island and the limited relief. Also notable is the clear separation of the various vegetative communities. Extensive transition zones are absent. The island can be divided roughly in two parts: The higher-lying eastern part with the remains of semi-evergreen tradewind forest and the larger, flatter western part, which is dominated by mangroves and wet savannah.

The mangroves on Utila make up one of the most important, but azonal (i.e., not linked to climate zones) vegetative communities (Walter and Breckle 1999). Their occurrence is much more strongly tied to the presence of salt and/or brackish water in the tidal zone. Strictly speaking, genuine mangrove habitat (Hogarth 1999) is characterized by the following criteria (Tomlinson 1986): (1) They are woody tree species, whose occurrence is restricted to mangrove habitat where they can form

These photographs of Iron Bound Lake during high and low tides demonstrate the extreme and dynamic nature of Swamper habitat.

stands; (2) Stands are periodically flooded by salt water; (3) The mangrove species have both physiological and morphological adaptations to their habitat, e.g., mechanisms for salt elimination and pneumatophores (erect roots that rise above the soil or water and promote gas exchange). Mangroves on Utila are surrounded in some areas by mangrove-accompanying flora, which has a transitional character between the genuine mangrove and the bordering vegetation. This flora includes species that are not found in pure mangrove habitat and have only limited tolerance for salt water and flooding. Adaptations, such as pneumatophores and salt glands, are lacking in these species.

Materials and Methods

Field studies occurred mainly in two phases, from 27 June 1999 until 17 July 2000 and 1 January to 31 December 2001, allowing examination of distribution, abundance, and population structures within a complete yearly cycle.

Due to the arboreal lifestyle of *C. bakeri* and the fact that the ground beneath the trees was usually submerged, trapping, as suggested for other large lizards (e.g., *Varanus niloticus* and *Iguana iguana*; Lenz 1995, van Marken Lichtenbelt and Alberts 1993), was not possible. In addition, traps would be in constant danger of plundering by poachers. Nighttime capture (as with *I. Iguana* and *Amblyrhynchus cristatus*; Boersma 1982, Harris 1982) is also not possible, because these lizards spend the night in largely inaccessible tree hollows. Consequently, animals were captured by hand with the aid of a noose. This was facilitated by a particular behavior of *C. bakeri*. Although many animals would flee at the approach of humans, some would remain motionless on their perches, bodies pressed against the branch.

I climbed trees to 17 m in height, using a 3-m-long catchpole equipped with a self-closing noose. I used 2–3 mm strong, smooth cord for adult iguanas and waxed dental floss for lighter juveniles. Once noosed, a secure grip behind the head would calm the animal, which was then transferred into a sturdy cloth bag and passed to a second person on the ground. Handling time between capture and removing the noose was generally less than one minute.

Following capture, I examined, measured, and marked each iguana. This task was facilitated by the lethargic behavior individuals generally began to exhibit once caught. I recorded biometric data, sex, any special characteristics, cloacal and ambient temperatures, and the identification code. Two types of marking were used; a permanent code by removing some dorsal spines, and a temporary lateral color code for distance recognition. I also noted the exact circumstances of capture, such as the location and time, tree criteria (e.g., the presence of a hollow retreat or basking perch), exact position of capture, and the current weather conditions. Data collection and marking required about 15 min. Subsequently, each iguana was released in the tree from which it was taken.

Results

Ctenosaura bakeri exclusively inhabits the genuine mangrove swamps and iguanas occurred in all areas with mangrove stands. Individuals might inhabit an appropriate tree in mangrove-bordering vegetation, which would only occasionally be influenced by tides; however, this tree would always be within a few meters of true mangrove habitat. Because the mangrove areas are clearly differentiated from the bordering vegetative communities and transition zones rarely extended more than a few meters, the habitat of *C. bakeri* was essentially congruent with areas covered by mangrove.

The brackish mangrove swamps form a permanent part of Utila's wetland and cover about 30% of the island. Large portions of Utila's west side are covered with the non-permanent wet savannah, a unique and fascinating landscape rarely seen on the mainland because of deforestation and draining of land. The wet savannah is covered with up to 30 cm of fresh water during rainy seasons and completely dry during dry seasons. The primary vegetation is reed grass, small palm trees, and shrubs; carnivorous plants are common in some spots.

Knob-like aerial roots of the White Mangrove (*Laguncularia racemosa*). The most striking feature of mangrove trees is the aerial roots, which are essential for the trees to breathe in the saturated soil.

ALEXANDER ARZT

To catch the Swamper, the author had to climb as high as 15 m into the trees with his catchpole and noose loop.

The total distribution area of *C. bakeri* consisted of three separate mangrove areas not connected by corridors of mangrove or mangrove-bordering vegetation. The smallest of these areas (115 ha) is on the eastern part of the island. It extends around Big Bight Pond between the settlement at Utila Town and Utila's eastern coast. Another area lies in the central part of the island and extends from the northern coast of Utila at Rock Harbor and Iron Bound along the canal to Oyster Bed Lagoon in the south and from there first to the west and then north to Turtle Harbor Pond. With a total area of 612 ha, this is the largest stretch of habitat. The third area is in western Utila and has an area of 364 ha. It extends from the southern coast at Aliah Channel in a northeasterly direction as far as the north coast at Turtle Harbor, where it splits into two small stretches, one east along the coast at Turtle Harbor and the other west as far as Don Quickset Bay. The total size of the three mangrove areas is 1091 ha or 10.91 km^2 and comprises 26.6 % of Utila's total land area.

Three mangrove species occur on Utila: Black Mangrove (*Avicennia germinans*, Verbenaceae), White Mangrove (*Laguncularia racemosa*, Combretaceae), and Red Mangrove (*Rhizophora mangle*, Rhizophoraceae). The three mangrove species display no particular distribution pattern on Utila, across the island and within individual stands. In principal, the following formations could be identified. A large portion of mangrove stands was composed of a mix of the three species with mean tree height of 8–10 m. The mixture of mangrove species was not homogeneous, instead *R. mangle* predominated and small groups of the other two species were interspersed in a mosaic pattern. One other formation was characterized by the clear dominance of one of the three species, with the non-dominant species scattered individually. Tree height was highly variable. For example, in the area of Oyster Bed Lagoon, stands were dominated by *R. mangle* with a mean height of 3 m, whereas the two interspersed species reached heights to 6 m. In contrast, stands in the area around Iron Bound Lake were dominated by *A. germinans* that reached heights to 12 m, whereas the interspersed species reached only 3–5 m. Stands consisting of only one of the three mangrove species were both rare and small. Trees within these stands were mostly very old, massive, and tall. Examples include *A. germinans* west of Oyster Bed Lagoon (to 17 m), *R. mangle* on the banks of Turtle Harbor Pond (to 15 m), and *L. racemosa* north of Aliah Channel (to 20 m). Several mangrove lakes, such as Iron Bound Lake, occurred in all areas. These are open basins with isolated mangrove islands and often only temporary drainage. Noteworthy was a high proportion of dead mangroves inside of the lakes.

The periodic flooding (tide) of the mangroves on Utila occurs over lagoons (e.g., Oyster Bed Lagoon) and canals as well as over the coralline, highly porous ground, which is filled with an extensive network of cavities (J. Grant, USAID, pers. comm., 2001). According to my measurements, the normal tidal rise along the coast was about 300 mm, in the mangrove areas in the interior of the island only 30–50 mm. Only mangrove areas close to the shore are subjected to periodic tides throughout the year. Areas far from shore were extremely dependant on precipitation-related flooding. During the rainy season, these areas, depending on relief, would be covered by up to 800 mm of floodwater. During the dry season, water levels would be

ALEXANDER ARZT

One of the essential requirements for Swampers is a refugium. Tree hollows are necessary for mangrove dwellers unable to dig holes in the ground. Older Black Mangroves (more often than the other mangrove species) offer hollow trunks and branches. From our studies, we were able to conclude that a high incidence of older Black Mangroves (with the Swamper's preferred tree hollows) correlated with higher population densities of Swampers. Without a compelling reason to seek a new home (outgrowing a current one or destruction of a tree by a hurricane or poachers), Swampers may stay in the same tree for years.

Swamper habitat in a White Mangrove stand near Iron Bound Lake. "Mangrove" is a generic name for an intertidal forest.

reduced to a few centimeters or nothing. Occasionally even the flatter mangrove lakes would be completely dry for long periods of time. When the spring tides came, the tidal rise along the coast measured about 600 mm. Mangrove areas that had dried up completely were flooded within a few hours without any precipitation.

Salt content of the mangrove areas varied considerably and was inversely proportional to the yearly distribution of precipitation. During the winter rainy season, brackish water in the mangroves is diluted by precipitation. Beginning at the onset of the dry season, the salt content increased over the course of the summer, sometimes substantially exceeding that of the ocean. Also, heavy rains spontaneously decreased concentrations.

Capture-recapture Study.—The following data pertain largely to adults. Wherever relevant, data from juvenile animals is included, although detailed conclusions were not possible due to the nature of the data. Animals with an SVL > 150 mm were designated as adults and smaller animals as subadults.

I collected and marked 171 iguanas at three study sites, each about one ha in size, over a period of 11 months. The most animals (107) were caught at the Iron Bound site, fewer than half that many (40) were caught at Big Bight Pond, and only 24 iguanas were caught at Blue Bayou. Adult iguanas totaled 125 individuals (73.1 %), 2.7 times the number of subadults (46 individuals, 26.9 %). Similar adult-biased ratios occurred at all three study sites: 1.00:0.20 (Blue Bayou), 1.00:0.05 (Big Bight Pond), and 1.00:0.60 (Iron Bound). Population densities were 63 adults per ha or 103 iguanas (adults + subadults) per ha (Iron Bound), 37 adults or 39 iguanas per ha (Big Bight Pond), and 20 adults or 24 iguanas per ha (Blue Bayou).

Variation in population density was closely correlated with the abundance of appropriate tree hollows that were used by iguanas as retreats for sleeping and hiding. Blue Bayou exhibited a comparatively small number of iguanas and a comparably small number of retreats, whereas Iron Bound had both a high density of iguanas and a greater number of retreats. Even on a small scale within study sites the distribution of tree retreats is heterogeneous. For example, in one of two 300-m^2 areas at Iron Bound, two retreats exist and were used by two adults. In the other area, of 12 retreats, only nine had adult inhabitants, while the other two were unoccupied.

The abundance of tree retreats depended largely on the presence of particular mangrove species. Within the three study sites, 31 of 945 mapped mangrove trees contained retreats. Of these, 27 (87.1 %) retreats were in Black Mangroves, four (12.9 %) in White Mangroves, and none in Red Mangroves. In relation to the number of trees of each species, 14.8 % of Black Mangroves (n = 182), 10.8 % of White Mangroves (n = 37), and none of the

Surrealistic view of a mangrove lake during low tide. Open places like this, with dead remnants of mangrove trees, are common components of Utila's swamp vegetation. The genesis of Utila's mangrove lakes is not precisely clear; they nevertheless create a fascinating landscape.

Red Mangroves (n = 726) contained retreats. The proportion of mangrove species varied among study sites. Blue Bayou was dominated by Red Mangroves with few retreats and a limited number of iguanas. Iron Bound, with a smaller percentage of Red Mangroves and an increase in Black Mangroves, had a greater abundance of iguanas (Table 1).

Space and Time Constancy.—The greater the spatial and the longer the temporal constancy of the animals locally, the more precise the estimates of population size and structure (White 1982). The measure used to determine spatial constancy for *C. bakeri* was the distance between capture and recapture location, and for temporal constancy, the time span between first and last capture or sighting. To calculate the distance covered by the iguanas, all adult iguanas with at least one recapture were considered.

The number of recaptures ranged from 1–14 and generated 123 distances involving 52 individuals (25 females and 27 males). Five animals, three females and two males, were recaptured exclusively at initial capture sites. Extreme values occurred at Iron Bound, where one male was recaptured 14 times at his original capture site and another male was recaptured twice with displacement distances of 77 and 89 m. Of the 123 distances, 50 (42.3 %, 30 females and 20 males) fell within 5 m of their first capture site. The number of recaptured animals diminished with increasing distance. Only 22 (44.0 %) captures involved distances > 20 m from the site of initial capture.

Mean distance covered, as well as the minimum and maximum values for males at both Big Bight Pond and Iron Bound were higher than for females. At Blue Bayou, no females were recaptured. Altogether, the mean distance covered by females was 8.8 m and the greatest recorded distance for any female was 36 m. With a mean of 19.6 m, the mean distance for males was 2.2 times greater than that of females. The individual time differences between first capture and last recapture for the 52 iguanas ranged from 10–323 days. Seven (13.5 %) animals were recaptured within one month, 29 (55.8 %) animals within to six months, and 16 (30.8 %) animals within 7–11 months after initial capture. Sex specific differences were not evident.

Population sizes.—I selected two models to calculate adult population sizes at each of the three study sites (Table 2). Both models are extrapolations using proven statistical methods. Based on recapture data, the population numbers calculated for each of the individual study sites varied from 35–78 individuals per hectare using the first model and from 72–114 individuals per hectare for the second model. The lowest values were for Blue Bayou, the highest for Iron Bound. Based on the reality that the total distribution is small and of known size, adult iguanas display site fidelity over several years, and individual activity radii are small, I calculated an estimated total adult population size for the entire island (Table 3) as 21,820–68,733 based on actual capture data, 38,185–81,825 (model 1) and 78,552–120,010 (model 2).

Discussion

The habitat of *Ctenosaura bakeri* is limited exclusively to three disjunct mangrove areas of Utila with a total area of 1091 ha. I could not determine whether the surviving remnant mangrove areas were once contiguous. Such a scenario is quite possible given the flat topography of Utila and the variable water levels evident in the region's geological history (Perfit and Heezen 1987, Pregill and Olson 1981). Larger anthropogenic influences on the extent of the mangroves, at least in modern times, can be ruled out. Older local people claim that the current extent is the same as it was about 30–40 years ago (J. Gabourel, S. McNab, BICA-Utila, pers. comm., 2000). However, clearing and draining of small sections of mangrove around Utila Town occurred at the end of the 19th Century (Rose 1904).

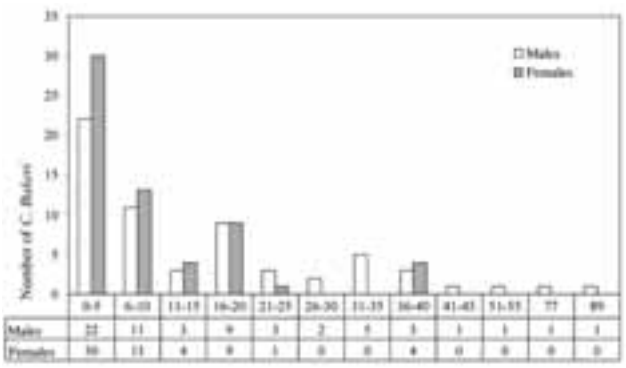
With a total distribution of 1091 ha, *Ctenosaura bakeri* has the smallest range of any species in the genus *Ctenosaura* (Köhler 2002). Only *C. nolascensis*, with a range of barely 1500 ha (Grismer 1999), comes close. Consequently, *C. bakeri* was recently upgraded to the status of "Critically Endangered" by the IUCN (Zoerner and Köhler 2004).

Habitat association.—Based on both biotic and abiotic factors, the habitat of *Ctenosaura bakeri* can be characterized as extreme. The mangroves of Utila correspond to a type of basin or inland mangrove (Hogarth 1999). Limited tidal influence and the accumulation of nutrients and sediment are typical for this type, as is the influence of local conditions such as precipitation, evap-

Table 1. Characterization of habitat relative to the abundance of *Ctenosaura bakeri* in three study sites on Utila.

High Abundance (Iron Bound)	Dominance of Black Mangrove (> 60 %) or pure stands, predominantly medium to larger sized trees (6–12 m), other species interspersed.
Medium Abundance (Big Bight Pond)	Slight dominance of Red Mangrove (ca. 50–60 %), predominantly of medium height (6–8 m), other species in small areas or interspersed in a mosaic pattern.
Low Abundance (Blue Bayou)	Strong dominance of Red Mangrove (> 80 %), predominantly of low to medium height (3–6 m), other species isolated or scattered throughout.

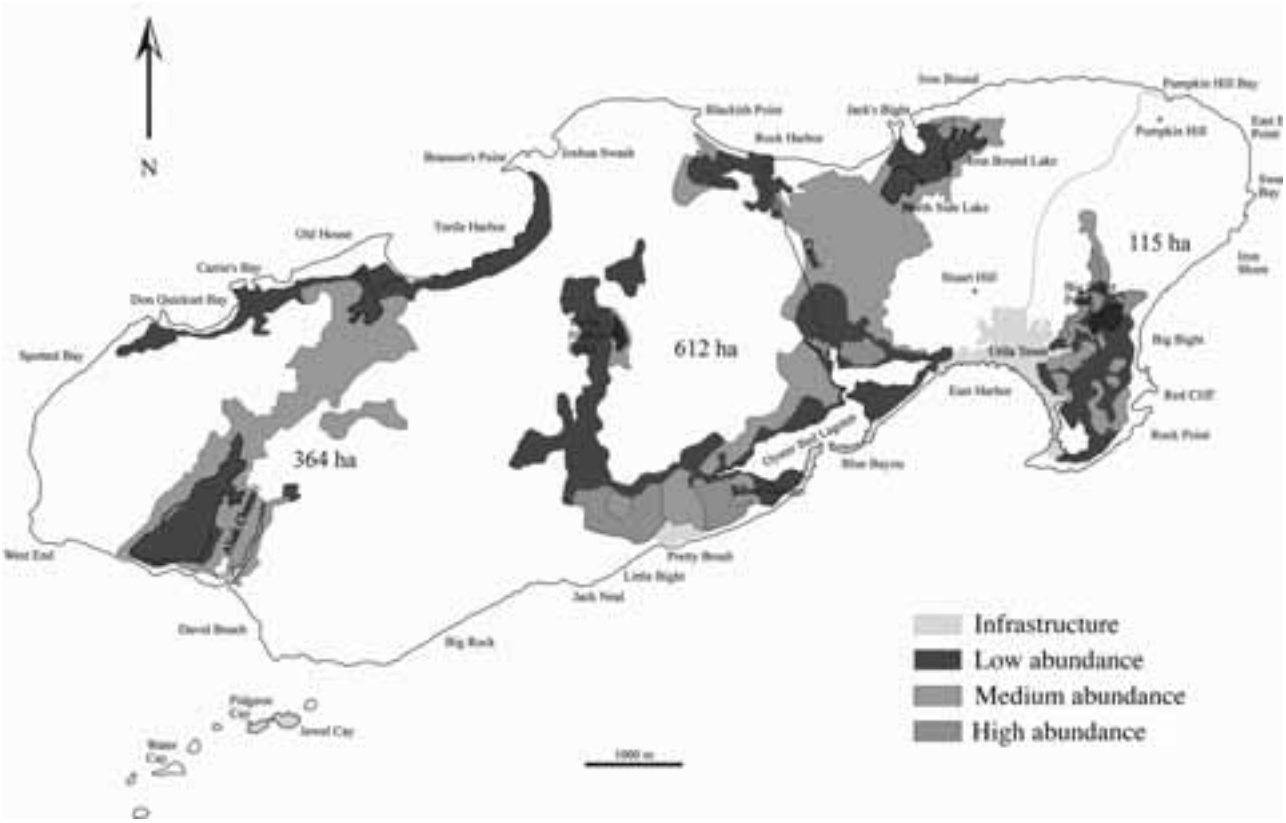
Resting volunteers in Swamper habitat in a pure Red Mangrove (*Rhizophora mangle*) stand. Surveying the Swamper population is a difficult job involving a great deal of climbing.



Distances between initial capture and recapture sites for *C. bakeri* in the three study areas. The x-axis is distance (m).

oration, and the flow of ground water, which collectively result in enormous fluctuations of salt content. Such abiotic conditions have a crucial influence on the distribution of individual mangrove species (Hogarth 1999, Tomlinson 1986) and may be responsible for the heterogeneous composition of Utila's mangroves.

The reasons for *Ctenosaura bakeri* adapting to specialized mangrove habitats on Utila are unclear. The species probably evolved from mainland-based ancestors. Potential ancestors may include the same ancestors as for *C. melanosterna* and *C. palearis*. *Ctenosaura similis*, which also occurs on Utila, belongs to a different subgenus (Buckley and Axtell 1990, Köhler et al. 2000, Köhler 2002). Access to the island may have involved over-water dispersal during hurricanes, as is known for *I. iguana* in the Lesser Antilles (Censky et al. 1998), or a landbridge to the mainland during the last ice age (Perfit and Heezen 1987, Pregill and Olson 1981). Two possible explanations for the habitat associa-



Hypothetical abundance of *C. bakeri* on Utila.

Table 2. Hypothetical total population of adult *Ctenosaura bakeri* on Utila. Calculations reflect extrapolations from actual capture data and from models 1 and 2.

Study Site	**#/ha** (capture data)	**#/ha** (model 1)	**#/ha** (model 2)	**Total Population Estimates** (1091 ha)
Blue Bayou	20	35	72	21,820 / 38,185 / 78,552
Big Bight Pond	37	43	70	40,367 / 46,913 / 76,370
Iron Bound	63	75	110	68,733 / 81,825 / 120,010

Table 3. Population density estimates of adult *Ctenosaura bakeri* in the individual study sites based on recaptures of marked animals. Data are from two different models. Each value is presented ± one standard error (SE), followed by the 95 % confidence interval in parentheses.

Study Site	Model 1	Model 2
Blue Bayou	35 ± 9 (26–65)	72 ± 20 (45–129)
Big Bight Pond	44 ± 3 (41–55)	72 ± 15 (53–117)
Iron Bound	78 ± 5 (73–91)	114 ± 16 (93–155)

tion include forced adaptation, since mangrove swamps largely covered Utila at the time of speciation, or, more likely, ecological exclusion from other habitats that had been successfully colonized by *C. similis* and *Iguana iguana*. Niche partitioning would account for the coexistence of three species of large iguanas in a limited area, a situation unique to Utila, the only known location with more than two sympatric, naturally-occurring species of iguanas.

Population density.—The high population densities within my three study sites (24, 39, 103 individuals/ha) was comparable to findings from three other sites where Kuttler (2000) found densities of 27, 39, and 50 individuals/ha. In contrast, studies of other large iguana species in areas not threatened by hunting often found lower population densities, e.g., 5.1 individuals/ha for *Ctenosaura similis* (Case 1982, Fitch and Henderson 1978), 1.5–17.7 individuals/ha for *Iguana iguana* (Muñoz et al. 2003, Van Devender 1982), and 12.4 individuals/ha for *Sauromalus varius* (Case 1982). High population densities seem to correlate with a high proportion of juveniles, mainly because adults are territorial and usually protect large individual territories (Fitch 1973, Fitch and Henderson 1978). This would account for isolated high population densities of *C. similis* (139.2 individuals/ha) and *I. iguana* (100.5 individuals/ha), where the proportion of adults was only 10 % (Van Devender 1982).

In contrast, the average proportion of adult *Ctenosaura bakeri* in all six study sites (this study and that of Kuttler 2000) was

Typical view of a Swamper, high in a tree, difficult to see, and almost impossible to reach. When it is too late for them to hide in holes (as in this picture), they rely on crypsis by pressing their bodies against a branch and remaining motionless.

77.6 ± 11.3 % (62.6–95 %) and all available personal observations indicate that the animals are territorial throughout the year. An explanation for the high density of individuals would be the favorable distribution of limited resources, e.g., suitable retreats for hiding and sleeping (Duellman and Duellman 1959, Fitch and Henderson 1978, Köhler 2002). Where retreats were abundant locally, high concentrations of individuals were observed, e.g., for *C. similis* (Fitch and Henderson 1978). Similar correlations seem to exist for *C. bakeri*, as the number of tree-hole retreats corresponds to abundance. The behavior of *C. bakeri* confirms the significance of suitable retreats. Retreats were inhabited exclusively for at least four years, regarded as territory year-round, and aggressively defended. Retreats were found predominantly in *Avicennia germinans*, usually in older trees. This is due to core rot, which begins in early stages of growth. The correlation between the number of retreats and iguanas and the obvious significance of suitable retreats thus appears relevant for extrapolating the total distribution area of *C. bakeri*.

During the capture-recapture study, adults displayed site-fidelity and remained predominantly within a radius of about

In the face of any threat (in this case, the author), Swampers move behind branches and carefully assess the risk while relying on crypsis and lack of motion to prevent detection. Such "squirreling" behavior is not uncommon among iguanian lizards..

Another avenue of escape is to jump from a tree and dive or swim away from the threat. In this case, the male jumped from about 10 m when the author tried to catch it, but Iron Bound Lake was too shallow and it could not escape.

20 m from their home tree. Suitable retreats continued to be inhabited even past the 11-month study period. Of 29 animals recaptured in Iron Bound during the course of the study, 17 were recaptured at the same home tree in later control captures after periods of 410–1305 days. Behavioral observations in 2001 (in Iron Bound) additionally showed that individuals not recaptured during the study (1999/2000) continued to inhabit their home trees. With animals situated permanently, the basic conditions for the most precise possible calculation of the population size are satisfied (Begon 1979, White 1982). The estimated population size of 21,820–73,097 adults, in comparison to earlier population estimates of only a few hundred individuals (Köhler 1998) was surprising, although similarly high numbers (21,000–24,000) were estimated by Kuttler (2000). The earlier lower estimate was attributable to a lack of sufficient data.

Maximum densities in the study sites had not yet been reached. New captures originated predominantly from animals that were present within the study area. This resulted in observations of individuals living in the study sites but not yet captured, as well as studies of flight behavior. When approached, over 90 % of iguanas fled into retreats. Only a few animals would remain in place with bodies held tightly against the branch and could be captured or identified. This was further verified by the low number of iguanas sighted per catch day, which ranged from 5–19 % of the total number of animals captured and the number of animals actually proven to be in the areas.

New captures were distributed over the entire catch period, so that the probability of capture was not based on time-dependant criteria. The total recapture rate (41.6 %) would have been lower if capture and marking had substantially influenced behavior. Many marked animals were recaptured during the next catch day. Personal observations indicated that some iguanas would leave their retreats within 30 min of being marked. The recapture rate of males was higher than that of females. This is probably attributable to more aggressive territorial behavior in males, and is similar to observation of male *C. similis* and *C. pectinata* (Evans 1951, Fitch and Henderson 1978).

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Sunset on the west coast of Egmont Key: The box turtle was not placed in the photo, but was found naturally on the beach.

Dilemma of the Common Species: Florida Box Turtles

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The Eastern Box Turtle, *Terrapene carolina*, one of four forms that may be found in Florida, is familiar to both residents and visitors. Box turtles are known to occur in virtually all counties plus offshore islands in the Gulf of Mexico, where they presumably dispersed over water by floating during floods. Although often considered to be "common," box turtles are not evenly distributed within the state and statements of abundance are misleading in the absence of empirical demographic data, and probably result from a variety of misperceptions. At the same time, knowledge is lacking concerning the status of *T. carolina*, which may impede conservation efforts, even on so-called "protected" lands.

Adult Florida Box Turtle (*Terrapene carolina bauri*) on Egmont Key, Florida.

Plastron of a Florida Box Turtle; plastra vary from yellow to dark brown, and many have colorful patterns.

Juvenile Florida Box Turtle: Juveniles comprise >20% of Egmont Key's box turtle population.

Hatchling Florida Box Turtle: Hatchlings are found occasionally in the leaf litter under a dense overhead canopy.

Florida Box Turtle buried under cover: Turtles seek refuge in deep leaf litter during drought, cold, and heat.

The large influx of people into Florida, especially in the latter half of the 20th century, has resulted in the shrinkage and isolation of box turtle habitats to the point where turtle survival may depend on the presence of public lands. This is especially true in the southern and central parts of the state, areas that historically were known to contain large populations. State, federal, and privately held conservation-based lands may still contain sizable populations.

Box turtles are ecological generalists, a niche that has made them successful for millions of years. In Florida, they are usually terrestrial, although they like to soak in water, especially after dry periods. They are omnivorous, eating a wide variety of both animal and vegetable matter, and Florida populations are active throughout the year to varying degrees, depending on temperature. Home ranges are generally small and individuals frequent the same areas from one season to the next. Box turtles are very aware of their environments, such as the location of food sources, hiding places, nesting sites, and retreats from cold and drought. However, a few turtles are wanderers and never seem to remain in one place. Although not generally considered social animals, they are tolerant of conspecifics and may recognize neighbors. Populations may be dense (14–16 or more turtles per hectare) and large, given favorable habitat and environmental conditions.

The Legal Basis for Conserving Box Turtles in Florida

No statutory regulations in Florida are specifically designed for the protection of box turtles in native habitats. However, commercial collecting is banned, and state law limits possession to two individuals per person without a permit. Box turtles gain some protection on certain federal and state lands, such as national and state parks, since removing any fauna from such lands is illegal without special permits.

Internationally, all *Terrapene* are protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Florida Box Turtles (*T. carolina bauri*) are listed in Appendix II. Trade in Appendix II species must be monitored, lest these species become threatened as a result of commercial exploitation.

Constraints on Conservation

The biological constraints on conservation are those characteristics of a species that relate to its behavior, physiology, population structure, reproduction, and longevity, among others, that are not amenable to change as a result of human management. The life-history characteristics of a population of box turtles reflect a fine balance resulting from natural selection over a long period of time. Thus, the constraints imposed by the species'

Dense habitat formed by Brazilian Pepper (*Schinus terebinthifolius*): The exotic Pepper provides cover, leaf litter, shade, and helps retain high humidity.

physiological, demographic, or other life-history requirements set the biological limits within which researchers and natural resource managers must fashion conservation programs.

As a result of many natural history studies (see Dodd 2001), box turtles are categorized as long-lived, somewhat slow-maturing, iteroparous (i.e., with overlapping generations) reptiles with a high rate of adult survivorship, high mortality among eggs, hatchlings, and juveniles, and a relatively low reproductive output. This suite of life history characteristics, together with their needs for space and a proper biophysical environment, form the boundaries within which options for long-term survival must be framed. These same traits make them vulnerable to habitat change and exploitation because animals with such life history traits take a long time to rebound from perturbations, whether natural or as the direct result of human activity (Seigel and Dodd 2000, Dodd 2001).

