

Inventory No. 0, CEER-T-136 of the Puerto Rican Boa (*Epicrates Inornatus*) in the Caribbean National Forest by Douglas P. Reagan and Carol P. Zucca. Terrestrial Ecology Division, Center for Energy and Environment Research, Caparra Heights Station, San Juan, Puerto Rico. Final Report to Forest Service, U.S. Department of Agriculture, 1720 Peachtree Road, NW, Atlanta, Georgia. May 1982. Center for Energy and Environment Research.

Inventory of the Puerto Rican Boa (*Epicrates Inornatus*) in the Caribbean National Forest by Douglas P. Reagan and Carol P. Zucca. Terrestrial Ecology Division, Center for Energy and Environment Research, Caparra Heights Station, San Juan, Puerto Rico. Final Report to Forest Service, U.S. Department of Agriculture, 1720 Peachtree Road, NW, Atlanta, Georgia. Principal Investigator.

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Young Puerto Rican boa from the vicinity of the El Verde.

Field Station 26 Adult Puerto Rican Boa from the Job Corps Center along Route 186 (El Verde Road) = 26 4

## INVENTORY OF THE PUERTO RICAN BOA (*EPICRATES INORNATUS*) IN THE CARIBBEAN NATIONAL FOREST

### 4.0 INTRODUCTION

The Puerto Rican boa, *Epicrates inornatus*, is an endangered species endemic to the island of Puerto Rico (Philibosian and Yntena 1977), which it shares with a variety of other species, including man. In the past five centuries, the human population has increased from approximately 40,000 Taino Indians to the present population of 3,500,000. During the same period, most of the areas of natural habitat, particularly in lowlands, were destroyed or greatly altered in the process of agricultural and industrial development.

Accidental and planned introductions of exotic species including rats (*Rattus* spp.), house mouse (*Mus musculus*), and the Indian mongoose (*Herpestes auro-punctatus*), have additionally affected natural food webs and contributed to the decline or extinction of some indigenous species. Despite these changes, the Puerto Rican boa has survived and become firmly established in the island's folklore. Its food habits, reproduction, and population size, among other things, are still little known. Relevant published information is scarce, and much of it is anecdotal rather than rigorously scientific (Steineger 1904, Grant 1932 and 1933). The species is known to inhabit several locations within the Caribbean National Forest.

In order to include the Puerto Rican boa in future management and planning, the U.S. Forest Service requires reliable information on the distribution, habitat, and basic aspects of its life history. In response to this need, an inventory of the Puerto Rican boa was conducted between November 1981 and March 1982 within the Caribbean National Forest. Surveys covered remote and developed areas at all elevations. This report combines inventory data with information from published and unpublished sources to provide guidelines for managing the forest in relation to the species.

Suggestions for additional studies within the forest are also proposed.

### 2.0 METHODS

Information on the Puerto Rican boa was obtained from literature surveys, contacts with regional authorities, and from field studies conducted within the Caribbean National Forest. Published materials were obtained and reviewed, and unpublished documentation (e.g. U.S. Forest Service reports, data from CEER's El Verde Field Station collection) was examined. Additional contacts were made in the course of this project in order to update and augment existing information.

Boas were handled using either Pilstrom snake tongs or by hand to prevent injury to the boas. Preserved and dissected specimens examined during this study were all road kills. Snake specimens were preserved according to standard museum procedures (Anderson 1965; Hall 1962) and temporarily maintained in the El Verde Field Station collection. Each specimen was dissected in order to determine reproductive condition and to obtain food habit information. Preserved snakes will be deposited in a scientific museum collection designated by the U.S. Fish and Wildlife Service.

Field work was performed from November 1981 to March 1982. The weight, total length, tail length, color, pattern, and sex (where possible) were recorded for each boa observed. Taxonomically important characteristics such as the number of subcaudals and number of dorsal markings were also noted. Evidence of injuries (e.g. incision marks for removal of oil), individual marking, and evidence of external parasites were recorded as appropriate. Two small individuals in the collection at the El Verde Field Station (found dead on the road) were dissected to determine gut

contents. Each live snake observed in the course of this study was photographed to record color and pattern and document individual differences. The major focus of this investigation was on field surveys. In order to obtain the most information within the limited scope of this project, three

The approaches used were: (1) road-cruising surveys, (2) walking transects, and (3) plot sampling. The rationale and details of each technique are described below.

