The Last Survivors: current status and conservation of the non-volant land mammals of the insular Caribbean

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Running header: Status of Caribbean land mammals

The insular Caribbean is among the few oceanic-type island systems colonized by non-volant land mammals. This region also has experienced the world's highest levels of historical mammal extinctions, with at least 29 species lost since AD 1500. Representatives of only 2 land-mammal families (Capromyidae and Solenodontidae) now survive, in Cuba, Hispaniola, Jamaica, and the Bahama Archipelago. The conservation status of Caribbean land mammals is surprisingly poorly understood. The most recent IUCN Red List assessment, from 2008, recognized 15 endemic species, of which 13 were assessed as threatened. We reassessed all available baseline data on the current status of the Caribbean land-mammal fauna within the framework of the IUCN Red List, to determine specific conservation requirements for Caribbean land-mammal species using an evidence-based approach. We recognize only 13 surviving species, 1 of which is not formally described and cannot be assessed using IUCN criteria; 3 further species previously considered valid are interpreted as junior synonyms or subspecies. Of the 12 reassessed species, 5 have undergone a change in threat status since 2008, with 3 species (*Capromys pilorides*, *Geocapromys brownii*, *Mesocapromys angelcabrerai*) increasing in extinction risk by 1 IUCN category, and 2 species (*Plagiodontia aedium*, *Solenodon paradoxus*) decreasing in extinction risk by 2 categories. Only 1 change in threat status represents a genuine change; all other changes are mainly associated with new information becoming available. Hunting, habitat loss, and invasive species represent major threats to surviving species, and conservation of the highly threatened Caribbean land-mammal fauna will require a range of targeted management strategies.

Key words: *Capromys*, Cuba, *Geocapromys*, extinct, Hispaniola, hutia, *Mesocapromys*, *Mysateles*, Red List, solenodon

El Caribe insular es uno de los pocos sistemas insulares de tipo oceánico colonizados por los mamíferos terrestres no voladores. Esta región ha tenido niveles de extinción históricos de mamíferos de los más altos en el mundo, con la extinción de al menos 29 especies desde el año 1500. Representantes de solo 2 familias de mamiferos terrestres (Capromyidae y Solenodontidae) sobreviven ahora, en Cuba, La Española, Jamaica y el archipiélago de las Bahamas. El estado de conservacion de los mamiferos terrestres del Caribe es asombrosamente poco conocido. La mas reciente evaluacion de la IUCN Red List, llevada a cabo en 2008, reconoce 15 especies endemicas de las cuales 13 son consideradas amenazadas. Reevaluamos todos los datos de referencia disponibles sobre el estado actual de la fauna de mamíferos terrestres del Caribe en el marco de la Lista Roja de la UICN, para determinar las necesidades específicas de conservación para estas especies utilizando un enfoque basado en la evidencia. Sólo reconocemos 13 especies que sobreviven, 1 de las cuales no se ha descrito formalmente y no se pueden evaluar mediante criterios de la UICN; 3 nuevas especies previamente consideradas válidas son interpretadas como sinónimos menores o subespecies. De las 12 especies reevaluadas, 5 han sido sometidas a un cambio en el estado de amenaza desde el año 2008, con 3 especies (*Capromys pilorides*, *Geocapromys brownii*, *Mesocapromys angelcabrerai*) que aumentan en riesgo de extinción por 1 categoría de la UICN, y 2 especies (*Plagiodontia aedium*, *Solenodon paradoxus*) decrecientes en riesgo de extinción por 2 categorías. Sólo 1 del los cambios en el estado de amenaza representa un verdadero cambio de situacion; todos los demás son asociados principalmente desde que hay nueva información. La caza, la pérdida de hábitat y las especies invasoras representan las principales amenazas a las especies que sobreviven y la conservación de la

fauna de mamíferos terrestres del Caribe, altamente amenazadas, requerirá una serie de estrategias de gestión dirigida.

Palabras clave: *Capromys*, Cuba, *Geocapromys*, extinguido, La Española, jutia, *Mesocapromys*, *Mysateles*, Lista Roja de la UICN, solenodon

The insular Caribbean is a global biodiversity hotspot (Mittermeier et al. 2005), and its terrestrial biota exhibits both substantial species-level endemism associated with recent evolutionary radiations and higher-order endemism represented by ancient relict clades (Woods and Sergile 2001; Roca et al. 2004). This region is biogeographically unusual in that it is among the few oceanic-type island systems to have been colonized by non-volant land mammals. Its Late Quaternary land-mammal fauna comprised over 100 endemic species or distinct island populations of lipotyphlan insectivores, rodents, sloths, and primates (Woods and Sergile 2001; MacPhee 2009; Turvey 2009). Island faunas have been disproportionately affected by human-caused extinctions, and the insular Caribbean has the distinction of having experienced the highest recorded levels of species extinction in its postglacial mammal fauna both during the post-AD 1500 historical era and throughout the Holocene (MacPhee and Flemming 1999; Turvey 2009; MacPhee 2009; Dávalos and Turvey 2012).

Problems with defining species boundaries for extinct taxa (Díaz-Franco 2001; Condis Fernández et al. 2005; Hansford et al. 2012), and radiometric dating of ancient bone samples from tropical environments (e.g., Turvey et al. 2007), have impeded an understanding of the region's past extinction dynamics and chronology. However, 90 non-volant insular Caribbean land-mammal species are recognized as having become extinct during the Holocene (Turvey 2009). This number now is seen as an underestimate, as additional

recently extinct species continue to be described from the region's Quaternary fossil and zooarchaeological records (Turvey et al. 2010, 2012; Zijlstra et al. 2010; Cooke et al. 2011; Brace et al. 2015). The first wave of extinction, which primarily affected the endemic radiations of sloths and large-bodied heptaxodontid rodents or "giant hutias", appears to have followed initial settlement of the insular Caribbean by Amerindians from about 6000 years ago. A second wave of extinction began around AD 1500 following the arrival of Europeans in the Caribbean. This was associated with increased habitat destruction and the introduction of a variety of invasive mammals, which led to the disappearance of many smaller-bodied species such as the endemic nesophontid island-shrews (Nesophontidae) and the Lesser Antillean rice rats (Oryzomyini; MacPhee and Flemming 1999; Turvey 2009). This second wave currently is considered to include the extinction of 29 formally described endemic Caribbean non-volant land-mammal species during the past 500 years, the time interval assessed by IUCN when considering human-caused extinctions (Table 1). The largest and smallest body-size classes in the Caribbean non-volant mammal fauna now have been lost, probably because larger-bodied and smaller-bodied species were each vulnerable to different anthropogenic threats associated with these 2 extinction phases (the "Goldilocks Hypothesis" of Hansford et al. 2012).

Of a pre-human Holocene fauna containing over 100 endemic non-volant land mammals, only a handful of species now survive, and nearly all of these have been considered highly threatened with extinction (Cuvier 1836; Verrill 1907; Allen 1942; Schipper et al. 2008). Other than species (e.g., Hummelinck's vesper mouse *Baiomys hummelincki*; Husson 1960), that occur on non-oceanic Caribbean islands associated with the South American continental shelf and which are characterized by a continental biota (e.g., Aruba, Bonaire, Curaçao,

Margarita, Tobago, Trinidad), all of the extant Caribbean mammal species are restricted to islands in the Greater Antilles, including Cuba, Hispaniola, Jamaica, and the islands of the Bahama Archipelago. They comprise only 2 surviving families of relatively small-bodied mammals (approximately 0.5–6.9 kg; Borroto-Páez and Mancina 2011), Solenodontidae and Capromyidae, both of which are endemic ancient Caribbean clades (Roca et al. 2004; Fabre et al. 2014). They have been recognized as global priorities for conservation attention on the basis of their unique evolutionary history (Isaac et al. 2007; Collen et al. 2011).

Despite this global conservation prioritization, the status of the surviving representatives of the endemic Caribbean mammal fauna is surprisingly poorly understood. Even recent estimates of extant species diversity vary substantially, with a possible maximum of 16 valid surviving species but potentially as few as 10, due to uncertainty surrounding both species concepts and synonyms, and the status of possibly extinct species (Table 2). As is also true more widely for other small-bodied mammal species identified as conservation priorities on the basis of evolutionary distinctiveness (Sitas et al. 2009), most surviving Caribbean land mammals have received little conservation attention in terms of either baseline studies of population status and threats or targeted management, indicating an urgent need to better understand and address their conservation requirements. Furthermore, access to such information as is available often has been limited for researchers or policy-makers, as data often have been distributed in foreign-language or limited-circulation journals or unpublished gray-literature reports, or synthesized only at a country level rather than a wider regional level.

