

Chapter 14

Terrestrial Mammals of the United Arab Emirates



Jacky Judas

14.1 Introduction

About 6400 living species of mammals have been described in the world, distributed in 23 orders and 162 families (Burgin et al. 2018). In the United Arab Emirates, more than 50 species have been recorded, which represents less than 1% of the global mammalian diversity (Fig. 14.1). This relatively low diversity can be attributed to the difficult environment, with an arid and harsh climate with very hot summer temperatures in which these species occur (see Chap. 3). Mammals are generally less well represented in desert environment than insects or reptiles (Cunningham 2004). Low and unpredictable rainfall limits the growth of plants, resulting in low primary production, which cascades onto the whole food chain. Scarce water and food availability constrain the species diversity, abundance and carrying capacity in these habitats. Most mammal species are native, but over the time of occupations by humans, several species have been introduced. These introductions of non-native species have increased, particularly in the last few decades. Through this chapter, we will describe which mammal species live in the country, how they adapt to the arid environment, threats they are facing, our relations with them, and how we can protect these fascinating and important animals.

14.2 Diversity and Biogeography

In the book *The Emirates: A Natural History*, published by the Environmental Agency of Abu Dhabi in 2005 (Hellyer and Aspinall 2005), Dr Chris Drew and his wife, who authored the chapter on mammals, listed 43 species known from UAE,

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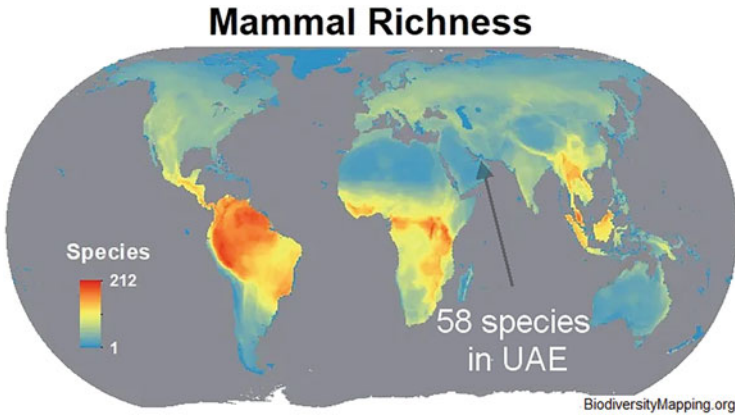


Fig. 14.1 Worldwide mammal diversity map, showing the relative low species diversity in the UAE. Source: Modified from BiodiversityMapping.org derived using mammal species range data from IUCN Red List, reused with permission

of which 5 were extinct. As of 2022, the list now contains 58 species of mammals known to occur or to have occurred in recent decades in the nation (Appendix), adding 15 new species in the past 17 years. Four are feral species, which were already present in the natural environment, but not previously listed; four (Northern Palm-Squirrel, Indian Desert Jird, Patagonian Mara and Aoudad) are newly reported introduced species, of which the Northern Palm-Squirrel is already well-established, while the seven remaining are new addition to the native fauna, and previously unrecorded. Of these 58 species overall, 44 are native species distributed among six orders and 18 families, of which 10 are endemic or near endemic to the Arabian Peninsula (Fig. 14.2a). When adding the 12 feral or well-established introduced non-native species, the number of mammalian orders represented in the UAE fauna raises to eight and the number of families to 21 (Fig. 14.2b). Six species, and probably seven if we include the Honey Badger, can be considered as locally extinct. Among the 37 extant (i.e. still living) native species, bats are the most diversified with 13 species, followed by the rodents with nine species, and the carnivores with seven species. The geographic position of the United Arab Emirates, at the crossroad of different continents and biogeographic realms, is reflected in its mammal fauna. Without entering in the phylogenetic origin of the species, but broadly considering their extant distribution ranges, the native mammalian fauna of UAE has a more important palearctic origin (55% of species), than afro-tropical (32%), while the Indomalaya origin accounts for only two species (the Indian Crested Porcupine and the White-tailed Mongoose). Spatially, mammal diversity is the highest in the Hajar Mountains (Fig. 14.3), with 19 species regularly using mountainous habitats, but only four of them are strictly confined to this ecosystem, most of them are also using other habitats, like shrublands, farms or forested areas.

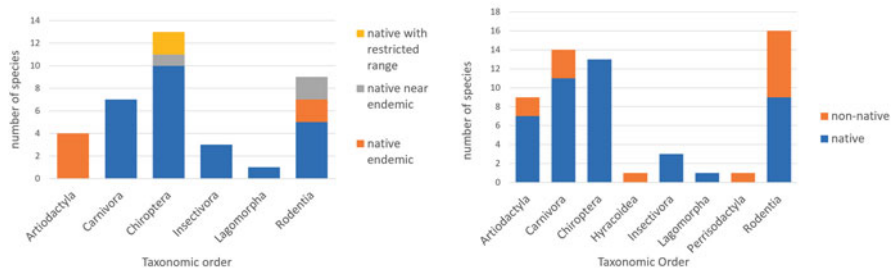


Fig. 14.2 (a) Number of native species recorded in UAE per taxonomic order, with reference to their endemism. (b) Number of native and introduced mammal species, recorded in UAE per taxonomic order



Fig. 14.3 Typical landscape in the Hajar Mountains, here in wadi Shees (Sharjah Emirate). Photo credit: Jacky Judas

14.2.1 Native Rodents

Nine species of native rodents are known in UAE, distributed among three families: the porcupine family (Hystricidae, one species), the Jerboa family (Dipodidae, one species), and the mouse and rat family (Muridae, seven species). In this last family, the sub-family of Gerbils and Jirds (Gerbillinae) is the most diverse with six species, while only one true native mouse is present, the Arabian Spiny Mouse (*Acomys dimidiatus*, Fig. 14.4). The latter is a nocturnal sociable species, that forages at night for seeds, and sometimes insects and grasses. It is mainly found in the wadi beds of the Hajar mountains, and more rarely in farms or shrubby areas. It has been reported



Fig. 14.4 Arabian Spiny-mouse (*Acomys dimidiatus*). Photo credit: Jacky Judas

from Nad Al Sheba in Dubai. The Wagner's Gerbil (*Gerbillus dayurus*) is the second most common species of native rodent found in the mountains, where it prefers rocky slopes and terraces than wadi beds and is generally more abundant than the Spiny Mouse at higher elevation (Melville and Chaber 2016). This species, also active at night, spends the day in holes, often under the perennial bushy spurge, *Euphorbia larica*, one of the dominant plants growing on the slopes of the mountains.

The Indian Crested Porcupine is the third and largest native species of rodent found in mountainous habitats. This species was only recently discovered in UAE. In April 2014, Alexander Cloke, working for Emirates Nature-WWF, briefly observed at night an animal, that he identified as a Porcupine, fleeing away from the roadside near the entrance of Wadi Wurayah National Park, some 600 km from the species' nearest known distribution range edge in Arabia. It was only in 2015–2016 that the presence of this species was confirmed by pictures obtained from a network of camera traps deployed by Emirates Nature-WWF and Fujairah Municipality in the National Park, and from interviews of residents conducted by the park staff (Chreiki et al. 2018). In 2018, Indian Crested Porcupine was also recorded by camera traps in Abu Dhabi emirate in some coastal areas near Mirbah (Al Dhaheri et al. 2018).

The Lesser Jerboa, which looks like a miniature kangaroo with its disproportionately large hind legs is a nocturnal and secretive species; it is found in the inter-dunal plains of sandy areas. Data are lacking to establish its status in UAE. The species was listed as 'Near Threatened' in the UAE National Red Data List published by Richard Hornby in 1996, and as Data Deficient for the Abu Dhabi Red List in 2005 (Drew and Tourenq 2005).

Gerbils and Jirds are well-adapted to live in sandy deserts, able to cope with high temperatures and food scarcity. All UAE species, except the Wagner's Gerbil which is a mountain species, are found in sand dunes and interdunal gravel plains that offer

some vegetation cover. The most common are certainly the Baluchistan and Cheesman's Gerbils. The Baluchistan or Dwarf Gerbil, rather similar in appearance to the Wagner's Gerbil, with a yellow-grey back and white belly, is a solitary nocturnal animal. Cheesman's Gerbil is slightly larger, with an orange back. Both lives in burrows during the days and go out at night to forage for seeds and other plant materials. Three species of Jirds are present in UAE. The Arabian Jird (*Meriones arimalius*), endemic to central and East Arabia, was for some time considered a sub-species of the Lybian Jird (*Meriones lybicus*) found further north in Arabia. Based on genetic analysis, it is now considered a valid species (Cassola 2016). Very little is known on this species, except for a few records in sandy deserts. The Sundevall's Jird (*Meriones crassus*) is a more common and widespread species of sand deserts, living in colonies or alone according to environmental conditions. Fat Jird (*Psammomys obesus*) is another recent addition to the mammal fauna of UAE. Mentioned by Cunningham (2004) as a good candidate species to be found in UAE, as it was known from Qatar and South-eastern Saudi Arabia, it was effectively discovered by wildlife researchers of the Environmental Agency of Abu Dhabi (EAD) in June 2019 by camera trapping (EAD, pers. Comm.).