## 2.1 Road-cruising Surveys

Many of the records of Puerto Rican boas within the Forest have been live and dead specimens found on roads. By conducting systematic surveys along roads within the forest, it is possible to obtain information on both the distribution and activity of boas in addition to the specific data (e.g. length, weight, etc.) collected for each individual observed. Surveys were conducted along approximately 37 kilometers of paved and unpaved roads within the Forest. Limited surveys were conducted along additional routes (rt. 191 above 500m and rt. 930 within the Forest), although the likelihood of encountering boas in these areas was judged to be low. All survey routes are shown in Figure 1 (map pocket). The following roads were systematically surveyed: rts. 191, 966 (Jiménez Rd.), 988 (Sabana Rd.), 915, and 186 (see Table 1). Surveys were conducted by driving a motor vehicle at speeds less than 15 miles per hour along each route. A spotlight was used to augment the headlights for night surveys and allowed the observer to scan trees and bordering vegetation while driving. Each route was surveyed during the day (0700 to 1700 hours) and again at night (2000 and 0400 hours). Day and night surveys were conducted during wet weather (roads and vegetation wet during or following rain) and during dry weather (no rain for at least 48 hours). With one exception, 11 surveys were conducted by a single driver observer. At the beginning and end of each road segment the time, wet and dry bulb temperatures, wind velocity, and general weather conditions were recorded (Table 2). At each observation point, the elevation, dominant vegetation, slope, and significant topographic features were noted.

## 2.2 Walking Transects

These transects were conducted in conjunction with plot sampling.

Sampling was conducted throughout six major watersheds and along the trail to El Toro Peak. Transect locations are described in Table 1 and shown in Figure 1 (map pocket). Surface litter was overturned, and likely resting locations on the ground and in trees were visually searched while traversing each area.

### 2.3 Plot Sampling

Two types of plots were sampled during field investigations within the Forest. Strip transects (plots) of 4m x 50m were established in each of the areas specified in Table 1. Seven plots were surveyed in each of the two major river systems, the Rio Espiritu Santo and Rio Mameyes. Plots were also sampled along routes 966 (7 plots) and 988 (7 plots), at the Catalina Tree Nursery (2 plots), and near the Forest Service house at El Verde (1 plot); all areas of known boa habitat. An additional plot was established near El Toro Peak in order to include at least one dwarf forest location. A total of 32 plots were simultaneously surveyed once for vegetation and boas. Plots were selected so that no plot was closer than 200m to any other plot except the two Catalina Tree Nursery plots. All river basin and road plots were within 400m of the stream or road being surveyed.

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Effort was made to locate plots at approximately equal altitudinal intervals to ensure that all major vegetation/habitat types were represented. Plots were located at predetermined elevations by walking a randomly determined distance (usually 50m) perpendicular to the stream/road. Distance measurements were made with a hip chain device. Within each plot, the species and DBH (diameter at breast height) of all woody vegetation with a diameter greater than 5cm were recorded, and the location of each individual mapped. The dominant herbaceous and shrubby vegetation were noted, and percent herbaceous cover estimated by measuring five m<sup>2</sup> quadrats per plot. The slope, litter depth, canopy height, and presence of significant topographic features, wet and dry bulb temperatures, wind velocity, and general weather conditions were recorded. Canopy cover was determined by the ocular tube method (Winkworth and Goodall 1962, Reagan 1974). Within each plot, surface litter was overturned and likely boa resting locations were searched.

Less detailed spot surveys were conducted in the remaining four river systems (Table 1). Intensive searches were conducted at selected locations (spots) of potential boa habitat (e.g., rocky stream banks, cave areas, and open habitat in dense forest). A minimum of five such locations were sampled in each river basin. Each spot was marked with flagging. General weather information, wet and dry bulb temperatures, wind speed, dominant vegetation, and significant topographic features were noted for each area sampled.