In the most recent IUCN global mammal Red List assessment (Schipper et al. 2008), 15 species of Caribbean non-volant land mammals were recognized and assessed, with 1 species

listed as Least Concern, 1 as Near Threatened, and the remaining species (comprising 87% of the fauna) listed under 1 of the threatened Red List categories: 3 were Vulnerable, 6 were Endangered, 2 were Critically Endangered, and 2 were Critically Endangered (Possibly Extinct; Table 3). Since this global assessment, national Red Lists that include status assessments of regionally endemic mammals have been produced for the Dominican Republic (Ministerio de Medio Ambiente y Recursos Naturales de la República Dominicana 2011) and Cuba (Mancina 2012). Standard IUCN Red List categories and criteria apparently were used to evaluate national Red List assessments; however, many mammal species status-assessments differ between global and national Red Lists (Table 3). The period since the last global mammal assessment also has seen the publication of new syntheses on regional components of the Caribbean land-mammal fauna (e.g., Borroto-Páez and Mancina 2011; Borroto-Páez et al. 2012b), as well as new large-scale field research programs that have generated substantial new information on the distribution, ecology, and conservation status of particular species (Timyan and Hedges 2011; Young 2012; Martínez et al. 2013; Kennerley 2014).

To determine the specific conservation requirements of different members of the surviving Caribbean land-mammal fauna by use of an evidence-based approach, and to contextualize the patterns and severity of threat faced by this fauna within a wider comparative global context, it is necessary to assess all available baseline data on the current status of these species within the standardized framework of the IUCN Red List. This will allow for an evaluation as to whether the current global and/or national Red List assessments provided for Caribbean mammal species are both up-to-date and accurate. Herein, we present a review of available knowledge on the status of the surviving Caribbean non-volant land-

mammal fauna, and propose revised Red List assessments incorporating this new information for all of the species previously assessed by Schipper et al. (2008).

MATERIALS AND METHODS

Data on the current or recent status, threats, and conservation requirements for Caribbean non-volant land-mammal species were sourced from recent English-language and Spanish-language publications and unpublished reports, and through correspondence with knowledgeable experts in Caribbean range states. Relevant data are summarized in the following series of species accounts, and were used to determine an updated Red List status assessment for each species by use of IUCN Categories and Criteria (version 3.1; IUCN 2001). Data on generation length were obtained from Pacifici et al. (2013). Additional quantitative data on extent of occurrence (EOO, based on a minimum convex polygon; Joppa et al. 2016), population size and number of subpopulations also were obtained where possible (Table 4). Species ranges were mapped according to IUCN criteria (see IUCN Spatial Data Resources, http://www.iucnredlist.org/technical-documents/red-list-training/iucnspatialresources; Figs. 1 and 2), to help determine species threat status against the quantitative thresholds for these parameters provided in IUCN (2001). Where available, national Red List statuses are provided within the species accounts, both for Cuban country endemics and for Hispaniolan species where only Dominican Republic national Red List assessments are available. Threat status of currently recognized subspecies was not considered separately, although some recent publications have advocated provisional Red List status assessments for some highly threatened subspecies (Turvey et al. 2015, 2016).

SOLENODONTIDAE (SOLENODONS)

ATOPOGALE CUBANA (PETERS, 1861)

CUBAN SOLENODON, ALMIQUI

Distribution.—Cuba.

Current IUCN Red List status.—Endangered B1ab(iii,v).

Cuban National Red List status.—Critically Endangered B1b(i,ii,iii), C2ai.

Proposed IUCN Red List status.—Endangered B1ab(iii).

Rationale for revised criteria.—The conditions of criterion B1 were changed because there is no evidence for a recent decline in the number of mature individuals.

Assessment.—The Cuban solenodon has been considered to be among the world's rarest mammals, and periodically was interpreted as already extinct (Allen 1942; Borroto-Páez and Begue Quiala 2011; Fisher and Blomberg 2011; Scheffers et al. 2011). The historic distribution of this species has been affected by extensive reduction and fragmentation of forest habitat. It persists only in the Nipe-Sagua-Baracoa Massif in eastern Cuba, where it occurs mainly in montane and submontane primary forest in Sierra Cristal National Park (Holguín Province), Alejandro de Humboldt National Park (Guantánamo and Holguín provinces), and Cuchillas del Toa Biosphere Reserve (Guantánamo and Holguín provinces; Fa et al. 2002; Borroto-Páez and Begue Quiala 2011, 2012a; Echenique-Díaz et al. 2014). However, it also has been reported from forest-agricultural mosaic habitat outside protected areas in Pinares de Mayarí (Santiago de Cuba Province), suggesting that it may have a wider environmental tolerance than previously assumed (G. García, Oriente University, Santiago de Cuba, Cuba, personal communication, April 2012).

This species is considered particularly vulnerable to invasive mammals. Solenodons killed by feral dogs, dog excreta containing solenodon fur or bones, and dog excavations around probable solenodon dens have been found in Baracoa (Guantánamo Province) and Sierra Cristal National Park (Rams et al. 1989; Borroto-Páez 2009). Abandoned solenodon dens in Alejandro de Humboldt National Park are occupied by black rats (*Rattus rattus*). High rat density in this protected area raises concerns that rats may have a negative impact on solenodons through resource competition. Feral pigs (*Sus scrofa*) also are abundant within the range of solenodons in Cuba and their burrowing for food could destroy solenodon burrows (Borroto-Páez 2009). Mongooses (*Herpestes javanicus*) apparently do not occupy the same landscapes in Cuba, although they occur in the buffer zone of Alejandro de Humboldt National Park (Borroto-Páez 2009).

Recognized subspecies.—None.

Synonyms used in recent publications.—*Solenodon cubanus.* This species traditionally has been placed in the genus *Solenodon*, but the extremely deep, mid-Cenozoic genetic divergence between the 2 living solenodons was used by Roca et al. (2004) to support their assignment to different genera. This classification is supported by the morphological distinctiveness of both taxa, which exhibit major differences such as varying presence of an os proboscis (Ottenwalder 2001).

SOLENODON PARADOXUS BRANDT, 1833

HISPANIOLAN SOLENODON

Distribution.—Hispaniola (Dominican Republic and Haiti).

Current IUCN Red List status.—Endangered B2ab(iii,v).

Dominican Republic National Red List status.—Endangered A4ce, (B2).

Proposed IUCN Red List status.—Near Threatened.

Rationale for revised status.—This species has a large EOO of 80,490 km^2 (Table 4) and is found in numerous protected areas There is no evidence that a substantial decline has yet taken place. However, there is concern about ongoing habitat destruction and degradation (including loss of forest cover within protected areas) across several parts of its range, possible effects of dog predation, and synergistic effects of these threats (i.e., opening up of habitat to allow increased access by invasive predators). This species, therefore, may qualify as Vulnerable A4ce in the future if further data show that habitat loss or predation by invasive mammals are significant threats and that a decline is occurring.

Assessment.—Like the Cuban solenodon, the Hispaniolan solenodon regularly has been considered to be among the world's rarest and most threatened mammals (Verrill 1907; Bridges 1936; Allen 1942; Fisher and Blomberg 2011). Previous threat assessments were based on sparse data and anecdotal evidence, leading to assumptions that the species was rare and patchily distributed. However, recent country-wide surveys have shown that the species is far more widely distributed across the Dominican Republic than previously thought, with no obvious evidence of recent subpopulation declines or extirpations. It occurs in numerous protected areas in the Dominican Republic including Sierra de Bahoruco National Park, Jaragua National Park, Los Haitises National Park and Del Este National Park, and is able to occur in human-modified landscapes as well as primary forest (Young 2012; Martínez et al. 2013; Kennerley 2014; Turvey et al. 2014). It also still persists as a remnant subpopulation in the Massif de la Hotte in southwestern Haiti (Turvey et al. 2008; Timyan and Hedges 2011) and in southeastern Haiti close to the border with the Dominican Republic (Turvey et al.

2014). Genetic analyses indicate that solenodon subpopulations in the southern Dominican Republic and Massif de la Hotte have extremely low effective population sizes; these genetically impoverished subpopulations may have reduced viability and adaptive potential, and may be particularly vulnerable to future environmental change (Turvey et al. 2016).

Ongoing forest loss is documented within the Dominican Republic's protected areas (Sangermano et al. 2015; Pasachnik et al. 2016). However, the Ministerio de Medio Ambiente y Recursos Naturales de la República Dominicana (2014) reported that the country's forest cover has increased over the past decade. There is no consistent evidence that 30% of the Dominican Republic's forest will have been lost within 3 solenodon generations, or that such a loss would have a major impact on solenodons, as they are not dependent on primary forest. This means that the species cannot be assessed as Vulnerable under criterion A3 or A4. There is very little direct hunting of this species. It is possible that dog predation, in particular predation by free-roaming village dogs, may pose a significant threat (Turvey et al. 2014). Camera-trap photos from the Dominican Republic also have shown feral cats entering known solenodon den sites (Rupp and Leon 2009). However, there is again no evidence that predation by invasive mammals is causing a solenodon decline.

Recognized subspecies.—*S. p. paradoxus* (Dominican Republic north of the Neiba Valley), *S. p. haitiensis* (Massif de la Hotte, Haiti), *S. p. woodi* (Massif de la Selle, southeastern Haiti, and Sierra de Bahoruco, southwestern Dominican Republic; Ottenwalder 2001; Turvey et al. 2016).

Synonyms used in recent publications.—None.

CAPROMYIDAE (HUTIAS)

CAPROMYS PILORIDES (SAY, 1822)

DESMAREST'S HUTIA

Distribution.—Cuba.