Human constraints on conservation include the need for a legal or administrative mandate to protect or conserve a species; the funds, equipment, and personnel (both in the short and long term) to carry out management programs; the time and logistics necessary to conduct preliminary research or other management activity; and a determination whether public support or opposition is present. The diverse types of public lands also have many diverse types of management mandates. The adoption of an "ecosystem approach" to land management by many natural resource agencies (e.g., the U.S. Fish and Wildlife Service, USFWS) may even result in ignoring so-called "single species" problems, except where legal mandate or traditional agency focus dictates otherwise. Therefore, the designation of "public" does not mean that the land and its ecosystems are protected or managed for biological diversity or for the long-term benefit of its natural resources.

Case Study: The Box Turtles of Egmont Key

Egmont Key (27º 36' N, 82º 45' W) is a small (ca. 180 hectares) continental island precariously situated at the junction between Tampa Bay and the Gulf of Mexico. The island has a long history of human occupancy, and little was known of its flora and

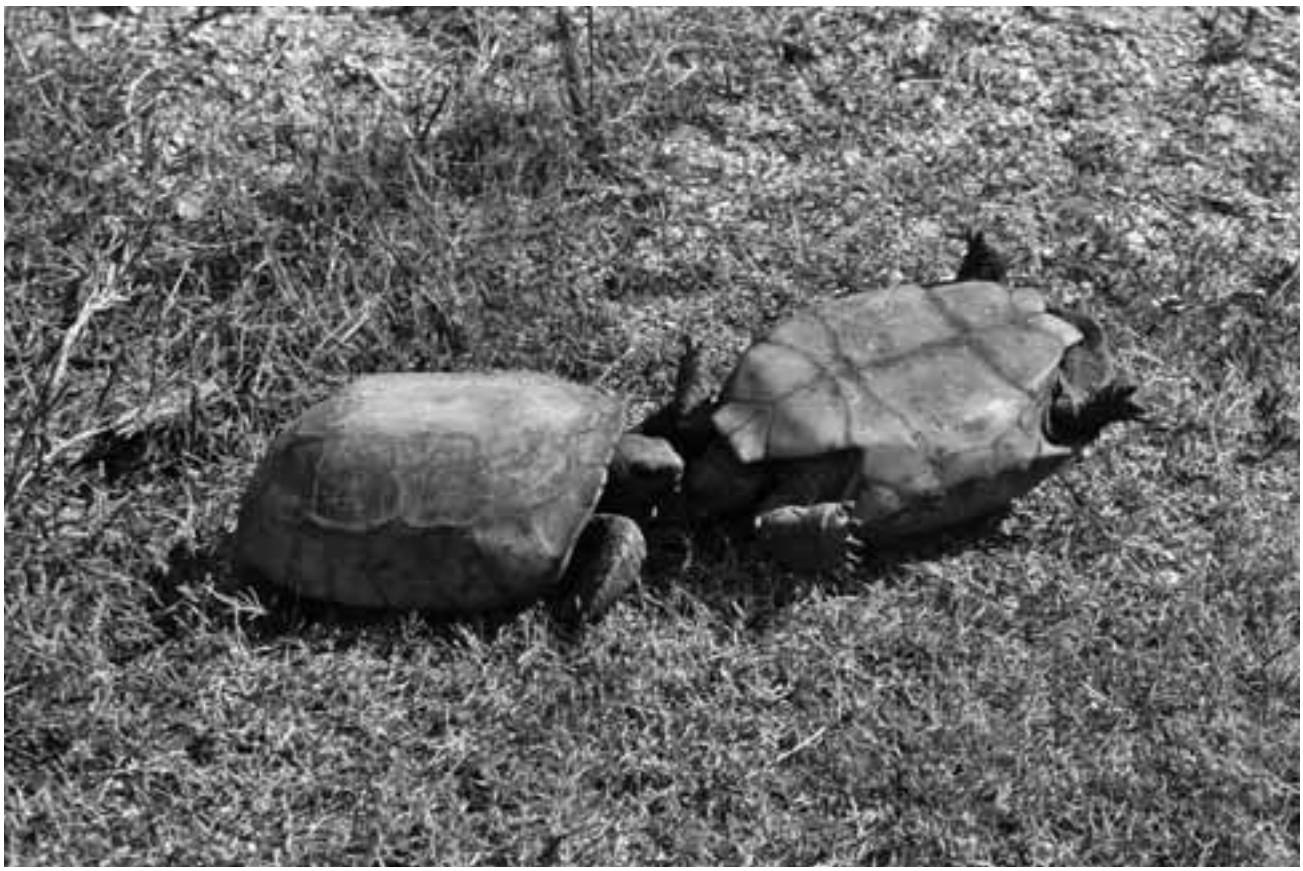
An aerial view of the island looking to the southwest from the lighthouse toward Fort Dade: At one time, the island was nearly twice the size of its present configuration.

fauna prior to extensive modifications made in connection with lighthouse construction and military use beginning in the middle 1800s. Herpetological collections made in 1869–70 and 1904 did not mention box turtles and, indeed, not until the early 1990s did biologists become aware of the large population of Florida Box Turtles (*Terrapene carolina bauri*) on the island (Franz et al. 1992). The origin of the population and the length of time that box turtles have been on the island are unknown, although box turtles are frequent residents on the barrier islands of the southeastern Atlantic Coast and Gulf of Mexico.

Adult Gopher Tortoise (*Gopherus polyphemus*): Gopher Tortoises are common on Egmont Key, with estimates of >1500 tortoises on the island.

Because of their large population size, their relative freedom from overabundant human-associated predators (especially raccoons and other mammals), and their physical isolation from current anthropogenic activities that threaten turtle populations everywhere (e.g., massive habitat destruction and alteration, disturbance, and collection; see Klemens 2000), the box turtles on Egmont Key do not represent just another population, but a unique natural resource that cannot be replicated elsewhere. The large numbers of conspicuous individuals form a dense population that may provide a glimpse of what box turtle populations were like prior to human colonization. Although human activities have severely changed the environment of Egmont Key through past land clearing and the introduction of non-indigenous plants, habitat conditions favorable to turtles (box turtles, Gopher Tortoises, *Gopherus polyphemus*, and nesting Loggerhead Sea Turtles, *Caretta caretta*) have created a unique phenomenon in North America, "l'Île des Tortues" (the island of turtles; Devaux 1993).

Since 1991, scientists from the U.S. Geological Survey, Florida Integrated Science Center (USGS/FISC), have marked more than 2400 box turtles and recorded more than 5200 individual recaptures in a long-term USGS study of the life history of this declining species. Project goals include: (1) Gathering biological data that will provide immediate assistance in habitat management; (2) monitoring box turtle population dynamics during restoration efforts; (3) documenting effects of increased human activity on box turtle population dynamics; (4) determining spatial and temporal aspects of habitat use by box tur-



Fighting Gopher Tortoises: Behavior not normally witnessed is routinely observed on Egmont Key. These were both females!

tles, their activity patterns, population structure and size, and reproductive activities; and (5) determining characteristics of life-history, such as survivorship, growth, disease, and the biology of all age classes.

One might expect that the occurrence of large populations of turtles seemingly unaffected and undaunted by humans on a National Wildlife Refuge/State Park would ensure their protection — but this may not be the case for box turtles. No plan guides resource management and the development of the island,

The author's wife, Marian Griffey, removing box turtles from an abandoned Gopher Tortoise burrow. Florida Box Turtles sometimes use these burrows to escape drought, heat, cold, and sudden decreases in humidity — but never if a tortoise is present.

MARIAN GRIFFEY

The author measuring a box turtle.

Mellon Battery at Fort Dade: Gopher Tortoises prefer the open areas afforded by the restoration of the buildings of the Spanish American-era fort.

This sign alerts visitors to the presence of box turtles on the island. Visitors flock to Egmont's beaches and to historical remnants of Fort Dade (1898–1924).

Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) on Egmont Key: Although now extirpated, this was one of the last observed specimens on the island. Soldiers serving at Fort Dade in the early part of the 20th Century complained about rattlesnakes, mosquitos, and boredom.

Black Racers (*Coluber constrictor*) are common on the island; they more closely resemble specimens in the distant Florida Keys both morphologically and in coloration than those on the nearby mainland.

although many ongoing activities have profound effects on box turtles and other non-protected species. The northern third of the island has had extensive amounts of vegetation removed in order to expose historic sections of Fort Dade for visitors and to stabilize remaining structures; a visitor center is being established using Fort Dade's renovated guard house; tour boats discharge an increasing number of day visitors, and thousands of people may visit, especially on holiday weekends.

Visitors to the island can assist endeavors to protect and conserve all of Egmont Key's natural resources by: (1) Avoiding restricted areas, (2) Maintaining a NO LITTER policy, (3) Leaving plants and wildlife alone, (4) Taking from the island nothing but photographs and memories, and (5) Leaving behind nothing but temporary footprints in the island's glittering sands.

Perceptions and the Future

In effect, Florida Box Turtles have been labeled as common in public parlance, without the benefit of supporting data. So labeled, they face the "dilemma of the common species," that is, if a species is perceived as common, no incentive, legislatively or financially, exists to promote studies and monitoring. This is especially true when critical resources are limited by public priorities that do not regard the environment or natural resources as matters of high importance.

Threats certainly affect box turtles in Florida, as is apparent from the rapid landscape changes that have occurred within the last 60 years. With hundreds of thousands of people moving to Florida annually, native terrestrial habitats and marshy wetlands are being converted to housing and other forms of urban development. Between 1936 and 1995, forests in Florida declined by 22% and herbaceous wetlands by 51%, whereas agricultural lands increased by 60% and urban lands by 632% (Kautz 1998). Certain Florida habitats known at one time to contain sizeable box turtle populations have nearly disappeared and all trends point to a continued loss of habitat diversity within the state (Kautz et al. 1993). Increasing numbers of people in Florida will bring more transportation corridors (leading to mortality), isolate populations, increase contacts with people (who will collect them) and domestic pets (that will kill them), and increase susceptibility to disease through contact with infected captives or other species of chelonians. Commercial collecting is the only threat to box turtles that has been addressed thus far by resource agencies in Florida.

In order to maintain an ecosystem, the functional biodiversity of that ecosystem, including the role of common species,

This is the only specimen of Mole Skink (*Eumeces egregius*) observed on the island; its coloration resembles none of the other described subspecies of *E. egregius*.

must be understood before the common species decline to the point that their existence is jeopardized. Ironically, the somewhat vague concept of ecosystem management (see Goldstein 1999), an idea with many interpretations and practical applications (Yaffee 1999), should be used as a basis for not taking the abundance and biomass of common species into special consideration during natural resource planning, and thereby perhaps even to jeopardize the "commonness" of these species. Certain places should be maintained where presently common species can be appreciated and protected in their sheer numbers and diversity, and where abundance can be left alone or managed as a national asset, rather than be seen as a reason to do nothing (or very little) or as an excuse for exploitation. Only on public lands is this likely to be feasible in Florida's future, especially for box turtles and other reptiles and amphibians. Scientists, resource managers, and concerned citizens must work together to ensure that scientific principles and careful deliberation guide natural resource decisions on public lands, perhaps through the development of a formal, independent, scientific review of management options (Meffee et al. 1998). Box turtles (particularly unique populations such as that on Egmont Key) and other perceptively common species should not be forgotten or subsumed in the decision-making process, especially when valid concerns suggest that they too might join the ever-increasing ranks of imperiled species in Florida.

Open forest of Sabal Palms (*Sabal palmetto*): This is ideal habitat for box turtles on Egmont Key.

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The Life and Times of a State Agency Herpetologist

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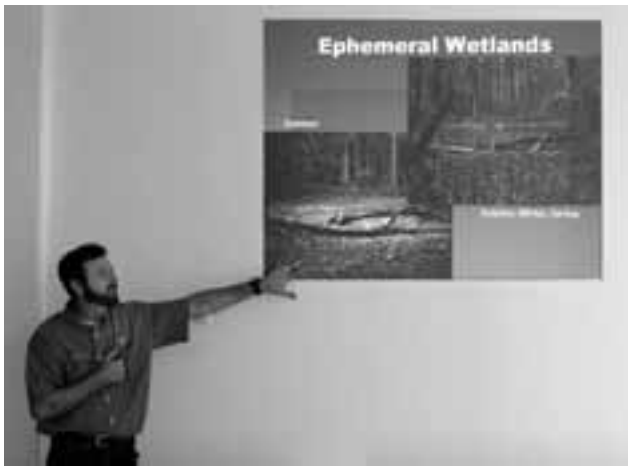
Photographs courtesy of the Missouri Department of Conservation unless otherwise indicated.

So you want to be a herpetologist? I can't blame you. The discipline can be both exciting and challenging. Each week offers a rollercoaster of experiences that range from disappointing to elating and from near misses to complete success — but I didn't start out with this career in mind.

While I've always loved spending time outdoors and had an interest in wildlife, I never dreamed that I would become a herpetologist. Throughout my undergraduate work at the University of Arkansas–Conway, my primary goal was to become a game biologist — amphibians and reptiles weren't on my radar screen. During my last semester in college, I took a vertebrate biology course. This course provided my first glimpse of the rich diversity of species besides those you hunt or fish. My eyes were opened to a whole new world of species that had always been there but which I had never really "seen."

After receiving my B.S. in Biology, I began graduate work at the University of Arkansas–Fayetteville. I struggled to decide what type of project I should pursue for my thesis. I looked into possible research on Red-cockaded Woodpeckers and Red Foxes. However, due to opportunity and funding, I finally resolved to study pond-breeding amphibians in the Ouachita National Forest. Although I had little experience working with amphibians, spending night after night at my field sites studying their biology and behaviors changed all of that. After completion of my Master's thesis, I knew I wanted to spend my life learning



Speaking to a Master Naturalist class, the author presents information on the importance of the ephemeral wetlands on which many of Missouri's amphibians rely for reproduction.

The author and a protection agent release an Ozark Hellbender (*Cryptobranchus alleganiensis*). Hellbender populations in Missouri and throughout the range of the species are declining, with failed recruitment largely responsible, although specific causes remain unknown in many instances. Numerous brochures have been produced in an effort to increase awareness of Hellbenders and their plight.

more about these creatures and helping to protect them and their habitat. With this goal in mind, I decided to pursue to a Ph.D. at the University of Arkansas–Fayetteville. I had no idea where I would end up after getting my doctorate, but I knew that, wherever it was, I wanted to be working with amphibians and reptiles.

I was hired as the herpetologist of the state of Missouri in July 2000. I replaced Tom R. Johnson, who had held the position since its inception in 1977. I spent the first few years learning more about the state's amphibians and reptiles and their distributions across Missouri, familiarizing myself with the millions of acres of publicly owned land, and becoming acquainted with hundreds of land managers throughout the state.

Being the herpetologist for the state of Missouri, I rarely do the same thing two days in a row. I may be on the phone or writing emails to address questions from the public and department staff on Monday, searching for Massasauga Rattlesnakes (*Sistrurus catenatus*) in northwestern Missouri on Tuesday, helping a land manager inventory all of the ponds in his area on Wednesday, attending a Regulations Committee meeting on Thursday, and writing a manuscript detailing my most recent research on Friday.

A large part of the job deals with providing technical support to Missouri Department of Conservation staff, other agencies, and the public. I spend considerable time addressing questions from the public regarding amphibians and reptiles. The majority of questions pertain to snakes and how to keep them away from people's homes — but, on occasion, I receive a call from an individual on how to attract snakes to their property. In

The author (top) looking at a Flat-headed Snake (*Tantilla gracilis*, middle) on an Ozark glade. Glades occur where soluble surface rocks have dissolved, leaving largely insoluble rocks and little soil. These very dry, harsh habitats, characterized by drought-tolerant Eastern Red Cedar trees (*Juniperous virginiana*), support a large number of Missouri's reptiles, many of which are prairie- or desert-dwelling species that reach the northeastern most extents of their ranges on Missouri's glades. For example, populations of Eastern Collared Lizards (*Crotaphytus collaris*, bottom) in Missouri are closely tied to glades and are extremely vulnerable to habitat alterations that result from fire control and invasions of non-native plants.

During a workshop training session (top), participants learn how to use a dipnet and how to identify tadpoles and larval salamanders. The author dipnets an Ozark pond looking for amphibian larvae during a herpetofaunal survey of a state-owned conservation area (middle). General surveys such as this are essential for developing inventories of wildlife resources and necessary management plans that include considerations for the needs of amphibians and reptiles. Most known populations of the Ringed Salamander (*Ambystoma annulatum*; bottom) seem to be doing well, but the species has a very limited range, most of which is within the state of Missouri.

Public education may be the most important facet of a state agency herpetologist's job. Here, the author shows a group of individuals a live Eastern Tiger Salamander (*Ambystoma tigrinum*). This species is common in many parts of Missouri, but seldom encountered due to its secretive burrowing lifestyle.

The author installing a drift fence during a Massasauga Rattlesnake (*Sistrurus catenatus*) survey. This survey was conducted in a State Park in collaboration with personnel from the Missouri Department of Natural Resources, federal authorities (especially when dealing with populations on National Wildlife Refuges), and university researchers. Numerous surveys have been conducted for Massasaugas during the author's five-year tenure at the Missouri Department of Conservation. The species presumably ranged across much of northern Missouri in historical times, but is now limited to three known populations on state or federal refuges and a few scattered individuals that may or may not represent viable, self-sustaining populations.

addition, I write and edit many educational materials (articles, brochures, posters) and give numerous presentations on amphibian and reptilian life histories. Overall, Missouri's citizens are eager to learn more about the biodiversity of their state.

Besides dealing with questions from the public, I work with land managers to address management and conservation needs as requested. I commonly provide management recommendations regarding prescribed burning, pond construction and renovation, mowing and haying, disking, timber harvests, etc. I also provide technical workshops each year for individuals wanting to learn more about amphibian and reptilian conservation. Workshops include amphibian and reptile management, stream-team training, venomous snake handling, conservation agent training, Hellbender (*Cryptobranchus alleganiensis*) ecology, and rare and endangered species training. I have learned over the years that the key to increasing awareness and appreciation of amphibians and reptiles is through educational materials and especially through hands-on workshops.

As the state herpetologist, I oversee many activities related to rare and endangered amphibians and reptiles. Of the 108 species native to Missouri, 29 are considered rare or endangered. These species receive extra attention in an effort to preserve them as part of Missouri's wildlife. Information regarding the status and distribution of each of these species is archived and used to determine the vulnerability of these animals to extirpation. Currently, I represent Hellbenders and Massasauga Rattlesnakes on national recovery teams. These two species are in the most need of recovery efforts in Missouri. In addition to them, other species have received considerable attention over the years. The restoration of Eastern Collared Lizards (*Crotaphytus collaris*) on glades has been and continues to be successful. I provide considerable management information regarding these species to area managers and private landowners, and much of my work involves surveys of these rare and endangered species and supervision of department-sponsored research projects through which we seek to learn more about their basic biology.

A large part of my job involves surveying amphibians and reptiles across Missouri. Even though this is the best part of the job, one person cannot effectively survey the entire state. Therefore, much time is spent acquiring grants to coordinate projects with staff, other agencies, and universities to conduct the work. Currently, the Missouri Department of Conservation is conducting surveys on Natural Areas and Conservation Areas around the state to obtain baseline information on all amphib-

The author explaining to a state forester (above) how to tell a male from a female Prairie Lizard (*Sceloporus consobrinus*, below). Much of the work of a state agency herpetologist is working with the personnel of other agencies on issues relating to amphibians and reptiles.

ians and reptiles. Over the past five years, I, with the assistance of staff, have conducted specific surveys on Illinois Chorus Frogs (*Pseudacris streckeri*), Wood Frogs (*Rana sylvatica*), Northern Crawfish Frogs (*Rana areolata*), Ringed Salamanders (*Ambystoma annulatum*), Hellbenders, Illinois Mud Turtles (*Kinosternon flavescens spooneri*), Western Chicken Turtles (*Deirochelys reticularia*), Massasauga Rattlesnakes, and Timber Rattlesnakes (*Crotalus horridus*), to name only a few. I take a

During an amphibian and reptile workshop, participants learn how to install drift lines and hoop traps in order to collect and survey for aquatic turtles. In addition to monitoring effects of such natural events as the massive floods of 1993, during which all of Missouri's major rivers ranged far out of their banks, some aquatic turtles, such as the Chicken Turtle (*Deirochelys reticularia*, top left), Blanding's Turtle (*Emydoidea blandingii*, left), and Illinois Mud Turtle (*Kinosternon flavescens spooneri*, top), are of conservation concern in the state. Chicken Turtles are relatively common in the southeastern United States, Blanding's Turtles have a disjunct distribution in the upper Midwest, and Illinois Mud Turtle populations are isolated relicts of what once was a much wider distribution. All are known from only one or very few localities in Missouri.

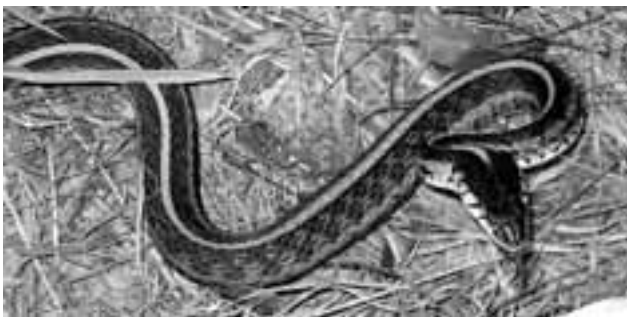
Wood Frogs (*Rana sylvatica*) in Missouri are relicts of times when massive glaciers covered much of the state north of where the Missouri River now flows. These remnant populations are scattered across the state in localized habitats that remain suitable for this cold-tolerant species, which is distributed for the most part far to the north. In 2005, the Missouri Department of Conservation conducted numerous surveys for Wood Frogs in southwestern Missouri.

great deal of pleasure and satisfaction when I capture and photograph a species that has not been seen in the state in 20+ years, or capture a species I had not previously encountered.

Although my job is exciting, some activities, especially those dealing with regulatory issues, may be less than thrilling — but they can be equally rewarding. Much paper work is involved in overseeing wildlife collector permits and breeder permits. Over 150 amphibian and reptile collector permits are processed and reviewed annually in Missouri. In addition, I provide advice to pet stores, commercial farms, and other interested parties regarding the rules and policies and appropriate permits needed to propagate and sell native species in Missouri. One of the more demanding parts of the job is to provide input on wildlife code regulations that impact amphibians and reptiles. Much time and effort are involved with code changes, but the ultimate goal is better protection for wildlife.

Although the majority of a state agency herpetologist's job is to increase awareness through educational materials, management recommendations, and regulation changes, some time remains to work with academic colleagues. I serve as primary contact person for university faculty and students who conduct research on amphibians and reptiles. Numerous meetings occur with professors and graduate students across the state regarding potential projects. I've discovered that guiding a student's research interests is exhilarating and gratifying. I also see the need for state agency biologists to publish data in peer-reviewed journals. Considerable data is collected by agencies and the need to get this information to the academic world will further stimulate research and collaboration.

Although I never dreamed that I'd become a herpetologist, even during those long hours sitting by ponds listening to frogs as a master's student, I can't imagine anything else I'd rather be doing with my life. Nothing can compare with the sense of joy when a member of the public who has always been afraid of snakes holds one for the first time, the elation of finding a clutch of eggs produced by an animal on the brink of extinction, the delight of spending a day creating a list of species for an area that has never been surveyed, the challenge of writing regulations that will protect a sensitive species, or the accomplishment when a manuscript is accepted for publication in a peer-reviewed journal. I am thankful every day that Missouri has the funding and the public support for a full-time advocate of the state's herpetofauna — and that I'm the one that gets to do the job.



BRIAN S. EDMOND

We're still learning about species that are common in Missouri. A student project investigating the distribution of purported subspecies of the Common Garter Snake (*Thamnophis sirtalis*) is shedding new light on what has been a "standard" taxonomy for many decades.

JOHN BINNS

"Sapphire" is one of the Queen Elizabeth II Botanic Park's most beautiful and most prolific female Blue Iguanas.

Restoring a New Wild Population of Blue Iguanas (*Cyclura lewisi*) in the Salina Reserve, Grand Cayman[1]

Frederic J. Burton

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Photographs by the author except where indicated.

Abstract.—Twenty-three immature Grand Cayman Blue Iguanas (*Cyclura lewisi*) were released into xerophytic shrubland in the Salina Reserve on Grand Cayman in December 2004. After seven months in the wild, at least 91% had survived, remained in the release areas, and grown. The iguanas are expected to reach sexual maturity by 2006. The females were occupying average usage areas of approximately 0.6 acres in summer 2005, very similar to the summer usage areas occupied by much older, mature females in the QE II Botanic Park. The maximum viable population density for this age class in this habitat is estimated to be between 4 and 5 iguanas/acre. The existing release area is just sufficient to accept the next release of 60–70 two-year-old Blue Iguanas, scheduled for December 2005. One concern is that these iguanas may instinctively leave the reserve to seek historic nesting habitat on the adjacent coast, where vehicular traffic is now a severe threat.

Key Words: *Cyclura lewisi*, Grand Cayman, Blue Iguana Recovery Program, Reintroduction, Restocking, Conservation

Burton (2004) wrote of the Blue Iguana Recovery Program's transition from successful pilot projects, to large-scale population recovery for the Grand Cayman Blue Iguana (*Cyclura lewisi*). Since then, 21 young Blue Iguanas have become established in the Salina Reserve on Grand Cayman, and thanks to strategically targeted grants and a truly impressive roster of international volunteers, we now know a great deal about how they are doing.

The Salina Reserve is a 625-acre protected area, owned and managed by the National Trust for the Cayman Islands. It is a very wild, inaccessible place, and exceptionally rich in natural diversity, mainly because it encompasses a wide range of different environments. The reserve is named for a large sedge wetland in its southern environs, a habitat somewhat reminiscent of Florida's northern Everglades. In the dry season, a cyanobacterial mat dries out to leave a pale crust that could be mistaken for salt. To the east and west, the sedge wetland transitions to seasonally flooded Buttonwood shrubland. To the north, the land rises and an almost pristine semi-deciduous dry forest cloaks a low ridge of savage dolostone karst terrain. Here are nesting parrots, bats roosting in caves, and rare trees thriving in a community that has been evolving together for millions of years.

North of the dry forest is the area of the Reserve that we believe once supported Blue Iguanas. Here the lower terrain supports the characteristic xerophytic shrubland of Grand Cayman's east end. This too is a highly diverse natural community that is in many ways quite distinct from the dry forest. For iguanas, it meets several critical needs. The shrubland canopy is low (often less than 10 ft) and open, allowing sun to reach the ground — vital for Rock Iguana thermoregulation. The karst offers a huge array of rock holes, providing potential retreats for iguanas of all sizes. The diverse vegetation provides a variety of food, sinkholes offer access to fresh groundwater, and here and there among the expanses of razor-sharp karst are soil basins where iguanas could nest.

We already knew that the Salina's xerophytic shrubland could support iguanas. In the early 1990s, we tested this point[1]. Three sterilized *C. lewisi* / *C. nubila caymanensis* were the "guinea pigs." We released and radio-tracked them for about six months, during which time they set up territories, found retreats, fed, and grew. While we were watching these temporary pioneers, a wild, true blue hatchling migrated in from who knows where, settled a while, then disappeared.

Since then the Blue Iguana Recovery Program has been focusing on establishing a small wild population of Blue Iguanas in the QE II Botanic Park. By 2004, that work had progressed so well that the Park was close to its carrying capacity for Blues and the time had come to embark on a larger-scale release in a new area. The Salina Reserve was the obvious choice.

The Release

Before we could monitor released iguanas in the Salina, we needed some sort of access. This was no trivial issue — the only 'trails' were the reserve's overgrown boundary cuts and the almost

[1] National Trust for the Cayman Islands, Annual Reports for 1993 and 1994. Grand Cayman, Cayman Islands.

JOHN BINNS

Dry shrubland of the Salina Reserve, Grand Cayman, with the Salina wetland in the background.

Agave caymanensis, an endemic succulent, is a characteristic species of Cayman's dry shrubland environment.

vanished remnants of our 1993–4 study site paths. Now, after careful examination of aerial photography, and an IRCF-sponsored helicopter survey flight, we had three main soil areas from which to choose, and no trails to two of those. This turned into a marathon trail-cutting exercise, with then-volunteer and now Blue Iguana Warden, Chris Carr, helping me through the summer of 2004. As we approached the target release date in September, student Nick Louis and the Durrell Wildlife Conservation Trust's Matt Goetz joined the team, and we finished a trail network to the northern and central soil zones.

At the same time we needed to build release retreats, wooden "iguana houses," which had recently proven themselves to be extremely successful in anchoring young iguanas to their release sites in the Botanic Park. Again with help from local volunteers, notably Chris Carr and Penny Clifford, 23 hefty release retreats were ready to be placed in the Salina Reserve. We planned to lift them there by helicopter.

Then Hurricane Ivan slammed the island, and suddenly all thought of work in the Salina had to give way to coping with crisis. That somber story has been told elsewhere, but from those difficult times the program has found its feet again and, thanks to truly amazing support from all quarters, we were able to resume the release plan in December.

The helicopter was 'Ivanized," so we had to backpack the retreats in, one by one. By the beginning of December, everything was ready and our first team of trackers was standing by. Late in the afternoon of 4 December, we carried the first 13 young iguanas into the north and central soil zones of the Salina Reserve and placed each one into its designated release retreat. These were the females, which we released first in order to allow them to set up territories before having to deal with males. Initially nervous at the sight of the dark tunnel, each iguana hesitated, half in hand, half in the retreat, then scrambled deep inside. The daylight was fading, and we knew from experience that they would all remain in the retreats overnight.

Each iguana was fitted with a PIT tag, a unique bead tag, and a tiny 2-gram radio transmitter glued to the back near the tail. Starting on 6 December, the tracking team began their routine, which continued almost without interruption until 17

Wooden iguana retreats stacked and ready to be backpacked into the Salina Reserve.

Two-year-old *Cyclura lewisi* being introduced to an artificial retreat.

January 2005. The males went out on 28 December, bringing the total release to 23.

