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Population Abundance and Range Use of Desmarest's Hutia (Capromyidae: *Capromys pilorides*) in Southeastern Cuba

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Abstract–The Desmarest's hutia (hereafter hutia, *Capromys pilorides*) is a rodent endemic to the Republic of Cuba (hereafter Cuba) and its associated islands. There is little recent research focused on hutia population abundance and range use in southeastern Cuba. We evaluated the current status of the hutia population in southeastern Cuba through (1) estimation of population density via walking and driving surveys, and (2) hutia spatial ecology via Global Positioning System (GPS) collars. Driving surveys indicated lower mean hutia density ($\bar{x}$ = 0.14 hutias/ha) than walking transects ($\bar{x}$ = 1.13 hutias/ha). Three of 13 GPS-collared hutias provided sufficient data for range analyses as 10 hutias severely damaged their GPS units. Ranges were relatively small (50% Core Area, $\bar{x}$ = 0.50 ha; 95% Range, $\bar{x}$ = 2.63 ha) and individuals tended to stay very close to tree cover, only emerging at night to forage. We recommend continued monitoring of hutia populations due to their influence on rare vegetative communities and importance as a significant food source for the Cuban boa (*Chilabothrus angulifer*).

Desmarest's hutias (also known as Cuban or Conga hutias; *Capromys pilorides* (Say, 1822)) are a member of the Capromyidae family, which includes rodent species located throughout the Caribbean (Fabre et al. 2014). In general, Capromyidae is geographically fragmented, with unique genera dispersed over a variety of Caribbean islands (Milishnikov et al. 2010). Desmarest's hutias (hereafter hutias; Fig. 1) are endemic to the Republic of Cuba (hereafter Cuba) and surrounding islands, and are the largest native mammal located on the island nation (Alvarez and González 1991; Whitmer and Lowney 2007). Hutias are considered common and widespread in Cuba; however, local abundance varies with some populations requiring management for overpopulation and others experiencing local extinction (Whitmer and Lowney 2007; Borroto-Páez 2011). Some recent evidence indicates hutias may be in population decline in parts or all of their range due to overhunting, habitat degradation, and pressure from exotic species such as feral dogs (*Canis lupus familiaris* (L.); Turvey et al. 2017). They are a nocturnal rodent that spends the heat of the day in trees (occasionally caves or root systems), and forages on the ground in the cooler night hours (Whitmer and Lowney 2007; U.S. Navy 2014). Hutias generally live within family groups in large trees and copses distinguished by high numbers of curved banana-shaped fecal pellets located within the area (inspiration for the nickname "banana rats"). Hutias are herbivores with a highly complex stomach that allows effective digestion of cellulose-rich foods focusing on roots, fruit, bark, and other vegetation (Angulo 1945; U.S. Navy 2014).

We found that hutias have challenges that impede survey efforts including limited eye shine that decreas-

Fig. 1. Adult male hutia with global positioning collar in southeastern Cuba, 2019.

es detectability and efficacy of spotlight-based surveys. Additionally, there are few established survey guidelines for hutias (Pimentel 2007). Previous research indicated a very high hutia population in southeast Cuba, with individuals and groups found in many locations and being easily observed (e.g., Higginson and Howe (2001) estimated 4–11 hutias/ha). Some population estimates have been as high as >50 hutias/ha (Alvarez and González 1991). Across Cuba, recent density estimates ranged from 0.8 hutias/ha to 31.5 hutias/ha (Rodríguez et al. 2016).

Determination of current hutia population abundance is critical to continued effective and informed population management (U.S. Navy 2016). Hutias are an important component of the natural environment and serve as a critical food-source for the endemic Cuban boa (*Chilabothrus angulifer* (Cocteau and Biron, 1840)), which is designated as Near Threatened by the IUCN (Day and Tolson 1996; U.S. Navy 2001). Conversely, overabundant hutia populations have degraded subtropical dry and mangrove forests through herbivory (U.S. Navy 2014). Our two primary goals were to: (1) determine hutia population abundance in southeastern Cuba, and (2) analyze hutia spatial ecology. We focused on the following objectives: (1) conduct sampling surveys along walking transects in a representative selection of vegetation types, (2) conduct sampling surveys along driving transects in urban and non-urban areas, and (3) place Global Positioning System (GPS) collars on hutias to determine their activity ranges.

MATERIALS AND METHODS

Study Area

We conducted our surveys in a mixed-use area (~3,200 ha) located on the southeastern portion of Cuba (19°54'07.56" N, 75°05'12.95" W; Fig. 2) during the dry season (May 2019) and wet season (October 2019). The unique coastal location and nearby mountain range increases temperatures and impacts precipitation as compared to the rest of the island. The local ecology depends upon the wet summer and fall seasons when the majority of the yearly rainfall occurs (50 cm). The annual temperature averages 28°C, though summer temperatures can exceed 38°C (Country Reports 2020).

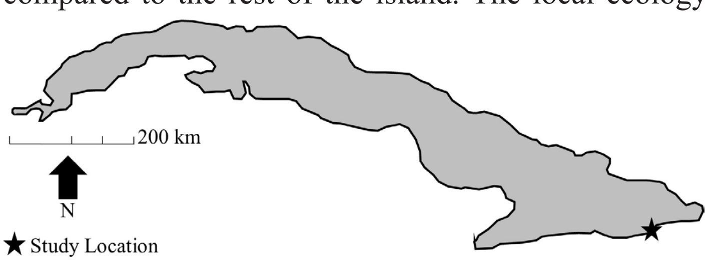

FIG. 2. Hutia project study location in the Republic of Cuba.

The mix of topographies and associated vegetative communities makes the study area a highly heterogenous and diverse environment (Roca and Sedaghatkish 1998). The general vegetation is an array of coastal lowland flora mixed with deciduous forest biomes and upland desert communities. Mangrove forests dominated by red mangroves (*Rhizophora mangle* L.) and black mangroves (*Avicennia germinans* (L.) L.) line the coastal areas. These coastal zones quickly transition into marshes and estuaries populated with buttonwoods (*Conocarpus erecta* L.) and seashore dropseed (*Sporobolus virginicus* (L.) Kunth). The upland areas are also diverse to include tropical arid forests, palm woodlands, tropical arid scrub, perennial grasses, and sparsely vegetated rock (U.S. Navy 2016). A variety of Caribbean tree and cactus species are common throughout the system (e.g., soldierwood tree [*Colubrina elliptica* (Sw.) Brizicky & W.L. Stern] and *Phyllostylon* spp.).

Hutias exist in a variety of vegetative communities including residential landscaping, semi-deciduous forests, coastal forests, mangrove forests, and arid subtropical dry forests (Roca and Sedaghatkish 1998). Hutias also can be found in ornamental or non-native trees in residential areas and native cactus in remote arid dry forests. In the daytime, we most commonly found hutias in dense tree cover with open interiors and large branches or in the crooks of mature cacti. At night, we commonly found hutias at the base of trees that they resided in or feeding at the edge of dense vegetation.

Population Surveys

Driving Surveys–We conducted driving surveys along pre-determined routes (May 2019, October 2019) using a driver and an additional observer (travel speed 25–40 km/hr). Driving surveys were conducted exclusively at night in order to allow the use of spotlights when hutias were more active and allowed easier observation of hutias in trees or in open areas. Driving surveys were divided into urban and non-urban areas. Urban areas contained residential neighborhoods, docks, and other areas with large amounts of built infrastructure and human activity. Non-urban areas were areas with minimal built infrastructure to include scattered fencing and utility poles, and primarily native vegetative cover.

Walking Transects–Walking transects were randomly selected from a 0.25 km × 0.25 km grid overlaid on the study area. Potential transects were identified from selected grid block-based areas of suitable habitat, walking trail access/length, and evidence of hutia presence (e.g., fecal pellets). Transects ranged from 50 m to over 1,000 m in length based on local habitat conditions and access (e.g., obstructive fence lines). Walking transects were conducted both at night and during the day in order to maximize data collection opportunities. Night transects allowed observation of hutias during cooler temperatures when they were most active. Day transects allowed personnel to go into rugged areas inaccessible at night due to safety concerns (e.g., rugged terrain, vertical drops) and focus on hutia daytime resting locations such as trees and cacti. Walking transects were conducted by a single individual walking at a slow speed (3–4 km/hr).