Current IUCN Red List status.—Least Concern.

Cuban National Red List status.—Not assessed.

Proposed IUCN Red List status.—Near Threatened.

Rationale for revised status.—This species is widespread, and occurs in several protected areas. However, there have been reports of subpopulation declines or extirpations due to hunting, invasive species, and habitat degradation. This species, therefore, may qualify as Vulnerable A2cde in the future if these threats are demonstrated to be causing a decline of 30% or more.

Assessment.—This species is widely distributed across Cuba and its associated islands (Borroto-Páez 2011a). It was recorded in all 17 protected areas surveyed for hutias by Berovides Álvarez et al. (2009), although these authors only considered it to be abundant in 2 of these protected areas, and also is present in high densities around the American naval base in Guantanamo Bay (Witmer et al. 2002). Some subpopulations are stable, but others have declined or been extirpated due to several threats.

Extensive overharvesting occurred in the 1990s during Cuba's economic crisis (Berovides Álvarez et al. 2009). Indiscriminate hunting in this period led to extirpation of some formerly abundant subpopulations, such as the Najasa subpopulation (Sierra de Chorillo, Camagüey Province). This was considered to be the densest hutia subpopulation in Cuba with an estimated 100,000 individuals in 1989-1990, but was rapidly eliminated following a targeted

289 program of week-long campaigns which caught 200-300 hutias/day and >20,000
290 hutias/month. No animals were detected during a survey in 2002, and locals reported that
291 hutias disappeared several years earlier (Borroto-Páez 2011a). Uncontrolled illegal hunting is
292 likely to continue to affect many subpopulations, with evidence of substantial hunting
293 pressure in 9 of the 17 protected areas surveyed by Berovides Álvarez et al. (2009).
294 The species is partly terrestrial, so may be vulnerable to predation by feral dogs (Borroto-
295 Páez 2011a). Subpopulations on Cayo Blanco, Cayo Mono, and neighboring islets in
296 Matanzas Province have been extirpated by dogs brought by fishermen to hunt hutias and
297 then abandoned on the islands. There are concerns that feral dogs present on other islands
298 (e.g., Cayo La Vaca, Villa Clara Province; Archipiélago de Sabana-Camagüey) might
299 similarly impact insular hutia subpopulations (Borroto-Páez 2009). Subpopulations in the
300 Archipiélago de los Canarreos and Archipiélago de Sabana-Camagüey have diminished
301 considerably or been extirpated apparently due to the presence of several species of
302 competing introduced monkeys (*Chlorocebus aethiops*, *Macaca arctoides*, *M. fascicularis*,
303 *M. nemestrina*), as well as from hunting by researchers managing the monkey populations for
304 biomedical research (Borroto-Páez 2009). Hutias also may be threatened by predation of
305 young by feral cats (Borroto-Páez 2011a), and by competition with introduced agoutis
306 (*Cuniculus paca*, *Dasyprocta mexicana*, *D. punctata*) in western Cuba and introduced rabbits
307 (*Oryctolagus cuniculus*) near Matanzas, in Archipiélago de Sabana-Camagüey and Cayos
308 Santa Maria, and around Punta del Este in southern Isla de la Juventud (Borroto-Páez 2009).
309 Multiple threats are considered responsible for driving some subpopulation declines.
310 Hutias formerly were widely distributed in northern Isla de la Juventud, but are now largely
311 confined to mangroves and forest fragments in the northeast around Capitan and Del Soldado

as a result of a combination of habitat loss due to agriculture and the marble industry, hunting, and invasive species (Borroto-Páez 2011a).

Recognized subspecies.—*C. p. pilorides* (Cuban mainland), *C. p. relictus* (Isla de la Juventud), *C. p. doceleguas* (Archipiélago de las Doce Leguas), *C. p. gundlachianus* (Archipiélago de Sabana; Varona 1980, 1983; Silva Taboada et al. 2007; Borroto-Páez 2011a). A fifth subspecies, *C. p. ciprianoi*, has been described from southern Isla de la Juventud (Borroto Páez et al. 1992), but *ciprianoi* and *relictus* show a low level of cytochrome *b* sequence divergence (0.4%) which is similar to that observed within other subspecies of *C. pilorides* (0.0-0.5%); therefore, *ciprianoi* has been interpreted as a junior synonym of *relictus* by some authorities (Woods et al. 2001), but was retained as a valid taxon by Silva Taboada et al. (2007). Cytochrome *b* sequence divergence data also have been used to propose the existence of an undescribed subspecies from Cayo Campo, Archipiélago de los Canarreos (Woods et al. 2001). The taxonomy and phylogenetic interrelationships of allopatric subpopulations of this species, particularly those on offshore archipelagos, are complex and require further study.

Synonyms used in recent publications.—*Capromys garridoi*, described from a single individual collected from Cayo Majá, Archipiélago de los Canarreos (Varona 1970), was considered to be a distinct, Critically Endangered species in the previous Caribbean mammal Red List assessment (Soy and Silva 2008a; see below), but has been reinterpreted as a misidentified specimen of *C. pilorides* (Silva Taboada et al. 2007; Borroto-Páez 2011a).

CAPROMYS UNDESCRIBED SPECIES

Distribution.—Cuba (Cayo Ballenato del Medio, Archipiélago de Sabana-Camagüey).

Comments.—A *Capromys* specimen studied by Borroto-Páez et al. (2005) from Cayo Ballenato del Medio, an island at the eastern end of the Archipiélago de Sabana-Camagüey, was morphologically similar to individuals of *C. pilorides* but showed a markedly higher level of cytochrome *b* sequence divergence (5.5–6.4%) compared with levels of divergence seen between samples from all currently recognised *C. pilorides* subspecies (0.4–1.9%). Borroto-Páez et al. (2005) proposed this specimen represented a previously unrecognised cryptic species of *Capromys*. This taxon remains undescribed, because the skull of the only available specimen is damaged, and part of the *Capromys* population on Cayo Ballenato del Medio reportedly has been introduced from another unknown locality (Borroto-Páez et al. 2005). Red List assessment of this taxon must await formal description and evaluation of its proposed species status.

GEOCAPROMYS BROWNII (FISCHER, 1829)

JAMAICAN HUTIA, JAMAICAN CONEY

Distribution.—Jamaica.

Current IUCN Red List status.—Vulnerable B1ab(iii,v).

Proposed IUCN Red List status.—Endangered B1ab(iii).

Rationale for revised status.—This species is listed as Endangered because its EOO is estimated to be 2,960 km^2 (Table 4) Its range is severely fragmented and apparently it has disappeared from Cockpit Country in recent decades, suggesting that there is a continuing decline in extent of occurrence, area of occupancy, number of locations or subpopulations, and extent and quality of habitat.

Assessment.—Initial assessment of the status of this species indicated it had been extirpated across much of its historical range in Jamaica, was only definitely known from 3 unconnected localities (Hellshire Hills, John Crow Mountains, Worthy Park), and was threatened by ongoing hunting, habitat disturbance, and introduced mongoose predation (Clough 1976). However, further studies suggested that, although some small subpopulations were threatened by continued agricultural or urban development, the species was much more widely distributed than previously supposed; 16 separate subpopulations were identified during survey work in the 1980s, with hutias still relatively abundant in some areas (Oliver 1982; Oliver et al. 1986; Oliver and Wilkins 1988). Although population modelling indicated the extreme vulnerability of this species to overhunting, some subpopulations in Coco Ree and Worthy Park showed apparent signs of expansion where hunting pressure had subsided (Mittermeier 1972; Wilkins 2001). There has been no systematic assessment of the status of this species since the 1980s, and recent reports on its current status and likely threats vary across Jamaica.

There are regular reports from farmers of damage caused to root crops and roots of economic tree crops by the species in the Blue and John Crow Mountains National Park (S. Koenig, Windsor Research Centre, Trelawny, Jamaica, personal communication, May 2015), with local people in the Rio Grande Valley reporting an increase in hutia abundance since 2012 based on an increase in incidences of crop damage (S. Otuokon, Jamaica Conservation and Development Trust, Kingston, Jamaica, personal communication, June 2015). However, this may reflect reduction in suitable available habitat forcing hutias to utilize agricultural areas and come into greater contact with people. Hunting of hutia in this national park decreased substantially from 1971 after the species was included within the Wildlife Act of

1945. Local hunting pressure subsequently increased due to immigration of people returning to the region from outside Jamaica. Strengthened relationships between park rangers and local communities have discouraged direct hunting of hutias, although local hunting of wild pigs using dogs might lead to continued non-targeted take of the species (S. Otuokon, Jamaica Conservation and Development Trust, Kingston, Jamaica, personal communication, June 2015). The species also is considered to be common in the Hellshire Hills, even in areas of degraded habitat, although a proposed Goat Island port mega-structure could lead to destruction of much of this ecosystem (B. Wilson, University of the West Indies, Mona, Jamaica, personal communication, May 2015).