Seven days a week, one tracker went to the north zone, another went to the south. Each one used radio-tracking gear and an array of other sleuthing techniques, to locate every iguana about once per hour. We recorded their positions by estimating distance and compass bearing from previously mapped fixed points or new GPS locations. By the time the tracking team went home, we had 6,399 separate observations of iguanas in specific places at specific times. We then took the radio

TEAM BLUE

The program's permanent staff was assisted throughout by a rotating team of volunteers and professional assignments, primarily from overseas. The International Reptile Conservation Foundation took the lead role in recruiting and coordinating this essential human resource. The project teams were as follows:

Blue Iguana Recovery Program staff:

Frederic Burton
Samantha Addinall
Chris Carr

Habitat survey, summer 2004:

John Binns - IRCF

Salina release team, December 2004–January 2005:

Andrew Grant
Craig Pelke, Milwaukee County Zoo
Desiree Wong, IRCF
Janice Blumenthal, Cayman Island Department of Environment
John Bothwell, Cayman Islands Department of Environment
John Kunna
Jude Bryja, Houston Zoo
Robby Addinall
Sarah Doty, IRCF
Tandora Grant, San Diego Zoo / CRES

Team Blue 2005, fieldwork April–July 2005:

Ae Nash, Colorado Reptile Humane Society
Amanda Stenman
Barbara Watkins
Brian Carson
Coralie Farren, Reading University, UK
Desiree Wong, IRCF
Emily Holfeldt
Erika Delgado
Gaby Besne
Janice Gerritts, National Zoo, Washington DC
Janie Coleman
JeffreyAckley
Joel Kuhns
Jude Bryja, Houston Zoo
Karin Nelson
Lorraine Scotson
Matthias Goetz, Durrell Wildlife Conservation Trust
Nick Louis
Paul Watler
Tandora Grant, San Diego Zoo / CRES

Ae Nash, Coralie Farren and Lorraine Scotson examine an iguana in the northern release zone.

JOHN BINNS

The Salina Reserve: Xerophytic shrubland and artificial retreat.

BLUE IGUANA SUPPORTERS HONOR ROLL

Three major grant sources made this challenging project possible. The Blue Iguana Recovery Program wishes to express appreciation for this financial support to:

Dennis Curry Charitable Trust,
via the Durrell Wildlife Conservation Trust
International Reptile Conservation Foundation
International Iguana Foundation

Financial and other support for staff assignments were provided by the Colorado Reptile Humane Society, Durrell Wildlife Conservation Trust, Houston Zoo, Milwaukee County Zoo, National Zoo, San Diego Zoo/CRES, and the Cayman Islands Government (Department of Environment).

Accommodation for the teams was donated by Roger and Mary Bumgarner and Frederic Burton. Transport assistance was provided by Nigel and Penny Clifford.

The Blue Iguana Recovery Program operates under the auspices of the National Trust for the Cayman Islands, with local and international partners. The Trust provided hospitality and other support throughout.

transmitters off, weighed and measured each iguana, and let them free to live their lives without observers.

In May, we caught them again and, after another weighing and measuring session, we glued on the radio transmitters once more and tracked the iguanas from 13 May to 25 June. Another 4,157 observations went into the huge database, another batch of boots was destroyed, and another team of scratched, bruised, and bitten volunteers headed triumphantly home. Now the iguanas are living free and unmolested, and the time has come to assess the huge mass of information we gathered and to draw some conclusions.

Survival and Growth

The most conspicuous observation resulting from our winter tracking data was that the released iguanas were very slow to move away from their retreats. The vast majority of observations recorded iguanas in, on, or very near the retreat into which they were released. After many weeks, some individuals moved into new retreats; by the end of the winter tracking, six had abandoned artificial retreats in favor of rock holes or tree holes.

The wild card was the male, bead-tagged Orange-Pale Blue-Pale Blue (OPP). From the day he was released, OPP was a loner and a wanderer. Over the winter tracking period, he gradually drifted north and eventually left the Salina Reserve altogether. I caught him in late January, and re-released him in the central zone, where he was sure to encounter other iguanas. By summer, he had moved off again, and we have not seen him since.

Jude Bryja (Houston Zoo) with radio tracking equipment.

JUDE BRYJA

A pair of released two-year-old *Cyclura lewisi* courting.

By summer, another male (Green-Red-Green, GRG) also had disappeared. We do not know if he migrated away or if he died. Apart from those two, however, all of the iguanas we released were seen at least once in the summer, so we know we have at least a 91% survival rate in the seven months after release.

The iguanas almost all lost weight in the two months after release, as they adjusted to life in the wild and faced the dry season. By May, the trend had reversed and the iguanas grew vigorously through the summer — so much so that they all shed their old skins — with radio transmitters attached! Fortunately,

by this stage they were so used to their trackers that we managed to recapture them to re-glue the transmitters.

The other big change from the winter was that the iguanas were now far more adventurous. Their "usage area" (a measure of their home range over the periods during which we tracked them) was about sixteen times as large in the summer compared to the two months after release. This was as true of females as it was for males, so this was not just the typical expansion in usage area we normally see in males during the breeding season.

Examining the patterns of land use by the iguanas, we found that they had discovered one resource we had not realized was so important. Scattered around the release areas in the rocky shrubland, the scrambler "Yellow-root" (*Morinda royoc*) sometimes grows into impressively large, tangled masses. These "Yellow-root bushes" are all visited regularly by the iguanas, indeed the little male WOW makes a journey every day from his retreat in the central zone to a Yellow-root bush some 70 yards away. He is commuting for food. The iguanas eat the Yellow-root leaves and also the fruits, which soften, turn translucent, and (to human noses) start to smell distinctly unpleasant as they ripen and fall. The dense tangle also is a safe place to hide, and it provides convenient shade in the heat of the day.

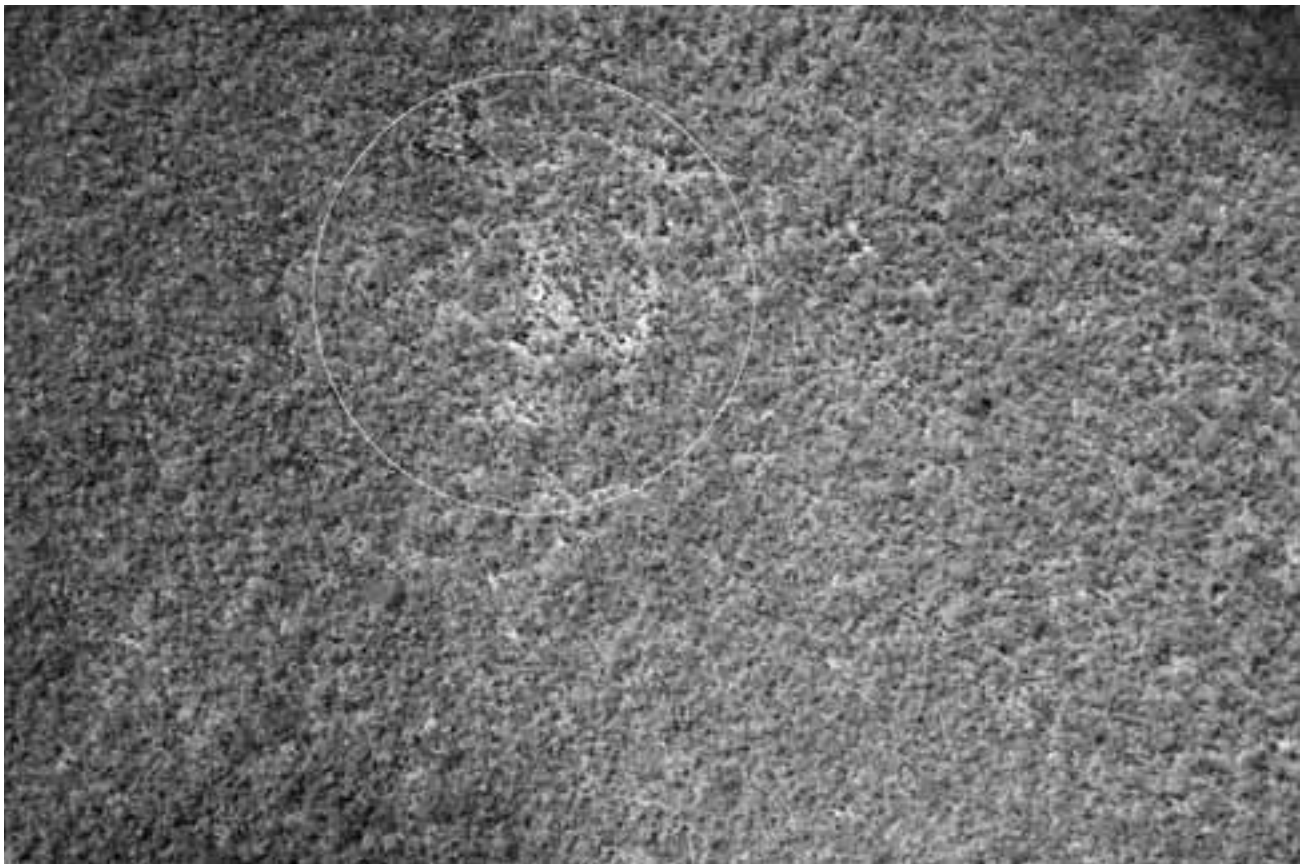
They survived, discovered and claimed their surroundings, and grew, but this year, despite all the courting we saw, the released Blues were not quite big enough to reproduce. Everything looks to be on course for these iguanas to nest for the first time in 2006.

Land Use

One key question underlying this study is one we have been asking for years: How much protected, managed iguana habitat is going to be needed to support at least 1,000 wild Blue Iguanas? This question will have to be answered in stages. We started getting hard facts about Blue Iguana population density with Rachel Goodman's research (Goodman et al. 2005) on the released population in the QE II Botanic Park. With this summer's tracking data, we have another piece to fit into the puzzle. The pattern that seems to be emerging is that the females establish and maintain small, stable home ranges, which do not seem to get much bigger as they age and grow. They seem to defend even smaller, exclusive territories, and overlap with their neighbors in the rest of their range. In contrast, the males occupy larger and larger home ranges as they grow. Because the sex ratio remains around 1:1, this means that mature male home ranges overlap much more than those of females.

The immature females in the Salina, the much older ones in the Park, and even one totally wild female we monitored in the eastern interior this year are all occupying average summer usage areas of about 0.6 acres. In the Salina, the centers of their core territories have settled down at an average closest-neighbor spacing of 112 ft.

Using these female core territories as a guide, we think we can roughly double the number of females in the Salina release areas that are already somewhat occupied. To maintain the even sex ratio, that means doubling the number of males as well. The



Aerial view of the Salina's northern release zone. The circle indicates the area of soil patches where the release took place.

iguanas seem to be telling us that, in this habitat, they can accept between four and five two-year-old iguanas per acre.

Implications for the Future

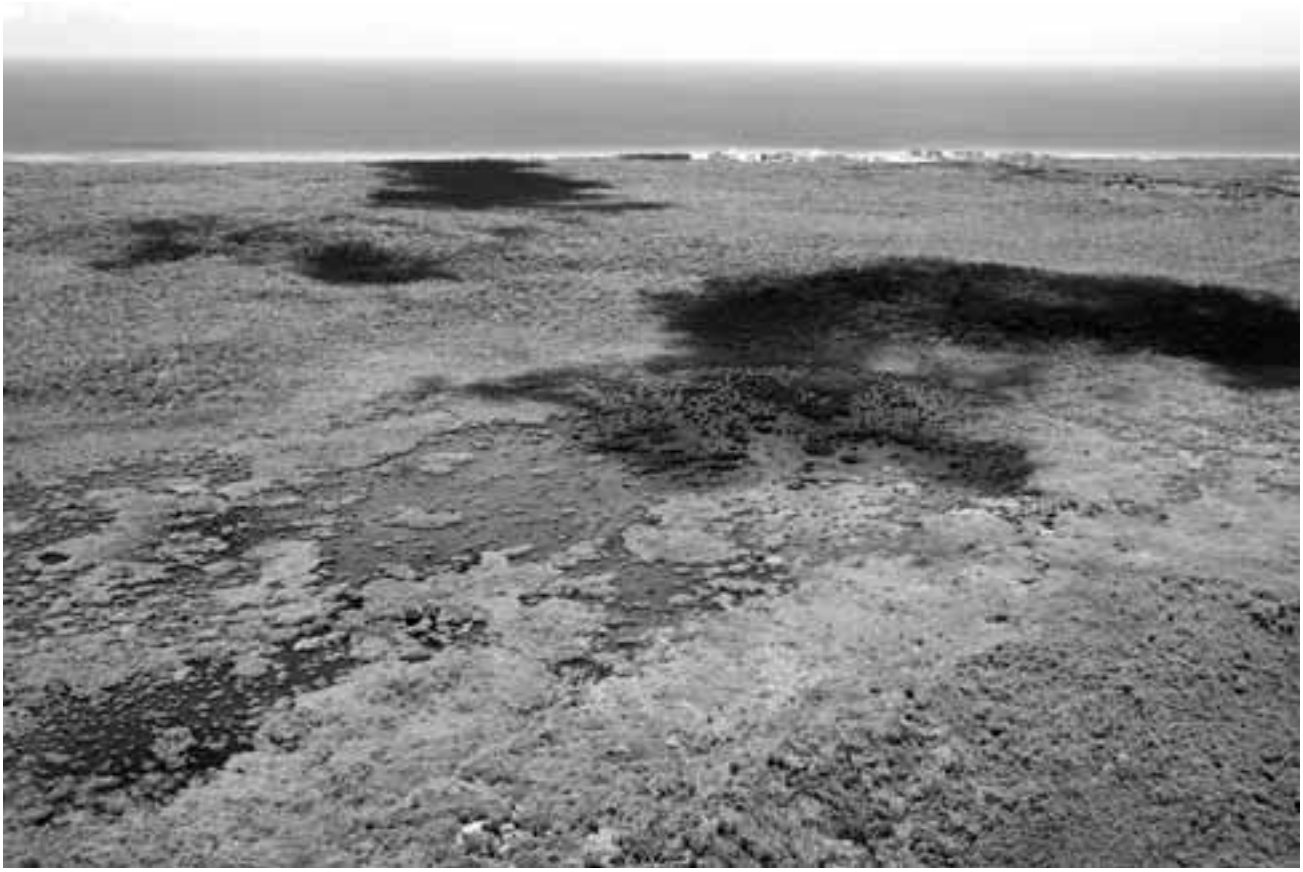
In December 2005, we plan to release between 60 and 70 two-year-old iguanas into the Salina Reserve. At that time, the first released group will be three years old and coming into sexual maturity. Our results from this year suggest we can squeeze these — but no more — into and immediately around the northern and central soil zones, where we have been working this year. That will bring the total population in this area to 80–90 individuals.

The following release, tentatively scheduled for December 2006, will have to involve a new area — probably the southernmost soil zones of the Salina Reserve, where we currently have no access. These areas are so far from the north coast road that we may need to set up a field camp where trackers can stay in the field for several days at a time. Establishing a trail network and preparing release sites will require months of work.

Overall, the limited soil zones and modest area of xerophytic shrubland in the Salina Reserve looks capable of establishing at least 200 Blue Iguanas in the wild. However, in the enthusiasm of initial success, we should not lose sight of potential problems that may yet surprise us.

One nagging question is to what extent these iguanas will seek access to the coast as they mature and grow. The coast immediately north of the Salina Reserve, across the Queen's Highway with its fast vehicular traffic, is a historic nesting site

A blanket of oxisol in the Salina's southern soil patches, a future release area.



View across the Salina Reserve toward buildings on the northern coast.

JOHN BINNS

One outstanding question faced by researchers is whether the iguanas released in the Salina will instinctively seek historic beach nesting habitat — on the far side of the busy coastal highway — especially as human population pressure increases.

Cactus, Thatch Palm, and Agave: shrubland plants adapted to the harsh dry climate of Grand Cayman's East End.

for Blue Iguanas. Unfortunately, this large sandy coastal area is now slated for a major hotel development. Before the highway was built, iguanas used to move freely between the sandy coast and the interior xerophytic shrubland.

The coast, especially before it was claimed by humans, probably provided much richer food resources for iguanas than the xerophytic shrubland. The Blue Iguana Recovery Program's staff deliberately focuses its attention on sandy coasts when collecting food for the captive-breeding and head-starting facility; large stands of *Scaevola plumieri*, mats of *Ipomoea pes-caprae* and *Canavalia rosea*, and a range of other fast-growing coastal strand species make iguana food collection more efficient in this environment than in any other. The sand may also be an easier and more reliably moist nesting substrate, especially when compared to the compacted and seasonally desiccated oxisols in the Salina soil basins.

The possibility exists that the female Blue Iguanas now living in the Salina Reserve may instinctively head for the coast when they are older, ready to nest, or when unseasonable drought strikes and food resources in the Salina Reserve become scarce. Any iguana that heads to the coast from the Salina Reserve faces the grave risk of being flattened by a 50-mph vehicle. Even if successful in crossing the highway, it then will find all the trappings of modern human civilization developing in place of Inkberries, Beach Morning-glory, and Sea Bean vines.

This and other potential concerns, not to mention the need to manage forthcoming releases, means we need to be keeping a very close eye on happenings in the Salina Reserve over the next few years. Any claims of success are premature at this time.

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Pharaoh: A Tribute

Joe Ehrenberger

Senior Keeper, Indianapolis Zoo

After seven years, "Pharaoh," a male Grand Cayman Blue Iguana (*Cyclura lewisi*), will be leaving the Deserts exhibit at the Indianapolis Zoo in 2005. Based on a recommendation for breeding by the coordinator for AZA's West Indian Rock Iguana Species Survival Plan, the Indianapolis Zoo has agreed that Pharaoh should be relocated to the Gladys Porter Zoo in Brownsville, Texas. During summer 2005, a very young breeding pair of Grand Cayman Blue Iguanas will be arriving at the Indianapolis Zoo. The pair is currently in quarantine at the San Diego Zoo, after being sent from Grand Cayman earlier this year. These iguanas represent "founder" animals for the U.S. zoological Blue Iguana breeding program. The earliest expected breeding of this pair would be in 2006.

When I first came to the Indianapolis Zoo as a volunteer in 2001, one of the first animals I met was "Pharaoh," a four-foot-long, bright electric blue monster of a lizard. Pharaoh is a Grand Cayman Blue Iguana (*Cyclura lewisi*), a very rare lizard in the wild, and especially rare in zoological collections. Pharaoh is a little more unpredictable than the other animals in the Deserts exhibit, as I and the rest of the volunteers quickly discovered. He has this way about him, this strut of sorts that demonstrates that he knows he is the king of his domain — perhaps this is the origin of his name. He is not afraid to offer small head-bobs of recognition as you enter the exhibit, building into more deliberate movements of territoriality as you slowly approach. Then he takes a step or two toward you with mouth agape before abruptly turning away at the last moment, moving back a few feet just to start it all over again. Today, I am a Senior Keeper, and he remains Zoo royalty, and he still considers me to be his lowly servant bringing his food and cleaning his kingdom.

In 1999, Pharaoh came to the Indianapolis Zoo from Grand Cayman and the Cayman Islands National Trust. He was sent to us as an animal ambassador of sorts, since Blue Iguanas are found solely on the island of Grand Cayman. The island has many species of plants and animals that are endemic (found nowhere else in the world), but the Blue Iguana is arguably the most special. Pharaoh represents the most critically endangered species of lizard in the world, with fewer than 50 left in the wild out of a population that once numbered in the thousands. To put this in perspective, although they are rare in zoo collections, hundreds of Chinese Giant Pandas are left in the wild, far outnumbering Blue Iguanas. Pharaoh is an ambassador from Grand Cayman making a last plea for help to save his kind.

At the beginning of 2005, there were only 21 blue iguanas spread among nine zoological institutions in the United States. With so few Blue Iguanas in the U.S., visitors rarely hear this species' cry for help. Pharaoh is what is called a "founder" animal; his genes are not represented anywhere else in the U.S. population. To educate and promote awareness of the Blue Iguana among the general public, we hope that individuals like Pharaoh will successfully breed and produce offspring. More offspring means more Blue Iguanas in more zoos. More "little Pharaohs" running around mean more genetic diversity for the entire captive Blue Iguana population.

Pharaoh strikes a majestic pose: He has been the undisputed "king" of the Indianapolis Zoo's Deserts exhibit for the past seven years.

At the Indianapolis Zoo Deserts exhibit, Pharaoh keeps up on all the latest fashions. He patiently waits near the front glass of the exhibit just to look at and hope to get a taste of the latest brightly colored shoes — shoes that resemble fruit, the candy of the iguana world. Likewise, he is easily noticed on exhibit. He impresses visitors daily with his size, swagger, and color. During a normal day in the Deserts exhibit, Pharaoh is the star of the show, but, in the afternoons, visitors get an even more exceptional display. Around 2:30 pm each day, our exhibit animals are offered insects or fruit in addition to the mixed salad they received earlier in the day. A grape speeding across the exhibit substrate brings on a demonstration of the excellent sight and swiftness of the Blue Iguana. As the sound of Pharaoh racing over the dirt and gravel echoes in the building, visitors pop up from around corners of other exhibits to catch a glimpse. Our visitors are surprised to see this monster excitedly eating his fruits and vegetables. Parents often comment with envy, "If only little Bobby would eat his fruits and veggies like that."

Although fruits and vegetables are his favorite treats, Pharaoh's ultimate desire is for birdseed. As keepers, we do not

Pharaoh is being transferred to the Gladys Porter Zoo in Brownsville, Texas in an effort to optimize his chances of reproductive success.

quite understand the origin of his obsession. Wild Blue Iguanas are primary vehicles for plant and tree seed dispersal. They eat the fruits, walk away, defecate, and the following year another plant or tree begins to climb out of the ground toward the sky. However, birdseed, not contained with a sweet or colorful fruit, is a bit different from the typical seeds iguanas help to disperse. The Indianapolis Zoo's other three Grand Cayman Blue Iguanas, three Jamaican Iguanas (*C. collei*), and two Rhinoceros Iguanas (*C. cornuta*) couldn't care less for birdseed. Only Pharaoh jumps at it and will do almost anything for it. Even Fred Burton, Director of the Blue Iguana Recovery Program (www.blueiguana.ky), who sent Pharaoh to us, cannot explain this peculiar behavior. Birdseed is the most precious loot this scaly Caribbean pirate could steal to bury in the depths of his stomach.

Pharaoh is not just an impressive exhibit animal at the Zoo. He came to us from Grand Cayman in an effort to get him to breed with females already in the U.S. However, his role producing offspring is not his only job. He is a novel research subject. Over the years, we have studied his behavior in an effort to identify specific reproductive cues and territorial characteristics. We have studied his blood and compared it to blood of other captive iguanas, as well as to that of wild iguanas. Most recently, we are studying hormone levels in his feces in an innovative approach to understanding his reproductive cycle. Throughout these research duties, Pharaoh rarely "complains" of his job at the Zoo. After all, he gets to harass and chase us while getting an occasional tail-whip in, and then gets paid in grapes and birdseed.

However, one of his primary duties in the country is to reproduce. Although seven years have passed, Pharaoh has no offspring. Overall, reproduction of Rock Iguanas (lizards in the genus *Cyclura*, Grand Cayman Blue Iguanas and their Caribbean relatives) is limited and inconsistent at all of the best zoos in the U.S. Cues from our vast knowledge of Green Iguanas (*Iguana iguana*) have provided little help. As researchers, we are just starting to identify behaviors of many Rock Iguanas in the wild, including reproductive behaviors. With this knowledge, Pharaoh's next best chance for reproduction could be with a female Blue Iguana at a zoo in Texas.

To encourage successful breeding for Pharaoh, the Indianapolis Zoo has decided to send this giant blue monster of a lizard to a zoo in Brownsville, Texas. Although his departure is difficult for us, we retain many fond memories of Pharaoh at the Indianapolis Zoo. While he isn't exactly cute or cuddly, like many of the warm-and-fuzzy zoo animals favored by many visitors, he is impressive with his fantastic other-worldly color and his large size. How many other animals are four feet long and bright blue? He is charismatic and attentive. With his extraordinary red eyes, he has seen almost every visitor who walked by his exhibit. He is a "magnet." He attracts all sorts of people, from visitors to keepers, and even the Zoo's own CEO became enamored with him within his first few weeks at the Zoo, often telling the story of the endangered Blue Iguanas to donors, the media, and anyone who would listen. All of us at the Indianapolis Zoo hope that Pharaoh will be a magnet to a Blue Iguana female and achieve reproductive success in his new Texas home.

HUSBANDRY

Captive Care of Monitors[1]

Part I: Introduction and Housing

Bernd Eidenmüller

Frankfurt, Germany

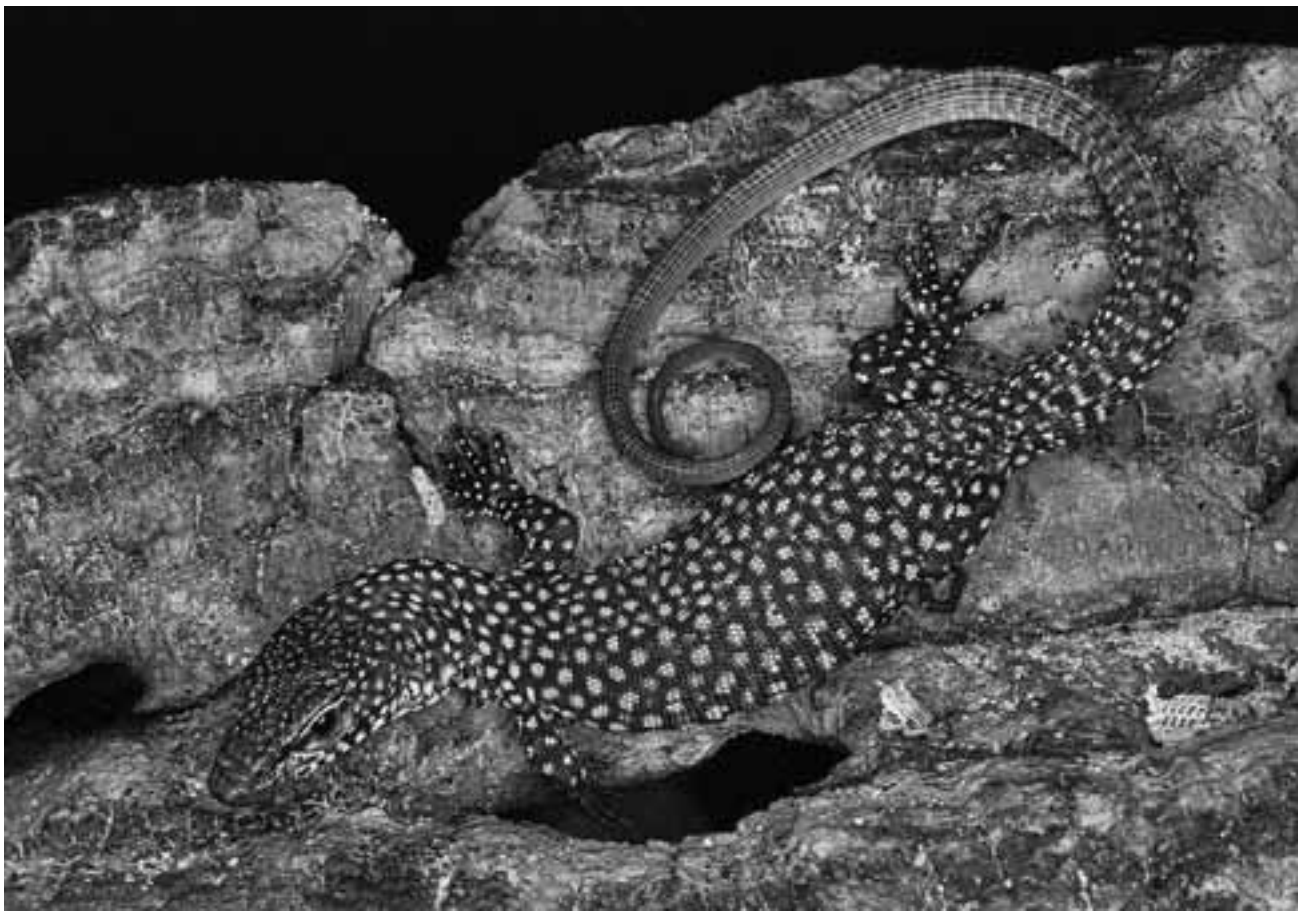
The family of monitors is monotypic, and all living members belong to the genus *Varanus*. The genus is subdivided into nine subgenera. Two distinct geographical radiations have been identified (Böhme 1988a, 1993). The Afro-Asian radiation includes the subgenera *Psammosaurus*, *Empagusia*, *Philippinosaurus*, and *Polydaedalus*. The Indo-Australian radiation includes the subgenera *Odatria*, *Varanus*, *Papusaurus*, *Euprepiosaurus*, and *Soterosaurus*.

Monitors are restricted in distribution to the Old World, where they inhabit the tropical and subtropical climatic zones of Africa, Asia Minor, South and Southeast Asia, Australia, and the Indo-Australian archipelago. Australia appears to be a significant hub for monitors worldwide, with 25 species and ten subspecies in three subgenera.

Monitors occupy almost all habitats: they live in sandy deserts, open savannas, and even tropical rain forests. Rivers and lakes are used as habitat refugia by some species. Monitors can be categorized by their preferred habitat. These include: water monitors, ground-, rock-, and tree-dwellers.

All monitors share certain characters. They all have a completely ossified skull, which makes it possible for them to swallow large food items without the risk of pressure on the brain. The throat can be enlarged by raising the hyoid cartilage appa-

[1] Adapted by AJ Gutman from B. Eidenmuller, *Monitors: Natural History — Captive Care — Breeding*. Herpeton Verlag, Offenbach, Germany.



Juvenile *Varanus kingorum*. This small species needs a rocky habitat equipped with many hiding places.

Juvenile *Varanus glauerti* basking in a terrarium.

ratus, helping them to swallow food. This inflation of the gular region increases the overall body size, and also acts to help intimidate enemies or impress rivals. All monitors have four limbs with five toes that are equipped with strong, backward-curving claws. The head is situated on a long neck, the eyes have round pupils, a distinct tympanum is clearly developed, and the tongue is very long and deeply forked. Using the tongue, monitors extract minute particles from the air or substrate and convert these into a traceable scent using chemoreceptors in Jacobson's organ, which consists of a pair of pits in the roof of the mouth into which the tips of the forked tongue are inserted. These cues can be used to detect food, rivals, or sexual partners.

The difference in size between the largest (Komodo Dragon, *V. komodoensis*, from the island of Komodo, length to 350 cm, weight 150 kg) and smallest (the Short-tailed Monitor, *V. brevicauda*, from Australia, length about 23 cm, weight about 20 g) living monitors spans almost four orders of magnitude (i.e., *V. komodoensis* is 7500 times heavier than *V. brevicauda*). This represents the largest size disparity between vertebrates within a single genus in the world.