Rodents play important role in their ecosystems as they disperse seeds on which they feed and are an important food resource for numerous predators, like owls, diurnal raptors, and mammalian carnivores.

14.2.2 Bats: An Under-studied Group in the UAE

Bats constitutes a difficult taxonomic group to study, which explains the paucity of information related to these species in UAE. Very little is known, even the list of species present is not yet fully established (Judas et al. 2018). Most of the knowledge on UAE bats fauna date back from field surveys conducted by Paul Harrison in the 1950s and published in its authoritative book on Mammals of Arabia (Harrison and Bates 1991). Surveys conducted by Emirates Nature-WWF in 2018–2019 contributed to the addition of three new species to the UAE fauna, the Geoffroy's Bat (*Myotis emarginatus*), the Botta's Serotine bat (*Eptesicus bottae*, Fig. 14.5), the Egyptian Tomb Bat (*Taphozous perforatus*), and some more species likely remain to be found (Judas, pers.info). As of 2022, 13 species belonging to 4 families have been identified, including 4 additional species to add to the 9 species listed by Harrison.

The Vespertilionidae is the most represented bat family, with seven species. The most common species is the Kuhl's pipistrelle (*Pipistrellus kuhlii*, Fig. 14.6), a widespread species, that benefits from human development and urbanization (see also Chap. 23). If you see a bat flying in the urban streets or parks (Dubai, Sharjah or Abu Dhabi) at dusk or night, it will most probably be this species. They live in colonies of a few dozen to some hundred individuals under the roof of villas or building that they access through very tiny holes. The Sind Serotine (*Rhyneptesicus nasutus*) seems to also be widespread throughout the UAE, although in lower abundance than the Kuhl's Pipistrelle. They live alone or in small family groups,

Fig. 14.5 Botta's Serotine Bat (*Eptesicus bottaë*).
Image: Jeremy Dechartre



Fig. 14.6 Kuhl's Pipistrelle (*Pipistrellus kuhlii*). Photo credit: Gabor Csorba



probably hiding in small rock crevasses or under the bark of trees. Little is known on their habitat and ecology. The Common Pipistrelle (*Pipistrellus pipistrellus*), one of the most common and widespread species in Western Europe and across Turkey up to West Asia, has been recorded once in 2018 in Abu Dhabi Western Region, during surveys conducted by a private environmental assessment company (Smithson, pers. comm.). The Parti-coloured Bat (*Vespertilio murinus*) has also been recorded only once in Sharjah, from a dead individual found in May 2014 (Monadjem et al. 2016). This migrant species lives in steppes, mountains, and forested areas from Western-Central Europe across central Asia up to North-East China. This record, presumed to be from a vagrant individual, was the first for the Arabian Peninsula. The Hemprich's Long-Eared Bat (*Otonycteris hemprichii*), specialized in capturing arthropods from the ground, including scorpions, was also only recorded once in Ras Al Khaimah in the 1970s (Harrison and Bates 1991). It was identified from bones collected in an owl pellet. The lack of further records might simply be due to the absence of surveys.

Fig. 14.7 Egyptian Tomb Bat (*Taphozous perforatus*).
Photo credit: Jeremy Dechartre



The Sheath-tailed Bats family, or Emballonuridae, is represented by two species: the Naked-bellied Tomb Bat (*Taphozous nudiventris*) and the recently discovered Egyptian Tomb Bat (*Taphozous perforatus*, Fig. 14.7). The first occurs in colonies in desert rocky outcrops, and along the Western foothills of the Hajar Mountains. Paul Harrison described a new subspecies from the UAE, named *Taphozous nudiventris zayedii* in honour of the late Sheikh Zayed bin Sultan Al Nahyan, who procured him some specimen from Al Ain and showed him their roost (Harrison 1955). The Naked-belly Tomb Bat seems to prefer the higher elevation of the Hajar Mountains. It has been recorded in Fujairah and Ras Al Khaimah.

The Old-World Leaf-nosed Bats family, or Hipposideridae, is represented by two species, the Geoffroy's Trident Leaf-nosed Bat (*Asellia tridens*, Fig. 14.8) and the Persian Leaf-nosed Bat (*Triaenops persicus*). Both were present in numbers in the 1950s (Harrison 1955), feeding at night in Al Ain/Buraimi oasis and roosting in the underground network of 'falaj' (the traditional irrigation system) (Fig. 14.9). The Geoffroy's Trident Leaf-nosed Bat is still present at that location in much smaller numbers and can also be found in small caves within the Hajar Mountains. Not recorded from more than 50 years, the echolocation calls of the Persian Leaf-nosed Bat was recorded once by this author during surveys conducted near Jebel Hafit in 2017.

The Muscat Mouse-tailed Bat (*Rhinopoma muscatellum*, Fig. 14.10), the only representative of the Mouse-tailed Bats family, or Rhinopomatidae, is relatively widespread in the eastern mountains of the UAE, where it lives in small colonies in

Fig. 14.8 Geoffroy's Trident Leaf-nosed Bat (*Asellia tridens*). Photo credit: Eric Sansault



Fig. 14.9 Traditional underground irrigation system in Al Ain–Buraimi (Falaj) used as roosting site by Geoffroy's Trident Leaf-nosed Bat and Persian Leaf-nosed Bat. Photo credit: Jacky Judas



Fig. 14.10 Muscat Mouse-tailed Bat (*Rhinopoma muscatellum*). Photo credit: Jacky Judas



Fig. 14.11 Egyptian Fruit Bat (*Rousettus aegyptiacus*). Photo credit: Jeremy Dechartre



caves or abandoned buildings. It can also be found on the Arabian Gulf coast in Sharjah and Dubai, as well as in Jebel Hafit.

The Egyptian Fruit Bat (*Rousettus aegyptiacus*, Fig. 14.11), from the Old-World Fruit Bat family, Pteropodidae, also lives in the Mountains of Fujairah and Ras Al Khaimah, visiting orchards and farms at night in search of fruits, roosting in trees or in caves during the day. This species, the largest found in UAE, is also common in gardens and parks of Al Ain, but more rarely in Abu Dhabi.

14.2.2.1 Bats as Viral Vectors

The Covid-19 pandemic of 2020–2022 (and continuing at the time of writing) has raised growing concerns and fear about bat populations worldwide, driven by the strong suspicion that the novel coronavirus SARS-Cov-2 at the origin of the outbreak took its origin in bats near Wuhan, China. Bats are known to host a large diversity of viruses (Anthony et al. 2017; Markotter et al. 2020) and their implication in several zoonotic outbreaks has been demonstrated. They are the natural reservoir for the Marburg, Nipah and Hendra viruses, which have caused human diseases and outbreaks in Africa, Malaysia, Bangladesh and Australia. They are thought to be the natural reservoir for the Ebola virus. They also carry the rabies virus, but in that case, contrarily to other viruses, the bats are also affected by the disease. The probability of a new bat-borne virus to jump from bats to humans is believed to be greater in areas of higher bats diversity, where active habitat encroachment favors closer contacts between wildlife and humans, like in the tropical forests of Africa or Asia. However, in 2012, the emergence of the Middle East Respiratory Syndrome (MERS), caused by a bat coronavirus, showed that outbreaks can also occur in areas of low bat diversity and low human population density, like in Arabia. In 2013, bats were the known reservoirs of more than 60 viruses that can infect humans (Woo and Lau 2019), and there have been at least 30 bat coronaviruses discovered in the last 15 years after the SARS epidemic in 2003. There are clearly some links between bats, human health, and national security. Bats and humans have lived together for thousands of years without records of such emergence of bat-borne viruses' outbreaks. It is the human disturbances in the environment that are facilitating emergence of these diseases, through activities like deforestation, destruction of their natural feeding and roosting habitats, and hunting animals out of some areas. It is our interactions with these species that are causing diseases to jump. Their ability to coexist with viruses that can spill over to other animals, in particular humans, can have devastating consequences, when we eat them, trade them in livestock markets and invade their territory (Chan et al. 2013). While bats populations are in severe decline worldwide (Tuttle 2017) and often misleadingly feared (Tuttle 2020), cases of bats being killed by fear, ignorance, and sometimes superstition, have multiplied during the Covid-19 pandemic. Yet, bats are important to humans by playing important ecological functions in their ecosystems and a major role in agriculture since they pollinate fruit trees (Whittaker and Jones 1994; Kelm et al. 2008) and help controlling populations of insects (Leelapaibul et al. 2005; Kalka et al. 2008). By consuming tons of insects, they also control insects carrying diseases, like mosquitoes. Except the Egyptian Fruit Bat, which as its name indicates is frugivorous, all other species are insectivorous.