The species was confirmed to still occur in Cockpit Country up until the 1980s, e.g., near Quick Step, although it was considered to have a sparse distribution or occur at low density in this region, with hunters and foresters reporting that it was rarely encountered (Oliver 1982; Oliver et al. 1986). Wilkins (2001) suggested that the species was extirpated from Cockpit Country, probably due to continued local hunting as apparent suitable habitat still remained. The species apparently has not been detected in Cockpit Country for at least 15 years if not considerably longer, despite the regular presence of environmental researchers in this protected area (Southern Trelawney Environment Agency 2002; S. Koenig, Windsor Research Centre, Trelawny, Jamaica, personal communication, May 2015).

Although hutias recently have been brought into captivity at Hope Zoo, Kingston, there currently are no ongoing *in situ* conservation measures in place for the species. There is a clear need for standardized surveys across remaining areas where it is thought to occur.

Recognized subspecies.—None.

Synonyms used in recent publications.—None.

GEOCAPROMYS INGRAHAMI (ALLEN, 1891)

BAHAMAN HUTIA

Distribution.—Bahamas (East Plana Cay, Little Wax Cay, and Warderick Wells Cay).

Current IUCN Red List status.—Vulnerable D2.

Proposed IUCN Red List status.—Vulnerable D2.

Assessment.—This species formerly was widely distributed across much of the Bahama Archipelago, including most or all of the islands of Little Bahama Bank, Greater Bahama Bank, Crooked-Acklins Bank, and Plana Cay Bank (Morgan 1989; Dávalos and Turvey 2012), but only 1 native subpopulation is known to survive, on East Plana Cay. Other subpopulations probably became extinct due to a combination of hunting, predation by dogs, and competition with other invasive mammals (Clough 1972). The timing of disappearance of hutia subpopulations on most other islands in the archipelago is unknown, although a second, now-extirpated native subpopulation was reported to have been present on Samana Cay before 1934; this subpopulation may have been wiped out by severe hurricanes that hit the island in 1929 and 1932 (Barbour and Schreve 1935). There also have been recent suggestions that other previously undetected native subpopulations may persist on other cays, including Moriah Harbour Cay (Bahamas) and John Higgs Cay (Turks and Caicos), but these claims have not been substantiated (B. Naqqi Manco, Department of Environment and Maritime Affairs, Turks & Caicos Islands Government, Grand Turk, Turks and Caicos Islands, personal communication, May 2015; K. Swinnerton, Island Conservation, San Juan, Puerto Rico, personal communication, May 2015). Additional subpopulations have been

established through conservation translocation on Little Wax Cay in 1973 and Warderick Wells Cay in 1981 (Clough 1985; Jordan 1989).

Published population estimates are outdated and only available for East Plana Cay (12,000 individuals; Clough 1972) and Little Wax Cay (1,200 individuals; Jordan 1989). Subpopulations apparently are stable on the 3 islands where the species is found, and there are concerns that high densities of translocated hutias have caused significant damage to the vegetation of Little Wax Cay, including local plant extinctions (Campbell et al. 1991), and possibly also to local herpetofauna (Franz et al. 1993). However, all subpopulations are susceptible to being wiped out by stochastic events such as hurricanes, and also are vulnerable to accidental or deliberate introduction of feral cats or other non-native mammals, which have been responsible for the disappearance of populations of other *Geocapromys* species on small islands in past decades (Clough 1976). Invasive black rats are absent on East Plana Cay but are present on Little Wax Cay, but are not considered to pose a threat to hutias on this island (Clough 1985; Jordan 1989). There is no regular monitoring of any subpopulations of this species.

Recognized subspecies.—2 extinct subspecies have been described from Quaternary fossil material: *G. i. abaconis* (Great Abaco) and *G. i. irrectus* (Crooked, Eleuthera, Great and Little Exuma, and Long Islands; Lawrence 1934; Koopman et al. 1957).

Synonyms used in recent publications.—None.

MESOCAPROMYS ANGELCABRERAI (VARONA, 1979)

CABRERA'S HUTIA

Distribution.—Cuba (Cayos de Ana María).

Current IUCN Red List status.—Endangered C2a(i).

Cuban National Red List status.—Critically Endangered B2a.

Proposed IUCN Red List status.—Critically Endangered B1ab(iii), B2ab(iii).

Rationale for revised status.—This species has an extremely small EOO and area of occupancy (estimated as 22 km^2 and 5 km^2 respectively; Table 4). It has a fragmented distribution comprised of 1 native subpopulation and 1 separate tiny introduced subpopulation. It is experiencing a decline in area, extent, and quality of habitat associated with causeway construction and increased disturbance from local people and invasive mammals.

Assessment.—This species has an extremely restricted distribution as a single population found on 3 closely adjoining small islands in the Cayos Salinas (northern Cayos de Ana María, Ciego de Ávila Province), where it occurs in red mangrove (*Rhizophora mangle*). Recent population size, based on a 2009 survey, is estimated as 380-760 individuals (Borroto-Páez et al. 2011, 2012a). Previous status assessments erroneously have reported it is also present on the neighboring mainland around Júcaro (Borroto-Páez et al. 2011). Although the Cayos de Ana María are a wildlife refuge, the species is intrinsically vulnerable because of its restricted distribution (e.g., through damage to habitat from hurricanes), and also is increasingly threatened due to recent construction of a causeway from the mainland to the Cayos Salinas, which damaged mangrove habitat and enabled increased access by local people and invasive predators and competitors. Following causeway construction, human disturbance on the Cayos Salinas has increased in the form of illegal fires and poaching of hutias, with this species sometimes mistaken for juveniles of the co-occurring *Capromys pilorides* (Borroto-Páez et al. 2012a). Black rats are very abundant in the Cayos Salinas, and

feral cats have been observed travelling across the causeway from the mainland (Borroto-Páez et al. 2012a). In 2005, 6 hutias were translocated to Cayo La Loma in the southern Cayos de Ana María, and about 20 individuals were detected on this small island in 2010 (Borroto-Páez et al. 2011); the current status of this subpopulation is unknown.

Recognized subspecies.—None.

Synonyms used in recent publications.—None.

MESOCAPROMYS AURITUS (VARONA, 1970)

LARGE-EARED HUTIA, EARED HUTIA

Distribution.—Cuba (Cayo Fragoso).

Current IUCN Red List status.—Endangered C2a(ii).

Cuban National Red List status.—Critically Endangered B1a.

Proposed IUCN Red List status.—Endangered B1ab(iii), C2a(ii).

Rationale for revised status.— This species has a fragmented distribution comprised of 1 small native subpopulation and 1-2 separate tiny introduced subpopulations which may be unviable or already extinct. Its mangrove habitat may be declining in extent and quality due to hurricanes and rising sea levels; and, it has an extremely small estimated EOO of 349 km^2 (Table 4).

Assessment.—This species has an extremely restricted distribution within the Refugio de Fauna Lanzanillo-Pajonal-Fragoso in Archipiélago de Sabana-Camagüey, where it is largely dependent on red mangrove (Borroto-Páez and Hernández Pérez 2011, 2012; Manójina and Abreu 2012). Its native range is restricted to Cayo Fragoso, where it has a distribution of <10 km^2 (Borroto-Páez and Hernández Pérez 2011, 2012). Individuals were introduced to the

nearby small islands of Cayo Pasaje in 1987, Cayo La Sagra in 1988, and Cayo Pajonal in 1988 and 1989; however, surveys in 2006 and 2009 detected only 2 hutia nests on Cayo La Sagra and none on Cayo Pajonal, with the status of hutias on Cayo Pasaje not determined (Borroto-Páez and Hernández Pérez 2012). The tiny population(s) of this species are vulnerable to destruction of mangrove habitat by hurricanes and climate change. Also, they may be threatened by black rats, which are common on Cayo Fragoso. Hutia nests are sometimes occupied by rats that may transfer diseases to hutias (Borroto-Páez 2009; Borroto-Páez and Hernández Pérez 2012).

Published population estimates and trends for this species vary. Borroto-Páez and Hernández Pérez (2011) suggested that the population consists of 600-1320 individuals and is stable. However, the most recent published estimate suggests that the population consists of only 400 individuals (Borroto-Páez and Hernández Pérez 2012).

Recognized subspecies.—None.

Synonyms used in recent publications.—None.

MESOCAPROMYS MELANURUS (POEY IN PETERS, 1864)

BLACK-TAILED HUTIA, BUSHY-TAILED HUTIA

Distribution.—Eastern mainland Cuba.

Current IUCN Red List status.—Vulnerable A2cd.

Cuban National Red List status.—Vulnerable B2b(i,ii,iii).

Proposed IUCN Red List status.—Vulnerable A2cd.

Assessment.—This species has a restricted distribution in eastern Cuba (in Granma, Guantánamo, Holguín, and Santiago de Cuba provinces). It is present within several

protected areas (Alejandro de Humboldt National Park, Holguín and Guantánamo provinces; Cuchillas del Toa Biosphere Reserve, Guantánamo Province; Desembarco del Granma National Park, Granma Province; Hatibonico Ecological Reserve, Guantánamo Province; Sierra Cristal National Park, Holguín Province; Borroto-Páez and Begue Quiala 2012b). It occurs as several fragmented subpopulations (Borroto-Páez and Beque Quiala 2011). Its status varies across its range, with evidence of local abundance in some areas in recent decades (e.g., Guisa, Granma Province), but reduced abundance in most areas, such as Alejandro de Humboldt National Park (Borroto-Páez and Beque Quiala 2011; Borroto-Páez et al. 2012b).