Data Collection and Analyses

Similar data collection and statistical analyses were used for both driving and walking surveys. Distance estimates were obtained for hutia locations perpendicular to the centerline of the survey route. When hutias were observed on these walking/driving transects, we recorded the number of hutias observed, distance, surveyor location via GPS unit (Garmin International, Olathe, Kansas, USA), and age class (juvenile, adult). Bearing and distance to each observed animal or group of animals were determined using a laser rangefinder (Sig Sauer, Newington, New Hampshire, USA) and compass. All night surveys were conducted using handheld spotlights (1,000 lumens; No Cry, Saaremaa Parish, Estonia). We first attempted to use distance sampling in the program DISTANCE (Thomas et al. 2010) to estimate density and population size, with perpendicular distance data right truncated at 20 m, and model fit parameters for detection probability, density, cluster size, and encounter rates stratified by survey month using uniform and half-normal models, with model selection based upon Akaike Information Criterion (AIC), and estimated expected cluster size by regression of log(s(i)) on g(x(i)) for all sightings (Buckland et al. 1993; Pierce et al. 2012). Limited observational data prevented adequate model fit using distance sampling methodology. Preliminary model estimates using the program DISTANCE suggested that a 20 m (0.02 km) fixed half-width (total strip width = 40 m) was an appropriate width for these estimates. As such, density estimates were made using strip transect analysis (n/strip area).

Ranges and Spatial Ecology

Capture and GPS Collars–Hutias were captured in May 2019 using meso-mammal-sized traps (18–23 traps total; double door trap = 81 cm × 25 cm × 30 cm, single door trap = 93 cm × 32 cm × 37 cm; Havahart, Lancaster, Pennsylvania, USA) placed at multiple locations within the study area. These traps were placed in areas of good habitat and extensive hutia signs (i.e., scat and tracks), and baited with combinations of fruit, peanut butter, and oats. Traps were set at dusk and checked at dawn. Non-target individuals were immediately released at the capture site. All captured hutias selected for GPS collars remained in the traps and were anesthetized by a veterinarian. We affixed LiteTrack 60 GPS collars (~60g, Lotek Wireless, New Market, Ontario, California, USA) to healthy captured adults. We recorded hutia sex, age class, and core morphometrics including weight, body length (nose to base of tail), and tail length from telemetered animals. When hutia handling was completed, anesthetized individuals were provided with a reversal agent and returned to the traps. They were placed in a shaded area at the veterinary clinic and monitored throughout the day. All captured animals were returned to their area of capture in the evening when the temperatures were cooler and all signs of sedation were gone.

Data Collection and Analyses–The GPS collars recorded a location every two hours over a full 24-hour period during May–October 2019. Data were remotely downloaded from the GPS collars when individuals were located via VHF (very high frequency) homing. These data were analyzed in ArcMap 10.6 (Environmental Systems Research Institute, Redlands, California, USA). We calculated 95% ranges and 50% cores using the kernel density estimator (KDE) embedded in ArcMap 10.6 (Wand and Jones 1995). Lotek proprietary software was used to determine time-stamped daily movements.

Results

Population Estimates

Driving Surveys–We delineated a total of 30.61 km of driving transects divided between urban (19.86 km) and non-urban (10.75 km) areas. Transects were driven multiple times during the May 2019 (urban, *n* = 3; non-urban, *n* = 2) and October 2019 (urban, *n* = 3;

non-urban, $n = 3$) field seasons. We surveyed a total of 172.91 km, including replication, during driving surveys. We observed a total of 95 hutias ($n = 90$ urban; $n = 5$ non-urban) during driving surveys, yielding a combined encounter rate of 0.55 hutias/km (0.78 hutias/km urban; 0.09 hutias/km non-urban) and a combined density estimate of 0.14 hutias/ha (0.19 hutias/ha urban; and 0.02 hutias/ha non-urban).

Walking Transects–We conducted a total of 134 walking transects (24.27 km) through multiple hutia habitats divided between urban (11.37 km) and non-urban areas (12.90 km). May 2019 consisted entirely of night transects ($n = 39$ transects [including 7 replicates]; 5.06 km) using handheld spotlights. In order to increase data collection opportunities in October 2019, night transects were adjusted ($n = 38$ transects; 5.79 km) and a variety of day transects ($n = 57$ transects; 13.41 km) were included (October, $n = 95$ total transects). We observed a total of 110 hutias ($n = 80$ urban; $n = 30$ non-urban) during walking surveys, yielding a combined encounter rate of 4.53 hutias/km (7.04 hutias/km urban; 2.33 hutias/km non-urban) and a combined density estimate of 1.13 hutias/ha (1.76 hutias/ha urban; 0.58 hutias/ha non-urban. Day ($n = 38$ hutias observed) and night ($n = 72$ hutias observed) walking transect surveys yielded density estimates of 0.71 hutias/ha and 1.66 hutias/ha, respectively.