### 3.0 RESULTS AND DISCUSSION

The Puerto Rican Boa (*Epicrates inornatus*) was described as a separate species over a 100 years ago and given its present taxonomic designation early in this century (Stejneger 1908). Since that

time, surprisingly little information, much of it anecdotal and occasionally conflicting, has appeared in the scientific literature. Although reliable data is scant, the species is well established in Puerto Rican folklore. The

The boa is believed to insert its tail in the mouth of a crying baby, which is calmed while sucking it. Meanwhile, the boa then sucks milk from the mother (Rivero 1978). Grant (1932) mentioned a story dating from 1788 in which boas are reported to inhabit houses and hunt rats. The snake fastens its head to the floor, lifts its body in the air and "uses it as a flail to slay the rats". Snake oil, used as a medicinal remedy, is obtained by heating the fat removed from living snakes (Grant 1933, Rivero 1978). The practice is still widespread throughout the island. The oil reportedly sells for \$5-15 per bottle. The Puerto Rican boa is listed as an endangered species by the U.S. Fish and Wildlife Service, but there is a general consensus that the species is not as scarce as was once thought. The species account in the "red book" of threatened wildlife (Bureau of Sport Fisheries and Wildlife 1973) describes the boa as very uncommon throughout its range and further states that there are probably fewer than 200 in Puerto Rico. Although the species is probably less abundant than it was in pre-Columbian times, recent accounts suggest that it is still widespread on the island, and in some locations it is considered common (U.S. Department of Agriculture 1973; Perez-Rivera and Vélez 1976; J. Rivero, pers. comm; R. Thomas, pers. comm., and many others). Specific data is provided in subsequent sections.

### 3.1 Distribution

The boa has been recently reported from several localities throughout Puerto Rico (Pérez-Rivera and Vélez 1978). Several additional localities apart from the Luquillo Mountains were reported to us during the course of this investigation, but are beyond the scope of this report. Stejneger (1904) lists *Epicrates inornatus* as inhabiting the coffee belt of Puerto Rico, but doubted that it went much above 1,000ft. (300m) in elevation. Rivero (1978) states that the boa probably occurs up to at least 1,500ft. (450m) in elevation on Puerto Rico. In view of what is known about the boa's habitat and life history, higher

The elevational limits for the species likely occur in the drier western part of the island. Noel Snyder, a research biologist in the U.S. Fish and Wildlife Service's Endangered Species Research Program, listed several localities for the boa in the Luquillo Mountains and stated that all observations were made below 400m elevation (Snyder, personal communication to Ken Dodd, 1976). Most boa sightings made during this study and in the recent past within the Caribbean Forest were confined to northern and western sections. This is consistent with the known altitudinal distribution of the species. Nearly all of the land less than 400m in elevation is in the northern and western part of the Forest. All confirmed boa localities obtained from published and unpublished documents, museum records, and observations made during project surveys were below 400m. Figure 2 (in the map pocket) indicates areas of the Caribbean National Forest below 400m in elevation and shows all documented boa localities within the Forest. Grant (1933) reported collecting two boas at about 1,500ft in the Luquillo Mountains at Piedra Blanca Cliff. However, we were unable to locate this topographic feature to determine either the elevation or exact location. Grant (1932) also reported two more boas from the headwaters of the Mameyes River, but provided no elevation or vegetation information to reliably locate the capture site. Because the headwaters of the Rio Mameyes are above 700m, significantly higher than any other known boa localities, it is likely that the actual capture site was probably at a somewhat lower elevation. Most observations of boas have been made in the course of activities other than specific boa searches

(e.g., driving along the road, conducting forest inventories, etc.). The cryptic coloration and secretive nature of the species make it difficult to locate even in areas of known occurrence. Boas have been found along all major roads in the Caribbean National Forest within the probable elevational limits of the species. Forest road

Road 915 is unpaved and seldom traveled, although boas may also occur here. Roads in other parts of the forest (e.g., southern portion of 191, 930) are at higher elevations. Road-cruising surveys (Table 2) failed to find any boas, probably because of the time of year in which surveys were conducted (see section 3.3). No boas have been reported from the vicinity of the Rio del Cristal or the Rio Fajardo, probably as a result of their remote location and because of the absence of regular forest management activities.

Apparently, suitable habitat is present throughout much of these watersheds (see section 3.2). It is highly probable that the Puerto Rican boa inhabits both areas at lower elevations within the Forest. A few boas may occur in the small patches of forest below 400m scattered around the southern periphery of the forest, but the species is not likely to be substantially impacted by forest management practices in these areas.

### 3.2 Habitat

Descriptive information on boa habitat was obtained by conducting semi-quantitative vegetation/habitat surveys in areas known to be inhabited by boas and at other randomly selected locations throughout the forest. A comparison of data from boa habitat with data from other locations supports the assertions of previous authorities regarding the major features of boa habitat and has permitted the formation of useful generalities consistent with known aspects of boa life history (see section 3.3). The habitat analysis surveys were designed to quantify and characterize the major vegetation types and topographic features within the Caribbean National Forest. By conducting extensive small plot surveys, we expected to identify aspects of the habitat relevant to the distribution of the Puerto Rican boa in the Luquillo Mountains. Each location is briefly described in the following text. Plot-specific data are summarized in Tables 3 and 4.