Care

As some species of monitors can reach both substantial total length and body mass, potential keepers must carefully consider the amount of space needed to properly maintain these animals. Most enthusiasts are limited in the size of enclosures they are able to provide. Given such constraints, the monitors in the subgenera *Odatria* and *Euprepiosaurus* are the most appropriate, although nearly all species within these subgenera are from either Australia or the Indonesian islands. The export of monitors from Australia is strictly forbidden, and export from Indonesia is very restricted. Therefore, captive-bred animals must be sought. These animals are legal and offered regularly in fairly large numbers.

Which Species Suits Me?

Deciding which species to purchase should be guided by the amount of space you have available for an enclosure and the amount of money you are prepared to pay. If you purchase a relatively inexpensive monitor such as the Water Monitor (*V. salvator*) from a pet shop, you need to be aware that this animal, if properly fed, has the potential to grow to more than two meters in less than two years. It will very quickly outgrow that small enclosure in the living room. Furnishing the enclosure should be another consideration. Preferably, the enclosure should be set up to mimic the type of habitat and climate that your particular species of monitor would encounter in the wild.

In most monitor species, the sexes are almost impossible to differentiate. Although a degree of sexual dimorphism (variable size and color) exists in some species, this tends to be the exception rather than the rule. Many lizards and snakes are easily sexed by inserting a rounded probe into the hemipenial pockets at the base of the tail. The probe slides posteriorly into the pouch in the direction of the tail tip. The length of the inserted probe is used to determine sex, with males having a deeper probe depth than females. This method is not appropriate for sexing monitors, as females have a similar pouch at the base of the tail, which is the mirror of the hemipenial pocket of the male. This hemipenial structure in the female has been described as the hemiclitoris (Böhme 1995, Ziegler and Böhme 1996a). Similarly, the clusters of spines located at the base of the tail in some monitor species do not always indicate sex. In *V. tristis*, this feature is prominent in males but not females. In order to be 100% certain of sex in monitors, a reptile veterinarian must perform an endoscopic inspection of individual animals (Schildger and Wicker 1992, Schildger et al. 1993).

Captive-bred animals obtained from a private breeder are generally healthy and should present few maintenance problems. Wild-caught animals from reptile dealers are very often of inferior quality; these animals are likely to be highly stressed from capture and transport. Although the initial cost may be a little higher, captive-bred animals are likely to be much more cost-effective in the long term. The exception is for species new to the market, which may not as yet have been bred in sufficient numbers for their breeding biology to have become understood by specialist keepers who will eventually make them available as captive-bred progeny.

Opportunistic infections often appear in parallel with parasitic infestations, thus wild-caught animals should be observed for at least six weeks in a quarantine enclosure following acquisition, without exception. During this period, feces should be collected and examined by a reptile veterinarian for parasites. Medication should not be administered without direct instructions from a reptile veterinarian. Visible external injuries should also be referred to a veterinarian. Problems seldom appear with captive-bred animals, although some exceptions to this may

Juvenile *Varanus storri* are often aggressive towards cagemates and must be raised separately.

A tree dweller, such as this *Varanus timorensis*, benefits from plenty of vertical structure within a terrarium.

become apparent as more and more people keep monitors as pets. *Varanus storri*, for example, should be housed individually and paired only for the breeding season, as they tend to fight.

The wide geographic distribution of some monitors presents another problem. A visual inspection of a wild-caught animal will not necessarily reveal its point of origin. With considerable climatic divergence within the distribution ranges of some monitors, problems may occur in synchronizing mating with seasonal differences between locations. A *V. tristis* from Kingoonya in South Australia may mate at one time of the year and the same species from Daly Waters, some 2000 km north in the tropics, may mate at another time of year. Thus, even when two animals of the same species are paired, breeding success can remain elusive. With captive-bred animals, this does not appear to be a big problem, nor with animals that are long-term captives (i.e., three years or more).

To date, little attention has been paid to the territoriality of monitors. In captivity, one animal simply cannot be replaced with another. Monitors have an acute sense of smell and any new intruder in the cage is immediately recognized, a phenomenon I have observed in *V. storri*. When a new animal is introduced into a cage, it immediately begins to tongue-flick to investigate the entire enclosure. In several places within the cage, it will rub its cloaca, presumably to mark its territory, as well as to inform rivals and sexual partners living in the area/enclosure of its presence (Eidenmüller 1993).

The Enclosure

The goal of every responsible private keeper should be to strive for species-specific care for his or her captive monitors. Each species will have different needs in terms of climate (including temperature, lighting and humidity), housing, and diet.

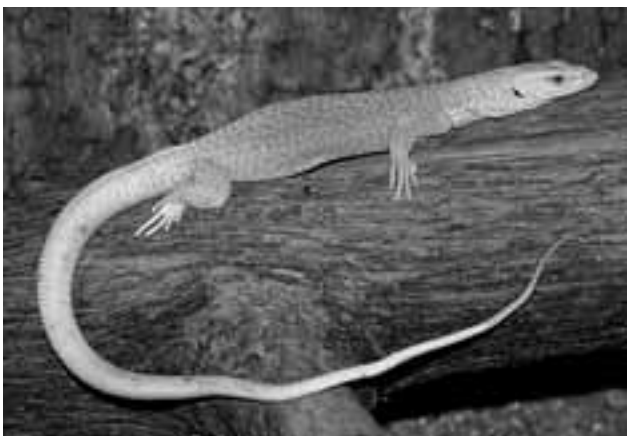
The captive habitat should be set up to simulate as closely as possible the natural environment of its inhabitant(s). Obviously, attempting to recreate natural elements such as flood and fire is neither simple nor desirable. However, this still leaves us with any number of parameters to manipulate in order to provide the greatest natural comfort and the highest probability of breeding success for our captive charges.

Monitors appear unable to distinguish between types of branches in the enclosure, be they cherry tree or some other tree branch. In my experience, the most important consideration is allowing the animal to feel secure when climbing and holding a branch. Illumination is perhaps the most important and one of the most overlooked elements of the captive setup. Since artificial lights cannot approach the degree of illumination provided by natural sunlight, in general, the highest degree of illumination that can be provided without overheating the enclosure is most appropriate. Diet also is of great importance and appropriate food items (mice, rats, chickens, insects) to approximate each species' natural diet should be provided.

Social conditions within any one enclosure must be closely monitored. Housing animals of unequal size together may result in one becoming prey for another. Parasitic infections in captive animals also require immediate intervention. Under natural conditions all monitors carry both endo- and ectoparasites and appear unaffected except in exceptional circumstances. In captivity, any number of factors can result in a parasitic imbalance, which can rapidly overwhelm an already stressed animal.

Let me again emphasize that the care of animals should approximate conditions in the wild as closely as practicable. The highest objective in captivity should be to maintain fit and healthy captives, capable of reproduction. Enclosure size and furnishings need to be adapted to the natural movement and behavior patterns of the animals you wish to keep.

Different species will have different spatial needs within an enclosure. Every keeper should offer the animals as much space as possible. Recommended enclosure size for tree dwelling animals is 5 x 2 x 4 (length x width x height) times greater than snout-vent length (SVL) or 4 x 2 x 5 times SVL. For ground dwelling animals, cages should be 5 x 2 x 2 times SVL. These guidelines will ensure that your monitor has sufficient room to move. For quarantine and hibernation enclosures, these meas-



An albino juvenile *Varanus kingorum* relaxes on a bare branch.

urements can be reduced by half. During quarantine, the enclosure should be cleaned frequently and a small space can be cleaned with relative ease. During hibernation at lower temperatures, the movements of the animals are restricted and a smaller enclosure is sufficient.

Water monitors have different cage requirements compared to terrestrial and rock-dwelling monitors. They require a fairly large water tank in which they can swim and dive. A small water dish is not sufficient. Animals from arid regions should be provided with dust-free sand as ground cover. Sand need not be sterilized before use. Cypress mulch is the perfect substrate for animals from the tropics. This substrate retains moisture over long periods, thus increasing humidity within the enclosure. Mulch should not be sterilized, as this will kill off natural microorganisms that serve to retard the growth of fungi.

Furnishings should be such that they are compatible with the general movements of the monitor being housed. Most monitors are good climbers, and both the side and rear walls of the enclosure should be formed so that they can be used for climbing. This will increase the amount of activity area available to the animals. Ground- and rock-dwelling animals from desert areas will make ready use of a terrarium that has a rear wall modeled with styrofoam and epoxy-resin. As the resin dries, the whole wall can be dusted with sand to give it a stone-like texture (Eidenmüller 1989, 1992a). For tree monitors, thick cork sheets can be affixed to the side and rear walls (Eidenmüller and Wicker 1992) to form climbing areas. Cage structure can be enhanced further by using tree branches in the enclosure. Smooth branches should be avoided, as they are difficult for the animals to grip. The overall layout of the terrarium is basically one of personal preference. My own water monitor terraria are built on top of an aquarium. Atop the aquarium, I used Styrofoam and epoxy resin to construct a ground area onto which the animals climb from the water. This type of layout offers the monitors both water for swimming, and a large overhanging ground area. The styrofoam rock area also serves as a basking area suitable for thermoregulation (Eidenmüller 1990, 1995, Eidenmüller and Wicker 1995).

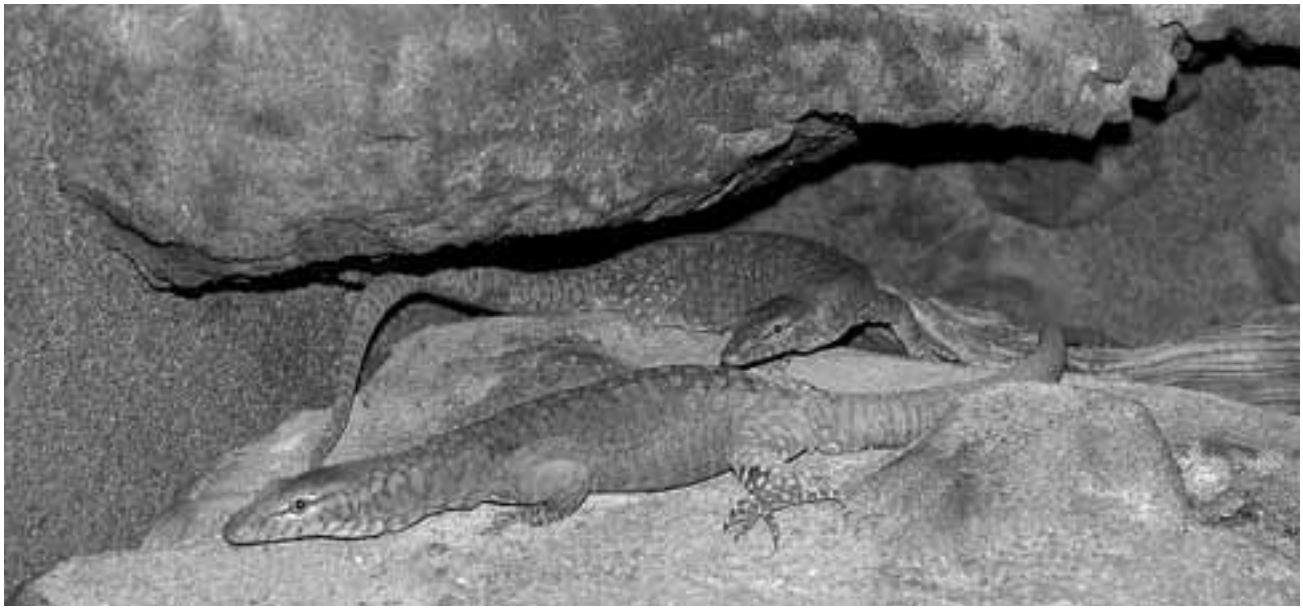
Varanus mertensi is a highly aquatic species from Northern Australia and even a juvenile requires a fairly large swimming area. Appropriate housing can be constructed above an aquarium.

JOHN BINNS

Although animals such as this Black-throated Monitor (*Varanus albigularis* ssp.) can become quite tame, potential owners must consider the amount of space required by a pet that can attain a length of up to 200 cm.

Since live plants rarely survive in monitor enclosures, I do not recommend their use. Ground-dwelling monitors will inevitably dig, and during these excavations plants become uprooted and die. Even the hardiest plants can only survive this activity for a short period. Living plants in an enclosure for rainforest inhabitants (e.g., *V. prasinus*) appear very natural; however, even trees like the robust Fig Tree (*Ficus benjamina*) die in a very short time when continually subjected to monitor claws. Plastic plants do very well in some of my enclosures. They appear fairly natural and are easy to clean. Animals do not seem to care whether the cover is natural or not. When using artificial plants, however, be careful that monitors do not ingest any broken parts of these plants along with their food.

Proper lighting is critical for the well-being of monitors in captivity; nevertheless, I find that many keepers fail to provide sufficient illumination in their enclosures. No amount of artificial light will replace natural lighting conditions. Whereas low-intensity bulbs and common fluorescent tubes may be more efficient in terms of initial cost and long-term energy expenditure, and may even provide lighting that appears sufficient to the human eye, they represent a false economy and will inevitably result in health problems for captive monitors in very short order. In my experience, the use of mercury vapor lamps has a positive influence on the behavior of animals. Mercury vapor lamps radiate ultraviolet (UV) light, which is critically important in a monitor enclosure. Ultraviolet lighting must be installed in such a manner that animals have direct access to it without any intervening glass barriers that can block the UV rays. The temperature range produced within the enclosure should be carefully measured to avoid the problem of overheating. To this end, proper ventilation of the enclosure is essential.



Varanus pilbarensis is a small, attractive rock dwelling monitor from Western Australia.

Also, ensure that no animal can come in direct physical contact with any of the heating lamps. Burns from lights are all too common, and can potentially result in fatalities.

All monitors are diurnal, and should be provided with a daytime photoperiod of appropriate length and intensity. The animals must also be able to regulate their body temperatures. A basking area under a spotlight should be provided as well as cooler areas more distant from a direct heat source. Many keepers think that desert animals require high to very high temperatures. In actuality, animals in the wild can move from areas with high solar radiation to areas that offer protection from extreme temperatures. This movement in and out of high temperatures is known as "shuttling" behavior and is common to many reptiles.

Conditions that support this type of behavior are difficult to reproduce within an enclosure. Keepers rarely have a terrarium deep enough to offer their captive monitors the opportunity to dig into 50 cm of sand or other substrate. I would recommend keepers use a heating source that has been installed to heat only one half of the enclosure. In many of my own enclosures, I have a 60-watt spotlight with a wide angle of light directed onto a flat rock some 40 cm away. This provides a good thermal gradient within the cage, but allows the monitor to attain an optimum body temperature without risk of overheating. I would not recommend the use of a ceramic heater, because it does not give off light; the animals do not realize that the amount of heat generated is substantial and can cause severe burns or even death. Larger monitors will sometimes incur localized burns under a spotlight because the part of the body directly under the lamp heats up to burning point while the temperature over the rest of the body is insufficient to warn it of the danger presented by the spotlight.

In Sri Lanka, Water Monitors (*V. salvator*) occasionally suffer dorsal burns due to their propensity for hiding in rubbish heaps. When the rubbish is burned, the animals are caught with a low body temperature while the flames create a high single-point temperature.

An under-tank heating pad can be installed beneath the preferred hot spot. If a heating cable is used, it can be coiled around one half of the enclosure to create a temperature gradient. Because most monitors are accomplished at digging, the cable must be secured so that the animals cannot dig it out or sustain electric shocks. The best method is to install the cable under the half of the terrarium that is to be heated.

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Bob Powell examining an anole with a student in his lab at Avila University.

PROFILE

Successfully Wearing Two Hats: A Profile of Robert Powell

Robert W. Henderson

Milwaukee Public Museum
Milwaukee, Wisconsin 53233

Over the past 30+ years, I have had the good fortune of three prolonged and prolific collaborations. The first was with Dr. Henry Fitch. It began in the early 1970s, continued into the late 1980s, and was briefly resurrected in the pages of this journal in 2003. I began my collaboration with Dr. Albert Schwartz in 1982, and it continued until his untimely death in 1992. The third collaboration, with Dr. Bob Powell, began in 1992 and, 14 years and 45 publications later, we're still at it. Over the course of this professional relationship, I have come to consider Bob a good friend and someone whom I admire tremendously.

Born in Germany, but raised in Missouri (and eventually earning his Ph.D. at the University of Missouri), Bob has had an amazingly productive career as an educator and researcher. He is Professor of Biology at Avila University in Kansas City, Missouri. As a small, private school, the emphasis is on teaching and not research. Despite a full teaching load, Bob has nevertheless found time to write books, edit journals, and produce hundreds of research papers, often co-authored with undergraduate students.

Employed as he is with a heavy teaching load and many contact hours with students, it would have been easy for Bob to relegate research to "hobby" status; i.e., publish an occasional note here and there, based on some fortuitous observation made on a class field trip. His passion for, and dedication to, herpetology has prevented that from happening — and how has Bob accomplished this? By involving undergrads with a serious interest in biology in general, and perhaps amphibians and reptiles in particular. In 1991, Bob applied successfully to the

JOHN S. PARMERLEE, JR.

Photograph taken during the late 1970s before an attempt by Bob, friends, and students to excavate an underground passage in an Ozark Cave. The "after" picture (apparently lost) showed less humanity and considerably more mud. Bob is on the left and John Parmerlee is second from the right (according to John, their positions in the photo correspond rather accurately to their political leanings).

PHOTO CREDIT: UNKNOWN

Meeting the local herpetofauna (*Geochelone* sp.) on a trip to Belém, Brazil in the late 1980s.

JOHN S. PARMERLEE, JR.

Bob in a "supervisory" posture with students on Grenada in 2002.

ROBERT W. HENDERSON

Bob with a Puerto Rican Racer (*Alsophis portoricensis*) on Guana Island in the British Virgin Islands in 2003.

JOHN S. PARMERLEE, JR.

Carrying dishes to the creek during the 1970s on an early trip with students to Mexico; Bob uses this photo to imply that "everyone" has to help in the field, even with tasks that are less than fun.

National Science Foundation for a Research Experience for Undergraduates (REU) grant. He and John Parmerlee then recruited undergraduate students from throughout the U.S. to participate in a 10-week summer program that would introduce them to conducting original field research with reptiles and amphibians in an "exotic" locale. Since the initial REU year, Bob has led seven REU trips to the Dominican Republic, Anguilla, Grenada, and St. Eustatius, and helped with another, organized by Alicia Mathis and Bob Wilkinson at Southwest Missouri State University (now Missouri State University), to Mexico. Another trip, this one to St. Vincent, is slated for 2006.

Prior to going in the field, the students gather at Avila, where Bob and John make sure that they familiarize themselves with the literature dealing with the frogs and reptiles they will encounter (and with which they will ultimately attain a high level of intimacy). They also learn something about the country they are going to visit, including local customs, health issues, conservation concerns, etc. Possible research projects are discussed, including methods that may be employed, equipment required, germane statistical procedures, and so on. When they get to the study locale, they hit the ground running. They have three weeks to find a study site, finalize methods, and collect data. Each student works on more than one project, making for three weeks of intensive biology. As an instructor on three REU trips, I know that it's not unusual to be going from before sunup to well into the night. After the fieldwork, the students return to Avila to analyze the data and write their research papers. This is accomplished under the guidance of Bob and John. They work with students on their statistical analyses and technical writing, wanting each student to ultimately have one or more publications as a result of the REU experience. Having those publications will look good when they apply to graduate schools, and Bob is adamant about students completing projects they've started (even if completion occurs a year or two after their REU experience). Powell knows this is in the students' best interest, and it reflects his three-pronged teaching philosophy: 1) provide students with the opportunity to acquire, practice, and receive reinforcement of fundamental knowledge and skills; 2) encourage students to think, question, analyze, and test; 3) design courses that provide students with both realistic challenges and opportunities for success. I have observed Bob apply this philosophy over and over with REU students, and I'm sure he employs it in the classrooms at Avila as well. He makes sure he knows what each REU student is doing every day and monitors the progress of each project.

Over the course of about 50 trips to the West Indies, Bob has, either in collaboration with professional colleagues or with REU students, studied various aspects of the ecology and behavior of a broad taxonomic array of frogs and reptiles. He produced a herpetological guide to Navassa Island, examined niche partitioning in several species of anoles, geckos, ameivas, and curlytails, and has made observations on several iguanids (*Cyclura*, *Ctenosaura*, and *Iguana*).

When it comes to fieldwork, Bob is tireless and, considering how out of shape he is, that's pretty remarkable. He will sprint after lizards and snakes, huffing and puffing but almost always successful in his pursuit of some very surprised critters. He will rise early in the morning and scout for similarly early-rising lizards, and he will work late into the night, collecting data on *Anolis* sleep-sites or gecko activity. Powell's research focuses heavily on lizards, and he is particularly (unnaturally?) fond of anoles and iguanas. He has cited more than once a comment I made initially in a letter of recommendation supporting an application for a sabbatical at Avila. In effect, I noted that we complement each other very nicely because he studies lizards and I concentrate on the snakes that eat them. Over the years, I have learned a great deal about lizards from Bob, and I think he

JOHN S. PARMERLEE, JR.

Bob climbing the "Castillo" at Chichen Itzá on the Yucatán Peninsula in 1980.

SARAH WISSMANN

Bob on a WinAir flight to St. Eustatius in 2004.

JAMES D. FORESTER

Exploring the extent of a recent clear-cut in a high-elevation cloudforest in the Dominican Republic in 1993.

knows a little bit more about snakes than he did before we started to collaborate — and, at times, I believe that a little knowledge can be dangerous; on a couple of recent trips, he caught more snakes than I did, something he never lets me forget.

In addition to fieldwork, Powell has volunteered his time to editing several herpetological publications. Between 1991 and 2004, Bob was editor of the *Catalogue of American Amphibians and Reptiles*, published by the Society for the Study of Amphibians and Reptiles. This often tedious and time-consuming responsibility produced detailed, loose-leaf accounts of at least 20 species every year. While still editing the *Catalogue*, Bob assumed the duties of editing this journal (*IGUANA*). Besides the editing, Bob solicited articles from a wide spectrum of potential contributors (zoo personnel, museum curators, his REU students, of course, and even his son), sought interesting illustrations, and wrote many articles himself. He has made a substantial contribution toward the transformation of *IGUANA* from a thin newsletter into a robust, attractive, and informative journal. The scope of the journal has expanded recently, but it has never lost sight of its original purpose of bridging gaps between hobbyists and "professionals" by emphasizing common interests in conservation, natural history, and husbandry. He also has co-authored two books and co-edited two others concerned with West Indian herpetology and, straying from the Antilles, he co-authored a book with identification keys to the amphibians and reptiles of the United States.

In short, I find much to admire about Bob, and to single out one attribute is perhaps doing him a disservice. Nevertheless, I shall. I never cease to be impressed by Bob's dedication to his students and to teaching. Although I only see him as a teacher in the context of the REU program, he never stops doing what he believes is in the best interest of the students. He gets down and dirty in the field, makes himself available at all hours, and will drive across an island at any hour of the day or night in order to get that last bit of data that might make all the difference in the quality of a student's project. He does his homework regarding various statistical procedures necessary to adequately analyze the data collected in the field. He does not hesitate to contact colleagues that he feels can contribute to the analysis or that might be a good collaborator or mentor for a student with an especially strong interest in a particular topic. I have difficulty imagining someone more dedicated to his students and to his research discipline. A less focused person would quickly choose to do one or the other well (that is, to wear one hat). Bob Powell has devoted himself to both and has demonstrated excellence as a concerned educator and a dedicated scientist.

Acknowledgments

I thank Bob's long-time friend John S. Parmerlee, Jr., for photos, information, and suggestions.

JOHN S. PARMERLEE, JR.

Helping measure and mark a sampling site on St. Eustatius in 2004.

TRAVELOGUE

Northern Perú: Ocean to Mountains to Amazonian Rainforest

Aaron Z. Savit

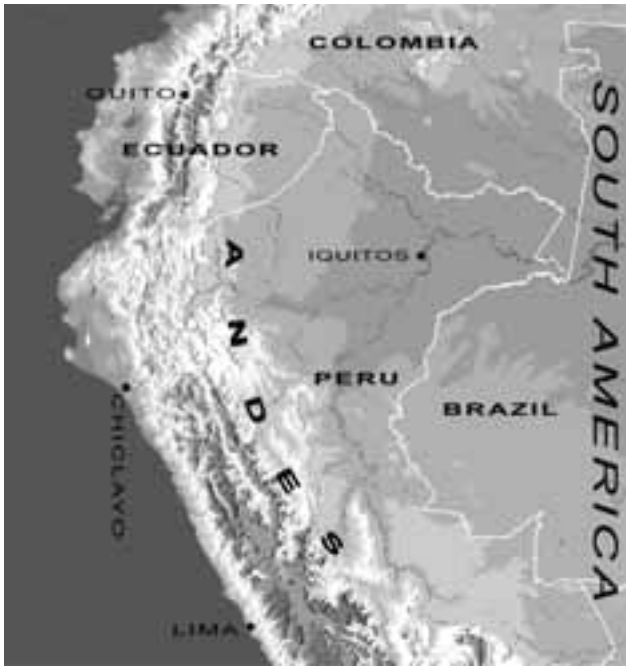
Biology Department, Earlham College, Richmond, Indiana

Photographs by the author.

The Andes Mountains along the western edge of South America run more or less due north–south, encompassing an amazingly large chunk of the latitudinal spectrum. They straddle the equator in Ecuador, and run north toward Venezuela and south to southern Chile and Argentina.

Naturally, such a wide geographic span gives rise to a varied and fascinating array of natural and anthropological histories, from the lush cloudforests and high altitude grasslands of northern South America to the towering conifer stands of Patagonia. On the northern half of the continent, the Amazon Basin dominates the topography east of the Andes.

The northern part of Perú offers a fascinating cross-section of this extraordinary diversity. As opposed to southern Perú, which has a well-developed tourist infrastructure centered around Machu Pichu in Cuzco, the northern half of the country gets only a small number of visitors and organized bus tours are all but unknown. Nevertheless, knowledgeable local guides are readily available for most of the major sites of interest.



JOHN BINNS

Northern Perú is geographically diverse and is both a biological and archaeological hotspot.

Tortoises (*Geochelone denticulata*) are commonly seen in Amazonian markets for use in soup.

I arrived in Perú from Ecuador, entering the country through Piura, a relatively large city near the coast with little to recommend. I continued almost immediately on to Chiclayo, another coastal city that is a major agricultural center. The city is very nice for several blocks surrounding the *plaza*, then quickly degenerates into the usual urban sprawl. However, a very large market offers for sale all varieties of produce, meat, and seafood, in addition to any other staple article of clothing, electronics, or toiletries. Other booths offer indispensable services ranging from haircuts to cobbling. Although I found the atmosphere a bit too hectic to even consider weekly shopping trips for groceries, I sure enjoyed taking a day or two strolling around the myriad stalls and gorging on cheap, fresh fruit, many varieties of which I'd never previously encountered.

From Chiclayo, I headed east into the Andes, stopping in the pleasant mountain town of Chachapoyas. Chachapoyas is the capital of the Department of Amazonas and is surrounded by many interesting archaeological sites representing several different cultures. The most prominent is the Lambayeque culture, named for the modern city in the south of Amazonas.

The bus I took from Chiclayo to Chachapoyas was old and cramped, even by Peruvian standards. I arrived at four or five o'clock in the morning and wandered with my pack to the central plaza to wait for the sun to rise. As the cloudless sky shifted

A llama takes a break from grazing in the pre-Inca fortress of Kuelap.

Cryptic symbols carved into the wall of a house in Pueblo de los Muertos.

slowly from black to blue and the cocks started to raucously advertise their presence, the city slowly came to life. The plaza started to see foot traffic; elderly couples or professionals dressed for work would take several minutes to stroll around the plaza chatting amongst themselves or just taking in the town center as it slowly began to awake.

That same morning, I caught a ride from Chachapoyas down through a winding maze of river valleys surrounded by steep, daunting ridges and peaks, finally arriving at the small village of Tingo. Tingo sits next to a river in a valley flanked by steep, rugged ridges. Most travelers stay there just long enough to get a ride to or from Chachapoyas, and perhaps for a meal in one of the very basic restaurants. The main reason for coming to Tingo is the trailhead that leads up the ridge to the impressive pre-Inca site of Kuelap.

Kuelap is a heavily fortified city perched atop a ridge overlooking the Utcubamba River valley. Although the hike from Tingo is only about 9 km, you gain about 1300 m in altitude from your starting point near the river. I arrived just as darkness was falling, and pitched my tent right next to the fortified ruins, overlooking the river valley and surrounding mountains. The ruins themselves are elliptical in shape, with one long side looking down into the river valley, and the other overlooking a large stretch of relatively flat and arguably arable land that now supports a small community of subsistence farmers. It is surrounded by a massive wall of cut stone that is up to forty feet tall in some places and pierced by three highly defensible entrances.

Walking into the ruins is surreal. The massive fortifications retain soil and rainwater, producing conditions that allow large trees, hardly ever seen on the very arid mountainsides of the area, to grown out of the ruined dwellings. Growing in large numbers on these trees are several species of orchid — and hundreds of one *Cyrtochilium* species were in full bloom during my visit. Excavations at the site are ongoing, and much of it has already been exposed. The bases and sides of the circular houses that are the trademark of this culture have been exposed, and decorative geometric stonework patterns are visible on several of them, and one has been completely restored. At one point, a small herd of llamas found their way in through one of the entrances and set about gently grazing on the low-growing vegetation. As I sat on top of an inner, secondary wall, and looked out on the llamas grazing in the ruins and the farmed land beyond, I was overwhelmed by the timelessness and tranquility of the area, the poor campesinos working to scratch a livelihood out of the rocky soil in the shadow of this monumental ruined city.

Before leaving the area, I visited another, less well-known archaeological site called 'Pueblo de Los Muertos' or City of The Dead. This is a row of about six houses that were built on a narrow rock outcrop about halfway up a vertical cliff face. Only one route allows access, and the space between the houses and the cliff edge was sometimes less than two feet. The surrounding cliff faces are dotted with the mud sarcophagi with stylized human faces that are typical of the area. The area is dotted with piles of ancient human bones, and symbols beyond my ken were engraved in the sides of some of the houses and painted in red pigments on the sides of the cliff. This site was not impressive in a monumental way, as was Kuelap, but it was powerful on a more esoteric and very human level.