It is hunted extensively by local communities (Borroto-Páez and Beque Quiala 2012b), primarily for subsistence but also as an important element of Oruba religion, which advocates the use of its fat for medicine (Borroto-Páez and Beque Quiala 2011). Destruction of nest sites in tree cavities to capture animals is a serious associated concern; in the core area and buffer zone of Alejandro de Humboldt National Park, it is estimated that 22.4% of nests have been partially or totally destroyed by hunters and the entrances of a further 24.8% of nests have been blocked or obstructed to facilitate capture, leading to substantial reduction in nest site availability (Borroto-Páez and Beque Quiala 2011, 2012b). Scats from feral dogs containing hair from this species frequently are found in Alejandro de Humboldt National Park (Borroto-Páez 2009). Predation by feral cats is also a concern (Borroto-Páez and Beque Quiala 2011). Feral pigs damage vegetation and limit regeneration of lianas and other climbing plants that this species depends upon for refuges and nests (Borroto-Páez 2009). This arboreal species occupies a similar niche to the introduced black rat, so may be particularly vulnerable to competition from this exotic mammal (Borroto-Páez 2009).

Expansion of mongooses inside Alejandro de Humboldt National Park may constitute a significant future threat (Borroto-Páez and Beque Quiala 2011). The species occurs in a range of primary and secondary forest habitats, including coffee, cacao, and fruit tree plantations (Borroto-Páez and Beque Quiala 2011, 2012b). Habitat fragmentation and conversion for agriculture and mining is a current threat (Borroto-Páez and Beque Quiala 2011). Available habitat has decreased by 20% during a recent 10-year period (Borroto-Páez and Begue Quiala 2012b). These quantitative estimates of levels of habitat loss and nest destruction or obstruction through illegal hunting are consistent with population reduction of >30% over the past 3 generations (approximately 18 years; Table 4), supporting the existing Red List assessment for the species.

Recognized subspecies.—None.

Synonyms used in recent publications.—*Mysateles melanurus*. This species was reassigned to *Mesocapromys* from *Mysateles* on the basis of cytochrome *b* sequence data by Woods et al. (2001), a taxonomic arrangement that has been followed by Borroto-Páez et al. (2005), Woods and Kilpatrick (2005), Borroto-Páez and Beque Quiala (2011, 2012b), and Kilpatrick et al. (2012), but it was retained in *Mysateles* by Silva Taboada et al. (2007). We follow the recent majority consensus on the genus-level placement of this species, although we note that the non-overlapping allopatric range delimitation across mainland Cuba seen between this species and *Mysateles prehensilis*, and its greater adaptations for arboreality than in other *Mesocapromys* species, suggest that it may be better placed in *Mysateles*.

MESOCAPROMYS NANUS (ALLEN, 1917)

DWARF HUTIA

Distribution.—Cuba (Zapata Swamp).

Current IUCN Red List status.—Critically Endangered (Possibly Extinct) C2a(i).

Cuban National Red List status.—Critically Endangered D, B1a.

Proposed IUCN Red List status.—Critically Endangered (Possibly Extinct) D.

Rationale for revised criteria.—It is likely that any surviving remnant population will contain extremely few mature individuals, meaning that criterion D can be used. However, there is no evidence for a continuing population decline, meaning that criterion B1 cannot be used.

Assessment.—Quaternary fossil and zooarchaeological remains indicate this species formerly had a wide geographic distribution across mainland Cuba and Isla de la Juventud (Silva Taboada et al. 2007). However, living individuals only have been reported from Zapata Swamp, Matanzas Province (Borroto-Páez 2011b, 2012), a refugium for relict populations of several threatened mainland Cuban taxa (Garrido 1980; Kirkconnell Páez et al. 2005) and within the protected area of Ciénaga de Zapata National Park. Dwarf hutias were caught and collected at unspecified localities in Zapata Swamp on several occasions during the early-mid 20th century (Garrido 1991), with the most recent verified collection taking place in 1951 (not 1937 as reported by Soy and Silva 2008b; Borroto-Páez 2011b, 2012). Local informants in Zapata Swamp reported that during the early 20th century, the species had been "rather common" in the cayos de monte near Santo Tomás and Soplillar and around Treasure Lake (Garrido 1991), with animals previously hunted in mangrove habitat in the vicinity of Soplillar (Garrido 1980). Fieldwork conducted in this region in the 1970s failed to detect hutias (Garrido 1991), but an individual reportedly was kept captive by a local guide in 1978. In the same year, Cuban biologist Orlando Garrido observed and tried to

capture an animal he identified as a dwarf hutia near the Canal de los Patos in Zapata Swamp. He also found nests and droppings in this region that he interpreted as having been made by the species (Garrido 1980, 1991). Subsequent field surveys in Zapata Swamp failed to detect the species (e.g., Kirkconnell Páez et al. 2005), and several authorities have expressed doubt as to its continued survival (Kirkconnell Páez et al. 2005; Borroto-Páez 2011b). In this region, invasive black rats, mongooses, and feral cats and dogs are present, fires are set intentionally for mosquito control and accidentally, and there is a history of deforestation for charcoal production (Borroto-Páez 2011b, 2012). However, as recently as the 1990s local informants in Zapata Swamp apparently were still familiar with the species (Nieto Dopico 1997). This area is large and difficult to access, and mammal surveys have not been conducted systematically across all areas of potential habitat. Further systematic surveys are an important priority for this species.

Recognized subspecies.—None.

Synonyms used in recent publications.—None.

MESOCAPROMYS SANFELIPENSIS (VARONA IN VARONA AND GARRIDO, 1970)

LITTLE EARTH HUTIA

Distribution.—Cuba (Cayos de San Felipe).

Current IUCN Red List status.—Critically Endangered (Possibly Extinct) D.

Cuban National Red List status.—Critically Endangered B2a.

Proposed IUCN Red List status.—Critically Endangered (Possibly Extinct) B1ab(iii,iv,v), D.

608 *Rationale for revised criteria*.—In addition to consisting of only an extremely small
609 remnant population if it survives at all, this species also has an extremely small estimated
610 EOO of 20 km^2 (Table 4). In recent decades it has experienced declines in area, extent and
611 quality of habitat, number of locations and subpopulations, and number of mature
612 individuals.
613 *Assessment*.—This species only has been reported from 2 neighboring cays, Cayo Juan
614 García and the smaller Cayo Real, within the Cayos de San Felipe (protected within Cayos de
615 San Felipe National Park; Varona and Garrido 1970; Borroto-Páez 2011b, 2012). Living
616 individuals were recorded only from the Cayos de San Felipe during field visits by Cuban
617 researchers in the 1970s and were last recorded in 1978 (Borroto-Páez 2011b). Researchers
618 failed to observe living hutias in 1979 and 1980, but detected droppings considered to belong
619 to the species (Frías et al. 1988). Later field surveys failed to detect any sign of the species
620 (Meier 2004). Information on habitat availability is conflicting. Frías et al. (1988) reported
621 that virtually no suitable habitat was left on the islands due to fires lit by increasing numbers
622 of visiting fishermen to control mosquitos and produce charcoal, and further accidental fires
623 are thought to have resulted from cooking fires used by fishermen (Soy and Silva 2008c), but
624 Meier (2004) reported that appropriate habitat still was widely available. A relatively large
625 number of hutias are known to have been collected by visiting researchers during the 1970s
626 (14 in 1970; 18 in 1974-1975; 43 in 1978; Frías et al. 1988), and hutias also are thought to
627 have been hunted intensively by fishermen and other temporary inhabitants, notably
628 personnel attached to a military installation formerly present on the archipelago, as well as by
629 dogs brought by these visitors (Soy and Silva 2008c; Borroto-Páez 2011b). There is a high
630 density of invasive black rats on the archipelago (Frías et al. 1988; Meier 2004; Borroto-Páez

2009), and feral cats also may be present (Meier 2004). The archipelago also was used in the 1970s to test methods for eradicating rats using baits containing biological control agents, which may have further impacted surviving hutia populations (Borroto-Páez 2011b). The species appears now to be extinct on both Cayo Juan García and Cayo Real (Borroto-Páez 2012); however, some other islets in the archipelago have not yet been surveyed for hutias, so a population "in the 10s of individuals" conceivably still may survive (Meier 2004).

Recognized subspecies.—None.

Synonyms used in recent publications.—None.

MYSATELES GARRIDOI (VARONA, 1970)

GARRIDO'S HUTIA

Current IUCN Red List status.—Critically Endangered (Possibly Extinct) C2a(i).

Cuban National Red List status.—Not assessed.

Proposed IUCN Red List status.—N/A (invalid species).

Assessment.—Reinterpreted as a misidentified specimen of *C. pilorides* (Silva Taboada et al. 2007; Borroto-Páez 2011b).