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Table 3 (Cantina) needs a base of 1,966 for Fajardo.

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Complexity indices were calculated in an attempt to provide a clearer picture of habitat structure (Holdridge 1967), but results could not be readily interpreted due to small plot size. El Toro. This

site was characteristic of mature dwarf forest, having typically low tree height and high stem density. The area was dominated (in basal area) by two species common to the Puerto Rico dwarf forest, *Micropholis garciniaefolia* and *Tabebuia rigida* (Howard 1968). Epiphytes and ferns were also abundant.

Rio Espiritu Santo. Plot 1 at 740m was also characteristic of a dwarf forest. The area was dominated by *M. garcinigefolia* and *Clusia* sp.. The greatest stem densities (3185 individuals/ha) and the second highest complexity index value (120.5) were measured in this plot. Plot 2 was in representative Colorado forest type, although no Colorado trees (*Cyrilla racemiflora*) were found in the plot. Both *M. garciniaefolia* and *M. chrysophylloides* dominated the plot and were characteristic of the upper Luquillo mountains (Wadsworth 1970). Plots 3-7 were disturbed. The 500m and 400m locations were old plantations of Maria trees (*Calophyllum calaba*). The 300m plot contained many large rocks and vines. At this site, the complexity index was the lowest (18.4) of this river basin, Plots at 200m and 100m elevations were characterized by successional species such as *Casearia arborea*, *Tabebuia heterophylla*, *Eugenia jambos*, and *Didymopanax morototoni*. 18

El Verde Area. The El Verde area near the U.S. Forest Service house was also planted with Marie trees. The large closely spaced trees accounted for the high basal area of 63.7 e/a. Scattered large rocks were present in and near the plot.

Jiménez Road (route 966). The elevation of the Jiménez Road plots varied from 270m to

470m. ANI of the sites appeared to be disturbed; some plots more than others. Plots 1 and 2 were in areas lined with mahogany. Some of the larger trees in the area have been girdled. Kadam (*Anthocephalus chinensis*) has been planted in plot 3. In addition, dead tree basal areas were high (10.4 and 5.0 m<sup>2</sup>/ha in plots 1 and 3, respectively). Plots 4-7 were more representative of a mature tabonuco forest but showed evidence of selective thinning. Many large rocks and rock piles were present throughout the area. Sabana Road (Route 988) and the plots of Sabana Road were disturbed and basal areas were generally low. Secondary species, citrus and breadfruit trees were abundant. The minimum basal area was only 2.5 m<sup>2</sup>/ha in plot 5, a mahogany (*Swietenia macrophylla*) tree plantation. Rocky stream channels and mossy piles of rocks were found in and/or near most plots.

Rio Mameyes - The sites along the Rio Mameyes were most representative of natural, mature native forests in the Luquillo Mountains (Wadsworth 1951). Two freshwater wetlands were measured, the palm break (*Srestoea montana*) and the *Pterocarpus officinalis* forest (plots 2 and 5, respectively). The highest basal area (72.7 m<sup>2</sup>/ha) and complexity index (126.1) were found at the 410m elevation plot dominated by *Dacryodes excelsa*, *Inga fagifolia* and *Honalium racemosum*. The mean basal area of the seven plots was 41.49 m<sup>2</sup>/ha, a high value for these mountains. Only the 100m elevation plot next to a pool in the river used for picnics appeared disturbed. The stream channel was rocky and large boulder piles were noted throughout the area surveyed.

Catalina Tree Nursery - Two plots were measured at the Catalina Tree Nursery. Plot 1 contained many exotic *Eucalyptus* species with a high seedling, sapling, and vine density. Plot 2 predominantly consisted of Kadam and mahogany. Both sites were part of an ongoing plantation study. An abandoned house and other small structures were present within the nursery area. The plots occurring in known boa habitat were: Rio

Espiritu Santo (plots 5-7), El Verde, Jimenez Road (plots 1-2), Sabana Road (plots 1-7), Rio Mameyes (plots 4-7), and the two plots at the Catalina Tree Nursery (Figure 1) are the areas of focus. The remaining plots were at higher elevations (above 400m) and were probably in areas not inhabited by boas. The habitat requirements of the species, based on data taken during this study and information gathered from other sources, appear relatively broad. Stejneger (1904) described the species as inhabiting wooded and rocky places in the foothills throughout Puerto Rico. Grant (1932) states that these boas are arboreal but descend to ground level and are found in rocky places. Rivero (1978) provided additional information indicating that they occur in trees and are also frequently found in caves and hollow trees.