A nocturnal Boat-billed Heron (*Cochlearius cochlearius*) in Picaya-Samiria National Park.

Waters were just beginning to recede from seasonally inundated forests.

The bus ride from Chachapoyas down the eastern flank of the Andes and into the Amazon basin offers amazing scenery, with a wide variety of vegetation and habitat types, from rugged, arid mountains to lush exuberant cloud forest. While crossing the last foothills of the Andes, you can see the wide Amazonian plain stretching out endlessly to the horizon. No real forest is left in the area; most has been converted to pasture. Much of some secondary growth is in the process of being cut and burned a second time.

The road runs due east into the Amazon, finally ending in Yurimaguas, a bustling river town on the banks of the Río Marañon. This city is an important port for riverboats taking cargo and passengers downriver to the large jungle city of Iquitos and to various smaller settlements in between. These boats pass by several small settlements on the outskirts of Picaya-Samiria National Park, the largest protected area in Perú. Because it is well off of the southern tourist circuit, it gets only a small fraction of the tourists of the Manu Reserve in the south. Nonetheless, some of the larger towns are used to seeing the occasional tourist, although one shouldn't expect luxury or an English-speaking guide. This area, however, is probably the best place to arrange a tour into the rainforest — if you cannot pay the often outrageous prices charged by tour operators in the south of Perú.

I disembarked at Lagunas, a town of about 5000 residents that is the most popular place to arrange a jungle tour into Picaya-Samiria National Park. Even before we got off the boat, several folks were visibly anxious to arrange a tour for us. We spoke with both of them, asked many questions, and ultimately went with a well-established tour operator who seemed fairly professional.

A large nocturnal treefrog (*Osteocephalus taurinus*) in Picaya-Samiria National Park.

Our guides with the evening catch; the catfish sustained our entire group for days.

After registering with the local police and the park rangers, we loaded our large dugout canoe with our gear and set out downriver. Most of our equipment was fairly traditional; our canoe was made from a single piece of wood in the same way they have been made for centuries, our guides used heavy, spade-shaped paddles made from a very dense wood, and our fishing equipment included a net and a three-pronged spear for fishing shallow water.

Picaya-Samiria contains a lot of seasonally flooded forest and, at the time, the rivers were still receding. For the first couple days of paddling, we saw almost no dry land. Our camping sites were no more than small islands in what was otherwise an endless expanse of flooded plain. The vegetation shifted notably as we passed downstream into the uninnundated forest. The flooded parts of the forest were dominated by several species of palm. The tufts of fronds perched atop the 30+ meter trunks gave the forest a sort of Dr. Seussian feel, and gregarious groups of brilliantly-colored Blue and Yellow Macaws (*Ara ararauna*) called raucously as they foraged in the trees or flew over the forest. During our first night, we camped on a small patch of dry land, with only mosquito nets between us and the moonlit jungle. Surrounded by the surreal sounds of the night, I listened to the haunting melodies of Howler Monkeys (*Alouatta* sp.) and a chorus of frogs and insects until they eventually lulled me to sleep.

I awoke the next morning to see our guides paddling back to camp. They had pulled in the fishing net that they left out during the night, and had met with some success. They had managed to catch a meter-long catfish of a type that usually swims too low for the nets to snag. The meat was a darker red even than tuna, and that fish kept me, two other tourists, and our two guides satiated for several days.

Monkeys, such as this Spix's Night Monkey (*Aotus vociferans*) are sometimes kept as pets in the Amazonian lowlands.

The Black Caiman (*Melanosuchus niger*) that we encountered were small; larger animals have been hunted extensively and are rarely seen.

As we passed downstream, the palms were replaced gradually by the towering hardwoods that come to mind when we think of the Amazonian rainforest. Monkeys were abundant and easily approached with our noiseless, motorless canoe. By night, we would scan the waters for caiman. Most of those we saw were quite small, as all of the larger individuals had been hunted for their meat. We also spotted some incredible tree frogs I was unable to identify and got quite close to a nocturnal Boat-billed Heron (*Cochlearius cochlearius*).

About midway through the third day, our guide pulled the boat onto a river bank still flooded under several feet of water and pointed to a large brown lump about 4 m up the trunk. It looked

The expression of an irritated Three-toed Sloth (*Bradypus variegatus*) bears a striking resemblance to every other expression of which the sloth is capable.

not unlike many of the other large, brownish lumps protruding from the tree and the various vines choking the trunk, but he told us it was a sloth. He hopped out of the boat and into the knee-deep water and started to clamber his way up the trunk of the tree. He proceeded to poke and prod the sloth until it worked its way far enough down the tree for an excellent photo opportunity. He also gave an interesting lecture on the behavioral psychology of the Three-toed Sloth (*Bradypus variegatus*): "If you tap it on the head," our guide Raul said, "it will go down."

I was excited when we finally reached an area of permanently dry forest. This is where you find the towering, 50-m hardwoods and, of course, all of the interesting land animals that you are likely not to see in a visit to the Amazonian rainforest. We hiked for several hours. Having size-15 feet, I was equipped with the largest rubber galoshes the guides had, but still three sizes too small. I consequently made obscenely flatulent noises with each step, sockless and awkward in my rubber galoshes.

The walk was interesting from a herpetological perspective as we encountered myriad frogs and toads. Many small, brown frogs were elegantly camouflaged to look like dead leaves, and only appeared as they hopped out of the way. We found a medium-sized toad with two crests protruding from behind its eyes. I spotted several brilliantly-colored teiid lizards (*Kentropyx* sp.) basking and foraging in the small patches of sun that occasionally reach the forest floor. We came across several snakes, including a black colubrid with yellow mottling that, according to our guide, produces a mild venom. We originally saw it on the ground, but it quickly shot about 3 m up into a tangle of vines when we approached too closely.

Botanically, the walk was very interesting as well. Raul showed us plants with traditional culinary and medicinal uses, including a small palm nut with a pill-shaped hollow containing a white coconut-like flesh. After these nuts fall to the ground, a large grub develops inside the nut, eating away the white flesh. It tastes pretty good — as long as you get to it before the grub does.

At one point, we came across a massive leafcutter-ant mound. This mound was about 2.5 m in diameter, over a meter tall, and the center of converging trails composed of thousands of ants scrambling to get leaf sections or carrying huge chunks of leaf back to the nest. Also clearly visible were large warrior ants with extremely big heads and powerful jaws, and even the tiny 'rider' ants that hitch a ride on sections of leaf and are carried back to the mound. The function of this odd caste of rider ants is unknown.

During our paddle back upstream toward Lagunas and relative civilization, our guides pulled the boat to the side of the river and urged us to be quiet. We first saw a flash of pink and then a large splash, then, after a wait, another. We were lucky enough to be seeing Botos (Pink Amazon River Dolphins, *Inia geoffrensis*) splashing and playing in the river. Due to the murk-

According to our guides, this colubrid snake (*Chironius fuscus*) has only a mild venom.

Stylized mud-brick reliefs in the Tschudi Complex at Chan Chan.

Mud-brick reliefs of birds in the Tschudi Complex at Chan Chan.

iness of the water, you only learn of a dolphin's presence as it jumps playfully out of the water. After watching for a while, we realized that not only were we seeing Pink River Dolphins, but also at least one member of the other Amazonian freshwater dolphin species, the Gray River Dolphin (*Sotalia fluviatlis*). We sat and watched in rapt amazement until ten minutes went by with no dolphin surfacing, at which point we shook ourselves out of our daze and continued paddling upstream.

Paddling back to the village was like slowly coming out of a daydream. The vegetation gradually shifted back to its disturbed state surrounding the village. The massive hardwoods became shorter and shorter, and the choking vines began to be replaced by the Seussian palms. With the palms came the groups of screeching macaws that flew by to bid us farewell. As we slowly shifted from one set of surreal surroundings to another, I had already begun to think back on all that I had seen and to plot my eventual return to this humbling forest. Before I knew it, we had traded the dugout for our own two legs, and were walking past burning fields of dry ferns and grasses, with most of the trees relegated almost to the horizon.

Back in Lagunas, my plan had been to catch one of the daily cargo boats heading down the river toward Iquitos. Once we got back, however, we quickly learned that this was no longer an option. Just a day or two before, the Peruvian government had started allowing rice imports from southeast Asia, which sent the cost of rice plummeting from about $300 per 1000 kg of rice to about $120. This prompted all the rice farmers nationwide to strike, setting up roadblocks on all the major roads and essentially bringing all ground transport to a halt. No transport meant no cargo and no cargo meant no boats heading downriver. I eventually ended up catching a boat back to Yurimaguas, and waited there for almost two weeks until I could start retracing my steps over the Andes. The road down from the mountains and into Yurimaguas was the last to open and, by the time I actually started making my way back, several roadblocks remained, forcing me to walk across and switch vehicles countless times.

Piles of human bones, Pueblo de los Muertos.

This young Matamata (*Chelus fimbriatus*) shows the elaborate head camouflage typical of its species. Adults with carapace lengths to 40 cm have been found.

With the little time I had left before my return to the United States, I decided to explore some additional archaeological sites. My first stop south of Chiclayo was Trujillo, another large city very near the coast. A few sites around Trujillo are of interest, including the massive mud-brick city of Chan-Chan. Chan-Chan was built by the Chimu culture from around

Ai Apaec, god of the Moche, also known as "The Decapitator," Huaca de la Luna.

850–1470 AD. One large complex, the Tschudi Complex, has been excavated and studied, but many more temples and other large complexes await systematic examination. The excavated parts of the site include a number of beautiful mud-brick reliefs centering on several motifs that included fishing nets, fish, birds, stylized figures, and basic geometric shapes such as circles and squares. A small on-site museum was accompanied by several overpriced gift shops.

Chan-Chan makes an interesting comparison with a nearby site that was built by the Moche (ca. 100–800 AD), the culture that immediately preceded the Chimu. The site is called Huacas de la Luna y del Sol, and its main features are two pyramids at opposite ends of the site. Excavations at the smaller pyramid, Huaca de la Luna, are uncovering many magnificent polychrome reliefs. The pyramid was actually a series of stepped structures superimposed upon one another, and it seems to have had regular resurfacing with the addition of another level every hundred years or so. Each time another addition to the pyramid was made, the underlying reliefs and painted patterns were sealed in a layer of mud-brick and mortar, which effectively preserved them.

The Moche were a coastal people living in a harsh, semi-arid region where life was centered around rivers and streams, and irrigation was almost essential for the growing of crops. Their religion centered on mountain worship and the god Ai Apaec, which translates to "The Decapitator." Huaca de la Luna is situated at the foot of a solitary peak in what is otherwise a very flat, dry region. Remains of several dozen human sacrifices have been uncovered, and some evidence suggests that some victims may have been tortured prior to being killed. In many of the reliefs and murals, the Ai Apaec, who assumes various forms such as felines and spiders, is depicted holding a severed human head. Several of the murals are still being renovated and are not yet open to the public. However, you can view them from a distance.

My last archaeological stop was in the small coastal city of Casma. Just outside of town is a fascinating and ancient archaeological site called Séchin. The site consists mainly of a single temple, which is fairly small in comparison to the other sites I visited. What sets this site apart is its age — it is about 3600 years old, outdating the Moche civilization by some 1700 years. The outer wall of the temple is covered with stylized and often gruesome reliefs. These consist mainly of warriors and decapitated heads, although various dismembered body parts and organs also are obvious. Compared to some of the other ruins in Perú, the site may seem plain, but the very age of the temple renders it impressive. Despite some discouragement and derisive reviews from the locals, I was enthralled with the reliefs and some of the relics in the small, on-site museum.

The northern section of Perú certainly has a lot to offer to the intrepid traveler with a keen interest in nature or archeology or both. The lack of tourists offers a more authentic glimpse of the challenges most Peruvians face and of the daily rhythms of Peruvian life. Smiles from the locals seem more genuine, restaurants and markets have more character, and a wide range of natural and cultural wonders await those curious and eager enough to seek them out.

Depiction of a warrior on the outer wall of the temple at Séchin; note the severed heads decorating the warrior's outfit.

HISTORICAL PERSECTIVE

Albert C. L. G. Günther *Biologia Centrali-Americana* Reptilia and Batrachia[1]

On *Iguana* and *Ctenosaura*

IGUANA

Iguana, Laurenti.

1. **Iguana rhinolophus.**

Iguana rhinolophus, Wiegm. Herp. Mex. p. 44; Dum. & Bibr. Erp. Gén. iv. p. 207; Tyler, Proc. Zool. Soc. 1850, t. 3 (*Metopoceros cornutus*); Cope, Proc. Ac. N. Sc. Phil. 1862, p. 356; Sumichrast, Ann. & Mag. N. H. 1864, xiii. p. 500; Bocourt, Miss. Sc. Mex., Rept. p. 134; Cope, Journ. Ac. N. Sc. Phil. viii. 1876, p. 124.

Hab. MEXICO, Mazatlan and Presidio (*Forrer*), Cordova (*Sallé*), Tehuantepec and Rio Coazacoalcos (*Sumichrast*), Cozumel Island on the coast of Yucatan (*G. F. Gaumer*); GUATEMALA, Chiapam (*Salvin*); COSTA RICA (*Cope*); PANAMA (*Brit. Mus.*), Darien, R. Truando (*Schott*).

"Iguana verde" of the Creoles; "Guchachi-guëla" of the Zapotec Indians.

This is the northern or Central-American race of the South-American *I. tuberculata*; it does not seem to extend southwards beyond the Isthmus of Darien, but occurs also in the island of Santa Lucia and probably other parts of the West Indies.

2. **Iguana tuberculata.**

Iguana tuberculata, Laur. Syn. Rept. p. 49.

Hab. GUATEMALA (*Salvin*); HONDURAS (*Brit. Mus.*); NICARAGUA (*Brit. Mus.*); PANAMA (*Dow*), Darien (*Schott*).—Generally distributed over the northern parts of SOUTH AMERICA and BRAZIL; occurring also in many West-Indian Islands.

CTENOSAURA

Ctenosaura, Wiegmann, Isis, 1828, p. 371.

1. **Ctenosaura acanthura.**

Lacerta acanthura, Shaw, Zool. ii. 1802, p. 216.
Cyclura teres, Harlan, Journ. Ac. Sc. Phil. 1825, p. 246, t. 16.
Ctenosaura cycluroides, Wiegm. Isis, 1828, p. 371; Bocourt, Miss. Sc. Mex., Rept. p. 143 (part.); Sumichrast, Bull. Soc. Zool. Fr. v. 1880, p. 175.
Ctenosaura shawii, Gray, Wiegm.
Cyclura pectinata, Wiegm. Herpet. Mex. p. 42, t. 2; Dum. & Bibr. Erp. Gén. iv, p. 221.
Cyclura denticulata, Wiegm. l. c. p. 43, t. 3.
Cyclura articulata, Wiegm. l. c.
Cyclura acanthura, Sumichrast, Arch. Sc. Phys. et Nat. xix. 1864, p. 49; Ann. & Mag. N. H. 1864, xiii. p. 500.
Ctenosaura acanthura, Gray, Cat. Liz. p. 191; Cope, Proc. Ac. Nat. Sc. Phil. xviii. p. 124; Bocourt, Le Naturaliste, 1882, p. 47; Boul. Cat. Liz. ii. p. 195, varr. A, B, D.
Ctenosaura pectinata, Gray, Cat. Liz. p. 191; ?Cope, Proc. Ac. Nat. Sc. Phil. xviii. p. 124; and Proc. Am. Phil. Soc. xxii. 1885, p. 388; Bocourt, Miss. Sc. Mex., Rept. p. 140, and Le Naturaliste, 1882, p. 47; Sumichrast, Bull. Soc. Zool. v. 1880, p. 174.
Ctenosaura teres, Bocourt, Miss. Sc. Mex., Rept. p. 142, and Le Naturaliste, 1882, p. 47.
Ctenosaura multispinis, *brevirostris*, and *teres*, Cope, Proc. Am. Phil. Soc. 1886, p. 266.

Hab. NORTH AMERICA, California.—MEXICO, Tres Marias Is., Presidio, Mazatlan, Cuidad, and Ventanas (*Forrer*), Tierra Colorado in Guerrero (*H. H. Smith*), Colima (*Dugès, in mus. Paris*; *U.S. Nat. Mus.*), Putla (*Boucard*), Tehuantepec (*Sumichrast*), Tampico (*W. B. Richardson*), Vera Cruz (*Sallé*; *Méhédin, in mus. Paris*), Yucatan, Cozumel I. (*Cope*).

Editors' Note.—Usually, we have chosen as featured historical works narrative pieces that lend insight into language as well as the state of knowledge applicable when the chosen article was written. The piece featured in this issue is quite different. Instead of a narrative, this piece by Albert Günther is indicative of the sometimes massive works that documented results of extensive expeditions and simultaneously summarized the knowledge available at the time. Although much less interesting to peruse, these types of publications allow us to recreate the historical events that lead to the present day and often include references to the works of authors that might otherwise be overlooked and forgotten.

[1] Reprinted in 1987 by the Society for the Study of Amphibians and Reptiles (Facsimile Reprints in Herpetology) in cooperation with Comité Herpetológico Nacional (México).

A BRIEF HISTORY OF THE BIOLOGIA CENTRALI-AMERICANA...

One of the most monumental biological publications of all time is the 67-volume *Biologia Centrali-Americana*, subtitled "Contributions to the Knowledge of the Fauna and Flora of Mexico and Central America." Edited by the eminent British naturalists Osbert Salvin and Frederick DuCane Godman, the series appeared in parts, with 1677 plates (more than 900 colored), at irregular intervals, often monthly, over a period of 37 years, 1879 to 1915. It was actually more nearly a synopsis of the entire biota, as then known, of Middle America — México (excluding Baja California) through Panamá — written by numerous specialists, although "certain groups, such as the Crustacea and most of the lower invertebrates, were never treated owing to a lack of material, while a number of groups of insect were omitted because no workers could be found to undertake them …"

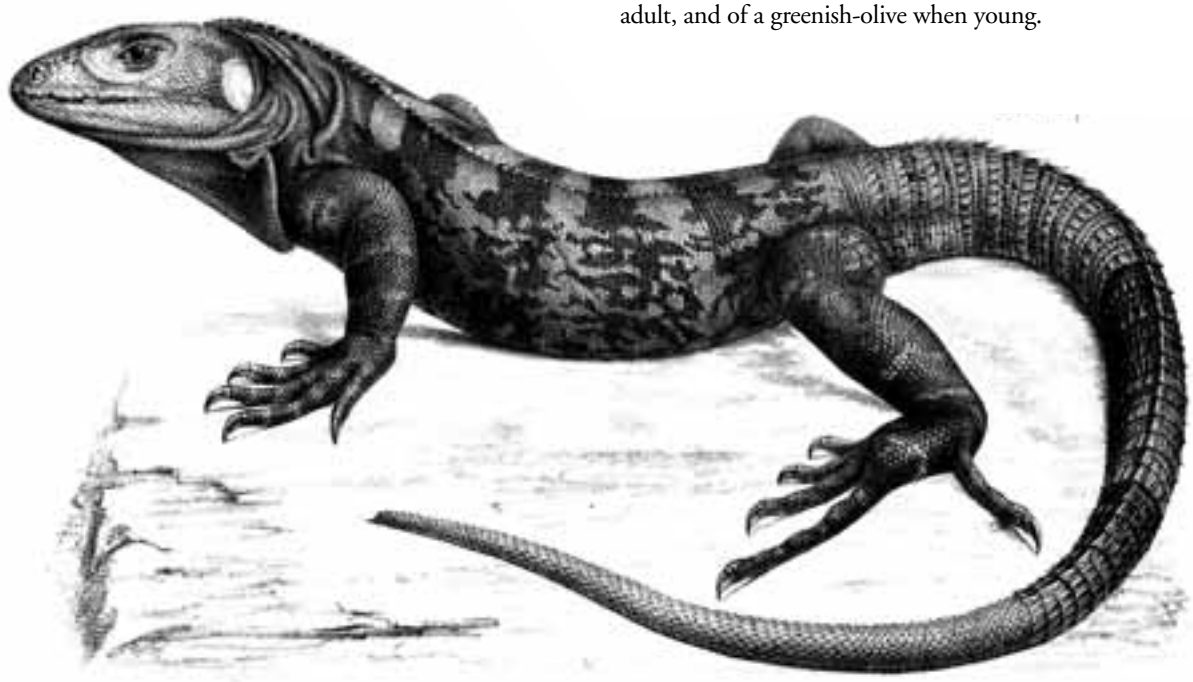
Selander and Vaurie. 1962.
Amer. Mus. Novit. 2099:1–70.

That the whole work was finished was due to the tenacity of purpose and administrative skill of Godman and the editorial assistance of George Charles Champion, a beetle specialist, for Salvin, the other editor, died June 1, 1898, at the age of 63, having been born February 25, 1835, in Elmhurst, Finchley, England. From 1898 on, all responsibility for *Biologia Centrali-Americana* and for the joint Salvin-Godman collection fell to Godman. He was then 64, having been born January 15, 1834, in Park Hatch, Surrey, England. Despite advancing years and ill health, he managed to complete the monumental work in all its parts, although the last, introductory volume of 1915 did not do justice to the overall theoretical analysis that had at one time been the editors' hope. The coverage of the work was admittedly not complete, but what was started was brought to a most admirable conclusion. A few years later, on February 19, 1919, Godman died, at the age of 85.

Hobart M. Smith

"Iguana negra" of the Creoles; "Guchachi-chévé" of the Zapotec Indians.

Tail subcylindrical; the spines of the broad rings moderately developed, the broad rings of the anterior verticelli separated by three or two narrow rings, rarely by one. Dorsal crest generally interrupted in the sacral region; if continuous, the continuity is effected merely by the low and somewhat enlarged scales of the median series. Scales of the calf of the leg very small. The coloration varies and changes with age. The ground-colour of the young is generally green, marbled with darker on the back, the dark markings forming more or less distinct, irregular cross bands, which are sometimes confluent, sometimes spotted with black, and about seven or eight in number on the back. With age the dark colour becomes more diffused and irregularly distributed over the body, at places entirely suppressing the ground-colour, which itself assumes a more olive tinge or changes into yellowish. Specimens from Tampico are uniform black when adult, and of a greenish-olive when young.



I have examined a great number of specimens, which I am unable to divide into species, although they by no means agree with one another in every point. The development of the crest, which by some authors has been used as a specific character, depends partly on age, partly on sex. The largest specimens I have seen, males as well as females, are thirty inches long, of which the tail takes two thirds. Shaw's type is still preserved in the British Museum, and said to be from California; also Bocourt has examined specimens from that country.

2. **Ctenosaura completa.** (Tabb. XXIX., XXX.)
Ctenosaura cycluroides, part., Bocourt, Miss. Sc. Mex., Rept. p. 143.
Ctenosaura completa, Bocourt, l. c. p. 145, and Le Naturaliste, 1882, p. 47; Cope, Proc. Am. Phil. Soc. 1886, p. 268.
Ctenosaura acanthura, var. C, Boul. Cat. Liz. ii. p. 197.

Hab. MEXICO, Yucatan and Cozumel I. (*Cope*), Mugeres I. (*G. F. Gaumer*); BRITISH HONDURAS, Belize (*Dyson*); GUATEMALA, Peten (*Morelet*), Chiapam (*Salvin*); HONDURAS (*Mus. Brit.*, *Bocourt*), Bonacca I. (*G. F. Gaumer*); SALVADOR, La Union (*Bocourt*).

Tail subcylindrical; the spines of the tail very prominent and acute in the adult male, the scutes of the narrow rings being also strongly armed. Dorsal crest not interrupted in the sacral region, the continuity being effected by short lobes in the adult male, and by depressed scales in females and young. Scales of the calf of the leg larger than in *C. acanthura*. Greenish or greenish-olive, with six black cross-bands on the back, of which the anterior is the least developed, and, like the following, more or less distinctly paired; in old specimens these bands are narrower and more or less broken up, and the anterior may disappear altogether.

Of this species I have seen nine specimens — two adult males and several young from Honduras, an adult female and young from Belize, and an adult female from Guatemala. It grows to the same size as *C. acanthura*, from which it is not easily distinguished.

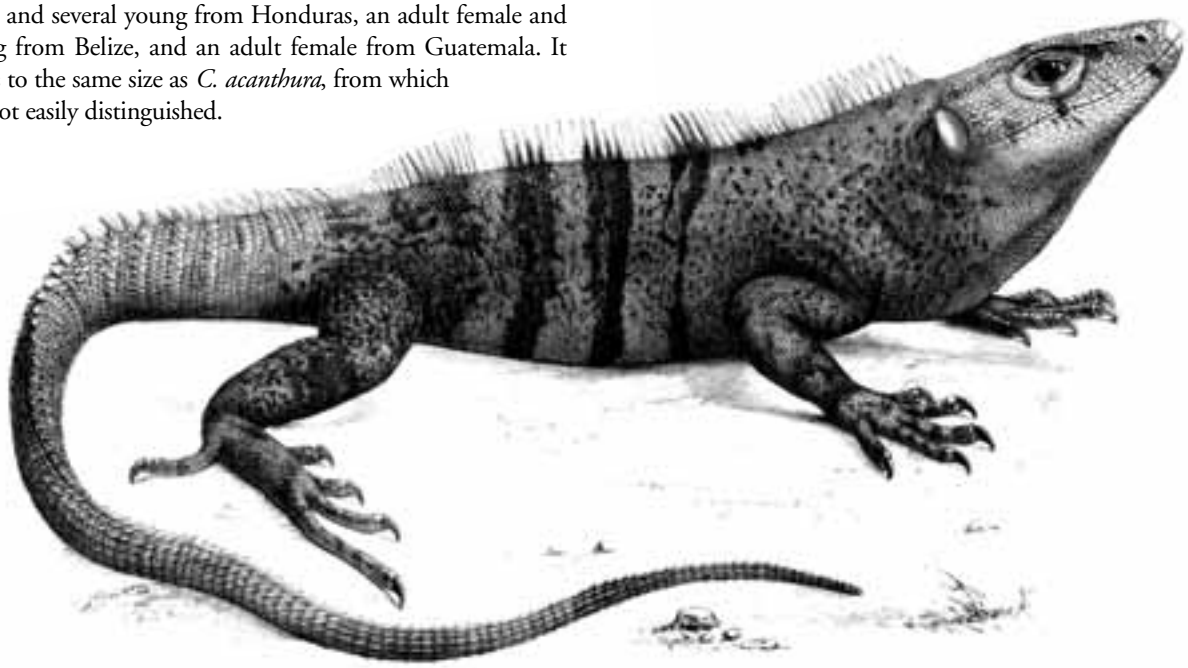
BIBLIOGRAPHIC INFORMATION

Günther's volume on amphibians and reptiles is one of the most important publications on the herpetology of Middle America and it is still in active use, yet it is not widely available. The original edition consisted of probably no more than 300 copies, according to the best estimates of several natural history booksellers, and is regarded by them as one of the scarcest volumes in the entire *Biologia Centrali-Americana* series. As Hobart Smith notes in his introduction [to the SSAR Facsimile Reprint], the herpetology volume cost the equivalent of about US$37 in 1902 when the volume had just been completed, a very considerable sum of money at the time. In recent years copies have sold for as much as $1000 on the second-hand market, when they can be found at all.

Dates of Publication. Günther's book was issued over the period 1885 to 1902 and at the foot of the first page of each signature the date of publication is given. Since the plates did not always accompany the corresponding text, these cannot be dated so easily. Fortunately, however, such details are recorded on the wrappers in which the original parts were published, and a copy of the *Biologia* with all of the wrappers intact exists in the Zoology Library of the British Museum (Nat. Hist.), London, …

Kraig Adler, Editor
5 February 1987

Tab. XXIX. represents a male from Bonacca Island, of half the natural size, with separate view of a part of the tail; Tab.



XXX. a female from Chiapam, of the natural size, also the inner side of the calf of the leg, to show the size of the scales.

3. **Ctenosaura quinquecarinata.**

Cyclura quinquecarinata, Gray, Zool. Misc. p. 59; Cope, Proc. Am. Phil. Soc. xi. 1871, p. 161.

Enyaliosaurus quinquecarinatus, Gray, Cat. Liz. p. 192.

Ctenosaura quinquecarinata, Sumichrast, Bibl. Univ. et Rev. Suisse, 1873, p. 259; and Bull. Soc. Zool. v. 1880, p. 175.

Hab. MEXICO, Oaxaca (*Boucard*), Tehuantepec (*Sumichrast*); HONDURAS (*Mus. Brit.*).

Tail much thickened and depressed near its base, verticillated, each verticellus formed by a ring of large strongly armed scutes, and by a ring of much narrower and unarmed scutes. The armature is confined to the upper and lateral surfaces of the tail, the lower side being comparatively smooth. The strongest spines are arranged in one median, and two or three lateral series. Dorsal crest very low, obsolete in the sacral region. Upper parts and throat yellowish, marbled with black or brown.

4. **Ctenosaura defensor.**

Cachryx defensor, Cope, Proc. Ac. N. Sc. Phil. xviii. p. 124; Proc. Am. Phil. Soc. 1869, p. 169, t. 10; Bocourt, Miss. Sc. Mex., Rept. p. 143, t. 17 bis. figg. 12, 12a.

Hab. MEXICO, Yucatan (*A. Schott, U.S. Nat. Mus.*).

Extralimital are the following species: —

1. *Iguana acanthura*, Blainville, = *Cyclura acanthura*, Dum. & Bibr., = *Cyclura hemilopha*, Cope, Boulenger, = *Ctenosaura acanthura*, Bocourt (Miss. Sc. Mex., Rept. p. 138), = *Ctenosaura interrupta*, Bocourt (Le Naturaliste, 1882, p. 47). — Lower California.

2. *Ctenosaura erythromelas*, Boul. Proc. Zool. Soc. 1886, p. 241, t. 23; *Cachryx erythromelas*, Cope, Proc. U.S. Nat. Mus. 1886, p. 437. — Probably Lower California.