Range and Spatial Ecology

Capture and GPS Collars–We captured hutias during 16–31 May 2019 using 15–20 traps per night totaling 200 trap-nights. We focused on two to three trap locations per night (five to seven traps/location). A total of 20 hutias were captured, however, we only selected the healthiest 13 adults for GPS collar attachment (9 M, 4 F). Collared individuals ranged broadly in size, with males averaging 7% heavier, 5% longer in body length, and 9% longer in tail length than females (Table 1). Individuals were captured in locations throughout the windward side of the study area; however, most were from urban areas (11 of 13 hutias). Average weights were typical for the species: males = 4.2 kg, females = 3.91 kg (Table 1; Páez 1992; Whitmer et al. 2001). Two of the four females were either pregnant or showed signs of recent parturition (i.e., positive ultrasound, lactating).

GPS Collar Data Collection and Analyses–We conducted remote data collection efforts from initial capture dates (May 2019) until project completion (October 2019). Data were successfully downloaded from 3 of 13 collared individuals. Hutias demonstrated high site fidelity over the 2–5-month observation period with small core areas and ranges, and few long-distance forays from their core areas (Table 2). They generally stayed within a single connected group of trees or

TABLE 1. Identification, sex, capture date, and morphometric data for collared hutias, Cuba, May 2019.

ID #	Sex	Capture Date	Weight (kg)	Body Length (mm)	Tail Length (mm)
1	M	20 May 2019	4.23	500	220
2	F	22 May 2019	4.45	505	204
3	M	22 May 2019	3.35	492	254
4	M	23 May 2019	4.10	570	273
5	M	24 May 2019	3.68	532	230
6	F	24 May 2019	4.01	535	225
7	M	25 May 2019	4.67	585	220
8	F	25 May 2019	4.13	545	260
9	M	25 May 2019	4.50	560	240
10	M	26 May 2019	4.80	570	250
11	F	26 May 2019	3.06	500	225
12	M	29 May 2019	5.25	590	290
13	M	29 May 2019	3.25	535	292
Female Averages			**3.91**	**521**	**229**
Male Averages			**4.20**	**548**	**252**

groups of trees. These core areas were situated close to foraging areas such as forest edges, residential lawns, and golf courses.

Communal grooming and chewing caused extensive damage to the GPS collars. Based on metadata downloaded from several individuals with no on-board data, collars often lost function within a day of attachment. Hutias would chew on the collar at the base near the battery and sever the majority of the embedded wires. This behavior would cause malfunctions in the antennas; however, no collars were chewed completely off. They chewed on the protective plastic outer coating and the wires without damaging the collar belting material. This may have been due to the simple fact that the coating and embedded electronics were on the outside of the collar material and more easily chewed upon. The collars on individuals we observed over the course of the study appeared to be correctly sized with no slippage, injuries, or distressed individuals. Ten of the 13 collars simply stopped working and either had no data when a signal allowed download, or could not be physically recovered for a download attempt. Due to the limited number of hutias with functioning collars, we were unable to compare ranges between land cover/land use classes or vegetation types. However, the small ranges of the individuals indicated that any differences may have been limited (Table 2).

Daily activity patterns were consistent for all individuals and throughout the observation period. These patterns reflected the small observed ranges. Individuals would emerge from cover after dark (23:00–03:00) and return to cover during most other hours. Locations for individual animals were so clustered that they seemed to return to the same trees or tree areas repeatedly. We often visually located individuals in the same tree or even the same branch during survey efforts.

DISCUSSION

The difference in encounter rates between walking and driving surveys in both urban and non-urban areas may suggest that hutias avoid vehicles or the habitat adjacent to roadways. Previous research routinely encountered hutias on roadways (e.g., 4–111 hutias/km; Higginson and Howe 2001) and also found higher population densities (e.g., up to 31.5 hutias/ha; U.S. Navy 2014). This may indicate that hutias now avoid roads as their population abundance has declined. This may have been compounded by efforts to reduce hutia infrastructure damage by limiting hutia access to certain areas near roads or buildings (e.g., fencing/walls, planting non-preferred vegetation; U.S. Navy 2014). As a result, walking transects may allow more comprehensive data collection across the study area. Walking transects should be conducted in both urban and non-urban areas rather than driving transects for obtaining estimates of hutia density and abundance estimates. Driving transects did not allow surveyors to cover heterogeneous habitats, effectively detect hutias that potentially avoided roads or persisted at low population density, or provide comprehensive coverage adequate to find hutia daytime resting locations.

We also found higher hutia population density in urban areas than non-urban areas. Previous research indicated higher population density in the non-urban areas (Whitmer and Lowney 2007), potentially due to control efforts by local authorities in urban areas conducted at that time. The current paradigm may be due to recolonization of urban areas after conclusion of control efforts, or availability of food and cover (e.g., ornamental plants) in residential and industrial locations. The underlying reasons for this shift in population density requires additional research.

The survey evidence confirms the telemetry findings, indicating that hutias were more active at night. Ideally, night walking transects should be conducted in preference to day transects for obtaining estimates of hutia density and abundance estimates when possible and safe. The rugged topography makes walking at night in non-urban areas difficult and potentially dangerous. Therefore, a mix of day and night transects is

TABLE 2. Core areas (50%) and ranges (95%), data points, and activity dates for three collared hutias, Cuba, 2019.

Hutia ID	50% Core Area (ha)	95% Range (ha)	GPS Points	Dates Active (2019)
32026	0.81	4.39	630	27 May–31 July
32028	0.23	1.15	921	25 May–6 September
32021	0.47	2.36	973	23 May–5 October
Averages	**0.50**	**2.64**		

warranted for practical and safety reasons.

The data obtained from the telemetered animals indicates that hutias maintained relatively small and consistent ranges during the period of the survey (May–October 2019). It is unclear if this small sample is representative of typical adult hutia range, dispersal, and habitat utilization. The average 95% range estimate (2.64 ha) is slightly higher than hutia ranges provided in one of the few locally relevant sources (1–2 ha; U.S. Navy 2014). Hutias did not move far from their core areas. They exhibited high site fidelity and scheduled movement patterns. Hutias were nocturnal, with peak movement occurring well after nightfall and before sunrise. Presumably, this was to avoid the high daytime temperatures (33–38°C). The observed hutias appeared healthy in small stands of trees or cacti with little need to travel far for resources. They were typically seen in small groups of approximately two to seven individuals.

Future hutia research and management efforts in southeastern Cuba should focus on a few pertinent areas. First, a new, detailed evaluation of vegetation ecology is recommended, particularly in non-urbanized areas. Second, hutia diet, energy physiology, and recruitment rates in the study area are sparsely documented (U.S. Navy 2014). These variables impact hutia use of the environment and density within the ecosystem, and present critical support information for management efforts. Third, the impact of various habitat changes, such as anthropogenic (e.g., development, fencing) and climate-related (e.g., sea-level rise) on hutia populations would provide additional information for local natural resources managers. Finally, future GPS collar efforts should include comprehensive pre-planning with the selected collar manufacturer to produce units more robust to hutia chewing. This would likely include more resistant collar material with internally protected electronics such as drop-off mechanisms and antennae. Integration of corrosion resistant covers such as aluminum or other materials may prevent extensive hutia chewing on vital areas.

A potential option for future population estimation and range analysis distinctly different than walking transects or GPS collars is a camera survey. A camera-based survey consisting 30–40 remote cameras deployed along a pre-determined grid (1-km or 0.5-km cells) would allow a spatial survey of hutia presence-absence (i.e., occupancy), and would be a time and cost-saving opportunity (reduced manpower, rapid setup and takedown during daylight hours for safety). This technique could also be combined with emerging spatially explicit mark-resight methodology (Borchers and Efford 2008; Efford and Fewster 2013), making it possible to determine population abundance and density using carefully deployed cameras on 2–4-day cycles (depending on data collection success). This would have potential drawbacks (e.g., high initial cost, camera failures, camera-induced behavioral changes, less comprehensive range use data than GPS collars) but this methodology may be worth exploring for future hutia research.

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