These aspects of the habitat are further supported by our observations in the forest and elsewhere in Puerto Rico and by other biologists who are familiar with the species (J. Rivero, pers. com.; R. Thomas, pers. com.; and many others). Information on boa sightings in the Luquillo Mountains is presented in Table 5. It is noteworthy that many of the areas within the forest where boas are found exhibit various degrees of human disturbance (e.g., managed tree plantations, roads passing through them, etc.). Man-made structures frequently provide suitable shelter for boas. Many residents of El Verde and elsewhere along the boundaries of the Caribbean National Forest report finding boas in their garages, patios, and in materials stored outside. Boas regularly occupy structures within the Forest, including the U.S. Forest Service garage on Rt. 186, the Job Corps Center, and facilities at the Catalina Tree Nursery on Rt. 191. While these man-made additions to the environment may actually enhance boa habitat, the boas found in these locations are more accessible to capture. Boas inhabiting areas near roads are also exposed to collecting and to death from cars as the boas cross roads (Prado 1972; Inmon, pers. com.).

Besides rocks and trees, access to openings in the forest, where boas may bask, is apparently an important habitat requirement. Wild boas are frequently observed sunning themselves on rocks or tree branches near the forest edge and along streams (6. Orewry, pers. com; A. Estrada, pers. com.). Representative boa habitat within the Caribbean National Forest is shown in Figures 3 and 4. The importance of this behavior is discussed in the following section, 3.3 Life History.

The Puerto Rican boa is the largest native snake in Puerto Rico. Like other boids, it is a constrictor and non-venomous. Most individuals are relatively slender in contrast to the larger heavy-bodied species found in other tropical regions. The genus *Epicrates*, to which this species belongs, is distributed throughout the neotropics from Costa Rica to Argentina and the West Indies (Stidworthy 1971). All members of this genus are characterized by the iridescent sheen of their skin which gives a rainbow effect in direct light. This sheen is particularly evident in newly molted Puerto Rican boas (Rivero 1978).

As the name *inornatus* (unadorned) implies, the species is rather drab. Young individuals usually show a distinct pattern of dorsal spots (Figure 5), but in older individuals, only indistinct dark blotches may be apparent. Dorsal spotting varies from brown spots on a tan background to light brown spots with dark borders on a lighter gray or tan background (Grant 1932, Bureau of Sport Fisheries and Wildlife 1973, Rivero 1978). Some of the boas examined during this study displayed intermediate patterns (Figure 6), having brown spots with dark borders on the anterior part of the body and solid back spots or blotches toward the posterior end. Data on boas examined during this



inventory is presented in Table 5.

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Figure 3. Basking habitat for the Puerto Rican boa in the Catalina tree nursery on rt. 191. Several boas reportedly bask in this general location. 28

Figure 4. Representative natural habitat occupy the vicinity of the Sabana Road (rt. 988) the Caribbean National Forest. 25

Figure 5. Young Puerto Rican boa from the vicinity of the El Verde Field Station. Figure 6. Adult Puerto Rican boa from the Job Corps Center along rt. 186 (El Verde Road). 26

Of the 37 boas from the Luquillo Mountains for which information was available, none exceeded 2m (6'8") in total length. This agrees with records of the species from elsewhere on the island (Grant 1932, Rivero 1978), although rare individuals may attain a somewhat greater size. Reports of individuals up to 14ft. long are not uncommon, but have not been supported by hard evidence. Life history data accumulated in the course of this investigation were consistent with the miscellaneous records and general information available in published sources. Data on boas examined during this inventory are presented in Table 5. The new material and supporting observations are presented in the following sections to provide an overview of the natural history of this endangered species.

### 3.3.1 Food Habits

A wide variety of prey, mostly warm-blooded, is consumed by adult boas. Rivero (1978) reported rats, mice, birds, and perhaps bats as typical items in their diet. A slender boa 1.24m in total length captured near the El Verde Field Station 3 January 1982 and kept overnight in a sack regurgitated a full grown rat (*Rattus rattus*). The house mouse (*Mus musculus*) and rats (*Rattus* spp.) have been introduced to Puerto Rico during the past five centuries. Although rats are distributed throughout forest habitat, mice

Boas are restricted to more open disturbed areas, which are often in association with humans. They undoubtedly use this food source and reportedly also consume chickens (Rivero 1978).

Recently, it has been established (Rodriguez and Reagan MS) that the Puerto Rican boa captures bats at cave entrances as the bats leave the caves at dusk. Similar foraging behavior has been reported for the Cuban boa (*Epicrates angulifer*), a close relative of the Puerto Rican boa (Hardy 1957, Stidworthy 1971). Bat caves may thus provide a concentrated natural food source for boas. However, bat caves do not occur in the Luquillo Mountains, but are found in the north-central and western Karst region of Puerto Rico.

Juvenile boas are restricted to smaller prey than adults. In captivity, they have been observed eating lizards (*Anolis* spp.). One road-killed specimen (total length 52cm) in the collection at the El Verde Field Station was found to contain 2 small beetles (*Lampyridae*). It seems probable that

lizards, large insects, and perhaps coquis may be included in the diet of small boas. This aspect of boa life history, however, is in need of further investigation and may provide a key to understanding the ecological requirements of the species during this critical phase in its life cycle.

### 3.3.2 Reproduction

Reproductive information on the Puerto Rican boa is scarce. Grant (1932) reported that a pair collected on the Rio Maneyes mated after capture in May 1931. When the female was killed in July of that year, she contained 32 embryos in capsules 34x30mm. The embryos were 90mm long. Twenty-seven eggs 30x50mm and embryos approximately 90mm long were removed from a female boa found dead on route 186 near El Verde on 28 July 1977 and were preserved in the collection of the El Verde Field Station.

These data suggest that some, and perhaps most, mating occurs at the beginning of the wet season (late April through May), which is also the probable...

Period of peak seasonal activity (see section 3.3.4). Perez-Rivera and Velez (1978) reported two gravid females giving birth to 26 and 23 young, respectively. At birth, the juvenile snakes were from 275 to 440mm long. Based on this and previously presented information, it is likely that females give birth about six months after mating and probably towards the end of the wet season. The reproductive potential for the species is within the typical range for other boa species. Available data indicate that between 23 and 32 young can be produced by one female at a time and that females probably produce one clutch per year. The species is ovoviviparous which enhances the chances of fertilized eggs being successfully hatched.

3.3.3 Diurnal Activity: In general, the Puerto Rican boa is active at night and remains dormant throughout the day. Daytime resting includes trees and caves (Rivero 1978, Rodriguez and Reagan MS), rocky areas along streams (A. Estrada, pers. com.; Drewry, pers. com.), and man-made structures which afford similar protection such as abandoned buildings and piles of equipment (U.S. Forest Service record: personal observation, and reports of many island residents). Most boas seen in the open during the day are coiled in sunny to partially sunny locations. This basking behavior is an important aspect of their life history. Exposure to the sun raises the body temperature of these poikilotherms, and benefits the boas by increasing the rate of digestion, shortening the period of embryo development within females, and allowing individuals to be more active during the night when ambient temperatures may be quite cool. Observations of boas basking during late afternoon in locations which receive sun only at that time of day suggest that basking may be required for nocturnal activity, particularly during the winter and at higher elevations. Limited activity during the day has been noted (G. Inmon, pers. com.), but this may only be movement between basking locations. Nearly all

Observations of active boas have usually been made at night, between 20:00 and 24:00 hours. Specimens active along forest roads were most often sighted during these hours. This may be related to the activity period of the observers as well as to the movements of the boas. On several occasions, boas have been found dormant during the day in the rafters of the U.S. Forest Service garage on Route 186. On the evening of February 2, 1982, a large boa (nearly 2m long) was observed actively moving along the eaves of the garage at 20:55 (refer to Table 5). Upon our approach, it retreated into the upper wall of the garage. We revisited the garage at 22:30 and

observed the boa active in the same location, but it retreated rapidly and evaded capture.

#### 3.3.4 Seasonal Activity

Although boas may be active throughout the year, there is strong evidence to suggest that seasonal differences exist. Most existing records of active boas in the Caribbean National Forest during and prior to this study (refer to Table 6) were made between March and June, with no boas observed active between October and December. Local residents near the Forest generally agree that boas are most active during April, May, and June. This coincides with the end of the dry season and beginning of the wet season. Activity at the end of the dry season appears to be during periods of rain immediately following prolonged dry spells. This activity may partially be related to rehydration, but peak foraging and mating probably also occur during this period. The period from August through December is the warmest and wettest of the year in the Luquillo Mountains (Odum et. al. 1970). The period of maximum boa activity (March through June) is when temperatures, day length, and rainfall are increasing. Further investigation is necessary to determine the direct or indirect influence of these factors on boa activity.

#### 3.3.5 Predators

Adult Puerto Rican boas are

Among the largest predators in Puerto Rico are introduced species such as the Indian mongoose (*Herpestes auropuntatus*) and feral cats (*Felis domesticus*), which are potential boa predators. Although a mongoose might occasionally eat a small boa, studies of mongoose food habits in Puerto Rico and throughout the Caribbean have not documented any such predation (Seaman 1952, Wolcott 1953, Pimentel 1955). Birds such as the red-tailed hawk (*Buteo jamaicensis*), pearly-eyed thrasher (*Margarops fuscatus*), red-legged thrush (*Turdus plumbeus*), and Puerto Rican lizard cuckoo (*Coccyzus vieilloti*) may prey on juvenile boas, but again, hard evidence is lacking.

The major "predator" documented for the species is humans. There are still boas being collected for their medicinal properties, which are used in folk medicine (Rivero 1978, A. Estrada, personal communication, and others). There are rumors of a pet trade in small boas through buyers in San Juan, but precise information is unavailable. A few boas are accidentally killed by vehicles each year while crossing roads within the Forest and elsewhere on the island. Although the species may not be as abundant as it formerly was, predation (other than by humans) does not seem to be a major factor in its decline.

Decline (Bureau of Sport Fisheries and Wildlife 1973, Dept. of Agriculture 1973). Recent reliable accounts

#### 3.3.6 Parasites:

A few mites were noted on some of the specimens examined during this inventory, but heavy infestations were not apparent. A tapeworm several inches in length was found in the lower digestive tract of a juvenile road-killed boa in the collection at the El Verde Field Station. The internal parts had been poorly preserved and the exact length and more specific identification were not possible. No evidence of heavy parasite loads was obtained either from the literature or from direct observations.

## 4: Conclusions

Results of this inventory, combined with scattered published information and observations, have

revealed preliminary but consistent patterns of distribution, activity, and habitat for the Puerto Rican boa. It has also produced useful information on other key aspects of its life history (e.g., food, reproductive potential). Although the material acquired to this point is valuable in providing initial guidance for the management of the Caribbean National Forest with respect to this endangered species, it has also shown that additional studies are needed within the Forest and elsewhere in Puerto Rico.

#### 4.1 Management Recommendations

No unique habitat requirements appear to limit the distribution of boas within the Forest. Forest, forest edge, and plantation situations all provide suitable habitat. Rocks, which provide basking locations, are found throughout the Forest and are not restricted to particular locations. Distribution within the Forest is below 400m, although some individuals may go higher. The species' tolerance of moderate degrees of habitat disturbance (see section 3.2) suggests that selective thinning, enrichment planting, plantation management, and limited construction within the Forest are not likely to adversely impact the species directly, provided that large areas are not cleared simultaneously and that no boas are destroyed during development. Indirect impacts, however, need to be carefully considered.

Effects (e.g. increased access) are potentially harmful.

Figure 2 (map pocket) shows the area within the Caribbean National Forest boundaries below 400m. Virtually all of the land appears suitable for boas, therefore development within these areas should be designed to minimize potential damage to the species. Forest management in areas above 4000m need not consider the boa unless secondary impacts (e.g. increased human use of lower areas made possible by development) are expected.

The two factors which have been responsible for the decline of the species, loss of habitat and human interference, are still the major threats. Within the forest, permanent habitat loss is probably a minor problem, but increased development in the lower forest presents a possible danger because additional forest habitat will become accessible.

A few boas are killed each year along roads in the Forest. The El Verde road (rt. 186), Jimenez road (rt. 966), Sabana road (rt. 988), and northern end of rt. 191 317 pass through boa habitat (Figure 2). These losses are practically unavoidable. A greater threat is the increased use of these areas by human visitors.

Residents near the Forest are known to collect boas which are either mutilated to obtain "oil" or sold to pet dealers. Areas where boas were once common in recent times (e.g. lower Rio Espiritu Santo) have been depleted of many individuals because of persistent collecting (A. Estrada, pers. com. and others).