As such, it is important to increase our knowledge of bats and to ensure the development of responsible mitigation strategies to not only minimize risks of infection but also ensure the conservation of the species and maintain their crucial role in ecosystem services. With the wide recognition of the links between bats and the potential emergence of new bat-borne virus outbreaks, it becomes urgent to get a

better understanding of how bats use their environment, and what are the critical habitats they are using. Tracing the origin and taking action to combat further outbreaks may depend partly on knowledge and monitoring of bats. At the 6th Public Health Conference at Arab Health 2019 in Dubai, it was agreed that infectious diseases should remain a public health priority and future research and ongoing surveillance is required. While bats must be studied, their physiology understood, and the viruses they harbor monitored for the sake of public health, that does not mean that they are to blame for outbreaks; studying them would also bring in to implement conservation measures to limit disturbance and interactions with humans, protect and restore their habitats.

14.2.3 *Insectivores*

Three native mammal species, belonging to the Insectivora Order, have been recorded in the UAE, two species of hedgehogs and one shrew.

The Ethiopian Hedgehog, or Desert Hedgehog (*Paraechinus aethiopicus*), lives in arid deserts across the whole Arabian Peninsula and in North Africa. It is relatively widespread in the Abu Dhabi emirate, often found in farms and suburbs gardens, where insects, its preferred food, are more easily available.

The Brandt's Hedgehog (*Paraechinus hypomelas*) is a mountain species of Asian origin. Its distribution encompasses a large part of Iran, South Turkmenistan, West Afghanistan and Pakistan (Bhattacharyya et al. 2016). In Arabia, its distribution is not well-known, but has been recorded from Saudi Arabia, Yemen, Oman and UAE, where it lives in the Hajar Mountains. It is well represented in Wadi Wurayah National Park and has been noted on Jebel Hafit (Aspinall and Hellyer 2004). Surprisingly, this species is a very good climber, finding shelters among small cavities in steep cliffs.

The Savi's Pygmy Shrew, or White-toothed Pygmy Shrew (*Suncus etruscus*), considered the smallest mammal species in the world, weighs only 1.8 g. It ranges from the Mediterranean basin, both in Africa and Europe, through the Middle East up to Southern Asia, Thailand, and Malaysia. This cryptic species, firstly observed in Sharjah in 2001, is known from very few records in UAE (Jongbloed et al. 2002).

14.2.4 *Carnivores*

Eight extant native species, belonging to four families represent the Carnivora Order in UAE. Three species belongs to the dog family (Canidae).

The Red Fox is the most widespread and abundant of the carnivores (Fig. 14.12). This ubiquitous species is well-adapted to live in human vicinity and has largely benefitted from development. Although often persecuted due to his habit of visiting henhouses and killing their inhabitants, red foxes use a large variety of habitats from



Fig. 14.12 Arabian Red Fox (*Vulpes vulpes arabica*). Photo credit: Jacky Judas–ENWWF

wadis, mountains, farms, gravel plains, sand desert, up to parks and gardens of the largest cities (Abu Dhabi, Al Ain, Dubai, Sharjah, Fujairah and Ras Al Khaimah), and it thrives over the whole country, benefitting from litter and food waste. It also reaches some of the not-too-distant Abu Dhabi islands, where it can be seen wandering on the beaches. This is mainly a crepuscular or nocturnal species, but it is not rare to see them during daylight, particularly during their breeding season, when they have cubs in spring (March to May). The Arabian subspecies (*Vulpes vulpes arabica*) is smaller and slender, than his European counterpart. The Blanford's Fox (*Vulpes cana*, Fig. 14.13) is a mountain species with a distribution range, quite similar to the Brandt's Hedgehog, occurring over Iran with some overlaps on the neighbouring countries, as well as in the mountains of the Arabian Peninsula (Hajar, Dhofar, Asir). Their presence in UAE, and in Arabia more generally, has been detected only recently (Smith et al. 2003). They were first trapped in Wadi Wurayah in 1995. Later surveys have shown their larger distribution through the Hajar Mountains of UAE, although in low density, and they have also been recorded on Jebel Hafit (Aspinall and Hellyer 2004). This species is quite distinctive from the more abundant Red Fox by their smaller size, wide ears, and long bushy tail that is nearly equal to the length of the body. The Ruppell's Sand Fox (*Vulpes rueppellii*) is another small fox that prefers to live in desert and semi-desert regions of North Africa and the Arabian Peninsula up to Iran. This is a rare species in UAE, known from only few locations in the western region of Abu Dhabi.



Fig. 14.13 Blanford's Fox (*Vulpes cana*). Photo credit: Jacky Judas–ENWWF

Fig. 14.14 Caracal (*Caracal caracal*). Photo credit: Jacky Judas–ENWWF



The Cats family, Felidae, is also represented by three extant native species. The largest, the Caracal (*Caracal Caracal*, Fig. 14.14), which weigh between 8 and 15 kg, remains in low numbers in the Hajar Mountains. Successful breeding has been confirmed by camera trapping in Wadi Wurayah in 2014, and a male has been recorded at Jebel Hafit in 2019 (EAD 2021). Its population, as for many other carnivores, has suffered from human persecution, with animals being trapped, killed

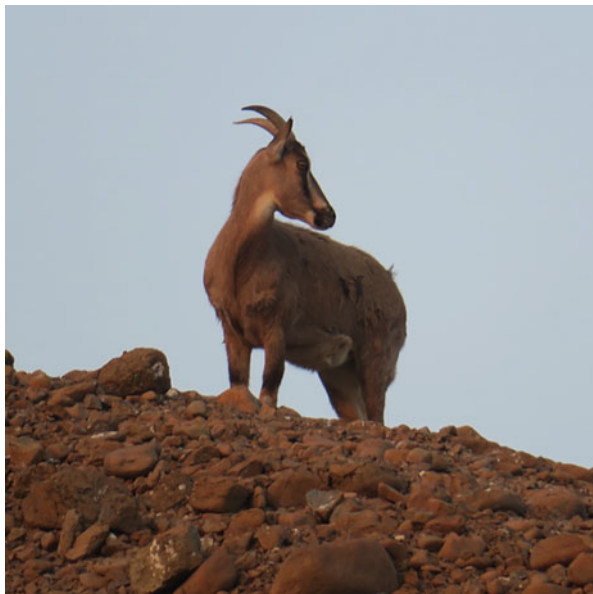
and hung in trees. It's a secretive, nocturnal species, and is very difficult to observe. The status of Arabian Wildcat (*Felis lybica*) is unclear. Feral cats, similar in appearance to wildcats by their size, fur pattern and general morphology, have been trapped or photographed. However, given the spread of feral cats in all habitats, sometimes deep in the mountains, it is becoming more difficult, perhaps even impossible without genetic analysis, to distinguish in the field between a native Arabian Wildcat, and a feral cat, whose morphology and appearance are very similar to the wild native species. Moreover, as has been demonstrated in Europe, wild populations of another Wildcat, *Felis sylvestris*, crossbreed with feral cat populations (Randi et al. 2001). Pure-bred Arabian Wildcats may already have vanished or become extremely rare. Only genetic screening of the wild population can clarify this. The Sand Cat, *Felis margarita*, inhabits sandy and rocky deserts across North Africa, Middle East, the Arabian Peninsula up to West Asia. In UAE, it is known from several locations, mainly in the Abu Dhabi western region, as well as in Dubai Desert Conservation Reserve. The species was reported around Sweihan a few decades ago but has not been confirmed recently (Eishaker pers. comm.).