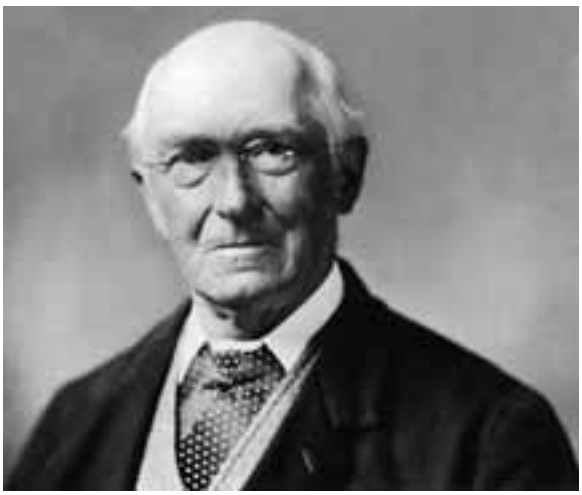
BIOGRAPHICAL SKETCH

Albert C. L. G. Günther (1830–1914)[1]

Albert Günther was born in 1830 in Esslingen, Württemberg (Germany). He entered the theological school at the University of Tübingen in 1847 and took holy orders in the Lutheran Church in 1851, although he subsequently turned to medical studies because of a longstanding interest in natural history and the influence of several professors. He received a doctorate in philosophy and arts in 1853 and went on to medical school, initially in Berlin, before teaching in Bonn, and finally completing his medical degree in Tübingen in 1857.

That same year, Günther offered his services to John E. Gray, Keeper of the Zoology Department at the British Museum, and was hired to catalogue the museum's snake collection, then the frogs, and finally the fishes, which occupied him for the rest of his life. Günther took over the Keeper's position from Gray in 1875 and, like Gray before him, aggressively built the collection, taking advantage of opportunities presented as the British Empire expanded. In 1879, he hired Georges Boulenger and placed him in charger of lower vertebrates, assuring that the long tradition of herpetological research at the British Museum would continue.

Günther founded *Zoological Record* in 1865, and it is still today the most complete index of the world's zoological literature. Günther's greatest zoological discovery occurred in 1867, when he announced the recognition that *Sphenodon* of New Zealand was not a lizard but the sole living representative of the order Rhynchocephalia. In addition, he published *Reptiles of British India* (1864), *The Gigantic Land-Tortoises (Living and Extinct)* (1877 [1878]), and the herpetological volume in the series *Biologia Centrali-Americana* (1885–1902). Günther's work on lower vertebrates was regularly cited by Charles Darwin in *Descent of Man* (1871), in which he depended heavily on Günther for his information about sexual characters. In addition to the books, Günther published some 200 papers on herpetology, with a geographic emphasis on Australia, Africa, and Asia. Günther retired in 1895 and died at Kew, London in 1914.



Albert C. L. G. Günther in about 1900. Photograph courtesy of Kraig Adler and the British Museum (Natural History) Library.

[1] **Source:** Adler, K. 1989. Herpetologists of the past, pp. 5–141. In K. Adler (ed.), *Contributions to the History of Herpetology*. Society for the Study of Amphibians and Reptiles, Contributions to Herpetology, vol. 5. Ithaca, New York.

COMMENTARY

The Economic Roots of Species Invasions[1]

Jenny A. Ericson[2]

Across ecosystems and geographic regions, the rate of newly detected biological invasions is increasing, and, in the case of individual species, this increase is often exponential (Ruiz et al. 2000, Ruiz and Carlson 2003, Fofonoff et al. 2003, Kraus 2003). Invasive alien species have become a real threat to our environment and economy. The economic costs of invading alien species in the United States alone come close to $120 billion per year (Pimentel et al., in press).

Harmful invasions of alien or non-indigenous species often produce devastating impacts on agriculture, recreation, and natural resources (OTA 1993). They threaten biodiversity, habitat quality, and ecosystem function and are now considered among the greatest threats to native species in the United States (Wilcove et al. 1998). In combination with other economic activities, the rapid expansion of international trade, travel, and transport have contributed significantly to the increasingly high rate of species invasions. Also, unfortunately, "the pressures to increase trade are currently greater than the pressures for precaution in moving biological material across former barriers" (Mooney and Hobbs 2000). The following discussion highlights the links between this exponential increase and the unrestricted trade of a growing global economy.

One of the by-products of international trade and travel is the transportation of species beyond their natural geographic range. A species that is not native to a particular ecosystem is

Opinions expressed are those of the author and may or may not reflect those of the IRCF.

[1] Adapted from "Economic Growth Forum," *Fisheries* 30(5):30–33 (May 2005) and published with permission.

[2] The author is an independent natural resource management consultant currently working with invasive species on a federal government contract. She can be contacted at riverine8@hotmail.com.

JOHN S. PARMERLEE, JR.

The House or Wall Geckos of Florida and other southern states actually represent a sequence of invasions that began with the Mediterranean Gecko (*Hemidactylus turcicus*), which was followed by the Cosmopolitan House Gecko (*H. mabouia*, pictured), and even more recently by the Asian House Gecko (*H. frenatus*). How these species will ultimately partition the available habitats remains to be seen.

referred to as alien, exotic, or non-indigenous. A subset of alien species is considered invasive by virtue of their ability to cause economic or environmental harm, or harm to human health (Executive Order 13112). They generally exhibit characteristics such as rapid growth rate, exceptional dispersal capabilities, large reproductive output, and broad environmental tolerance. Although naturally occurring movement of species has taken place across the surface of the earth for hundreds of millions of years, human activity has greatly increased the velocity of invasion and, by dissolving temporal and spatial boundaries, has enabled many species to relocate that would not normally have had this opportunity. Most arrive in relation to human economic activities, either intentionally or unintentionally.

PAMELA MEDINA DÍAZ

Introductions of mammalian herbivores, such as these burros on St. Eustatius, alter vegetative communities in ways that cannot be predicted, often with catastrophic effects on native herbivores such as iguanas.

Invasive species move along routes referred to as pathways. Their movement is facilitated by vectors, the means by which a species is moved, such as ships, planes, people, and other organisms. Throughout history, cultures and civilizations have relied on trade to improve relations and increase prosperity. Archaeologists have found evidence of human-assisted movement of species by way of seafaring trade connecting continents early in history. Among the first specialized sailors and merchants were the Phoenicians (ca. 3000 B.C.) who traded articles such as Lebanese cedar and processed dyes (Cameron 1997). Greek sailors and merchants traded basic storable foodstuffs, such as grain, grapes, olives, wine, and oil. During Roman times, sea trade existed between India and Egypt; and, as early as the sixth century, the Vikings were exchanging honey, fur, weapons, and slaves for Arabian silver, which has been found as far west as North America (Het Huis van de Aarde Museum 2005).

Between the eighth and fifteenth centuries, Indian Diaspora and Far East trade routes were used not only for economic expansion, but also for the expansion of religion. By the first half of the seventeenth century, the Netherlands had established a fully global trading network (Brummett and Edgar 1999).

JOHN S. PARMERLEE, JR.

The popularity of Red-eared Sliders (*Trachemys scripta elegans*) in the pet trade and the resultant and maybe inevitable escapes and releases have led to wild populations in many areas where the species is not native, with negative effects on native turtles and yet-to-be evaluated impact on native invertebrates and aquatic vegetation (see also Newsbriefs, p. 216).

JOHN BINNS

Alien carnivores, such as this Jamaican mongoose (*Herpestes javanicus*), originally imported from India to control rats in the sugar cane fields, were subsequently introduced to many other West Indian islands and to the major Hawaiian islands. Among the unintended consequences were little impact on rat populations and dramatic declines in populations of ground-nesting birds and diurnally active terrestrial reptiles.

Today, transportation of people and cargo via ships and planes has become fast, efficient, and frequent. Increased speed and efficiency of transport enables international trade and feeds aspirations for economic globalization and growth. One shipping company alone can maintain a global network of shipping lines. For example, in 2004, the shipping company Maersk Sealand advertised itself as one of the largest liner shipping companies in the world with over 300 shipping vessels and 950,000 containers traveling around the globe, with feeder vessels, trucks, and dedicated trains available for door-to-door service (www.maersksealand.com).

With increases in total volume of trade and the speed and frequency of transportation and delivery come greater risks of introduction, both intentional and unintentional. For example, larger numbers of products bring greater opportunity for unintentional introductions referred to as "hitchhikers," organisms that attach themselves to the product itself, such as insects on plants, or that exist within the transportation medium, such as ballast water. As shipping technology continues to improve, ships take less time to traverse greater distances, which means mortality decreases and organisms that might have once died while en route for a few weeks or a month may now have a better chance of survival, given that the journey has been shortened to a number of days. As the rate of non-indigenous, potentially invasive, species introduction accelerates, trade itself begins to look more and more like a sort of "metavector," comprising numerous, individual, yet associated, vectors.

International trade currently represents a growing share of the U.S. economy. Import volume increased from $40 billion in 1991 to around $100 billion in 2001, more than doubling in a 10-year period (Bureau of Transportation Statistics 2002). Some predict that global trade will double again by the year 2020. This international trade facilitates the intentional and unintentional transport of biological organisms around the world.

Approximately 42% of the plants and animals federally listed as threatened or endangered species are at risk because of alien and invasive species (Pimentel et al., in press). The National Invasive Species Council's (2003) working group on pathways identifies three major categories of pathways for the introduction of alien and invasive alien species: (1) transportation, (2) living industry, and (3) miscellaneous. Within the category of transportation, pathways include the movement of water (e.g., ballast water, sediments, and dredge spoil materials), items used in transport (e.g., vehicles and ships), and "hitchhikers," organisms attached to vehicles, ships, or materials attached to them.

Perhaps the most notorious example of a species entering through a transportation pathway is the Zebra Mussel (*Dreissena polymorpha*). This invasive species entered the United States through the St. Lawrence Seaway as planktonic larvae, probably in the ballast water of a bulk cargo vessel coming from a Black Sea port (Holeck et al. 2004). Since their discovery in 1988, Zebra Mussels have spread from the Hudson River in the east to Oklahoma in the west, and from Ontario and Quebec in the north to Louisiana in the south. Zebra Mussels are small bivalves that cluster in colonies of hundreds of thousands per square yard and clog the openings of underwater pipes, often closing them off altogether.

Additionally, invasions are facilitated by the mail, internet, and overnight shipping companies. In particular, the internet is a very difficult pathway to control. Although recognized as a federally-prohibited weed, Giant Salvinia (*Salvinia molesta*) is still available for purchase on the internet.

Within the council working group's category of "living" industry, pathways include the food industry and non-food industries transporting animals and other organisms, such as the pet trade, research, and public education and enjoyment such as zoos and public aquariums. Through any of the living industry pathways, species can be intentionally released, escape, or hitchhike with people, products, and services. The plant trade is often a vehicle for species introduction through nurseries and pet stores.

Water hyacinth, an example of a highly invasive aquatic species, began charting its course around the globe in 1884. This

JOHN S. PARMERLEE, JR.

Because of their sensitivity to desiccation and exposure to salt water, amphibians are rarely effective invasives. Nevertheless, some exceptions exist. Cuban Treefrogs (*Osteopilus septentrionalis*) are native to Cuba and may have expanded their range naturally to the Bahamas, Cayman Islands, and possibly to Florida. However, increasing numbers of populations are being established, mostly due to inadvertent "hitch-hiking" with exotic, tropical plants from southern Florida that are destined for resorts to meet tourists' expectations of what the tropics should be like.

plant originally came from the Amazon Basin in South America and is today a serious pest in North America, tropical Africa, and Southeast Asia. In certain parts of tropical Africa, riverboat transport has become impossible because this aquatic weed has completely blocked entire river systems. The control cost to seven African countries runs about $20–50 million per year (McNeely et al. 2003).

The council working group's category of miscellaneous pathways includes interconnected waterways for aquatics or interconnected landmasses for terrestrial organisms. One example of introduction by interconnected waterways is the Sea Lamprey (*Petromyzon marinus*), which is native to the Atlantic Ocean. It entered the Great Lakes through the Hudson River and the Welland Canal in 1829 and was later discovered in Lake Erie in 1921 (Mooney and Hobbs 2000). The Sea Lamprey attaches itself to other fish and with its suctorial mouth extracts blood and other body fluids.

In order to address the problem of biological invasions, some important legislation has been passed. In 1990, the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) called for a national program to prevent and respond to problems caused by the unintentional introduction of nonindigenous aquatic species into U.S. waters, and it established the multi-agency Aquatic Nuisance Species Task Force to carry out its mandates. A reauthorization took place in 1996 in the form of the National Invasive Species Act (NISA). Currently a second reauthorization, the National Aquatic Invasive Species Act (NAISA), is under review by Congress. The latter would require a standard for ballast water management and appropriation of funds for the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and the Smithsonian Institution to establish baselines and invasion rates, as well as improved tools for early detection. It also will focus on rapid response to incipient infestations, establish a separate fund administered by the U.S. Fish and Wildlife Service to assist states to respond to newly detected species. It would allocate funding for establishing a screening mechanism for intentional introductions. It also will encourage the examination of new pathways besides the historical focus on ballast water. Finally, it will mandate more and better research on the topic. Although nearly 30 federal acts and executive orders pertain in some way to invasive species, and some address terrestrial forms (e.g., the Brown Tree Snake Control and Eradication Act of 2004), none, individually or collectively, effectively addresses problems caused by terrestrial invasives in the same fashion as NAISA does for aquatics.

Efforts concerned with prevention, specifically risk identification and assessment, further research on pathways, and continued exploration of avenues available through regulation, must continue. We need to strengthen outreach at all levels and continue to support research specifically in invasion ecology. For management of invasive species at the field level to be successful, we must encourage a greater understanding of early detection/rapid response, control and management, and restoration techniques.

Invasive species have been recognized as one of the most significant drivers of environmental change worldwide — and biological invasions are facilitated by the increasingly expanding network of commercial highways underlying international trade, travel, and transport. We must address these pathways. However, even if urgent measures are taken, the number of species invasions in the United States will probably continue to increase in conjunction with the growth of the economy and the sectors that constitute or represent pathways for invasive species.

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URGENT:
Invasive Species Legislation in Highway Bill![1]

March 30, 2005

Action Alert! Action Alert! Action Alert!

If you have "non-native" weeds, grass, trees, or shrubs on your property (and everyone does) you're in trouble. Under "invasive species" provisions currently sitting in the Senate's version of the transportation bill, your property could quickly become the target of radical environmentalists and federal bureaucrats. The bill's name is the "Safe, Accountable, Flexible and Efficient Transportation Equity Act" or SAFETEA 2005 (*please note* that it does not yet have a bill number).

It is vitally important that you call both of your Senators this week, and next week, and tell them to DEMAND that any invasive species provisions be stripped from the SAFETEA bill. SAFETEA could come up for a vote before the full Senate at ANY TIME!

Call the Senate Switchboard at (202) 224-3121 and simply ask for your Senators by name.

Currently, the SAFETEA act contains provisions to "minimize invasive species." This is the foot in the door to federal control of ALL so-called "invasive species" — something that the greens openly covet. Under the Senate version of SAFETEA, the federal government will dictate to the states what types of grasses and plants are allowed to be planted next to roads. This has nothing to do with science or the environment. This is about LAND CONTROL and MONEY FOR RADICAL GREEN GROUPS.

****Call your Senators at (202) 224-3121 and tell them: NO INVASIVE SPECIES PROVISIONS in the transportation bill!****

Imagine the Endangered Species Act on steroids. Now multiply its devastating effect on property rights one-hundred fold. That should give you a pretty good idea of what "invasive species" legislation will mean for property owners in every state, county, and city in this nation. "Invasive species" is the radical greens' key to controlling every square inch of land in the United States. And SAFETEA is the just the beginning.

This nightmare all began when Bill Clinton signed Executive Order 13112 in 1999, creating an "Invasive Species Council" to monitor and control "alien species." What are alien species? According to Clinton's Order, "alien species means, with respect to a particular ecosystem, any species, including seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem." Most agricultural crops and animal species clearly fall within the definition of "alien." Domesticated pets, many houseplants, and Kentucky bluegrass used in most lawns and golf courses are already defined as alien species. Indeed, this is all the greens and their allies in the federal government need to control all land in the U.S.

Think the invasive species monster can't get any worse? It already has. In 2001, the Invasive Species Council issued a management plan that states: "Council member agencies will work with the Global Invasive Species Programme (GISP) and other relevant bodies to expand opportunities to share information, technologies, and technical capacity on the control and management of invasive species with other countries, promoting environmentally sound control and management practices." And just what is the Global Invasive Species Programme? A quick trip to the GISP website reveals it is: The United Nations Environmental Programme (UNEP), The United Nations Environmental, Scientific, and Cultural Organization (UNESCO), The Convention on Biological Diversity, The Nature Conservancy, The International Union for the Protection of Nature, [and] DIVERSITAS: An International Programme of Biodiversity Science (another UNESCO project).

Invasive species legislation opens the door to federal and international control over private property in the United States. And that's why greens in the Senate are trying to sneak it into the federal transportation bill — without ANY proper debate. We are running out of time. Contact your Senators TODAY, TOMORROW, AND NEXT WEEK. The House version of the transportation bill has already passed and thankfully does NOT include any invasive species language. But the Senate version (SAFETEA 2005) DOES! Once again, the House is on the right track and the Senate is out in left field. ACT NOW!

****Action to Take****

Call both of your Senators and tell them to DEMAND that any and all "invasive species" provisions are REMOVED from the Senate transportation bill (SAFETEA). Call the Senate Switchboard at (202) 224-3121 and ask for your Senators by name.

*****PLEASE SEND THIS URGENT ALERT TO AS MANY PEOPLE AS POSSIBLE*****

[1] From the American Policy Center (http://www.americanpolicy.org/sledgehammer/species.htm); the APC promotes its website as the "Property Rights and Back-to-Basics Education Grassroots Internet Headquarters."

Invasive Species Legislation[1]

Congressman Vernon J. Ehlers[2]

United States House of Representatives
Washington, D.C. 20515-2203

For many years, governments and citizens in Michigan and throughout the Great Lakes Basin have been battling a notorious invader – the Zebra Mussel. These small mollusks invaded the Great Lakes in the 1980s, quickly multiplied and spread across the region, clogging water intake pipes and creating problems for boaters who have to spend time and money cleaning hulls. Last summer, a voracious fish known as the Northern Snakehead became a media celebrity and a serious threat to Maryland waterways. This predator wipes out native fish and, once it is done feeding in one pond, it literally gets up and crawls across land to the next one. These are only two examples of "invasive species" – animals and plants that are introduced, take hold and multiply in ecosystems where they don't have any competition, causing tremendous economic and environmental harm.

If you polled Americans as to what the most pressing economic and environmental issues are, dealing with invasive species probably wouldn't make the list. But considering the economic and environmental threats they pose to our nation, attention must be paid to invasive species. For example, recent studies have estimated that Zebra Mussels have cost governments and utilities in the Great Lakes region more than $1 billion since the late 1980s. On an environmental level, invasive species are now recognized as the No. 2 threat to endangered species, as they often compete for food and destroy the habitat of other native plants and animals.

Congress must act to combat this threat. That's why I, along with Senator Carl Levin and others, have sponsored a comprehensive legislative package (H.R. 1080 & 1081 and S. 525) to do just that. One central theme drives our effort – "an ounce of prevention is worth a pound of cure." If we spend millions preventing aquatic invasive species from entering our waters, we will avoid spending billions trying to control and manage them once they are here. Our legislation does three overarching things fitting with this theme.

First, this legislation takes major strides forward in managing the shipping industry, which is responsible for (unintentionally) bringing most of the aquatic invasive species into our waters through ships' ballast tanks. The legislation contains provisions that require shippers to ensure that they are using best management practices, and, most importantly, treat ballast water so that species are killed before ballast water is dumped into our waterways. This is the most effective way to prevent the next Zebra Mussel from entering our waterways and wreaking economic and environmental havoc.

Second, we will, for the first time, establish a screening program to look at the intentional introduction of new plants and animals into the United States. People have been bringing new species into America since before our nation was created. The rate of these introductions has increased dramatically over the past 50 years because of global trade and efficient and fast transportation systems. Under current law, we take no action until we know that a species is harmful, which is too late. This legislation changes that burden by allowing federal agencies to screen for potential "bad actors" and prevent the next Northern Snakehead from being imported into the United States.

Finally, we establish a comprehensive research program, which was sorely lacking in previous legislative efforts to deal with invasive species. I'm taking the lead on this part of the legislative effort, because when I looked at the underlying law, it became clear that research was simply an afterthought. This explains why so much of the invasive species management program has been stalled for years. Good science must underpin management decisions if these decisions are going to be considered credible to the outside world.

It is time to change our strategy in dealing with aquatic invasive species. It is time for Congress to realize that this threat continues to grow and will not go away unless we act. It is time for Congress to move this legislation forward. Invasive species don't recognize or respect political boundaries or timelines and they are arriving here even as you read this today.

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[1] Adapted from an op-ed piece for *Business Direct Weekly*, March 2003.

[2] The Honorable Vernon J. Ehlers, United States House of Representatives, serves Michigan's third district. He serves on the following committees: House Committee on Education and the Workforce, Subcommittee on 21st Century Competitiveness, Subcommittee on Education Reform; House Committee on House Administration; House Committee on Science, Subcommittee on Energy, Subcommittee on Environment Technology and Standards (Chair); House Committee on Transportation and Infrastructure, Subcommittee on Aviation, Subcommittee on Water Resources and Environment; Joint Committee on the Library of Congress.

BOOK REVIEW

Extinctions on Islands: A Classic Revisited

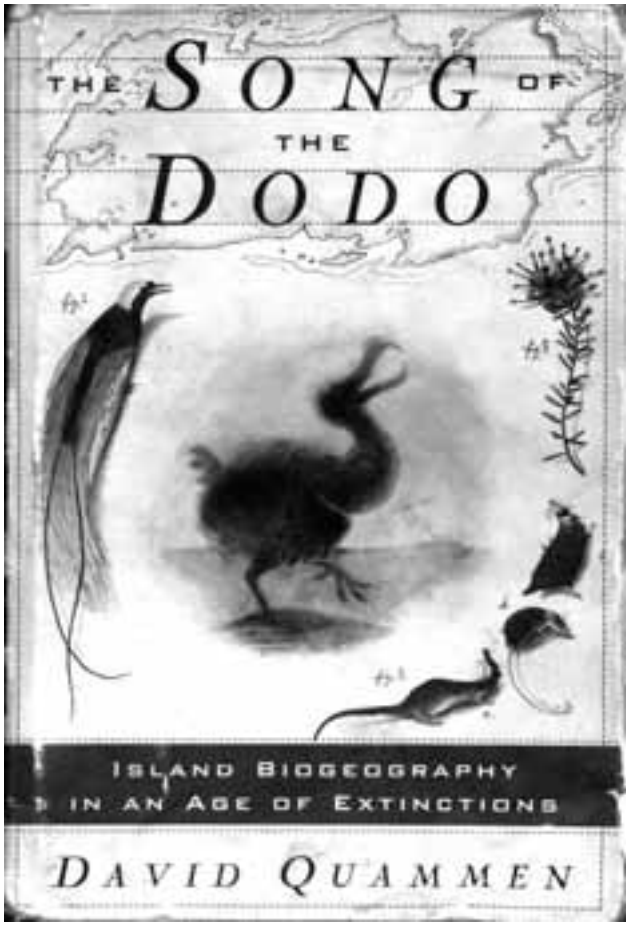
***The Song of the Dodo: Island Biogeography in an Age of Extinctions*. David Quammen. 1996. Scriber, New York. 702 pp. 15 maps, glossary, source notes, bibliography, index. Clothbound. $32.50 (Touchstone Paperback edition, $20.00).**

Move over Gould, Watson, Leopold, Darwin, and Wilson. The required reading list for biology students, professionals, and serious nature-lovers has expanded — *The Song of the Dodo: Island Biogeography in an Age of Extinctions* by science journalist David Quammen should definitely be included. *The Song of the Dodo* takes the reader on exciting adventures through the work of island biogeographers and studies of evolution and extinction. This book is not only educational, but also thrilling and highly entertaining — and can be enjoyed even by readers who are not familiar with island biogeography and the study of evolving species. Well-written and researched, this volume reads like a travelogue of fascinating animals and places while inspiring the reader to take action to curb habitat destruction and species extinction.

The Song of the Dodo is organized into ten sections, each of which covers one issue relevant to the world of island biogeography. The author begins with a brief introduction entitled, "Thirty-Six Persian Throw Rugs," an analogy he effectively uses to focus the reader's attention on the "unraveling of ecosystems." He also introduces one of the themes of the book, namely that most of us are not up to date on the subject of ecosystem decay and the field of island biogeography. In the following section, "The Man Who Knew Islands," the author defines biogeography (the study of the facts and the patterns of species distribution) and goes on to use examples of islands like Bali and Lombok to introduce some of the facts on which biogeographers rely when they ask questions pertinent to the discipline. In this section, the author also pays homage to Alfred Russel Wallace and his studies in the Malay Archipelago and the Amazon Basin. The reader is pulled into the life of Wallace and travels with him as he develops his own hypotheses concerning the evolution of species. The author also takes a look at Charles Darwin and his travels, including his famous studies in the Galápagos Islands. Quammen skillfully brings to life the quest to form theories and the race to see who can first publish their hypotheses on the evolution of species.

Editor's Note

Although the review of a book first published nearly a decade ago may seem odd, the subject matter and the readability of Quammen's book, combined with its relevance to the conservation and natural history of reptiles, caused me to solicit this review. I hope it encourages a few more readers to explore Quammen's world. R. Powell



In the third section, "So Huge a Bignes," Quammen addresses the main subject of the book: the relationship between the evolution and extinction of species. He emphasizes that evolution is best understood while simultaneously examining extinction by stating that "… the evolution of strange species on islands is a process that, once illuminated, casts light onto its dark double, which is the ultimate subject of this book: the extinction of species in a world that has been hacked into pieces." This section of the book provides several examples of species around the world that have or are rapidly disappearing, using events leading to declines in the numbers and kinds of tortoises to introduce features peculiar to island communities. These include dispersal ability, size changes, and the loss of defensive adaptations. In "Rarity Unto Death," the fourth section, Quammen passionately describes the extinction of several species. Of these, the extinction of the Dodo on the island of Mauritius is noteworthy. Until humans invaded Mauritius, the Dodo thrived, living in a balanced ecosystem. With the intro-

duction by the Portuguese of domestic mammals, the Dodos quickly expired. On Tasmania, the Thylacine (a hyena-like creature often called a Tasmanian "wolf") and the Aborigines both became extinct shortly after the British arrived. The plight of Tasmania's Aborigines provided fuel for Quammen's thoughts about the extinction of a human culture.

In "Preston's Bell," Quammen takes a close look at the species-area relationship, emphasizing that "less area harbors fewer species." He goes on to tell the story of Frank Preston and how he came to apply a bell curve to his data on communities of birds and insects. Preston saw a pattern, biological communities contained a few very rare species, many fairly abundant species, and a few species that are very abundant. With this pattern in mind, Quammen related the story of Preston's Bell to his own adventures while searching for Komodo Dragons. The sixth section of the book, "The Coming Thing," examines Robert MacArthur and Edward Wilson's theories on species reaching equilibrium on assortments of islands. MacArthur and Wilson hypothesized that, because new species were continually arriving and old species were continually becoming extinct, species eventually reach an equilibrium. MacArthur and Wilson used a mathematical model to foretell the specifics of equilibrium on any island. A highlight of this section is Quammen's personal interview with Wilson, in which they discussed MacArthur and the impact of their work on the very fundamentals of population biology.

COLETTE ADAMS

Galápagos Land Iguana (*Conolophus subcristatus*): two species are currently recognized, although some data suggest that they are mere geographic variants and other data provide support for even greater variation among populations on the various islands of the archipelago. Land Iguanas were among the species encountered by Charles Darwin during his sojourn in the islands. Like many island endemics, they evolved in an environment largely free of predators and competitors and are extremely vulnerable to human activities that alter habitats and expose them to invasive carnivores and to herbivorous mammals that deplete the vegetation on which they depend.

The seventh section of the volume takes the author to the world of Tom Lovejoy, "The Hedgehog of the Amazon." Quammen examined the SLOSS (single large or several small) debate and its effect on the creation of the Minimum Critical Size of Ecosystems Project. The author goes on to suggest that it might be Tom Lovejoy that needs to be thanked for those instances where larger natural reserves have been set aside. "The Song of the Indri" (the largest surviving lemur) shifts Quammen's travels and thoughts to Madagascar. Using the question: "How rare is too rare?" he extends the thoughts of minimum critical size to the world of population genetics and genetic drift. Once again, the author beautifully weaves the "soul" of biology (in this case, the story of the life and death of the guide, Bedo) into the world of professional science.

"World in Pieces" takes the reader from island ecosystems to the work of Carl Jones and the Kestrels of Mauritius and the primate work of Karen Strier in Brazil. Quammen summarizes his concerns about the patterns seen in these examples and others: "All over the planet, the distributional maps of imperiled species are patchy. The patches are winking. In some instances they're winking off and on, but in many instances they're merely winking off." In the final section of the book, Quammen takes the reader back to the travels and thoughts of Wallace. In "Message from Aru," we are reminded of the fragility of the natural world and Wallace's warning in 1869: "…should civilized man ever reach these distant lands, and bring moral, intellectual, and physical light into the recesses of these virgin forests, we may be sure that he will so disturb the nicely balanced relations of organic and inorganic nature as to cause the disappearance, and finally the extinction" of all too many species. For Quammen, it comes down to a question: Has it already happened, or do we still have time?

Readers of *The Song of the Dodo* will learn much about the research that has gone into the study of evolution and extinction — but the book is anything but a dry tome reciting facts, names, and dates. The author captures you and takes you into the minds of Charles Darwin, Alfred Wallace, Robert MacArthur, and other scientists during their quests for new insights. Quammen's gift is the story-telling that draws the reader into the events that led to each of many amazing discoveries. By incorporating exhilarating stories with educational information, the author painlessly teaches us the jargon of island biogeography, making this book an easy read for people who have little background in evolutionary biology and may have forgotten most of what they learned in high-school biology classes.

Although the subject matter is often depressing and the history of such an arcane discipline as island biogeography hardly seems appealing, this book is interesting and understandable — and often as entertaining as a best-selling novel. The occasionally hilarious, seat-gripping stories of well-known scientists combined with the depth of information make the book hard to set aside.

Sarah M. Wissmann
University of New England
Biddeford, Maine

and

David A. Wissmann
Avila University
Kansas City, Missouri

CONSERVATION RESEARCH REPORTS

Sea Turtles in the Netherlands Antilles

Until recently, information on sea turtle nesting in the Netherlands Antilles consisted mostly of anecdotal accounts and sea turtle nesting was considered to be a rare or accidental occurrence. DEBROT ET AL. (2005. *Caribbean Journal of Science* 41:334–339) cited several recent studies and presented documentation of several additional sea turtle nesting beaches on Curaçao, Klein Curaçao, St. Eustatius, and St. Maarten. Historically, most studies have focused on large sea turtle nesting beaches, whereas the results of this study support the idea that small, scattered nesting beaches could cumulatively contribute significantly to both reproductive output and recovery potential of several species when examined on a regional scale.

ROZENN LE SCAO (STENAPA)

Leatherback Sea Turtles (*Dermochelys coriacea*) are nesting more frequently in the Netherlands Antilles.

Impact of Foxes on Freshwater Turtle Populations

The resilience of a freshwater turtle population to stage-specific predation is density-dependent, and some species are more susceptible to predation because of their life-history strategies. Nest predation by introduced Red Foxes (*Vulpes vulpes*) on Australian freshwater turtles is a major source of mortality, but its full impact has yet to be evaluated. Freshwater turtles are long lived, and a population decline resulting from nest predation by foxes may take a long time to become evident. SPENCER AND THOMPSON (2005. *Conservation Biology* 19:845–854) evaluated the impact of foxes on population growth and patterns of survival of two widely distributed Australian freshwater turtles in the Murray River, where nest predation rates have previously been reported at above 95%. They estimated densities and survivorship of *Emydura macquarii* and *Chelodina expansa* from the nest to adult stage, and then conducted a fox-removal program to determine the impact of foxes on populations of these species. *Chelodina expansa* was five times less abundant than *E. macquarii*. Densities of *C. expansa* nests were low and situated away from shore, and nest-predation rates were half those of *E. macquarii*. *Emydura macquarii* populations had low productivity and relied on a standing crop of adult turtles for population maintenance, whereas *C. expansa* had relatively more juveniles in the population and was less reliant on adult survival. Despite its vulnerable status, *C. expansa* is relatively more stable than *E. macquarii*, primarily because there were proportionally more juveniles in the population. Management options focusing on reducing adult mortality in both species will be most effective.

DARREL SENNESKE

Populations of *Chelodina expansa* in Australia appear to be less vulnerable than those of *Emydura macquarii* to nest predation by introduced Red Foxes (*Vulpes vulpes*), presumably because nest densities of the former are low and nests are located farther from shores.

Destructive Collecting Practices and Reptilian Abundance

Collecting reptiles often results in irreparable damage to microhabitats. Such activities and the concomitant destruction of habitats are increasing in frequency due largely to rising demand for reptiles in the pet market. GOODE ET AL. (2004. *Journal of Wildlife Management* 68:427–432) compared abundance of reptiles on rock outcroppings in Arizona before and after disturbance. Results suggest that destructive collecting techniques led to a decrease in the abundance of diurnal lizards, which preferred undisturbed portions of rock outcrops. The authors recommended that collecting methods be strictly regulated and that implementation of these regulations be accompanied by increased enforcement to render them effective.

Loggerhead Turtle Nesting Trends

HAWKES ET AL. (2005. *Oryx* 39:65–72) analyzed a 24-year set of data from intensive monitoring of a nesting beach at Bald Head Island, North Carolina, USA and more limited data from nearby rookeries to investigate trends in Loggerhead Turtle (*Caretta caretta*) nesting numbers. Re-migrating turtles were larger and had larger annual clutch frequencies than neophyte turtles. However, no statistical evidence suggested either an increasing or decreasing trend in numbers of clutches laid per year, although a significant decrease in the number of turtles nesting and number of clutches laid per year was found over the period since 1991.

SCOTT A. ECKERT (WIDECAST)

Loggerhead Turtles (*Caretta caretta*) often nest on beaches in subtropical and even temperate zones.

Efficacy of Green Turtle Headstarting

Headstarting is a management technique employed to enhance recruitment of turtles into diminished or extirpated marine turtle populations. Although numerous worldwide projects have been implemented, few detailed investigations have examined the efficacy of the concept. BELL ET AL. (2005. *Oryx* 39:137–148) noted that between 1980 and 2001,

16,422 captive-raised hatchlings and 14,347 yearling Green Turtles (*Chelonia mydas*) were released from the Cayman Turtle Farm. Approximately 80% of all turtles released were subject to some form of tagging. A total of 392 tagged animals have been recaptured at intervals of up to 19 years. Of this total, 160 individuals were captured in the Cayman Islands and 232 were recorded from other locations within the wider Caribbean and southeastern United States. A positive relationship exists between time at large and size at recapture, and data suggest that growth rates are comparable to those of wild Green Turtles in the region. Age at maturity may be as short as 15–19 years, depending on stage at release. Results show that some headstarted turtles are moving around the Caribbean, surviving for long periods of time, contributing to local breeding population, and may be displaying age-related shifts in habitat utilization similar to those recorded for wild individuals.

JOHN SULLIVAN, RIBBIT PHOTOGRAPHY

An adult Green Turtle (*Chelonia mydas*) on a Grand Caymanian beach.

Marine Turtles in The Gambia, West Africa

BARNETT ET AL. (2004. *Oryx* 38:203–208) reported the first systematic survey of the marine turtles of the 80 km of The Gambian coastline, and brought together new data and all past records and reports of marine turtles in The Gambia. Green Turtles (*Chelonia mydas*) are the most abundant turtles and this is the only species so far observed nesting in The Gambia, with peak nesting between August and October. Although 75% (60 km) of The Gambian coastline appears to be suitable for turtle nesting, most nesting activity is confined to the southern coastline. Offshore foraging habitat is apparently extensive. Strandings of Green Turtles, Olive Ridley Turtles (*Lepidochelys olivacea*), Leatherback Turtles (*Dermochelys coriacea*), and Hawksbill Turtles (*Eretmochelys imbricata*) have been recorded, but we were unable to find evidence for Loggerhead Turtles (*Caretta caretta*). Threats are mainly of human origin, and include illegal harvesting of eggs, juveniles, and adults, as well as mortality as fisheries bycatch, including trawling. One stranded Green Turtle apparently had fibropapilloma disease. The major threat to nesting habitats is erosion and unregulated development of the coast for tourism. Marine turtles are fully protected under Gambian law.

ROWAN BYRNE (WIDECAST AND WWW.MARINECREATURES.COM)

Hawksbill Turtles (*Eretmochelys imbricata*) have been recorded along The Gambian coast.

Lesser Antillean Snakes: Conservation Concerns

Thirty-three islands in the Lesser Antilles range in area from 0.06–1,510 km^2 and collectively harbor 25 species of snakes representing five families and 10 genera. HENDERSON (2004. *Oryx* 38:311–320) noted that the islands have suffered at least six, and possibly as many as 11, historical extirpations and at least one historical extinction. The number of snake species per island is 1–5, and species richness is correlated with island size and habitat diversity. Islands that harbor three or more species exhibit greater habitat diversity, are larger, have a higher maximum elevation, and are situated closer to the South American mainland, the source area for most genera. North of the Guadeloupe Archipelago, islands support one or two species (an *Alsophis* or an *Alsophis* and a *Typhlops*). From the Guadeloupe Archipelago southward, snake faunas have species belonging to genera that are widespread on the Neotropical mainland: *Boa, Corallus, Chironius, Clelia, Liophis, Mastigodryas* and *Bothrops.* Between 50 and 75% of the Lesser Antillean snake fauna preys on *Anolis* lizards. Snake faunas in the Lesser Antilles are not saturated, and many islands could support additional species; fossil evidence and written records indicate that they did. The islands have a 5,000-year history of habitat alteration, but introduced predators probably have had the greatest negative impact on snakes. The potential establishment of an alien snake (e.g., *Elaphe guttata)* into the Lesser Antilles is a valid concern. Preventing additional introductions of alien predators and protecting satellite island populations of threatened species are the two most important mechanisms for snake conservation in the region.

RICHARD SAJDAK

Introduced predators, notably the mongoose (*Herpestes javanicus*), undoubtedly have had the greatest negative impact on native Lesser Antillean snake populations. *Mastigodryas bruesi* is somewhat less vulnerable than many other species because of its arboreal inclinations.

19TH ANNUAL MEETING OF THE SOCIETY FOR CONSERVATION BIOLOGY

Universidade de Brasília, Brazil
22 July 2005

Excerpts from abstracts dealing with the conservation of reptiles.

Santos, G., J. Pacheco, G. Ceballos, F. Mendoza-Quijano, G. Daily, and P. Ehrlich. **COUNTRYSIDE BIOGEOGRAPHY IN REPTILE AND AMPHIBIAN COMMUNITIES IN SOUTHERN COSTA RICA: CONSERVATION VALUE OF HUMAN DOMINATED LANDSCAPES.** The future of biological diversity in the tropics depends largely on the conservation value of human-dominated lands. In this study, we investigated the distribution of amphibians and reptiles in five habitats of southern Costa Rica: relatively extensive forest (227 ha), coffee plantation, pasture, coffee with adjacent forest remnant (<35 ha), and pasture with adjacent forest remnant (<35 ha). Species richness, composition, and abundance varied significantly with habitat type and distance from the extensive forest. Additionally, we recorded the local extinction of at least five species, likely as a result of human-induced changes such as forest fragmentation, introduced diseases, and global warming. Of the 67 amphibian and reptilian species recorded in our plots, most (48, 68%) were found in forests and forest fragments, 36 (50%) in coffee plantations, and 38 (51%) in pastures. Additionally, 20 were recorded exclusively in extensive forest and forest fragments, eight in coffee, and eight in pastures. Relatively continuous forest and small forest patches in combination with coffee plantations are important for the maintenance of the region's biological diversity, despite large scale negative human activities.

JOHN BINNS

The Brown Basilisk (*Basiliscus vittatus*) actually may benefit from forest fragmentation because of its dependence on edges. Many species however suffer when human activities break up contiguous stretches of suitable habitat into pieces too small to support viable populations.

JOHN BINNS

Ctenosaura nolascensis is restricted to an island in the Gulf of California, México. Like all islands in the Gulf, San Pedro Nolasco is a protected area. Enforcement, unfortunately, is inconsistent. Nevertheless, many Mexican species, including many that are threatened or endangered, have no populations in protected areas.

Santos, G., J. Pacheco, and G. Ceballos. NATURAL PROTECTED AREAS AND THE CONSERVATION OF AMPHIBIANS AND REPTILES IN MEXICO: PRIORIZING SPECIES AND AREAS FOR CONSERVATION STRATEGIES. One principal goal in establishing protected natural areas is to preserve ecosystems and associated biodiversity in order to perpetuate natural evolutionary processes. This study evaluates the efficiency of protected natural areas for the conservation of Mexican amphibians and reptiles. These groups are highly diverse in Mexico, with 1164 species (360 amphibians and 804 reptiles) and high endemism (60%, 241 and 450, respectively). We used 34 inventory lists from protected areas and considered conservation status, geographic range, and endemism of listed species to build a hierarchical system to identify priority species for conservation. The complementary study of these areas revealed that 56% of the Mexican herpetofauna is excluded from the protected areas.

Jessop, T.S., J. Imansyah, D. Purwandana, H. Rudiharto, and C. Ciofi. **MANAGEMENT AND CONSERVATION REQUIREMENTS FOR KOMODO DRAGON POPULATIONS IN KOMODO NATIONAL PARK, INDONESIA.** Within archipelagos, populations may exhibit intraspecific differences requiring plasticity in management and conservation practices. Four of the five island populations of the Komodo Dragon (*Varanus komodoensis*) reside within the world heritage-listed Komodo National Park in eastern Indonesia. To identify current management and conservation requirements for the park's dragon populations, a concerted long-term research program has been established. Results indicate that major differences in demography and ecology exist between dragon populations on the two large islands of Komodo and Rinca and the two small islands of Motang and Kode. Specifically, island area influences prey diversity and avail-

JOE WASILEWSKI

Populations of Komodo Dragons (*Varanus komodoensis*) remain vulnerable to human affects on their habitat. Reductions in the population size of Timor Deer, attributable to poaching, affected body condition and population size structure of the Dragons.

ability, which, in turn, influences the density, growth, and body size of dragons. The Motang Island population, estimated at 51 ± 6 post-hatchling individuals, recorded a recent reduction in catch per unit effort, body condition, and changes in population size structure. Such changes have resulted from a decreased abundance of Timor Deer, due to suspected poaching. Increased resource security and potential augmentation of prey density may be required to conserve this population.

Gerber, G.P. and A.C. Alberts. **TRANSLOCATION AS A RECOVERY STRATEGY FOR THE CRITICALLY ENDANGERED TURKS AND CAICOS IGUANA.** In response to threats from introduced mammalian predators and human development, Turks and Caicos Iguanas (*Cyclura carinata*) were translocated in January 2002 and 2003 from two large but threatened island populations to four small protected islands with suitable habitat but lacking extant iguana populations. Translocation islands received 18–82 adult iguanas of equal sex ratio from one of the two source islands, depending upon their area (1–12 ha) and estimated adult carrying capacity. Source and translocated populations were monitored 2–3 times annually between 2002 and 2005. By five months, post-translocation adult iguanas on translocation islands had established normal movement patterns and were exhibiting normal or increased growth rates relative to source populations. Successful reproduction has occurred on all translocation islands each year since reintroduction and iguanas hatched on translocation islands are exhibiting growth rates 2-4 times that of juveniles of the same age on source islands. This has resulted in a decrease in age at maturity on translocation islands, relative to source islands, from 6–7 years to 2–4 years. We attribute increased growth rates on translocation islands to decreased intra-specific competition (i.e., density), relative to source populations, and predict that growth rates will return to baseline as carrying capacities are approached.

JOHN BINNS

Translocated populations of Turks and Caicos Iguanas (*Cyclura carinata*) are showing growth rates and ages at maturity suggesting that they are taking full advantage of resources that are superabundant as long as the population of iguanas remains below carrying capacity.

LAURIE J. VITT

Animal populations inhabiting the Atlantic forest of northeastern Brazil are becoming increasingly fragmented, reducing the chances of maintaining long-term biodiversity. Particularly vulnerable are large species and those, such as *Corallus hortulanus*, dependent on forest habitats.

Freire, E.M.X., U. Caramaschi, M.T. Rodrigues, and S.T. Silva. **EFFECTS OF THE FRAGMENTATION OF ATLANTIC FOREST IN THE STATE OF ALAGOAS (NORTHEASTERN BRAZIL) ON THE DIVERSITY OF SPECIES OF LIZARDS AND SNAKES.** The Atlantic Forest of Brazil has become fragmented and reduced to about 7% of its original size. In the Northeastern Region, the most significant remnants are in the States of Bahia (6%) and Alagoas (2%). An inventory of different-sized forest fragments in the state of Alagoas involved 2,950 person-hours. Species diversity was high and 19% of the species were endemic to the northern part of the Atlantic Forest and two were new to science. The smallest area exhibited the highest diversity index, which two subsequent studies (1,100 person-hours) confirmed. This diversity may not be maintained, because the populations of animals in these fragments may not be viable in the long term.

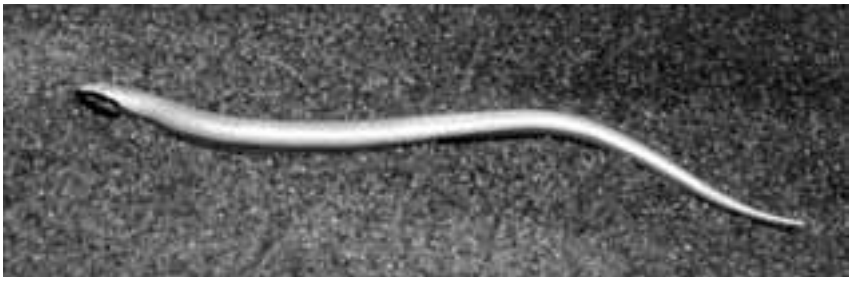
Bennett, D. **CONSERVATION OF A LARGE FRUGIVOROUS MONITOR LIZARD IN THE PHILIPPINES.** Frugivory is a rare strategy in lizards, but, in the Philippines, a group of large (>9 kg) *Varanus* lizards has evolved to become specialized frugivores in dipterocarp forest. Efforts to understand their ecology and promote their conservation have been hampered by their highly arboreal and secretive behavior. Here I report on the behavioral ecology of a population of *Varanus olivaceus* in fragmented forest on Polillo Island, Quezon Province, that have been the subject of a non-destructive and largely non-intrusive study instigated in 1999. Despite the large numbers of fruit types available to animals in dipterocarp forest, the lizards feed mainly on fruit from just four genera. They act as unique dispersers of *Pandanus* seeds, which results in high densities of these plants along slopes and ridges, which, in turn, has important implications for other fauna and flora dependent on *Pandanus* microhabitats. Their inability to fly means that large frugivorous lizards are more vulnerable to forest fragmentation than sympatric frugivores (birds and bats), but the results of this study indicate that populations can be maintained in disturbed forest if a few key resources are maintained.

JEFF LEMM

Varanus olivaceus is one of very few frugivorous lizards in the world and acts as an important disperser of *Pandanus* seeds.

NEWSBRIEFS

Sand Skinks are Elusive Creatures



SUZANNE L. COLLINS, CNAH

Florida Sand Skinks (*Neoseps reynoldsi*) are among a select group of lizards known as "sand-swimmers," most of which have reduced or missing limbs.

They leave S-shaped designs in the sand. Federal and state wildlife officials classify them as threatened. They live on the sand ridges of Central Florida. That sums up what most people know about Sand Skinks (*Neoseps reynoldsi*), if they've heard of them at all. Sand Skinks are among the creatures that live on the Lake Wales Ridge, a chain of prehistoric islands that comprised all of the dry real estate in what once was peninsular Florida.

Like better-known species such as Gopher Tortoises (*Gopherus polyphemus*), their habitat is often bulldozed to make way for new development. This is the time of year when biologists try to learn more about these elusive reptiles because the skinks become more active and easier to detect as temperatures rise. The survey method is fairly low-tech. It involves placing a 2 x 2 piece of plywood on bare ground and going back every week or so and looking for tracks. Sand Skinks forage in the sand beneath the board, leaving trails in the sand that can look like anything from a winding riverbed to a plateful of macaroni.

Data collection is simple. Either tracks are there or they aren't. In fact, it's good to stop here and mention that one of the important aspects in wildlife surveys is the ability to collect information along fixed routes, which are marked with flags, metal poles, wooden stakes or some other method. If you see these markers or the boards, that's what they're for. Don't disturb them or you could screw up someone's research project.

As wild creatures go, Sand Skinks are a relatively recent addition to the scientific list of creatures. The Sand Skink was officially described in the scientific literature as a separate species in 1910 by Leonard Stejneger (1851–1943), who was head curator of reptiles and amphibians at the Smithsonian Institution.

Sand Skinks look like small snakes — they're only about 5 inches long — with tiny legs. They belong to a group of reptiles known as "sand-swimmers." That means they move around just under the ground's surface looking for something to eat. Termites make up a major part of their diet. Mole Skinks (*Eumeces egregius*) and some species of snakes, such as Southeastern Crowned Snakes (*Tantilla coronata*), also are in this category.

Because of their secretive habits, Sand Skinks are rarely seen and scientists are still trying to learn more about what they need to survive. Surveys at various wildlife preserves are part of that research because they provide a baseline, a basis for comparison to spot population trends (used here in a generic sense, population estimates for Sand Skinks don't exist).

What do exist are lists that give the number of locations where Sand Skinks are found, but it's unclear how big a territory each Sand Skink occupies or where the young go after they hatch. One small step in Sand Skink research occurred when a University of Florida student named Byrum Cooper set out on a quest to figure out how to capture these elusive creatures. This short 1953 account, published in the Florida Academy of Sciences quarterly journal, concluded that a potato rake and quick hands were the best tools for collecting specimens. Some of you may know this young student as Buck Cooper, the retired B-52 navigator who served as naturalist at the Street Nature Center in Winter Haven for several years.

By the way, nowadays it is illegal to collect Sand Skinks or any other protected species without a permit from state and federal wildlife officials.

One interesting side benefit of Sand Skink surveys is learning about other creatures that inhabit the scrub. Researchers have reported finding millipedes, centipedes, ants, termites, spiders, and various other even smaller beetles and other invertebrates. Sometimes other reptiles are using the board as a temporary shelter. They include Scrub Lizards (*Sceloporus woodi*), a type of lizard called a Six-lined Racerunner (*Aspidoscelis sexlineatus*), and various species of snakes. One researcher even found a baby rattlesnake. I guess it's a good idea to lift the boards carefully.

The Ledger

Lakeland, Florida; 11 May 2005

Snake Sanctuary: Rattlesnakes Roost in Rocky Stretch of Western Iowa

Just north of here, Prairie Rattlesnakes (*Crotalus viridis*) slither among rocks and yucca plants in a stretch of Loess Hills that is Iowa's little slice of the West. Across the Missouri River, the Prairie Rattlesnake is common in Nebraska, but these 15 acres in Plymouth County are thought to be the species' only home in Iowa.

The Nature Conservancy, a private, nonprofit preservation group hoping to protect the species in Iowa, recently added the snake's hibernating area to its 3,050-acre Broken Kettle Grasslands, which is an important bird sanctuary. This rocky stretch of the silty-soil Loess Hills offers hiding places the snakes need for hibernation. The conservancy bought the land to prevent housing development, traffic, mowing, and, eventually, farming in the area, all of which could harm the snake, said Susanne Hickey, the group's Loess Hills project director. The area is open to the public. "It's a western species that gets into the Loess Hills because it's a drier habitat," Hickey said.

The Broken Kettle area has an estimated 110 adult rattlesnakes, said Conservancy herpetologist Dan Fogell. Fifty of the snakes have been tagged with microchips, which are injected under their skin with a syringe. The $6.50 chips

carry a 10-digit code that can be read by passing the scanner over the snake. They are similar to the microchips that veterinarians use in pets. On a recent day, Fogell and crew bet they could find a rattler within five minutes along a ridge a quarter-mile from Iowa Highway 12. They scored.

Fogell, who lives in Omaha and teaches at Southeast Community College in Lincoln, Nebraska, passed an electronic reader over the snake, and immediately saw an identification number in the display. A repeat customer, this snake. Fogell's colleague grabbed the snake with a gizmo similar to those some people use to pick things off the floor. Pulling a trigger operates a clamping device on the end. Fogell then grabbed a long plastic tube — picture a bigger and sturdier version of the ones they put on single roses at the floral shops — and pushed the snake's head inside. With the snake unable to bite, Fogell passed the rattler to a colleague, who weighed and measured it.

SUZANNE L. COLLINS, CNAH

Prairie Rattlesnakes (*Crotalus viridis*) range widely across the Great Plains and barely into extreme western Iowa.

The first of five rattlers found was a female, 31 inches long. These snakes mate in spring and late summer but often keep the sperm for a year before they become pregnant. They give birth to live snakes, often a dozen or more at a time, and hope the Blue Racers (*Coluber constrictor*), another snake species, don't eat them. Fogell is tracking the snake population for the Nature Conservancy. Earlier, he used radio transmitters to track the snakes' movements for the Iowa Department of Natural Resources. During that study, he discovered that the snakes slither up to two miles from their rocky homes.

Later, Fogell mentioned that the snakes roam the countryside for two reasons: Sex and food. One of the apparently nervous visitors asked Fogell if there is a time that the venomous snakes are aggressive. "Every day," Fogell replied. Especially if they've just given birth. Judging by the varying volume and frequency of the snakes' rattle-shaking, these snakes were in various stages of agitation.

But the snakes aren't normally aggressive toward humans. There is no record of anyone being bit by a rattlesnake on this land, Fogell said. Most people will find a way to get away from the snake when they hear its warning rattle. Landowners nearby, however, have reported that the snakes have bitten their dogs and cattle.

In Iowa's slice of the West, the rattlers rule.

Perry Beeman
Des Moines Register

Endangered Bog Turtle Holding up Highway Project

A turtle is slowing down a Route 7 highway bypass project in Brookfield (Connecticut), despite a push by Gov. M. Jodi Rell to speed things up. The state Department of Environmental Protection is withholding permits for work until a report is done on whether Bog Turtles (*Glyptemys muhlenbergii*) might live in the area of the bypass. In November, Rell had said there would be no holdup to planned construction on the bypass. The $98-million project was scheduled to go out to bid this month.

Chris Cooper, a spokesman with the Department of Transportation, said that, without permits from the DEP, the project cannot go out to bid. But Cooper said, even if the Bog Turtle is present, the road could still be built. "We will work with environmental experts because it is an endangered species," Cooper said. "The state is committed to the project as part of its regional transportation improvement plan."

SUZANNE L. COLLINS, CNAH

Bog Turtles (*Glyptemys muhlenbergii*) are listed as "threatened" under the Endangered Species Act and as "endangered" by agencies in states with extant populations.

Tom Harley, manager of the consulting design unit for the DOT, said a report on whether Bog Turtles are living in the area is expected in June and will be turned over to the DEP.

Julie Victoria, a wildlife biologist with the DEP, said the proposed bypass area might be a historic habitat for the Bog Turtle, which was listed as federally threatened in November 1997. The turtle grows to about 3 inches in length and has orange splotches on either side of its neck.

Boston Globe (Massachusetts), 18 May 2005

European Wall Lizards in British Columbia

Lizard Invasion: Scientists ponder the implications, as a species native to Europe appears to be thriving on South Vancouver Island. They're sunning themselves at the Saanich Fairground and scampering on the walls of Wilkinson Road jail. They're scurrying past Stelly's Cross Road and scaling Triangle Mountain.

Thousands of European Wall Lizards (*Podarcis muralis*), a non-native species, are making this part of the world their home. Biologists are wondering what effects they are having on BC's native Alligator Lizard (*Elgaria coerulea*). "We have great and grave concerns over exotic species," said Richard Hebda, curator of botany and Earth history at the Royal BC Museum. "Exotic species are poised to take over the niche abandoned by native species."

European Wall Lizards were introduced into Greater Victoria in the late 1970s, when Rudy's Pet Park Zoo on Durrance Road closed. A few Wall Lizards either escaped or were released into the wilds of Central Saanich. The reptiles survived, living in rock walls, and slowly spreading through the gardens and forests of the Saanich Peninsula. Hebda remembers spotting a few tiny green and black-flecked creatures in a broken concrete wall on his property about 1988. A few years later, they were quite abundant. "They're delightful creatures, but there were never as many as we see now. Their numbers have gone way up. At first they

European Wall Lizards (*Podarcis muralis*) have been repeatedly introduced into North American cities, where they frequently thrive in habitats dramatically altered by humans.

were a curiosity, now they're just everywhere," he said. The lizards — which are about 10 cm long, not including their tail — no longer inhabit just the warm cracks in rock walls at his home, they also dash around the garden.

University of Victoria biology professor Pat Gregory first heard about the European Wall Lizards in 1990 and immediately went to see them. "I was impressed by their numbers," said the herpetologist. "I don't know how many we saw that day." He thought about the possibilities they offered for future research studies. "Any introduced species is interesting and you have to take them quite seriously," said Gregory. "It's interesting to see how they fit into an entirely different system from their native one. It's interesting to know whether they pose a threat to native species."

A study by a master's student on the interaction between the European Wall Lizard and Alligator Lizard shows they didn't get along too badly, said Gregory. "The student found the Alligator Lizards were reluctant to go under the same cover as the wall lizards. But she didn't find any aggressive behavior." However, more research needs to be done on the population ecology of Alligator Lizards in places where wall lizards have been introduced, said Gregory. "Just because we haven't observed a depressing effect on the population of the Alligator Lizard doesn't mean it isn't happening. There's nothing really obvious in terms of their negative effects, but there might be some less obvious effects."

Hebda has already heard tales of people who grew up in Central Saanich capturing Wall Lizards and releasing them in their suburban neighborhoods — a practice he frowns on. "I think biologically we have enough challenges already." Getting rid of them would be impossible because there are far too many of them, said Gregory, and gardeners would probably object. "They're small and numerous and people seem to like them," he said.

Louise Dickson
Times Colonist, Victoria, British Columbia

European Wall Lizards in Ohio River Park

State wildlife staffers are putting out traps at the Falls of the Ohio State Park in an effort to exterminate an exotic lizard that has been found there. The Common Wall Lizard (*Podarcis muralis*) is native to parts of Europe and can grow to more than eight inches. It has no known predators in North America and can survive midwestern winters. How the lizards got to the park just north of Louisville, Kentucky is not known. They were introduced to the Midwest in 1951, when a Cincinnati resident brought some back from Italy and released them. Indiana Department of Natural Resources (DNR) herpetologist Zack Walker has designed special traps to capture Wall Lizards, while sparing native species. "I've constructed the traps to target Wall Lizards and to exclude other species of wildlife. If a non-target species is caught, it will be released without harm," he said. Once the Wall Lizards are caught, they will be exterminated.

WKYT, Lexington, Kentucky

The Island Snake Lady

Not many young women would take pride in being called "the island snake lady," but Kristin Stanford does. Based at Ohio State University's Stone Laboratory on Gibraltar Island in Lake Erie, Stanford acquired the nickname shortly after beginning a research project on the endangered Lake Erie Water Snake (*Nerodia sipedon insularum*). It lives only on the rocky shores of western Lake Erie islands, and, until Stanford arrived five years ago, it enjoyed a lousy reputation among island residents and visitors.

Water Snakes make poor neighbors. They bask innocently near docks, jetties, and piers, and curious travelers, especially children, try to catch them. That's a big mistake because, though they're harmless, they're mean, ill-tempered, and quick to bite. Combine their nasty personality with most people's innate fear of snakes and you've got a conservation education nightmare.

Enter Stanford. Five years ago, after completing her master's degree at Northern Illinois University, where she studied the Plains Garter Snake (*Thamnophis radix*), Stanford jumped at the chance to do her doctoral research on the Lake Erie Water Snake. She understood that a key to the unpopular species' survival was convincing the islands' human population that, if left alone, water snakes are harmless and even ecologically beneficial.

Over the course of four years, Stanford captured water snakes on South Bass, Gibraltar, Middle Bass, North Bass, and Kelley's islands. Her work included surgically implanting radio transmitters into 61 snakes so she could track their movements and locate their winter dens. The fieldwork is complete, and Stanford is writing her dissertation — but that was the easy part. Convincing people to appreciate water snakes was the greater challenge. Having just spent a week at Stone Lab teaching an ornithology class, I observed firsthand that Stanford's people skills are among her greatest assets.


SUZANNE L. COLLINS, CNAH

Endangered Lake Erie Water Snakes (*Nerodia sipedon insularum*) have become the subject of research for the island snake lady.