MYSATELES GUNDLACHI (CHAPMAN, 1901)

CHAPMAN'S PREHENSILE-TAILED HUTIA

Current IUCN Red List status.—Endangered B1ab (ii,iii,v).

Cuban National Red List status.—Not assessed.

Proposed IUCN Red List status.—N/A (invalid species).

Assessment.—Levels of cytochrome *b* sequence divergence (1.2%) between *M. gundlachi* from Isla de la Juventud and *M. prehensilis* from the Cuban mainland are lower than the 1.8% sequence divergence observed between similarly distributed subspecies in *Capromys pilorides* (Woods et al. 2001). *M. gundlachi* therefore has been reinterpreted as a subspecies of *M. prehensilis* by Woods et al. (2001), Borroto-Páez et al. (2005), Woods and Kilpatrick (2005), Silva Taboada et al. (2007), and Borroto-Páez (2011b).

MYSATELES MERIDIONALIS (VARONA, 1986)

ISLA DE LA JUVENTUD TREE HUTIA

Current IUCN Red List status.—Critically Endangered A2de; C2a(ii).

Cuban National Red List status.—Not assessed.

Proposed IUCN Red List status.—N/A (invalid species).

Assessment.—Interpreted as a subspecies of *Mysateles prehensilis* on the basis of morphological similarity by Silva Taboada et al. (2007) and Borroto-Páez (2011b).

MYSATELES PREHENSILIS (POEPPIG, 1824)

PREHENSILE-TAILED HUTIA

Distribution.—Western and central mainland Cuba and Isla de la Juventud.

Current IUCN Red List status.—Near Threatened.

Cuban National Red List status.—Not assessed.

Proposed IUCN Red List status.—Near Threatened.

Assessment.—This species still is distributed widely across western and central Cuba. However, loss of forest habitat across its range caused by conversion to agriculture has

reduced population size and driven population fragmentation (Borroto-Páez and Espinosa Romo 2011). Hunting by local people can be intensive, and constitutes a significant threat (Borroto-Páez and Espinosa Romo 2011). This arboreal species occupies a niche similar to the introduced black rat, which uses the same vines and tree holes, and so may be particularly vulnerable to competition and disease or parasite transmission from this exotic mammal. Nests of black rats are particularly abundant among the branches and lianas that constitute the preferred substratum of this hutia in the gallery forests of northern and southern Isla de la Juventud (Borroto Páez and Ramos García 2003; Borroto-Páez and Espinosa Romo 2011; Borroto Páez and Ramos 2012). Feral cats may be serious predators of this species, as they are able to climb (Borroto Páez and Ramos García 2003), and are known to predate this species on both Isla de la Juventud and mainland Cuba (e.g., Bolivia, Ciego de Ávila Province; Borroto-Páez and Mancina 2011). Competition with black rats and predation by feral cats are interpreted as the major causes of severe decline and possible extirpation of this species in southern Isla de la Juventud (Borroto Páez and Ramos García 2003). The species also faces predation risk from feral dogs when on the ground, and dog scats containing hair and bones of this species have been found in Sierra del Rosario Biosphere Reserve (Pinar del Rio and Artemisa provinces; Borroto-Páez 2009). Whilst this species remains widespread with a very large EOO (Table 4), the possible extirpation of 1 subpopulation and reported declines in other fragmented subpopulations in response to several ongoing threats could lead to it qualifying as Vulnerable A2cde in the future if these threats are demonstrated to be causing a decline of 30% or more.

Recognized subspecies.—*M. p. prehensilis* (Cuban mainland), *M. p. gundlachi* (northern Isla de la Juventud), *M. p. meridionalis* (southern Isla de la Juventud).

Synonyms used in recent publications.—None.

PLAGIODONTIA AEDIUM CUVIER, 1836

HISPANIOLAN HUTIA

Distribution.—Hispaniola (Dominican Republic and Haiti).

Current IUCN Red List status.—Endangered A4acde.

Dominican National Red List status.—Endangered A4c, (B2).

Proposed IUCN Red List status.—Near Threatened.

Rationale for revised status.—This species has a large EOO of 78,166 km^2 (Table 4) and is found in numerous protected areas. There is no evidence of recent subpopulation declines or extirpations. However, it appears to be dependent upon primary forest, and there is concern about ongoing habitat destruction and degradation (including loss of forest cover within protected areas) across several parts of its range, possible effects of dog predation, and synergistic effects of these threats (i.e., opening up of habitat to allow increased access by invasive predators). Therefore, this species may qualify as Vulnerable A4ce in the future if further data show that habitat loss or predation by invasive mammals are significant threats and that a decline is occurring.

Assessment.—This species has been considered rare and threatened since it was first described by Cuvier (1836), making it historically among the first species ever to be recognized as being at risk of human-caused extinction, and was widely thought to be extinct until the mid-20th century (Allen 1942; Fisher and Blomberg 2011). As with the Hispaniolan solenodon, previous threat assessments were based on limited data (e.g., Sullivan 1983), leading to the assumption that it was both rare and patchily distributed. However, recent

722 country-wide surveys have shown that it is far more widely distributed across the Dominican
723 Republic than previously thought. Although historical range contraction was documented in
724 southern Haiti before the late 20th century (Woods 1981), there is no obvious evidence of
725 more recent subpopulation declines or extirpations. It occurs in numerous protected areas in
726 the Dominican Republic including Sierra de Bahoruco National Park, Jaragua National Park,
727 Los Haitises National Park and Del Este National Park (Young 2012; Martínez et al. 2013;
728 Turvey et al. 2014). It also still persists as a remnant subpopulation in the Massif de la Hotte
729 in southwestern Haiti (Turvey et al. 2008) and in southeastern Haiti close to the border with
730 the Dominican Republic (Turvey et al. 2014).
731 The Hispaniolan hutia is more dependent than the Hispaniolan solenodon on primary
732 forest in the Dominican Republic, suggesting that it may be more vulnerable to human
733 pressures (Kennerley 2014). However, as for the Hispaniolan solenodon, this species cannot
734 be assessed as Vulnerable under criterion A3 or A4.While ongoing forest loss is documented
735 within the Dominican Republic's protected areas (Sangermano et al. 2015; Pasachnik et al.
736 2016), forest cover across the country reportedly has increased over the past decade
737 (Ministerio de Medio Ambiente y Recursos Naturales de la República Dominicana 2014). So,
738 there is no consistent evidence that 30% of the Dominican Republic's forest will have been
739 lost within 3 hutia generations. Hutias are also far more locally abundant than solenodons in
740 degraded landscapes in the Massif de la Hotte (Turvey et al. 2008), and genetic analysis has
741 shown that hutia subpopulations across Hispaniola have markedly higher effective population
742 sizes than sympatric solenodon subpopulations (Brace et al. 2012). As for Hispaniolan
743 solenodons, there is minimal direct hunting of Hispaniolan hutias. It is possible that dog
744 predation, in particular predation by free-roaming village dogs, may pose a significant threat

745 (Turvey et al. 2014), but as for solenodons there is no evidence that predation by invasive
746 mammals is causing a decline.
747 *Recognized subspecies*.—*P. a. aedium* (Massif de la Hotte, Haiti), *P. a. hylaeum*
748 (Dominican Republic north of the Neiba Valley), *P. a. bondi* (Massif de la Selle,
749 southeastern Haiti, and Sierra de Bahoruco, southwestern Dominican Republic; Brace et al.
750 2012; Hansford et al. 2012; Turvey et al. 2015).
751 *Synonyms used in recent publications*.—The Quaternary taxa *P. caletensis* and *P.*
752 *ipnaeum*, described on the basis of subfossil and zooarchaeological specimens, fall within the
753 range of morphometric variation seen in modern *P. aedium* and have been interpreted as
754 junior synonyms of this species. *Plagiodontia spelaeum* previously was considered to be a
755 junior synonym of *P. aedium*, but is now considered to represent a valid extinct species
756 (Hansford et al. 2012).
757

758 ## DISCUSSION

759 Our reassessment of the threat status of the Caribbean land-mammal fauna provides a
760 substantially different outlook in comparison to previous assessments. We only recognize 13
761 surviving Caribbean land-mammal species, 1 of which (an apparently valid species based on
762 available data, pending further published research) is not yet formally described and so
763 cannot be assessed according to IUCN criteria, with 3 further species considered valid by
764 Schipper et al. (2008) now interpreted as junior synonyms or subspecies of other species. Of
765 the 12 reassessed species, 5 have undergone a change in threat status since 2008 (Table 3),
766 with 3 increasing in extinction risk by 1 category (1 from Least Concern to Near Threatened,
767 1 from Vulnerable to Endangered, and 1 from Endangered to Critically Endangered) and 2