The White-tailed Mongoose (*Herpestes albicaudus*) is the only native representant of the Civets and Genets (the Viverridae family). It used to be relatively widespread in the UAE a few decades ago, with records from the agricultural areas of Ras Al Khaimah along its Gulf coast, and in Al Ain, Masafi, and several locations in the Hajar Mountains (Jongbloed et al. 2002). More recently, it has been observed in Wadi Shawka (Ras Al Khaimah emirate, but geographically near to Sharjah, Sawaf pers. comm.).

The Honey Badger (*Mellivora capensis*), from the Mustelidae family that includes weasels, ferrets, otters, martens, and minks among others, used to be present in various habitats from the Hajar Mountains to the desert sands of Abu Dhabi. The last record in Abu Dhabi might date back some 20 years ago, from second-hand information reported by Abu Dhabi rangers. More recently, it has been reported from Wadi Shawka in the Hajar Mountains (Buzas, pers. comm.). The paucity of recent records might reflect an important population decrease, which might ultimately lead the species to local extinction, if it is not already the case.

Larger carnivores have already experienced the same fate as the Honey Badger. The most famous example is certainly the case of the Arabian Leopard (*Panthera pardus nimr*), which once roomed in the Hajar Mountains, but has been led to local extinction from the UAE in the 1990s by constant persecution by hunters and habitat loss. The last record of a wild living leopard in the UAE is probably from an individual killed in Ras Al Khaimah in 1992 (Hellyer and Aspinall 2005). The Striped Hyena and the Arabian Wolf have also paid the price of human-wildlife conflict, and their populations have been extirpated by persecution. Larger carnivores are often among the first species to disappear from areas where human development occurs. The need for large territories to sustain their food requirements, coupled with their relative low densities, make their populations much more sensitive to the loss of few individuals.

Fig. 14.15 Arabian Tahr (*Arabitragus jayakari*).
Photo credit: Jacky Judas



14.2.5 Ungulates

Ungulates refer to a group of large mammals with hooves, which have morphological similarities, but are not necessarily related to each other genetically and taxonomically. This group contains the Artiodactyla, or even-toed Ungulate, which are represented by four extant native species in the UAE, all from the Bovidae family.

The Arabian Tahr (*Arabitragus jayakari*, Fig. 14.15) is a goat-like mammal, endemic to the Hajar Mountains of the UAE and Oman. It lives on steep slopes at higher elevations in small matriarchal groups, composed of adult females, sub-adult males and females as well as new-borns (Munton 1985). Adult males remain alone most of the year except during the mating season. The Arabian tahr has been brought close to extinction by over-hunting and poaching, and only few individuals still roam in a few locations of the mountains of UAE. It has probably vanished from Wadi Wurayah National Park, which used to be one of the strongholds for the UAE population. The last individual was photographed by camera trapping in 2012 (Judas 2016).

Two species of gazelles can be found in UAE: the Arabian Mountain Gazelle (*Gazella arabica*) and the Arabian Sand Gazelle (*Gazella marica*, Fig. 14.16). The taxonomy of these two species is quite complex and has been the subject of many debates and publications in the last few decades (Lerp et al. 2013). From the most recent genetic analyses, they are both now both considered as endemic species of the Arabian Peninsula. Both species have been subject to captive-breeding, transfers and releases in many parts of the country. It is now very difficult, if even possible, to



Fig. 14.16 Arabian Sand Gazelle (*Gazella marica*). Photo credit: Jacky Judas

know which populations are wild, translocated, or reintroduced. The Arabian Mountain Gazelle was previously considered a subspecies of the Mountain Gazelle (*Gazella gazella*), and lives in the Mountains and interior sand and gravel plains. They also used to live in coastal plains, but have been extirpated from these heavily developed areas. Their favoured habitat coincides with the distribution of the Umbrella Thorn Acacia (*Vachellia tortilis*), that provides them food and shelter. The Arabian Sand Gazelle was considered a subspecies of the Asian Goitered Gazelle (*Gazella subgutturosa*) up until 2010 (Wacher et al. 2010), and lives in sand dunes and gravel plains, but avoid rocky areas. They are mainly found in the Abu Dhabi western region, including deep in the Rub Al Khali desert, but they have also been reintroduced and kept in semi-captivity in Dubai.

The iconic Arabian oryx (*Oryx leucoryx*, Fig. 14.17) is the largest Ungulate found in UAE, weighing up to 70 kg. They live in sand dunes and inter-dunal gravel plains. All populations present in UAE are issued from captive-breeding and reintroduction programmes. Some few hundred animals are distributed among few protected areas of Dubai (Al Marmoum Protected Area) and Abu Dhabi (Umm Al Zoumoul Protected Area).



Fig. 14.17 Arabian Oryx (*Oryx leucoryx*). Photo credit: Jacky Judas

14.2.6 Non-native Species

Human activities and development have brought their share of non-native species to UAE, intentionally or accidentally. Some of these species have established viable populations, and have become invasive (an *invasive* species is a non-native species that causes harm to the environment, human health, the economy, etc). Others introduced species that survive, might breed several consecutive years when conditions are suitable, and eventually vanished when conditions become too challenging. Due to the harsh arid environment, few non-native species manage to thrive in the natural environment of UAE, particularly if they are not originating from a region with similar environmental conditions. However, they can adapt to live in artificial habitats, such as farmlands and urbanized areas (see Chap. 23).

The presence of mice and rats is probably as old as human civilization (Auffray et al. 1990). Following people on their trade routes, these commensal invasive species travelled by ships among goods, establishing in harbours before spreading further into the countryside of new areas. Brown Rat (*Rattus norvegicus*) and Black Rat (*Rattus rattus*) both occur in UAE, although their respective status and distribution is not well known. The Black Rat or House Rat is probably the most widespread, living in cities, gardens, parks, farms, where they eat from human food waste, crops, seeds and fruit. The Brown Rat, or Norwegian Rat is a larger

Fig. 14.18 Northern Palm Squirrel (*Funambulus pennantii*). Photo credit: Jacky Judas



species, more heavily built, that might prefer wide open spaces, such as labour camps or most frequented picnic areas. The House Mouse (*Mus musculus*) is present in nearly all human settlements, from city centres to villages and isolated farms, but can also be found in wilder habitats, such as scrublands and desert edges.

How the Northern Palm Squirrel (*Funambulus pennantii*, Fig. 14.18) made its way to UAE from its native range of western Asia (India, Nepal, Pakistan) is unknown. We might guess that it has been imported in the pet trade, where some individuals managed to escape or may even have been intentionally released (Judas and Hellyer 2016). The first known record of this squirrel in the UAE comes from Al Hamrania farms (Ras-Al Khaimah) in January 2011, and few months later from Fujairah near a housing complex. Since then, records have multiplied, coming from a growing number of locations. The species is now widespread all over UAE, with records from all emirates in farmlands, parks, and gardens.

On the other hand, few individuals of Persian Squirrel (*Sciurus anomalus*), presumably originating from the pet trade, have subsisted in parks and gardens of Abu Dhabi between 1999 and 2003, before they appear to have disappeared (Hellyer and Aspinall 2005).

A very healthy colony of Indian Desert Jird (*Meriones hurrianae*) was reported between 2008 and 2011 from farms in Ajban area, presumably these were escapees from local pet markets. This species, available in pet shops in the UAE, naturally occurs in Pakistan and northwest India in desert habitats. Being adapted to similar environmental conditions, the risk exists that they might extend their range and eventually compete with native Jirds.

Fig. 14.19 Patagonian mara (*Dolichotis patagonum*). Photo credit: Jacky Judas



More recently, another exotic species, the Patagonian mara (*Dolichotis patagonum*, Fig. 14.19), of South American origin, the second largest known rodent after the Capybara (*Hydrochoerus hydrochaeris*), made its appearance in Abu Dhabi and Dubai. This large rodent is a common species in zoological collections and undoubtedly found its way out from captivity. They can regularly be seen sleeping or eating grass in the middle of roundabouts at Al Qudra (Dubai Emirate). This species is not adapted to live in arid environment, although in the absence of his usual predators, like pumas, it can possibly survive in highly modified habitats with tree plantations, lawns and ponds.

The Indian Grey Mongoose, *Herpestes edwardsii*, was recorded in the northern emirates in the 1980s and two thought to have been this species were observed in Abu Dhabi in 1985 and 1988, although the lack of recent records may indicate that the species has failed to establish a viable self-sustaining population.

The Rock Hyrax *Procavia capensis* was introduced on Jebel Hafit (Al Ain, Abu Dhabi) in the 1990s, and a small population has been persisting until today around a water source. The species is also well represented on Sir Bani Yas.