Last year, she taught a popular and successful one-week herpetology class. She obviously excelled because she was recognized last week as one of 2004's outstanding summer instructors at the Stone Lab. This year she's co-teaching a five-week herpetology class. Although the class covers all types of reptiles and amphibians, snakes are her passion. One day she turned her class loose on six-acre Gibraltar Island. The assignment was to catch snakes. Ninety minutes later the students returned, each with a pillowcase filled with three or four writhing snakes. On a break, I wandered into the herp lab and found Stanford holding an absolutely beautiful Fox Snake (*Elaphe vulpina*). "Fox Snakes live in wetlands along Lake Erie in northwestern Ohio, and I'm studying their abundance and habitat requirements," she said. She's hoping to determine the effects of habitat fragmentation on these boldly patterned constrictors.

With her background, it's only natural that Stanford has acquired the "island snake lady" nickname. But her reputation is largely due to the outreach programs she does throughout a multi-county area. She provides educational programs to schools and other groups and writes a monthly newspaper column in which she answers reader questions about snakes and other herps. In fact, if you have any snake questions, contact her at "theislandsnakelady@yahoo.com."

During my week at Stone Lab, I discovered two additional tangible indications of Stanford's influence. Many driveways on the islands now sport signs provided by the U.S. Fish and Wildlife Service and the Ohio DNR that read, "Water Snakes Welcome Here." I doubt there were any of those before Kristin arrived. And finally, there's Arthur Wolf, Stanford's 9-year old protégé, who lives on Middle Bass Island. "I call him 'My little snake man,'" she said. "He's caught many water snakes for me on Middle Bass." His father, who captains one of Stone Lab's research boats, told me he's now catching Fox Snakes for Stanford. Wolf's extraordinary exploits are featured in the current issue of "Wild Ohio for Kids Magazine." Kristin Stanford does it all — researcher, teacher, mentor, community relations expert. Not a bad resume for the "island snake lady."

Scott Shalaway
Pittsburgh Post-Gazette

Spiny Softshell Scoped

Thirteen-year-old Steve Glen thought he was battling a big catfish in River Canard until he reeled in one strange looking turtle. A bit of research on the internet confirmed that he'd landed a threatened species, an Eastern Spiny Softshell (*Apalone spinifera*). The turtle had swallowed the worm and hook and needed medical attention.

A Spiny Softshell is a rare sight, said Tammy Dobbie, Point Pelee National Park's ecosystem management coordinator. "We usually have on average one valid sighting a year in and around Point Pelee National Park," she said, adding that 2002 was the last time live ones were spotted at the park. "You don't get many sightings. They are around but they're a shy and secretive turtle."

Dobbie said the Spiny Softshell, the only turtle like it in the country, is found in southern Ontario and southern Quebec. They're hard to spot because they're rare and the speedy swimmers spend most of their time underwater in lakes. Sometimes only their nostrils stick out of the water.

Erie Wildlife Rescue drove the turtle to a Windsor veterinarian who planned to anesthetize it and put a scope down its neck to find the hook Wednesday. The scope will help the vet see what damage has been done and, if all goes well, the turtle will be put on antibiotics and later released back in River Canard, she said.

The turtle is a female that is estimated by its size to be more than twenty years old, she said. The 2.4-kg turtle is 32 cm long and 26.5 cm wide. Males are usually up to 23 cm long.

Dobbie said the Glens did the right thing and the turtle is worth saving because females don't reproduce until they're more than twelve years old. She said losing even one female of the threatened species would hurt the population.

Sharon Hill
Windsor (Ontario) *Star*

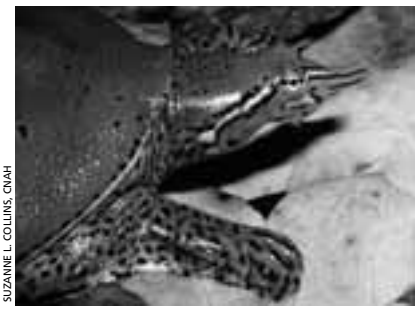
Turtle Saved from Soup

They're calling him "the lucky Royal Turtle" — an endangered reptile that was saved from a likely fate in a Chinese soup pot by keen-eyed wildlife officials and a microchip.

Poachers snatched the animal, a species called the Royal Turtle in Cambodia because the eggs were once fed to kings, from a Cambodian river two months ago and toted it across the Vietnamese border with a stash of more common turtles.

Conservationists said that at 33 pounds, the animal was sure to have fetched a good price when it reached the smuggler's destination — the food markets of China, where turtle meat is a delicacy often made into soup.

A raid on the smuggler's house in southern Vietnam's Tay Ninh province was the turtle's first stroke of good luck. About 30 turtles were confiscated and transported to a wildlife inspection center.


SUZANNE L. COLLINS, CNAH

Spiny Softshell Turtles (*Apalone spinifera*) range widely across eastern North America and as far north as southern Ontario and Quebec.


CHRIS TABAKA, DVM

A giant River Terrapin (*Batagur baska*) was saved from the soup pot by a keen-eyed wildlife official and a microchip.

"My staff said they had never seen a turtle that big," said Ta Van Dao, head of the forest control bureau in Tay Ninh. "Its head and eyes were also different from the regular turtles."

The Vietnamese wildlife officials consulted an endangered species book and then called Doug Hendrie, an Asian turtle specialist based in Hanoi for the New York-based World Conservation Society. They confirmed that it was a *Batagur baska*, or Asian River Terrapin. Officials then found a microchip implanted under its wrinkly skin, pinpointing its exact home on the Sre Ambel River in southern Cambodia.

Hendrie said there were only about two to eight females remaining there, making the return of this adult male even more vital. It had been tagged in Cambodia for research two years ago but not seen again until its discovery in Vietnam.

The turtle was shipped back to Cambodia last week.

The Associated Press

Save Rattlesnakes in New York Park

The ponytailed environmentalist hiked down the ridge, over the gray rocks and matted brown leaves, stopped among the hardwoods, and said, "Right down the side, it's prime country here."

The warm, southeast-facing rock cliffs overlooking Lake Champlain mark the northern limit of the Timber Rattlesnake's habitat. Jaime Ethier, in boots and jeans, was bushwhacking from Champlain Palisades down to the pebbled shores of the lake — through terrain where he wouldn't see a coiled dark snake unless he nearly stepped on it. The Adirondack Council conservation director appeared unconcerned. He kept going off the trail to peer into crevices likely to hold a den of poisonous reptiles, whose spiky tails make the telltale rattle or buzzing sound when disturbed. He'd met a rattlesnake almost two years earlier in this forest 110 miles north of Albany and wanted to see another. Ethier was out of luck on a day of overcast skies and temperatures in the mid-50s, probably still too cool for the snakes.

Ethier's group wants to undo state conservation plans to allow mountain bikes in this neck of the 6-million-acre Adirondack Park, afraid cyclists will kill

RICHARD SAJDAK

Populations of Timber Rattlesnakes (*Crotalus horridus*) near the species' northern-most limits remain vulnerable to human contact. A New York conservation group wants to undo state conservation plans to allow mountain bikes into portions of the 6-million-acre Adirondack Park, afraid cyclists will kill rattlers.

rattlers. Protected by state law, rattlers are considered a threatened species in New York, where bounties that led to their widespread killing were outlawed in 1971. State wildlife officials estimate New York has 3,000 to 6,000 rattlesnakes left, mostly around the Hudson Highlands and a dozen Adirondack dens.

But the U.S. Fish & Wildlife Service has declined to list them under the federal Endangered Species Act. "There are so few statewide, we feel that losing one or two to a mountain bike would be a tragedy," explained John Sheehan, the council's spokesman. With more than 1,000 miles of trails and primitive roads already open to mountain bikes in the park, the group sees no need to add "recreational conflicts" to the rattlesnake's diminishing range.

Cyclists counter that riding on 5 miles of trails in the Split Rock Mountain Wild Forest will do little harm. "It's a low probability that a biker's going to run a snake over," said Paul Capone, trail coordinator for the Adirondack Park Mountain Biking Initiative. "I'm sure there are rattlesnakes in that area, but for the most part I would say they prefer the habitat on the rocky open areas where bikes will not be riding." Bikes are allowed in 1.3 million acres of Adirondack wild forest and excluded from 1 million acres of more primitive wilderness areas. But as state officials issue new forest conservation plans, cyclists are losing ground. At Split Rock Mountain, they're being kept off trails down to the shoreline. "The reason people like to go there is access to Lake Champlain," Capone said. "It's kind of a critical time for mountain biking."

Wildlife biologists say it's also a critical time for Timber Rattlesnakes, whose bite is seldom fatal to humans (they don't always inject venom). Fear, misunderstanding, development sprawl and their attraction as dead curios or live pets have shrunk numbers, habitat and prospects. Timber Rattlesnakes are found in rugged terrain and hardwood forests from east Texas to southern Wisconsin, and from north Florida to a spot in New Hampshire. Believed gone entirely from Maine and Rhode Island, they are considered threatened or endangered in the Northeast except Pennsylvania, which has licensed hunting.

Rattlers hibernate in winter and are active from about May through September. In New York, females start reproducing at age 8 or 9, giving birth to litters of five to 12 every few years. They mate in late August. "Given their low reproductive rate along with a high mortality rate of young, as well as being killed or captured by humans, the Timber Rattlesnake is in serious trouble in the Northeast," James Beemer, a civilian Defense Department biologist, wrote in a 2001 study.

With no reports of snake-cyclist incidents in the Tongue Mountain Range above Lake George, where mountain biking is allowed on certain trails away from the dens, the state Department of Environmental Conservation says it expects none above Lake Champlain either but will monitor it. Rattlers have not been responsible for any fatalities in New York for decades. Unless you try to pick up or harass one, you stand a better chance of being struck by lightning than bitten, Beemer said.

After studying Timber Rattlesnakes for more than a decade on the U.S. Military Academy's reserve in the Hudson Highlands, he notes that the ambush hunters are deadly to mice, chipmunks and squirrels but are "extremely shy" of humans and will hide or try to leave unnoticed.

Red Nova (Dallas, Texas)

Arizona Roadkill: Huge Toll on Park-Area Highways

More than 50,000 wild animals are run over on roads in and around Saguaro

National Park each year. Taking a fresh look at old data, researchers have concluded that an earlier survey of park-area roadkills understated by roughly seven times the true casualty figures for toads, snakes, rabbits, lizards, javelina, and other critters.

After five years of weekly surveys of 50 miles of roads that ended in 1999, National Park Service officials determined that about 7,100 animals were killed annually in and around the east and west units of the park. However, researchers decided the original count was too low after reanalyzing the data to account for surveyor error, for animals that get taken off the road after they're killed, and for the limitations of hunting for roadkills by car. "We weren't seeing everything," said Natasha Kline, who has worked as a Saguaro Park biologist nearly 13 years.

While more animals are apparently dying on park roads than originally had been thought, some changes in road design are slowly occurring to make these and other thoroughfares more wildlife-friendly. The changes will be aimed not just at preventing roadkills, but also at preserving connections for wild animals crossing roads from one large block of desert to another. As much as $10 million would be spent over the next 20 years on making roads safer for wildlife under a plan that appears to be headed to the May 2006 ballot. The Regional Transportation Authority's 20-year plan would require voter approval of a half-cent sales tax increase to raise $1.9 billion for a host of other transportation improvements, including widened roads, transit, sidewalks, and bike paths. Pima County and state highway planners are looking for other ways to better design roads for wildlife, and the Park Service and county last year collaborated on a large $78,000 culvert project to provide more space for javelina and other animals crossing Sandario Road in Saguaro National Park West.

A major concern stemming from the roadkill study is the effect of the kills on populations of toads and larger animals, including Desert Tortoises, Gila Monsters, badgers, and rattlesnakes, said Kline, who worked on the roadkill study. The park is experiencing "massive" roadkill of three amphibian species — the Red-spotted Toad (*Bufo punctatus*), Sonoran Green Toad (*B. debilis*), and Couch's Spadefoot (*Scaphiopus couchii*), she said. Researchers have, for instance, found that Sonoran Green Toads taken from East Speedway north of the park were significantly smaller than those taken from loop roads within the park that close after dark. "This is very suggestive" that the toads' populations are affected by roadkill — not just individual toads, Kline said.

Although no statistics exist directly linking roadkills to declines of larger animals, biologists are concerned about them because they have both low reproductive rates and low adult mortality rates. Because they have low adult mortality rates, those creatures tend to live long lives, but because their birthrates are low, "once you start taking adults out of the population, you'll affect it very quickly," said Kline, who has emerged as Saguaro Park's spokeswoman for a study that involves many researchers and volunteers.

The operator of a wildlife rescue and rehabilitation center just north of Saguaro National Park East said that she's not surprised by the Park Service study's conclusions, because she regularly sees live wild animals in her center that were brought in after somebody found them lying on the road. "It's our No. 1 problem with animals that come in — that they're hit by cars," said Lisa Bates, who gets 300–350 injured animals each year at her Tucson Wildlife Center, just north of Saguaro Park East. "I would guess that a majority of animals admitted here were hit by cars." When center volunteers go out to rescue wild animals, they're all over the highways every day. Volunteers see a huge amount of roadkill, Bates said.

TOM WIEWANDT

Roadkills have a huge impact on populations of Arizona amphibians and reptiles. Species affected include particularly vulnerable species like Desert Tortoises (*Gopherus agassizii*) and Gila Monsters (*Heloderma suspectum*).

The sight of wild animals sprawled dead along roads or shoulders makes Rincon Valley Farmers Market executive director Molly Eglin truly sad, she said last week. But while she sees roadkill regularly on the roads, the 50,000-a-year figure shocked her, she said. "I go to town practically every day, and I usually see something practically every day off to the side of the road. But I never imagined it was that many," said Eglin, whose market lies about one mile south of the park's southern border. "What's worse is the people who drive down Old Spanish Trail like a maniac," Eglin said. "They drive really fast around the curves, the double lines. It's really, really dangerous." One morning last week, as she drove down Freeman Road and then Speedway abutting Saguaro Park East, Kline said that she had already seen six dead animals along park-area roads: a Longnose Snake (*Rhinocheilus lecontei*) and a Coachwhip (*Masticophis flagellum*), two ground squirrels, a Curved-bill Thrasher, and a rabbit. Then she stopped at a large wash along Speedway, about 16 miles east of Downtown Tucson, where she said she hopes to get grant money for a series of culverts to accommodate the toads and other animals so they can cross under Speedway instead of into the path of cars. Two years ago, the Park Service and the Pima County Department of Transportation applied for a $500,000 state grant to install two large box culverts and several smaller ones that would accommodate toads. The application failed, but Kline said she expects to seek the grant again. The area along Speedway where the culvert system would go had heavy concentrations of roadkills, ranging 85 to 1,000 in a small area, during the five-year study period ending in 1999, according to a Park Service map of the area.

A County Transportation Department official said he has not heard yet from the service about any effort to try

again for the grant. But the department now has a written policy calling for more environmentally sensitive roads in areas known for their wildlife populations, said Rick Ellis, the department's engineering division manager. The county has had the policy since December 2003 and has used it twice. One project, connected with the county's Thornydale Road widening, was to build a higher, wider shoulder with taller trees along Thornydale to accommodate endangered Cactus Ferruginous Pigmy Owls (*Glaucidium brasilianum cactorum*) trying to cross the road. The second project was the Sandario Road culvert.

Four major state highways in Southern Arizona could also be in line for new, wildlife-friendly design in the next few years because of a grant just obtained by a Flagstaff researcher. That study will focus on how to make those and other roads in the state more hospitable to birds and mammals.

The tally — estimated annual wildlife roadkills in and around Saguaro National Park East and West (Source: National Park Service): Reptiles, 27,000; amphibians, 17,000; mammals, 6,000; and birds, 1,000.

A. E. Araiza
Arizona Daily Star (Tucson) 16 May 2005

Diversity in Darwin's Tortoises

The giant tortoises of the Galápagos Islands inspired Charles Darwin to formulate his theory of natural selection to describe the evolutionary diversity of species. Now those tortoises have been found to be even more diverse than Darwin knew.

Nearly 150 years after Darwin's most important work, scientists have found the tortoise *Geochelone nigra*, found on the Galápagos island of Santa Cruz, is not one species but three.

The discovery, announced today, was led by Yale University scientists Michael Russello, Adalgisa Caccone, and Jeffrey Powell and is reported in the Royal Society of London's journal *Biology Letters*. Darwin and others identified the single taxon, or species, based on visible characteristics such as shell shape. The new research employed DNA analysis. Altogether, 11 taxa of tortoises are on the islands.

TOM WIEWANDT

Galápagos Tortoises in the genus *Geochelone* may be considerably more diverse than once thought. Application of sophisticated modern technologies revealed three distinct species on Santa Cruz, where only one (*G. nigra*) was previously thought to occur.

Between 2000 and 4000 individual tortoises remain on Santa Cruz, and as few as 100 individuals in each of the new taxa may exist, the scientists said in arguing for conservation of the habitat.

"It is ironic that, while Santa Cruz has the largest population of tortoises, it also has the largest human population — projected to double in the next eight years — which is their greatest source of endangerment," Russello said. "Since accurate taxonomy is crucial for effective conservation policy, these results have fundamental importance for preserving the genetic and taxonomic diversity of these historically significant reptiles."

Robert Roy Britt
LiveScience, 27 July 2005

Sale of Red-eared Sliders Skids to a Stop

Small turtles were being sold at kiosks in Tallahassee's two shopping malls on Monday despite a federal ban against their sale. Federal law prohibits the sale of turtles under four inches as pets. Their sale has been banned since 1970 because of concerns that they transmit *Salmonella*, a potentially deadly bacterium.

A Governor's Square mall spokeswoman said the lease for the Turtle World kiosk, where the little Red-eared Sliders (*Trachemys scripta elegans*) were being sold Monday, was being terminated this week. She declined to name the owner of the kiosk because of the mall's privacy policies. "I cannot stress enough that our main concern was the customers," said Eileen Walsh, marketing manager for Governor's Square. "Had we known this in advance, we would not have leased to him. And when we found out, we took action."

A worker at the Turtle World kiosk at Governor's Square Mall referred questions to the kiosk owner at Tallahassee Mall. A worker at the Tallahassee Mall kiosk told the *Democrat* that he wasn't authorized to comment and he hung up.

The U.S. Food and Drug Administration is sending out notices to malls, schools, and the news media about the ban, said Stewart Watson, public affairs specialist in the FDA's Florida district office in Maitland. "For a long time when the law went into effect people weren't selling the turtles as much," Watson said. "It seems in the past year it has exploded a lot." *Salmonella* can be found on the outer skin and shell surfaces of many turtles. Turtles under four inches are considered more of a risk because they're small enough for children to put them in their mouths, according to the FDA. Watson and a Florida Department of Health spokesman said they were not aware of any contaminations in Florida caused by turtle sales. However, six cases of illnesses in Wisconsin and Wyoming last year were traced to the sale of turtles.

The illegal sale of small turtles carries a possible fine of up to $1,000 and up to a year in prison, according to the FDA. Federal law allows the sale of small turtles for "bona fide scientific, educational, or exhibitional purposes, other than use as pets." Both kiosks at malls in Tallahassee had signs saying the turtles were being sold for educational purposes only. Watson said he couldn't comment on whether the signs mean the sales are allowed because he said it's a legal question.

At Governor's Square mall, the lease for the Turtle World kiosk was being terminated because of the apparent violation, Walsh said. "Having a vendor say, 'this is a good learning experience' is not the same thing as having them sold through an educational institution," she said.

Steven Darby, interim general manager of Tallahassee Mall, said he had spoken with FDA officials about the ban as well as turtle experts. "We have spoken with several people and are trying to make an informed decision with regard to the turtles," Darby said.

Turtle biologist Dale Jackson of Tallahassee said Monday he had contacted mall managers about the turtle sales. He's concerned that the Red-eared Sliders have been released into the wild and will harm native turtles. Jackson said he and biologist Matt Aresco are filing a petition with the state to ban the sale of any Red-eared Sliders, which live primarily in the Mississippi River valley and as close to Florida as Alabama. They are related to the Yellowbelly Slider (*Trachemys scripta scripta*), which lives in Florida. Once released in Florida, they can breed with the Yellowbelly Slider to create a hybrid subspecies, Jackson said. Red-eared Sliders also grow larger than the Yellowbelly Slider and can out-compete them for food and basking areas on logs, he said. "I think there is some value in people raising little turtles if it gets them interested in reptiles," Jackson said. "But we don't need them raising Red-eared Sliders if they are subsequently released in nature."

Bruce Ritchie
Democrat (Florida)

JOHN S. PARMERLEE, JR.

Because of their popularity in the pet trade, Red-eared Sliders (*Trachemys scripta elegans*) have been introduced in many areas where they are not native, often with dire implications for native species.

Red-eared Sliders Quietly Become a Threat

Red-eared Sliders for generations have been the most popular turtles sold in pet stores, and they also have been frequently dumped into the wild — so much so they have become common in some Hawaiian watersheds.

That's both illegal and a potential threat to native stream animals, but people who have brought the turtles home as pets have few options as the animals outgrow their aquariums. "They don't get sweeter as they get older. They can get snappy," said Christy Martin, public information officer for the Coordinating Group on Alien Pest Species. Martin recommended that unwanted turtles be taken to a humane society, where they have at least a chance of being adopted. "There's really nothing else you can do with them. That's the most responsible thing to do," she said.

In years past, the animals were sold as juveniles not much bigger than a silver dollar, but after the turtles were linked to the bacterial disease salmonella, the U.S. Food and Drug Administration in 1975 banned the sale of Red-eared Sliders less than 4 inches across. Officials thought the bigger size would make them less appealing to buyers and prevent children from putting the baby reptiles in their mouths, reducing the occurrence of salmonella.

Pet stores in Hawai'i and elsewhere still legally sell the sliders, which can reach nearly a foot in shell length. Since that's more turtle than most folks can handle, and since there is little demand for the larger animals, many have been released into the Hawaiian environment. "That's not a good idea because of the impacts they could have on native species," said Philip Thomas of Hawaiian Ecosystems At Risk, a government-funded organization that supports alien pest control efforts. The state has listed them an "injurious species" because young turtles could feed on 'o'opu, native freshwater gobies that live in Hawaiian streams.

The turtles, whose scientific name is *Trachemys scripta elegans*, have a green to brown shell, and their green heads have a characteristic red stripe behind the eye from which they get their name. They are known to be in Kawa'i Nui marsh and surrounding streams on O'ahu, have been found in at least two parts of Maui, and are in the Hanalei and Wailua river basins on Kaua'i. But they're probably in many other waterways as well. "I've had reports from all over the island," said Don Heacock, aquatic biologist with the state Division of Aquatic Resources on Kaua'i.

Horticulturist Keith Robinson recently found a 7-inch turtle walking on a road in Wainiha Valley this week, suggesting they also may be in that valley's stream on Kaua'i's north shore. He said people who saw that turtle recalled having seen others in the Hule'ia River near Lihu'e and in a drainage ditch near Kekaha.

Red-eared Sliders are primarily meat-eaters when young and eat a mixture of meat and vegetation as adults, according to Sean McKeown's book, *Reptiles and Amphibians in the Hawaiian Islands*. Young Red-eared Sliders can become carriers of salmonella if they eat tainted meat. Humans can contract the disease from handling the turtles. These turtles can live for up to 25 years. They require fresh water, a place to get out of the water to bask, and proper food. As they grow older, they need considerably more room than the average home aquarium provides.

When the FDA banned the sale of the smallest turtles, it found that 14 percent of all cases of salmonella poisoning in the United States were associated with the handling of pet turtles. Most of the victims were young children.

The organization Tortoise Trust urges people not to buy them in the first place, since little thought generally is given to providing care into their adulthood, if they survive. "There is a massive surplus of unwanted adult turtles looking for good homes, yet thousands of tiny hatchlings continue to be bred each year, making an already desperate humanitarian situation even worse," the organization said on its Web site (http://tortoisetrust.org).

Jan TenBruggencate
Honolulu Advertiser (Hawaii)

IRCF ON THE MOVE

IRCF Nets Record Amount for Rock Iguana Conservation at NRBE Auction

The auction sponsored by the International Reptile Conservation Foundation at this year's National Reptile Breeder's Expo in Daytona Beach was a tremendous success, bringing in a record $20,100 for the preservation of critically endangered Rock Iguanas in the West Indies. The IRCF would like to thank Wayne Hill and the Expo management, the many donors who gave generously and the countless volunteers for their many man-hours of work. We couldn't have done it without you!

Desiree Wong at the helm of the IRCF booth in Anaheim with Izzy, IRCF West Coast Spokesiguana.

Mark O'Shea becomes an IRCF member at the Anaheim show, shown here with John Binns.

Auction funds will be distributed to a number of conservation projects operated under the auspices of the IUCN Iguana Specialist Group and supported by the International Iguana Foundation as follows: (1) The San Salvador Rock Iguana (Bahamas) will receive $8,000 to assist with relocation work, (2) The Jamaican Rock Iguana will receive $5,000 to assist with predator control and iguana conservation work in the Hellshire Hills, (3) The Anegada Rock Iguana will receive $4,000 to augment existing funds for the purchase of a small used truck to assist with release of captive-reared iguanas into the wild and follow-up radio tracking, and (4) $3,100 will go to the Grand Cayman Blue Iguana Recovery Program for this year's Phase II release of captive-raised animals.

The IRCF would also like to welcome the 25 new members who joined in Daytona Beach. We are delighted to have you as part of our organization!

IRCF attends NARBC
Anaheim, CA – September 2005

The National Reptile Breeder's Conference and Trade Show marked IRCF's first official appearance at an expo on the West Coast, providing a wonderful opportunity to network with the Southern California community. The IRCF would like to express gratitude and appreciation to Bob Ashley and Brian Potter (*http://www.narbc.com*) for donating booth space. The IRCF also welcomed 15 new members.

John Binns, Joel Friesch, Desiree Wong, AJ Gutman, Mary-Jane Garnett, Sandy Binns, and Digger, IRCF East Coast Spokesiguana at the Daytona Expo.

An enthusiastic audience turned out for the auction to benefit West Indian Iguanas.

IRCF members at the joint annual meeting of the Society for the Study of Amphibians and Reptiles (SSAR), the Herpetologists' League (HL), and the American Society of Ichthyiologists and Herpetologists (ASIH) in Tampa, Florida in June 2005. From left to right: Chuck Shaefer, Joe Burgess, Kenny Krysko, Bob Powell, and Sandy Echternacht.

IRCF
International Reptile Conservation Foundation

JOIN ON-LINE AT: www.IRCF.org

Membership Questions?
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.

Editors' Remarks

DISCLAIMER!

When you see the term, "disclaimer," you probably think either of legal fine print or someone not taking responsibility for something they should. However, since we began including commentaries earlier this year (see, for example, p. 198 in this issue), the editorial board has been careful to include a disclaimer with each published essay. No lawyer told us we had to do this and we're certainly not trying to evade responsibility for what we publish. On the other hand, we do want to voice ideas and opinions that are relevant to any one of our three-fold emphases of conservation, natural history, and husbandry of reptiles. Because conservation programs and policies and issues related to husbandry can be controversial, we believe that ideas from different perspectives are not only appropriate but necessary for fostering discussions and reaching conclusions that are most likely to be correct and in the best interests of the animals about which we all are concerned. Consequently, we chose not to impose arbitrary constraints on our contributors and, by not doing so, left ourselves open to publishing opinions with which we do not necessarily agree. Faced with the choice of stifling input or adding a disclaimer, we opted for the latter.

On occasion, as in this issue, we may solicit additional input on the topic from other sources or reprint opinions available in the public domain (see pages 202 and 203). Again, these may or may not represent our views or those of the IRCF. Nevertheless, they are relevant to the discussion and worthy of consideration.

If you hold strong opinions on topics that are pertinent to the goals of the IRCF and the emphases expressed in *IGUANA*, feel free to send your commentary to us. We do not guarantee publication, but are interested in your input. Be aware, however, that you should be prepared to see different, even opposing ideas in the same or subsequent issues — which is the whole point: in order to be relevant and worthwhile, discussions should include more than one point of view. Also note that, regardless of how much we agree or disagree with you, we will disclaim your entry.

The Editors

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.

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*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.

FOCUS ON CONSERVATION

Turks and Caicos Iguana (*Cyclura carinata carinata*)

JOHN BINNS

Turks and Caicos Iguana Recovery Program

TURKS AND CAICOS

The critically endangered Turks and Caicos Iguana (*Cyclura carinata carinata*) is the smallest of the Caribbean Rock Iguanas and the most vulnerable to predation by introduced mammals. Once widespread, these iguanas now occupy less than five percent of their historic range, and island populations continue to be lost at an alarming rate. In response to this crisis, the San Diego Zoo's Applied Conservation Division, the Turks and Caicos National Trust, and the Turks and Caicos Department of Environment and Coastal Resources initiated an intensive conservation program to restore Turks and Caicos Iguanas to key portions of their former range.

Beginning in 2000, researchers translocated 218 animals from islands where they were threatened to four uninhabited cays within the Turks and Caicos reserve system. The research team is carrying out long-term ecological monitoring of restored populations, nutritional analysis of food plants, health and hormone evaluations, genetic studies, and educational outreach. To date, the translocated iguanas have experienced a 98 percent survival rate and nesting activity has been observed on all of the translocation cays. As a result of low population densities and lack of competition for resources, young iguanas hatched on translocation islands are growing up to four times faster than juveniles of comparable ages on source islands. Ongoing research on restored populations and their respective source populations continues to provide valuable information about iguana population ecology as well as new insights into improved translocation methodologies.

In 2003, the IUCN Iguana Specialist Group partnered with government officials, private businesses, and international iguana conservation experts to produce a detailed five-year management plan to conserve and restore populations of the Turks and Caicos Iguana. With the successful return of healthy iguana populations to four of their island homes, we are one step closer to the plan's objective — to conserve and restore iguana populations and perpetuate them as a symbol of national pride and sound environmental management in the Turks & Caicos Islands.

www.ConservationAndScience.org

JOHN BINNS

The Grand Cayman Island Anole (*Anolis conspersus*) is one of several species that should benefit from land protection for the Blue Iguana (see article on p. 166). This green variant is typically found in the western portion of the island, in George Town and around the airport. The western populations have been considered by some to represent a subspecies distinct from populations to the east. This individual was photographed far to the east of where lizards of this color phase are usually found, possibly after having "hitched a ride" on a car.

JOHN BINNS

Utila Iguana (*Ctenosaura bakeri*) (see article on p. 142).