768 decreasing in extinction risk by 2 categories (both from Endangered to Near Threatened).
769 Four further species have remained in the same threat category, but experienced a change in
770 the criteria justifying this status. Whereas no species are now considered Least Concern, only
771 8 of the 12 reassessed species (67%) are listed under 1 of the Red List threat categories, with
772 the remaining 4 species listed as Near Threatened, in comparison to 13 out of 15 species
773 (87%) listed as threatened in the previous assessment. Considered at an island level, Cuba's
774 surviving land-mammal fauna now is interpreted as more threatened than in the previous
775 assessment. For species currently recognized as valid, 6 of 8 (75%) are assigned to a Red List
776 threat category in both assessments, but 2 have experienced an increase in threat status by 1
777 category in the new assessment. Jamaica's single surviving land-mammal species also has
778 undergone an increase in threat status, from Vulnerable to Endangered. Conversely,
779 Hispaniola's 2 land-mammal species have been downlisted from Endangered to Near
780 Threatened, and the single surviving Bahaman species remains at the same threat status.
781 Schipper et al. (2008) also listed only 22 Caribbean land mammals as having become extinct
782 since AD 1500, but we recognize 29 historically extinct species (Table 1). Differences
783 between these 2 assessments result from recent revisions of extinct species diversity and
784 valid taxa (e.g., species recognized in *Hyperplagiodontia* and *Plagiodontia*; Hansford et al.
785 2012), reassessment of evidence for historical persistence of now-extinct species, and
786 ongoing taxonomic descriptions of extinct Caribbean mammals (e.g., *Antillomys rayi*,
787 *Megalomys georginae, Pennatomys nivalis*).
788 Changes in species' IUCN Red List status between assessments can reflect either
789 genuine status changes, or non-genuine changes resulting from several possible factors
790 (Hoffmann et al. 2011). Only 1 of the changes in threat status that we report in the Caribbean

land-mammal fauna—the elevation to Critically Endangered for *Mesocapromys angelcabrerai*—represents a genuine status change since the previous assessment; all other changes are instead non-genuine changes (Table 3). We also note that no changes in Red List status of Caribbean mammal species resulted from using the new minimum convex polygon approach for calculating EOO proposed by Joppa et al. (2016). In addition to the taxonomic revisions previously described, nearly all of these non-genuine changes are associated with new information having recently become available on the status of many species. Many aspects of the abundance, distribution, and population trends of Caribbean land mammals have been poorly understood in the past, due to difficulties in collecting extensive data on nocturnal or arboreal small mammals that occur in often remote landscapes, and also to socio-political factors that have limited the feasibility of conducting adequate field surveys across many Caribbean range states. Previous assessments often have been conducted with relatively few baseline data on key conservation parameters, having to rely instead on more anecdotal reports, which have suggested that some Caribbean mammal species (e.g., Hispaniolan land mammals) are extremely rare and threatened when in fact they appear to be more widely distributed but occur at low detectability levels (e.g., Verrill 1907; Bridges 1936; Allen 1942; Woods 1981; Sullivan 1983). Further discrepancies between past and present IUCN Red List assessments and national assessments (Table 3) are associated in some instances with a misunderstanding of IUCN categories and criteria. We encourage greater standardization of national Red Listing methods to provide more consistent and realistic baselines for informing conservation policy within Caribbean range states.

Data now available to assess the status and threats of Caribbean land mammals still vary in quality and quantity, both between different regions and for evaluating the relative

814 significance of different potential threat processes. For example, there has been a recent
815 focus on documenting the impacts of invasive mammal species in Cuba (Borroto-Páez 2009),
816 whereas fewer recent regional data are available to understand the comparative impact of
817 habitat loss in driving population declines for many species. Despite this continued variation
818 in data availability, 10 of the 12 reassessed Caribbean land-mammal species are considered
819 to be negatively impacted by hunting, 10 by habitat loss (including urban and tourist
820 development, farming, logging and wood harvesting, mining and quarrying, and increased
821 fires), and all 12 by invasive species (Fig. 3).

822 It is hoped that field research programs now being conducted in Cuba, Haiti, and the
823 Dominican Republic (e.g., Timyan and Hedges 2011; Young 2012; Echenique-Díaz et al.
824 2014) will be able to further strengthen our baseline knowledge on the status of and threats to
825 several Caribbean land mammals. However, additional field research to understand current
826 distribution and abundance, population trends, and vulnerability or resilience to potential
827 anthropogenic pressures across different habitat types and human-modified landscapes
828 remains an urgent conservation research aim for all Caribbean land-mammal species. Using
829 both standardized ecological field survey techniques (cf. Kennerley 2014) and alternative
830 approaches such as community-based surveys of local ecological knowledge can be effective
831 for determining status and threats for cryptic Caribbean small-mammal species (Turvey et al.
832 2014). New field surveys are particularly necessary to assess whether some species
833 (*Mesocapromys nanus*, *M. sanfelipensis*) are extant, and to inform the very limited
834 understanding of key conservation parameters currently available for other species (e.g.,
835 *Geocapromys brownii*). As demonstrated by the substantial changes in species richness and
836 taxonomy of Caribbean mammals between recent assessments, further research to clarify the

taxonomic status and relationships of surviving Caribbean mammal populations, notably *Capromys* and *Mesocapromys* populations across Cuba and its offshore archipelagos, is another priority to help ensure that unrecognized but potentially distinct taxa can receive appropriate conservation attention (cf. Brace et al. 2012; Turvey et al. 2016).

Uncontrolled hunting, deforestation, habitat degradation, and invasive species continue to have a major impact on most Caribbean mammal species, even inside protected areas and for species that still have wide distributions and relatively large remaining populations (Borroto-Páez and Mancina 2011). Conservation of the highly-threatened surviving Caribbean land-mammal fauna will require a range of targeted management strategies, including improved population monitoring; strengthened regulation of subsistence hunting; habitat management and restoration; reduction of native mammal mortality by invasive mammals; village-level and national environmental education programs in all Caribbean range states; and potentially, also more intensive *ex situ* approaches such as captive breeding for particularly vulnerable species or populations (Berovides Álvarez et al. 2009; Mancina 2012; Martínez et al. 2013; Turvey et al. 2014). In particular, sustainable populations of Caribbean land mammals need to be maintained within protected areas free from deforestation and illegal hunting and with appropriate control programs for harmful invasives. We encourage Caribbean range states to support this conservation priority for endemic regional biodiversity with appropriate environmental legislation and enforcement. We are hopeful that with such national conservation investment, combined with a greater Caribbean-wide co-ordination of conservation activities, these enigmatic, unusual, and irreplaceable mammals still can have a future.

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Table 1. Caribbean non-volant land-mammal species currently considered to have become extinct since AD 1500, the time interval considered by IUCN (2001) for listing species extinctions, and which corresponds approximately to the time since first European arrival in the insular Caribbean. Strength of evidence for inferring post-European extinction date given in ascending data quality: *=no radiometric dates to demonstrate survival into or close to post-AD 1500 historical era, and the only evidence for recent survival constitutes subfossil remains apparently associated with remains of historically introduced species, and/or historical accounts of animals that may represent this species; **=available radiometric dates (direct or indirect) indicate survival until close to European arrival, making survival into post-AD 1500 historical era very likely; ***=definite historical records available. Historically extinct Caribbean mammal populations likely to represent distinct species but not yet formally described (e.g., Cayman Island capromyids and nesophontids, many Lesser Antillean oryzomyine rice rat populations; Morgan 1994, Turvey et al. 2010) are excluded from this list, indicating that it almost certainly represents an underestimate of the true level of historical-era Caribbean mammal species extinction.

Species	**Distribution**	**Evidence for post-AD 1500 survival**	**Included in 2008 IUCN Red List?**	**Recently used synonyms**	**References**
Antillomys rayi	Antigua, Barbuda,	**	N	"*Ekbletomys*	Turvey et al. 2010;

	Guadeloupe, Marie Galante			*hypenemus*”	Brace et al. 2015
Boromys offella	Cuba	*	Y		Jiménez Vázquez et al. 2005
Boromys torrei	Cuba	*	Y		Jiménez Vázquez et al. 2005
Brotomys voratus	Hispaniola	**	Y		Miller 1929; McFarlane et al. 2000
Geocapromys columbianus	Cuba	*	Y	*Geocapromys pleistocenicus*	MacPhee and Flemming 1999; Silva Taboada et al. 2007
Geocapromys thoracatus	Little Swan Island	***	Y		Clough 1976
Heteropsomys insulans	Puerto Rico	**	Y	*Homopsomys antillensis* (?)	Turvey et al. 2007
Hexolobodon phenax	Hispaniola	*	Y		Woods and Ottenwalder

					1992
Hyperplagiodontia araeum	Hispaniola	*	N	*Plagiodontia araeum*	Hansford et al. 2012
Isolobodon montanus	Hispaniola	*	Y		Woods and Ottenwalder 1992
Isolobodon portoricensis	Hispaniola, Puerto Rico, Virgin Islands	**	Y		Miller 1929; McFarlane et al. 2000
Megalomys desmarestii	Martinique	***	Y		Allen 1942
Megalomys georginae	Barbados	***	N		Turvey et al. 2012
Megalomys luciae	St. Lucia	***	Y		Allen 1942
Nesophontes edithae	Puerto Rico, Virgin Islands	**	Y		Turvey et al. 2007
Nesophontes hypomicrus	Hispaniola	**	Y		MacPhee et al. 1999
Nesophontes major	Cuba	*	Y		Jiménez Vázquez et al. 2005