Barbary Sheep or Aoudad (*Ammotragus lervia*) is endemic to mountains across North Africa. It is kept in captivity in several private collections in the UAE, and some individuals have been released or escaped in Hatta area (Dubai). The species has also been reported from Jebel Hafit, Wadi Kub (Fujairah), and Wadi Shawka (Ras Al Khaimah). This species, well-adapted to live in arid mountains, might well survive in the Hajar Mountains, and become a competitor and threat to the native Arabian Tahr.



Fig. 14.20 Feral Goat (*Capra aegagrus hircus*). Photo credit: Jacky Judas

Feral species are another category of non-native species present in UAE. These species were once domesticated either for their meat, used to carry people and material, or as pets. Goats (Fig. 14.20) have been kept by villagers for centuries. Following rain, when the dry slopes of the Hajar Mountains turn green, it is not rare for shepherds to let their livestock pasture freely for several days or weeks. This practise might have been entertained for a long time, and it is unsurprising that some goats might have escaped into the wild. Feral populations have settled well, and are now widespread all over the Hajar Mountains.

Another feral group, donkeys (Fig. 14.21), used to carry goods and material on steep paths in wadis, although they became less useful when motorized vehicles appeared in the UAE. Some have probably been abandoned, left to their sad fate. They learned to survive in the wild and are now widespread through the Hajar Mountains. Unlike goats, less agile, they can't access the steepest parts of the mountains, and limit their movements to lower elevation, or areas relatively easy to access. Among other vegetal material they consume, donkeys eat the bark of some native trees (*Moringa peregrina* for instance), seriously damaging them, and compromising their growth and survival.

Camels have for a long time been left to free-range and feed in desert areas. Although this practise is increasingly controlled and regulated, they have largely contributed to overgrazing in most areas of the country. Camels are presumed to be



Fig. 14.21 Feral Donkey (*Equus asinus*). Photo credit: Jacky Judas

native to Arabia (Thompson 2015), although wild populations no longer exist; neither are there any feral populations—all camels encountered are domestic animals.

Cats and dogs have also established feral populations throughout UAE, presumably as abandoned, lost, or escaped pets. Dogs mainly remain in proximity of human settlements where they can find or beg for food. They often live in small clans of a dozen or more individuals and are particularly attracted by landfills. They do not venture far into natural habitats. On the contrary, feral cats are solitary, and although well represented in and around cities and villages, they also venture quite deep in natural habitats, being sometimes observed kilometres away from the nearest habitations, deep in the desert or in mountain wadis. Feral cats have important negative effects on the native fauna, predated on small rodents, birds and reptiles.

14.2.7 Potential Species

A few new species may remain yet to be discovered in the UAE, most likely among the most cryptic or less surveyed taxonomic groups. There are certainly two or three more bats that wait to be discovered. During surveys conducted by Emirates Nature-WWF, the echolocation calls of at least two species were recorded that could not be allocated to the species' already known. These are presumed to be the Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), and a small Pipistrelle, possibly Rüppel's Pipistrelle (*Vansonia rueppellii*). Without capturing them, their identity can only be assumed. The Blasius Horseshoe Bat (*Rhinolophus blasius*) and the Arabian Pipistrelle (*Hypsugo arabicus*), known from the Hajar Mountains in Oman are other potential candidates. The Arabian White-toothed Shrew (*Crocidura arabica*), known from Dhofar and Mussandam in Oman, and the House Shrew (*Suncus murinus*), which were recorded in various other regions of the Arabian Peninsula, are two other potential candidates.

14.3 Adaptations to Arid Environment

Living in the arid environment of UAE, being able to survive long periods of drought and cope with temperatures often raising above 45 °C during summer, which is at the limit of physiological limit of tolerance for many animals, requires specific adaptations from organisms, mainly to regulate water exchange and control body temperature (Lindsay Maclean 1996; Asres and Amha 2014). Native mammal species that have evolved in these harsh conditions have developed morphological, physiological, or behavioural adaptations.

Most UAE mammals have adopted nocturnal or crepuscular habits to forage and feed, avoiding the peak daily temperature period. During the day, they hide in burrows or caves. Bats generally emerge from their roosts in rock cracks, old buildings, caves, or trees very shortly after sunset, stay active all night, and end their hunt shortly before sunrise. This is also the case for carnivores and rodents, who hunt or forage at night and retreat in their burrows at night. By feeding at night, rodents are also able to make use of the dew on plants as a source of water. The Cheesman's Gerbil is known to carry damp vegetation to its burrow, which raises the humidity level inside. The burrow entrance is often at the base of a shrubby plant, and the gerbil closes the entrance when it enters by flicking sand across with its tail. Some species, like the Red Fox, become seasonally more active during daylight in early morning or late afternoon, in spring when food resources are more abundant and when they are raising their cubs. Diurnal species, like Gazelles and Oryx, spend the hottest hours under the shade of trees, and are mainly active at dawn or dusk.

Physiological responses to cope with thermal challenges involve neural and hormonal mechanisms, such as adapted sweat gland flow that regulates heat production (Tattersall et al. 2012). Mammals use evaporative cooling that allows them

to maintain a balance between thermoregulation and water balance (be it through panting or through sweat). Water scarcity often constrains these species to obtain much or all their water from the food they consume. The reduced water intake is partially balanced through lower volumes of fluids in concentrated urine and dry faeces.

Morphological adaptations also help mammals to maintain their heat and water balance, allowing them to survive the arid and hot environmental conditions. Desert Hares have hyper-enlarged ears that increase the surface area for exchange between the body and the air, and contribute to dissipate their corporal heat and control their body temperature. Fur density of camels greatly increases their skin and body insulation, allowing them to stay cool even in direct summer sun; the fat deposit that makes up their ‘hump’ also provides insulation on their highly exposed upper-back. Several species like the Cheesman’s Gerbil have their soles covered with hairs allowing them to step and to run on hot sand.

14.4 Main Threats to Mammals

Most factors that threaten biodiversity worldwide also occur in UAE. One of the most important, and still on-going, threats is certainly the degradation, fragmentation, and loss of habitats. The rapid growth of UAE economy in the last 60 years, following oil discovery in 1958, has resulted in a rapid human population growth and expansion of cities and industrial areas, mainly on coastal areas (Fig. 14.22), and encroachment into natural habitats (see Chap. 23). These lost and degraded habitats



Fig. 14.22 Coastal development in Khor Fakkan (Sharjah Emirate). Photo credit: Jacky Judas

Fig. 14.23 Highway crossing the Hajar mountains. Photo credit: Jacky Judas



are in many areas unsuitable for native mammals, as such reducing their overall populations.

An important network of roads has been, and is still being, developed across the Emirates (Fig. 14.23). Although this eases the time required to travel and transport goods from town to town, these roads—and more recently railways—are fragmenting once-extensive habitats into smaller and smaller areas. Such linear infrastructure creates barriers that animals avoid or hesitate to cross. In some places in the Hajar mountains, long concrete walls in the middle of the roads are used for separating traffic, and while certainly useful for security reasons represent barriers for mammals that attempt to cross roadways, and end-up impacted by vehicles. The ubiquitous road-side fences pose similar issues for larger mammal species. In addition, the noise generated by the traffic can be heard kilometres away, keeping the shyest species at distance.

Large areas that haven't yet been developed nevertheless have become unsuitable for many species. The repeated passages of off-road motor vehicles created tracks coming from all directions through the desert often degrade vegetation cover, crushing perennial plants that typically need years to grow and recover. Overgrazing by domestic livestock (camels, goats and sheep) in the interior sand and gravel desert or in the mountains also decreases vegetation cover, changes the composition of plants communities and decreases the floral diversity—often to the benefit of invasive and/or non-palatable species—and decreases food availability for

Fig. 14.24 Sheep grazing in the mountains of Fujairah Emirate. Photo credit: Jacky Judas



herbivores (see Chap. 5). Grazing and nomadic pastoralism has been practised in this region for millennia, long before the discovery of oil. The number and size of livestock herds were historically limited by the availability of pasture and rainfall. With economic development, access to water, transport, purchase of fodder during drought and natural food shortage became far easier. As a result, more livestock could be maintained (Fig. 14.24), increasing grazing pressure and competing with wild herbivores.

Over-hunting or poaching have been responsible for the local extinction of important populations, reducing many game species such as the Arabian and Sand gazelles, Arabian Oryx, Arabian Tahr, Cape Hare. In the last decades, hunting became more of a leisure than a means to obtain food, as it was in the past. Trivialization of the use of vehicles and firearms have worsened the situation, allowing more animals to be killed off in less time, farther into the wilderness. Predators, like Arabian Leopard, Arabian Wolf and Striped Hyaena, were persecuted and driven to local extinction because of past human/wildlife conflicts when these predators would regularly predate domestic livestock due to degradation of their natural habitats and loss of natural food sources.

The threat posed by non-native invasive or feral species, introduced above, adds to the pressure on native species. The numerous feral cats and dogs wandering in the UAE's environment are additional predators of rodents, bats, and other small



Fig. 14.25 Artificial lights at night in Bidiyah (Fujairah Emirate). Photo credit: Jacky Judas

mammals. Dogs have been seen chasing the endangered Arabian Tahr on Jebel Hafit.

Recent human population growth has resulted in increased frequentation of natural habitats by city-dwelling resident who are seeking connection with nature, but this too has led to conflicts with wildlife due to the incredible pressure that ‘attractive’ and interesting sites receive. Promotion of ecotourism, with the creation of hiking trails or camping sites, if not properly managed, raise the level of disturbance in natural habitats and can impact mammals populations. The time spent by mammals on alert or hidden reduces the time they can allocate for feeding (Schnidrig-Petrig and Ingold 2021), and can decrease the size of the areas in which they forage, ultimately impacting their body condition, reproduction success, or survival.

Artificial lights at night (Fig. 14.25) have spread everywhere through the country, in towns and along an important network of roads (see Chap. 23). Their impact has not been studied in UAE, but it is known from other nations in Europe and America to have important negative effects on wildlife (Beier 2006), including attracting insects and contributing to their decrease (Owens and Lewis 2018). Impacts to insects, being at the basis of the food chain for many animals, affects the whole

ecosystem by decreasing food resources for insectivorous species. Bat populations are particularly sensitive to the effects of light and its ramifications on the insect communities on which they feed (Seewagen and Adams 2021).

14.5 Relations with Humans

Humans have occupied the region, now known as UAE, for millennia, first as hunter-gatherers with a nomadic lifestyle, before progressively shifting to sheep-herders and villagers. Their relations with wild mammals changed accordingly. Hunting large herbivores for food, or killing predators—perceived as competitors or to protect themselves—were probably the most ancient relations they might have with wild mammals. Progressively, humans started domesticating goats, sheep, and camels from wild animals that were caught in natural habitats, herding them to pastures (when more humid times were common, see Chap. 4) and slowly beginning the process of domestication. Where water was more reliably available, like in mountains (Fig. 14.26), man started to cultivate crops and fruits, settling down in permanent villages. The time of domestication likely saw an increase in human-wildlife conflicts, as larger carnivores likely preyed on the easy-to-target prey that were domestic animals. Animal domestication likely started in modern day Iraq, and



Fig. 14.26 Oasis in wadi Shees (Sharjah Emirate). Photo credit: Jacky Judas

the practise exported later to southeast Arabia through human population movements and trade networks.

Nowadays, livestock breeding is still common practise, although much less vital than in the past since most food supplies, including meats of mammals and other vertebrates, are imported. Hunting of wild mammals is strictly regulated, and mostly forbidden.

Beside the direct benefits some mammals provide to man, all species have their role to play in ecosystems functioning by providing ecosystems services that indirectly benefit human populations. We have already mentioned some of them, like seed dispersal by rodents, pest control by bats that eat mosquitoes and other harmful insects, and predation by small carnivores (foxes, mongoose) that control rodents' populations (mice and rats). Bats also contribute by dispersing nutrients through the surrounding ecosystems.

Much must still be learned of the specific adaptations that mammals have acquired during their long evolution in arid environment and by studying the biological characteristics of species living in UAE. Several species are already used as animal models for human medicine (Gaire et al. 2021). Species of *Acomys* (Spiny-Mouse) have gained attention for their unique ability among mammals for tissue regeneration, and as a result have become more widely used in animal laboratories to understand the specific biological mechanisms. Moreover, this species has small litter size, and a relatively long gestation (42 days). Most organ development occurs in utero, resulting in precocial neonates. Unlike mouse and rats, *Acomys* might be a good model for studying the events of late human pregnancy due to the relatively advanced state of their foetus relative to many other mammals. Bats have good capacity in maintaining high blood glucoses levels, and glucose homeostasis, and to lower blood glucose levels through insulin. These physiological features suggest that bats might be good models for understanding lifestyle and genetic factors regulating glucose metabolism and studying diabetes mechanisms in humans. Bats are less sensitive to cancer than many other mammal species; they are also known to carry high virus loads without being affected. These characteristics also open doors to future research that can open avenues for potential applications in human medicine.

14.6 Management and Conservation

The IUCN Red List is the authoritative reference to assess and rank the level of threats on wildlife species. These lists can be assessed at the global, national, or local levels. According to the IUCN Red Data List, 20% of the 44 native mammal species present in UAE are threatened at the global scale (Table 14.1 and Fig. 14.27a). This percentage raised to 41% at the national level (Fig. 14.27b), excluding the 11 species listed as Data Deficient (i.e. insufficient information for experts to make a judgement on status, Mallon et al. 2019). Not enough is known on the status of these latter species to even assess if they range closer to the optimal 'Least Concern' status

Table 14.1 Number of mammal species per IUCN red list categories at the global and national levels

Red List status	Global		National
	Native	Non-native	Native
RE	1		6
CR	1		4
EN	1		3
VU	4	1	3
NT	2	1	2
LC	35	8	13
DD	0		11
N.E.	0	4	2
Total	44	14	44

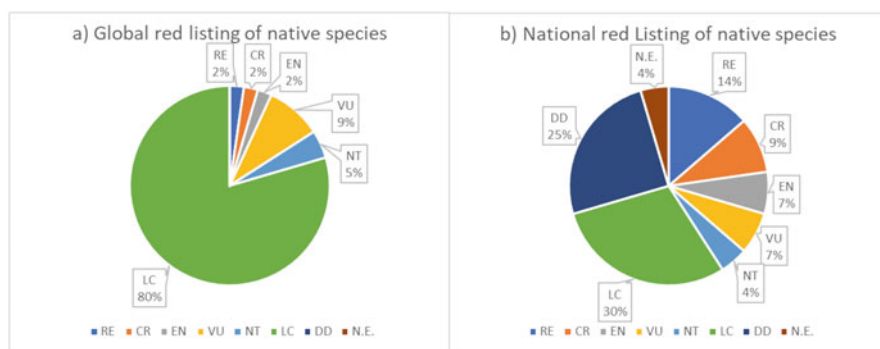


Fig. 14.27 Distribution of UAE native mammal species according to their IUCN red list status (a) at the global level and (b) at the National level. RE, regionally extinct; CR, critically endangered; EN, endangered; VU, vulnerable; NT, near threatened; LC, least concerned; DD, data deficient; NE, not evaluated

versus the highly concerning ‘Critically Endangered’ status. Data deficient species are mainly among bats (7 species out of 11), the others being the Baluchistan Gerbil, the Arabian Jird, the Honey Badger and the Savi’s Pygmy Shrew. Interestingly, two non-native species that were recently introduced in UAE, the Patagonian Mara and the Barbary Sheep, are considered ‘Near Threatened’ and ‘Vulnerable’, respectively, in their native ranges. More attention might be given to local populations of these species in the UAE—despite being introduced—by perhaps integrating them in local captive breeding programmes so that the UAE can contribute to global conservation initiatives.

The conservation status of some mammal species has been improving in the last few decades, mainly the ungulates, thanks to conservation efforts engaged by local environmental authorities. However, the status of many other species is poorly known and continues to deteriorate, due in large part to habitat loss. Population trends and status in the UAE are largely based on best-guess and assumptions of

experts, rather than on supportive empirical data. At the initiative of the Breeding Centre of Endangered Arabian Wildlife (BCEAW) of Sharjah, workshops evaluating the status of different taxonomic groups, including mammals, have been annually conducted for the past 20 years. These workshops regularly reunite regional experts to produce a number of region-focused conservation strategies for the most emblematic and endangered species, such as the Arabian Tahr and Arabian Leopard.

Captive-breeding and reintroduction programmes, mainly focusing on ungulates (Arabian Oryx, Arabian Mountain Gazelle and Arabian Sand Gazelle), but also on Arabian Hare, have contributed to partially restore their populations. Populations of Arabian Oryx were hunted to extinction from their wild habitats of Arabia in 1972. The species was only surviving captive in zoos or private collections (IUCN 2017). Thanks to captive-breeding and reintroduction programme initiated by the Phoenix and San Diego zoos, the species has been reintroduced to the wild in Oman, Saudi Arabia, Jordan and UAE. The last census recorded more than 7000 Arabian Oryx living in UAE, most in captivity or semi-captivity. The Environment Agency of Abu Dhabi has been managing a reintroduction programme in Umm Al Zummul since 2011, in the southeast of Abu Dhabi's western region at the border of the Rub Al-Khali, where more than 800 Oryx are now free-ranging. The species also successfully bred at the Dubai Desert Conservation Reserve, although the area is entirely fenced-in and has limited carrying capacity to support larger populations; they are provided supplemental feed and water to maintain their populations here. Al Marmoum Protected Area (Dubai Emirate) artificially maintains a population in semi-free conditions, also with water and feeding stations. Both Gazelle species have also been heavily managed, bred in captivity, maintained in private enclosure, translocated, and released. They are now well-present in several protected areas in the Emirates. The Arabian Tahr is bred in captivity in Al Ain by the Management for Nature Conservation, under HH Sheikh Khalifa bin Zayed Al Nahyan's private collection, with several hundred animals currently present. A dozen individuals were transferred to Fujairah to initiate another captive breeding for future reintroduction to Wadi Wurayah National Park.

The number and size of protected areas have been substantially increased over the last few decades and cover most habitats, from sand desert to gravel plains and mountains, offering protection for their mammal inhabitants. Wadi Wurayah National Park was declared as the first Mountain Protected Area in the UAE in 2008, designated as a Ramsar wetlands site in 2010 (Judas 2016), and as Man and Biosphere Reserve by UNESCO in 2018. Its management plan was developed by Emirates Nature-WWF in 2012–2015, and handed-over to Fujairah Municipality for further implementation. The reintroduction and conservation of the Arabian Tahr is one of the priority goals, as well as the conservation of the wider mammal community that include nationally endangered species such as Caracal, Blanford's Fox and Indian Crested Porcupine. Other Mountains Protected Areas have been designated by the Environment and Protected Areas Authority of Sharjah (EPAA) in subsequent years, in Wadi Helo and Kalba. Abu Dhabi has designated more than ten protected areas, mostly in the western region, including Al Bida'a, Al Dilmaweya, Al Ramlah, Qasr Al Sarab, Umm Al Zummul or Arabian Oryx Protected Area, Al Ghada, Al

Wathba Wetland reserve, Jebel Hafit, Yaw Al Dibsa, Badaa Hazza, Barqa Al Suqoor, Al Tawi, Baynunah mignas or Houbara Protected Area. All these areas offer protection for desert specialized mammals.

14.7 The Future of Mammals' Research and Conservation in UAE

As highlighted through this chapter, important gaps in our knowledge on mammal status, abundance, distribution, population trends, ecology still need to be fulfilled. It's only armed with such knowledge that successful conservation programmes can be implemented. The needs for additional research and populations monitoring, relying on sustainable governmental and financial supports, are important.

A number of methods can be used for mammal studies that vary according to the taxonomic groups. Except few large diurnal species that can be relatively easily seen, or their tracks found in the sand, most species are nocturnal and elusive and require more elaborate field surveys techniques.

Camera trapping is one such non-invasive method, which use has exploded since camera traps shifted from film to digital images in recent decades (Wearn and Glover-Kapfer 2017). Camera traps deployed in various habitats, left alone for several weeks or months, allow recording of the presence of many species of medium to large sizes that pass in their detection range up to 20–30 m; many include infrared capacity that allow the cameras to 'see' mammals at night as well. Smaller mammals, like rodents, might eventually be recorded too, but are often difficult to identify from pictures. Systematic deployment of camera traps can provide numerous information on species diversity, distribution, relative abundance, detection probability, density. The use of helicopters or drones, coupled with high-resolution imageries or video cameras is also increasingly used to survey larger mammals, such as ungulates in areas difficult to access, allowing to assess numbers and distribution. Large amount of data generated by these techniques can be facilitated by the development of deep learning algorithms and Artificial Intelligence (Zualkernan et al. 2022).

Other methods are more invasive and require trapping and capturing the animals to take their measurements, genetic samples, tag them with rings, or ear tags, equip them with loggers or transmitters, and monitor their movements and activities by radio- or satellite-tracking. Each species requires different trapping techniques, adapted to their morphology, behaviour and activities. Rodents are generally caught with special rodent traps (model Sherman or Tomahawk), larger mammals with larger cage traps or foot snares, while bats are caught in flight with mistnets or harps.

Field surveys to study bats have been carried out in recent years in several Arabian countries (Yemen, Lebanon, Jordan, Saudi Arabia), but to date, very few have been performed in UAE. Living at night, hidden in places difficult to access during the day, study of bats is challenging. One of the classical approaches to study

Fig. 14.28 Deployment of mistnet to capture bats in wadi Abadilah (Fujairah Emirate—March 2018). Photo credit: Jeremy Dechartre



them requires to identify areas where they fly, such as at the exit of their roosts and near a ponds where they drink or areas where they feed, and to deploy mistnets (Fig. 14.28) in an attempt to catch them (Mitchell-Jones and McLeish 2004). This technique, although efficient in the way it allows researchers to handle bats by hand to take their measurements (Fig. 14.29) and identify them from morphological criteria, remain very time consuming and has other practical limits. Not all species will get trapped in mistnets; many will detect the nets with their echolocation calls and avoid them, while others fly too high to get caught. Moreover, the number of sites that can be surveyed is limited by the time and effort required. In the last decades, the use of acoustic-based bat detectors (Fig. 14.30) has spread first among professional researchers and with the decrease of prices and multiplication of models available on the market to the wider naturalists' community (Brigham et al. 2002). These bat detectors transform the bats' ultrasound echolocation calls into audible sounds that can be recorded and digitized using specific sound analysis software for



Fig. 14.29 Bats specialists at work. Photo credit: Jacky Judas

species identification. While references describing echolocation calls of European or North American species are available, they are still scarce for the species encountered in UAE. Identifying bats from their echolocation call is not straightforward. While a few species have very specific calls and frequency characteristics, this is largely overlapping for many other species. Unlike birds, which often have stereotyped calls and songs that they use for communication, bats use their calls to navigate in the dark and locate their prey. Their calls vary according to the habitats in which they occur, the environmental conditions, or to interactions amongst members of the same species. Determining the frequencies and characteristics of the calls under different circumstances for each species thus requires capturing individuals for identification by hand and their release with a luminescent tag temporarily glued on their back. This tag allows researchers to visually follow them in darkness and associate specific individuals with specific echolocation calls. This work has been initiated by Emirates Nature-WWF in 2018–2020 to build a reference echolocation calls library, but it remains under development.

Radio or satellite transmitters deployed on mammals provides different information than camera trapping, and allows determination of activity rhythms, movement, home ranges and survival (Millsbaugh and Marzluff 2001). An important limiting

Fig. 14.30 Bat detector model D1000X from Pettersson Elektronik. Photo credit: Jacky Judas



factor for such approaches is the weight of the species under study as, in practise, the weight of the transmitter should not exceed 5% of the body weight. For instance, for a species weighing 5 kg, like a small red fox, the transmitter should not exceed 250 g. Most of the weight of the transmitter are from its batteries, which dictates its life expectancy and the volume of information that can be transmitted. For large species, the life expectancy of transmitters can often last a year or more, but for smaller species, like rodents or bats, transmitters of a few grams will last only a few weeks. Radio-tracking or satellite-tracking has only been conducted on few species in the UAE, mainly on Gazelles and Arabian Oryx, and for limited time periods on Blanford's fox.

In term of mammal conservation, the increasing number of protected areas and the percentage of terrestrial land under protection, which includes a diverse array of habitat types, is enhancing their chances of survival. However, improvements are required to develop and implement protected area management plans. Smaller species, those that do not need large home ranges, will benefit from this network of protected areas, as long as degraded habitats are restored and rewilded. Larger species that require larger home ranges can, in most cases, only be maintained as

managed semi-captive populations. With development, habitat loss and fragmentation, network of roads and highways through the mountains, a lack of suitable prey species, and increasing human disturbance in natural habitats, the amount of suitable area for habitation has shrunk considerably, leaving little space for entirely free-ranging large mammals. The reintroduction of the Arabian Leopard in UAE, which might have been considered earlier, is probably impossible now, at least with the objective to restore a viable self-sustaining population. At best, a few individuals might be maintained in semi-captivity in large enclosures, where prey are managed and released for these individuals to prey upon.

14.8 Conclusions

In the current context of global biodiversity loss, and increasing impacts of climate change, it is becoming critically urgent to take further actions to protect UAE natural environment, create and efficiently manage protected areas to strengthen ecosystems resilience, stop habitat losses, eliminate or reduce as much as possible all threats. The country holds a captivating mammals' diversity highly adapted to the harsh environmental conditions, including several species endemic to Arabia. However, much remains to be learnt on their status and ecology. Several species have already vanished, others are critically endangered or data deficient. It's only by increasing knowledge on these species, that efficient conservation measures can be implemented, and their populations securely protected for the benefit of future generation.

14.9 Recommended Reading

For readers interested in learning more about the mammal communities of the UAE written towards a general audience, see Hellyer and Aspinall (2005). More information on species biology and conservation and research techniques in animals' ecology can consult Campbell (1993) and Boitani and Fuller (2000), respectively.

Appendix

Taxonomic list of Mammalian species recorded in the United Arab Emirates, according to their taxonomic order and family, with indications on their origin and current status.

Taxonomy— scientific names	English names	Status UAE	Listed in 2005	IUCN Red List Global	IUCN Red List National
Order Chiroptera					
Family Emballonuridae					
<i>Taphozous nudiventris</i>	Naked bellied Tomb Bat	Confirmed	Yes	LC	VU
<i>Taphozous perforatus</i>	Egyptian Tomb Bat	Confirmed		LC	DD
Family Hipposideridae					
<i>Asellia tridens</i>	Geoffroy's Trident Leaf-nosed Bat	Confirmed	Yes	LC	DD
<i>Triadenops persicus</i>	Persian Leaf-nosed Bat	Confirmed	Yes	LC	DD
Family Pteropodidae					
<i>Rousettus aegyptiacus</i>	Egyptian Fruit Bat	Confirmed	Yes	LC	LC
Family Rhinopomatidae					
<i>Rhinopoma muscatellum</i>	Muscat Mouse-tailed Bat	Confirmed	Yes	LC	LC
Family Vespertilionidae					
<i>Eptesicus bottae</i>	Botta's Serotine Bat	Confirmed		LC	DD
<i>Myotis emarginatus</i>	Geoffroy's Bat	Confirmed		LC	DD
<i>Otonycteris hemprichii</i>	Hemprich's Long-eared bat	Confirmed	Yes	LC	DD
<i>Pipistrellus kuhlii</i>	Kuhl's Pipistrelle	Confirmed	Yes	LC	LC
<i>Pipistrellus pipistrellus</i>	Common Pipistrelle	Confirmed		LC	N.E.
<i>Rhyneptesicus nasutus</i>	Sind Serotine Bat	Confirmed	Yes	LC	LC
<i>Vespertilio murinus</i>	Parti-coloured Bat	Confirmed		LC	DD
Order Insectivora					
Family Erinaceidae					
<i>Paraechinus aethiopicus</i>	Ethiopian Hedgehog	Confirmed	Yes	LC	LC
<i>Paraechinus hypomelas</i>	Brandt's Hedgehog	Confirmed	Yes	LC	LC
Family Soricidae					
<i>Suncus etruscus</i>	Savi's Pygmy Shrew	Confirmed	Yes	LC	DD

(continued)

Taxonomy— scientific names	English names	Status UAE	Listed in 2005	IUCN Red List Global	IUCN Red List National
Order Carnivora					
Family Canidae					
<i>Canis lupus arabicus</i>	Arabian Wolf	Extinct	Yes	LC	RE
<i>Vulpes vulpes</i>	Red Fox	Confirmed	Yes	LC	LC
<i>Vulpes rueppellii</i>	Ruppell's Sand Fox	Confirmed	Yes	LC	CR
<i>Vulpes cana</i>	Blanford's Fox	Confirmed	Yes	LC	VU
<i>Canis familiaris</i>	Feral Dog	Feral		N.E.	N.A.
Family Mustelidae					
<i>Mellivora capensis</i>	Honey Badger	Confirmed	Yes	LC	DD
Family Viverridae					
<i>Ichneumia albicauda</i>	White-tailed Mongoose	Confirmed	Yes	LC	EN
<i>Herpestes edwardsii</i>	Indian Grey Mongoose	Introduced	Yes	LC	N.A.
Family Hyaenidae					
<i>Hyaena hyaena</i>	Striped Hyena	Extinct	Yes	NT	RE
Family Felidae					
<i>Felis libyca</i>	Wild Cat	Confirmed	Yes	LC	EN
<i>Felis margarita</i>	Sand Cat	Confirmed	Yes	LC	EN
<i>Caracal caracal</i>	Caracal	Confirmed	Yes	LC	CR
<i>Panthera pardus nimr</i>	Arabian Leopard	Extinct	Yes	VU	RE
<i>Felis catus</i>	Feral Cat	Feral		N.E.	N.A.
Order Hyracoidea					
Family Procaviidae					
<i>Procavia capensis</i>	Hyrax	Introduced	Yes	LC	N.A.
Order Artiodactyla					
Family Bovidae					
<i>Hemitragus jayakari</i>	Arabian Tahr	Confirmed	Yes	EN	CR
<i>Oryx leucoryx</i>	Arabian Oryx	Confirmed	Yes	VU	VU
<i>Gazella arabica</i>	Arabian Gazelle	Confirmed	Yes	VU	LC
<i>Gazella marica</i>	Arabian Sand Gazelle	Confirmed	Yes	VU	LC
<i>Capra aegagrus</i>	Wild Goat	Extinct	Yes	NT	RE
<i>Capra aegagrus hircus</i>	Feral Goat	Feral		N.A.	N.A.
<i>Capra nubiana</i>	Nubian Ibex	Extinct	Yes	VU	RE
<i>Ammotragus lervia</i>	Barbary Sheep or Aoudad	Introduced		VU	N.A.
<i>Ovis arabica</i>	Arabian Wild Sheep	Extinct	Yes	Ex	EX

(continued)

Taxonomy— scientific names	English names	Status UAE	Listed in 2005	IUCN Red List Global	IUCN Red List National
Order Perrisodactyla					
Family Equiidae					
<i>Equus asinus</i>	Feral Donkey	Feral		N.E.	N.A.
Order Lagomorpha					
Family Leporidae					
<i>Lepus capensis</i>	Cape Hare	Confirmed	Yes	LC	LC
Order Rodentia					
Family Caviidae					
<i>Dolichotis patagonum</i>	Patagonian Mara	Introduced		NT	N.A.
Family Sciuridae					
<i>Funambulus pennantii</i>	Northern Palm Squirrel	Introduced		LC	N.A.
<i>Sciurus anomalus</i>	Persian Squirrel	Introduced and extinct	Yes	LC	N.A.
Family Hystricidae					
<i>Hystrix indica</i>	Indian Crested Porcupine	Confirmed		LC	CR
Family Dipodidae					
<i>Jaculus jaculus</i>	Lesser Jerboa	Confirmed	Yes	LC	NT
Family Muridae					
<i>Rattus rattus</i>	Black Rat	Introduced	Yes	LC	N.A.
<i>Rattus norvegicus</i>	Brown Rat	Introduced	Yes	LC	N.A.
<i>Mus musculus</i>	House Mouse	Introduced	Yes	LC	N.A.
<i>Acomys dimidiatus</i>	Arabian Spiny Mouse	Confirmed	Yes	LC	NT
Family Muridae—subfamily Gerbillinae					
<i>Gerbillus nanus</i>	Baluchistan Gerbil	Confirmed	Yes	LC	DD
<i>Gerbillus dasyurus</i>	Wagner's Gerbil	Confirmed	Yes	LC	LC
<i>Gerbillus cheesmani</i>	Cheesman's Gerbil	Confirmed	Yes	LC	LC
<i>Meriones arimalius</i>	Arabian Jird	Confirmed	Yes	LC	DD
<i>Meriones crassus</i>	Sundevall's Jird	Confirmed	Yes	LC	LC
<i>Meriones hurrianae</i>	Indian Desert Jird	Introduced		LC	N.A.
<i>Psammomys obesus</i>	Fat Jird	Confirmed		LC	N.E.

Notes:

Endemic refers to species only found in the Arabian Peninsula. Species are listed as Near endemic, when most of their distribution is in Arabia, but some populations are also known in few neighbouring countries. LC, least concerned; VU, vulnerable; EN, endangered; CR, critically endangered; RE, regionally extinct; EX, extinct; N.A., not applicable; N.E., not evaluated

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