Although the habitat requirements and life history of the species remain largely undefined, some specific recommendations for management of the Forest in relation to the Puerto Rican boa are possible:

1. Management practices (including road construction, plantation establishment and management,

new buildings, etc.) in probable boa habitats (Figure 2) should provide for the protection of the species by preventing injury to boas encountered during project implementation.

2. General awareness (Forest Service staff and public) should be

Increase in awareness can be accomplished through displays at the Visitor Center, discussing the species in visitor brochures, and providing instructions (written or oral) to all Forest Service staff. The pertinent information to be provided includes, but is not limited to, a description of the species (color, size, non-poisonous), distribution in the forest (lower elevations), importance in natural ecosystems (largest indigenous predator in Puerto Rico, eats rats), popular myths (medicinal value of oil), legal status (currently considered endangered by the U.S. Fish and Wildlife Service, and by the Puerto Rico Dept. of Natural Resources) and large fines for harming or collecting individuals. Preparation of materials should be done in consultation with the Office of Endangered Species of the U.S. Fish and Wildlife Service.

Specific management recommendations to enhance boa habitat are not necessary, but the establishment of plantations which require clear cutting etc. should be restricted to a few hectares at a time so that large areas of habitat are not simultaneously rendered unsuitable for boas. Additional road construction or improvement which affects forest areas below 400m in elevation should be avoided if possible because of the cumulative adverse effects (increased road kills, increased access) which they would provide. In the event that such development is considered necessary, specific surveys should be performed by qualified biologists in order to assess the potential adverse impact on boas.

Rocky areas along rivers within the forest below 400m are known, and possibly preferred, basking locations for boas. This is particularly true in less disturbed forest areas where sunny basking sites may be otherwise limited. Habitat loss in these areas should be avoided wherever possible. If such loss is judged to be necessary, habitat surveys to evaluate potential impact on boas should be conducted.

#### 4.2 Future Research Needs

The information accumulated so far on the Puerto Rican boas

The text is decidedly inadequate. Distribution and general habitat descriptions provided herein have permitted preliminary recommendations for future consideration of the species in overall forest management. Additional aspects of its life history must be understood and its distribution more precisely determined in order to:

- (1) Better define its true status (e.g. ascertain if the species is really in danger of becoming extinct), and
- (2) Provide specific information for key aspects of its life history so that the adverse impacts can be avoided.

##### 4.241 Life History

Although the elevational limits of the species are known,

Several factors involved in limiting its altitudinal distribution are temperature, humidity, and food availability. Additional research is needed to determine the limiting factors. Fundamental population data are also lacking. Information on eye structure, population turnover rates, and population density are essential in determining the status of this species. Although some useful data have been obtained, other information (e.g. foraging rates, foraging strategies within the forest, home range, seasonal activity, etc.) is still needed.

The secretive habits and cryptic coloration of the species make it difficult to follow individuals for extended periods. Radiotelemetry is an efficient and appropriate technique for obtaining life history information. By fitting boas with transmitters, it is possible to keep track of individuals for several months and determine diurnal and seasonal activity patterns, home range, foraging behavior, temperature data, and much more. Suitable equipment is presently available and implantation techniques have been developed which inflict minimal injury on the snakes.

Radiotelemetry studies could easily be initiated in accessible areas (e.g. the Catalina Tree Nursery) and extended to include more remote areas such as the Rio Maneyes watershed. Studies would have to be approved by the U.S. Fish and Wildlife Service. The work could be undertaken by a single individual.

Scientists and assistants would produce a wealth of relevant information not easily obtained by other, more traditional methods.

#### 4.2.2 Distribution

Transect surveys conducted in six major watersheds (Figure 1) failed to turn up additional distributional information on boas.

Most boa records for the Forest were the result of random observations in the course of other activities. The presence of boas has not been documented in large areas of apparently suitable forest habitat (e.g., Rio del Cristal and Rio Fajardo). This is probably due to the relative remoteness of these areas, but further surveys are needed.

In view of the information already accumulated, these transects should be conducted during the months of April through June when boas are expected to be most active. Search efforts should concentrate on likely basking sites (low branches, large rocks) in sunny locations. A substantial amount of the total area visited should be along the stream channel within forest openings. Initial survey efforts should be confined to areas of presumed boa habitat less than 400m in elevation. Such efforts could be performed by U.S. Forest Service staff who are knowledgeable about boas, but could also be conducted with assistance from outside experts.

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