Nesophontes micrus	Cuba	**	Y		MacPhee et al. 1999
Nesophontes paramicrus	Hispaniola	**	Y		MacPhee et al. 1999
Nesophontes zamicrus	Hispaniola	**	Y		MacPhee et al. 1999
Oligoryzomys victus	St. Vincent	***	Y		
Oryzomys antillarum	Jamaica	***	Y		
Pennatomys nivalis	Nevis, St. Eustatius, St. Kitts	**	Y	May comprise 3 allopatric species on St. Kitts Bank	Turvey et al. 2010; Brace et al. 2015
Plagiodontia spelaeum	Hispaniola	*	N	Previously considered a junior synonym of *P. aedium*	Woods and Ottenwalder 1992; Hansford et al. 2012
Plagiodontia velozi	Hispaniola	*	N	Previously listed as *P. ipnaeum* (name now reinterpreted as junior synonym of *P. aedium*)	Hansford et al. 2012

Quemisia gravis	Hispaniola	*	N	Miller 1929
Rhizoplagiodontia lemkei	Hispaniola	*	N	Woods and Ottenwalder 1992
Solenodon marcanoi	Hispaniola	*	Y	Woods and Ottenwalder 1992
Xenothrix mcgregori	Jamaica	*	Y	MacPhee and Fleagle 1991; MacPhee and Flemming 1999

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1193 **Table 2.** List of Caribbean land-mammal species included in either the 2008 IUCN Red List assessment or the current study, indicating

1194 whether they were assessed in 2008 and whether there is uncertainty over their species status or continued survival.

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Species	**Island**	**2008 IUCN assessment?**	**Valid species?**	**Possibly extinct?**
Atopogale cubana	Cuba	Y	Y	N
Solenodon paradoxus	Hispaniola	Y	Y	N
Capromys pilorides	Cuba (mainland, Isla de la Juventud, offshore islands)	Y	Y	N
Capromys sp. (undescribed)	Cuba (offshore islands)	N	?	?
Geocapromys brownii	Jamaica	Y	Y	N
Geocapromys ingrahami	Bahamas	Y	Y	N
Mesocapromys angelcabrerai	Cuba (offshore islands)	Y	Y	N
Mesocapromys auritus	Cuba (offshore islands)	Y	Y	N
Mesocapromys melanurus	Cuba	Y	Y	N

Mesocapromys nanus	Cuba	Y	Y	Y
Mesocapromys sanfelipensis	Cuba (offshore islands)	Y	Y	Y
Mysateles garridoi	Cuba (offshore islands)	Y	N	N
Mysateles gundlachi	Cuba (Isla de la Juventud)	Y	N	N
Mysateles meridionalis	Cuba (Isla de la Juventud)	Y	N	N
Mysateles prehensilis	Cuba (mainland, Isla de la Juventud)	Y	Y	N
Plagiodontia aedium	Hispaniola	Y	Y	N

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1198 **Table 3.** Current and proposed Red List status assessments for extant or possibly extant Caribbean land-mammal species included in
1199 either the 2008 IUCN Red List assessment or the current study and reasons for proposed changes in IUCN status. National Red List
1200 status assessments for the Dominican Republic from Ministerio de Medio Ambiente y Recursos Naturales de la República Dominicana
1201 (2011), and for Cuba from Mancina (2012). Key: LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR,
1202 Critically Endangered; CR(PE), Critically Endangered (Possibly Extinct).
1203

Species	**2008 IUCN Red List status**	**National Red List status**	**Proposed IUCN Red List status**	**Reason for IUCN status change**
Atopogale cubana	EN B1ab(iii,v)	CR B1b(i,ii,iii), C2ai	EN B1ab(iii)	No change, but change in criteria
Solenodon paradoxus	EN B2ab(iii,v)	EN A4ce, (B2)	NT	Non-genuine change (new information)
Capromys pilorides	LC	—	NT	Non-genuine change (new information)
Capromys sp. (undescribed)	—	—	—	—
Geocapromys brownii	VU B1ab(iii,v)	—	EN B1ab(iii)	Non-genuine change

				(incorrect data used previously)
Geocapromys ingrahami	VU D2		VU D2	No change
Mesocapromys angelcabrerai	EN C2ai	CR B2a	CR B1ab(iii), B2 ab(iii)	Genuine change (recent)
Mesocapromys auritus	EN C2a(ii)	CR B1a	EN B1ab(iii), C2a(ii)	Non-genuine change (new information)
Mesocapromys melanurus	VU A2cd	VU B2b(i,ii,iii)	VU A2cd	No change
Mesocapromys nanus	CR(PE) C2a(i)	CR D, B1a	CR(PE) D	No change, but change in criteria
Mesocapromys sanfelipensis	CR(PE) D	CR B2a	CR(PE) B1ab(iii,iv,v), D	No change, but change in criteria
Mysateles garridoi	CR C2a(i)	—	Invalid species (=*C. pilorides*)	—
Mysateles gundlachi	EN B1ab(ii,iii),v	—	Invalid species (subspecies	—

			of *M. prehensilis*)	
Mysateles meridionalis	CR A2de, C2a(ii)	—	Invalid species (=*M. prehensilis*)	—
Mysateles prehensilis	NT	—	NT	No change
Plagiodontia aedium	EN A4acde	EN A4c, (B2)	NT	Non-genuine change (new information)

1204

Table 4. Biological and ecological parameters used to assess IUCN status of currently recognized Caribbean land-mammal species. Extent of occurrence (EOO) based on a minimum convex polygon was calculated using EOO Calculator v1.2 (see IUCN Spatial Data Resources, http://www.iucnredlist.org/technical-documents/red-list-training/iucnspatialresources). EOO estimates only include areas of native range where species are known or believed to still occur. Generation length data from Pacifici et al. (2013); estimation methods used by these authors are: a) difference between reproductive life span and age at first reproduction, age at first reproduction data directly available; b) difference between reproductive life span and age at first reproduction, age at first reproduction calculated as sum between age at female sexual maturity and gestation length; c) difference between reproductive life span and age at first reproduction, age at first reproduction calculated with age at male sexual maturity; d) estimated from confamilial species in same log body mass bin; and e) data from previous Global Mammal Assessment/IUCN Red List. The apparently valid undescribed *Capromys* species is excluded because no data on its specific biology or ecology are available.

Species	**EOO (km^2)**	**Total number of individuals**	**Number of subpopulations**	**Estimated generation length (days)**
Atopogale cubana	3,280	?	2	1902 [d]
Solenodon paradoxus	80,490	?	3	1902 [b]

Capromys pilorides	226,286	?	? (multiple)	1715 [b]
Geocapromys brownii	2,960	?	8	1413 [a]
Geocapromys ingrahami	2,863	>13,200? (out of date)	3	1153 [c]
Mesocapromys angelcabrerai	22	380–760	2	2955 [d]
Mesocapromys auritus	349	400–1,320	3?	2955 [d]
Mesocapromys melanurus	36,627	?	?	3650 [e]
Mesocapromys nanus	5,490	tens?	1	2955 [d]
Mesocapromys sanfelipensis	20	tens?	1	2955 [d]
Mysateles prehensilis	218,010	?	≥2	3650 [e]
Plagiodontia aedium	78,166	?	3	3650 [e]

Figure 1. Species range maps for 8 valid extant or possibly extant Cuban land-mammal species as of 2016, indicating where they are present (shaded) or possibly extinct (dotted). **a)** *Atopogale cubana* (1=Sierra Cristal National Park; 2=Alejandro de Humboldt National Park); **b)** *Capromys pilorides* (1=Isla de la Juventud); **c)** *Mesocapromys angelcabrerai* (1=Cayo La Loma (introduced); 2=Cayo Salinas); **d)** *Mesocapromys auritus* (1=Cayo Pasaje (introduced); 2=Cayo La Sagra (introduced); 3=Cayo Pajonal (introduced); **e)** *Mesocapromys melanurus;* **f)** *Mesocapromys nanus*; **g)** *Mesocapromys sanfelipensis* (1=Cayo Real; 2=Cayo Juan García); **h)** *Mysateles prehensilis.*

Figure 2. Species range maps for 4 valid extant or possibly extant Hispaniolan, Jamaican and Bahaman land-mammal species as of 2016, indicating where they are present (shaded) or possibly extinct (dotted). **a)** *Solenodon paradoxus* (1=Massif de la Hotte); **b)** *Geocapromys brownii* (1=Cockpit Country; 2=Worthy Park; 3=Hellshire Hills; 4=Blue and John Crow Mountains); **c)** *Geocapromys ingrahami* (1=Little Wax Cay (introduced); 2=Warderick Wells Cay (introduced); 3=Moriah Harbour Cay; 4=East Plana Cay; 5=John Higgs Cay); **d)** *Plagiodontia aedium* (1=Massif de la Hotte).

Figure 3. Number of Caribbean land-mammal species considered in this reassessment to be negatively impacted by different threats as categorized by IUCN (see IUCN Threats Classification Scheme Version 3.2, http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme).