Project: Management plan of honey badger (*Mellivora capensis*) populations in Karnataka, India (2018-2048)

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Adult honey badger (*Mellivora capensis*)

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Executive Summary

Honey badgers (*Mellivora capensis*) are known for their thick skin and fearless behavior. Honey badgers have a large distribution throughout Sub-Saharan Africa, Arabia, Iran and western India. Honey badgers are commonly found in open woodlands, desert, high mountains and coastal shrubs. Their diet consists of scorpions, *Hottentotta rugiscutis, Heterometrus swammerdami, Hottentotta tamulus,* and *Lychas tricarinatus*; small rodents: lesser bandicoot rat (*Bandicota bengalensis*), Indian bush rat (*Golunda ellioti*), soft-furred rat (*Millardia meltada*), little Indian field mouse (*Mus booduga*), house mouse (*Mus musculus*), Sahyadris forest rat (*Rattus satarae*), Nilgiri long-tailed tree mouse (*Vandeleuria nilagirica*), jungle palm squirrel (*Funambulus tristriatus*), Malabar spiny dormouse (*Platacanthomys lasiurus*), Etruscan shrew (*Suncus etruscus*), and the Asian house shrew (*Suncus murinus*); and herpetofauna, Brook's gecko (*Hemidactylus brookii*), bark gecko (*Hemidactylus leschenaultia*), brahminy skink (*Mabuya carinata*), Indian rat snake (*Ptyas mucosa*), and the banded racer (*Argyrogena fasciolatus*). Honey badgers are mustelids that burrow into the banks of streams, rock cavities, and thick brush along with the spaces naturally formed by tree roots. Ecological concerns threatening honey badger populations include deforestation, lack of space, and disease. Sociocultural and economic threats to honey badgers include bush meat trade, medicinal uses, illegal fur trade and apiarist's defending their hives from honey badgers. All of these issues have been documented in Sub-Saharan Africa, where the majority of research for this species has been done. The scope of this management plan focuses in Karnataka, India, these threats, are relevant and current concerns to honey badger populations in Karnataka. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species has the honey badger listed as a species of least concern, this listing is given due to the absence of information on this species. The goal of this management plan is to increase and stabilize honey badger populations in Karnataka in order to make the honey badger a flagship species for the state (2018-2048). Objectives of this goal include: increase protected honey badger habitat, by 10% in ten years, increase understanding of honey badger ecology in Karnataka in eight years publishing four, peer reviewed scientific articles, evaluate 85% of honey badger populations in Karnataka in five years, and having a honey badger acceptance rate of 70% by human populations in thirty years. Honey badgers are an elusive and unique species who have increased acclaim due to the use of social media websites. With proper management this species can have sustainable and sizable populations for the state of Karnataka.

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History

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (2016) lists the honey badger (*Mellivora capensis*) as a species of least concern. This classification is given because the honey badger has a large distribution range and high variation in diet. The classification of least concern is also given due to the lack of information on the species. IUCN clearly states that there are known threats to the species, and certain threats have already caused localized declines in the populations (Figure 1). Upon receiving more information on the species IUCN states that there may be a need for this species to be reclassified to a higher category of threat (Do Linh San et al. 2016).

The honey badger is an elusive creature in India, and throughout its range. Due to the elusive nature of the species, information on the status and distribution of the badger in India is scarce and unreliable, which is why the IUCN does not list this species as anything higher than "least concern" at this time (Gubbi et al. 2014). Much of the research done on the honey badger has been conducted at the southern end of its range, in sub-Saharan Africa, but can be applied to the geographic scope of this management plan, Karnataka, India.

Karnataka is a state in India on the western coast of the continent. The state has been divided into four different ecological regions: coastal plains, hill ranges (in the west), Karnataka Plateau (in the east) and the black soil tract in the northwest. Climate in Karnataka is subtropical, with an average rain fall, during the rainy season, up to 120 inches. Common wildlife in the monsoon forests in Karnataka include tigers (*Panthera tigris tigris*), elephants (*Elephas maximus*), gaurs (*Bos gaurus*), deer (*Axis porcinus*), wild boars (*Sus scrofa cristatus*), leopards (*Panthera pardus fusca*) and peacocks (*Pavo cristatus*) (Ghori 2017). The honey badger is rare in Karnataka, due to their large home range sizes, nocturnal behavior and elusive nature and their populations are declining (Figure 1; Do Linh San et al. 2016).

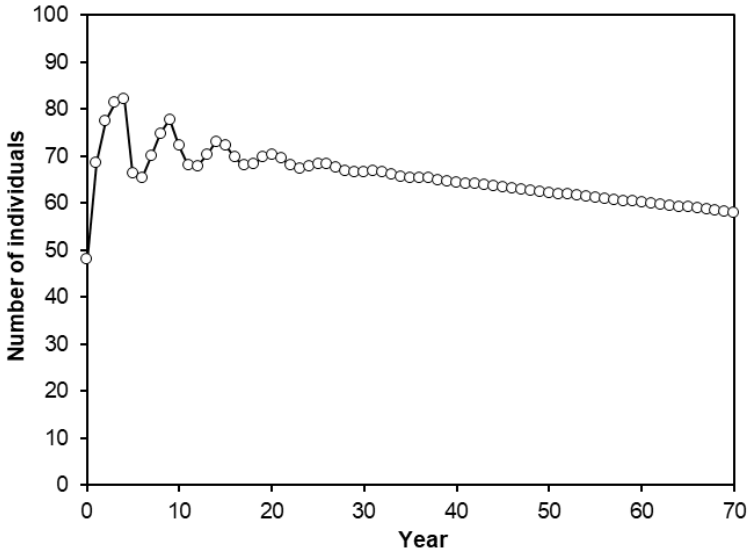

Figure 1 current population trends for honey badger (Mellivora capensis) in Karnataka, India. Trend was created using stage based model and assuming 48 individuals (Gupta et al. 2014) for the current population.

Figure 2 honey badger (*Mellivora capensis*) with conspicuous long claws and stocky build.

Photo credit: Honey Badger Battle, 2015

Natural History

Species Identification

Honey badgers stand around 250mm tall at their shoulders and weigh approximately 12kg. Their fur is course, with a strip of gray or brown hair running laterally down their dorsal side running from the base of the skull to the base of the tail (Siyabona Africa 2017). They have a stocky build, with short legs and long claws. Honey badgers are primarily terrestrial, but possess the ability to climb. They can run quick and for extended periods of time when chasing prey (Figure 2; Siyabona Africa 2017).

Breeding

Reproduction is considered asynchronous with an estimated gestation period of 50-70 days (Begg et al. 2005). Most commonly only one cub was produced, rarely two. Cubs stay in the den until three months of age, then they begin foraging with their mother. Cubs are almost completely hairless until 3-5 weeks. They do not become independent until 12-16 months old (Begg et al. 2005). Parental care is provided by the female while the male completes his involvement after copulation (Begg et al. 2005). Though breeding is considered asynchronous one study showed more cubs were produced in the hot, wet season and hot, dry season (Begg et al. 2005). Den cub survival rates are estimated at 98%, cubs (also referred to as foraging cubs) have a 57% survival rate and adults only have a 34% survival rate (Appendix D; Figure 3; Begg et al. 2005). According to a stage based population model that was run for the honey badger population in Karnataka, in order to increase the population size successfully there would need to be an increase in adult fecundity (sensitivity matrix=0.17). This however is not feasible. The parental care for each cub is very high since they are not independent for their first 12-16 months (Begg et al. 2005). The stage based elasticity matrix run for this population was based off of numbers and statistics found in Begg et al. (2005). The adult survival rate, however, was increased from 34% to 43%, because one of the largest factors killing honey badgers in Africa, where the Begg et al. (2005) study was done, is beekeepers killing the honey badgers. This has yet to be a documented issue in Karnataka.

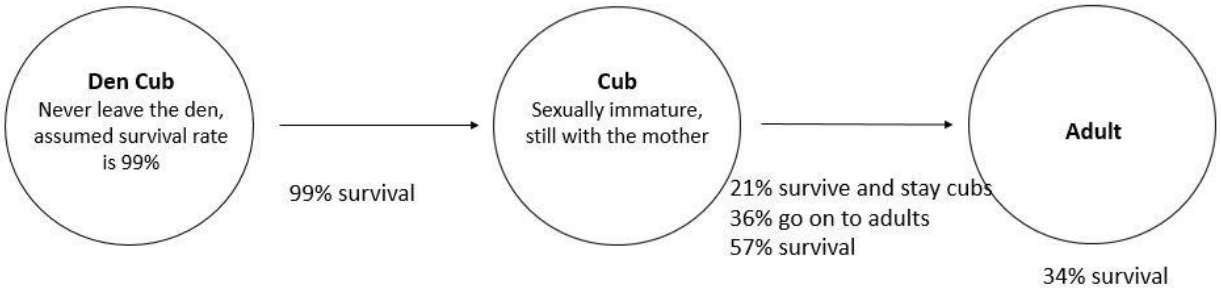

Figure 3 life cycle of the honey badger (Mellivora capensis) with survival rates from each stage.

Diet

More research needs to be conducted on the honey badgers prey consumption in India (Gubbi et al. 2014). In the Kalahari Gemsbok National Park, in Africa, Kruuk and Mills (1983) examine the fecal samples of 38 separate honey badgers, and found scorpions and small rodents have the highest percent composition of honey badger consumption, 60% and 58%, respectively. Kruuk and Mills (1983) also observe the honey badgers scavenge for food and take larger prey from larger organisms on two separate occasions. In Niokolo-Koba National Park in Senegal, Sillero-Zubiri and Marino (1997) conclude that the majority of the honey badger diet compromises of excavating social insects, larvae, scorpions and small mammals from the ground.

In Africa, the honey badger diet is classified as an opportunistic omnivore (Sillero-Zubiri and Marino 1997). The honey badger consumes the mole snake (*Pseudaspis cana*), cape cobra (*Naja nivea*), horned adder (*Cerastes cerastes*), Brant's gerbil (*Tatera brantsii*), hairy footed gerbil (*Gerbillurus paeba*), giant ground gecko (*Chondrodactylus angulifer*), striped mouse (*Rhabdomys pumilio*), barking gecko (*Ptenopus garrulous*), Kalahari tree skink (*Mabuya occidentalis*) and the yellow thin tailed scorpion (*Euscorpius flavicaudis*) in the largest quantities in the Kgalagadi Transfrontier Park in South Africa (Begg et al. 2003). All of the prey species listed by Begg et al (2003) are only found in southern Africa (Haacke et al. 1990; Coetzee and van der Straeten 2008; Goldberg 2010; Broadley 2010; Victor 2010; Cassola 2016a; Cassola 2016b). From the list of prey species provided by Begg et al. (2003) educated assumptions can be made about honey badger prey in Karnataka, India.

Herpetofauna found in Karnataka that could provide a food source for the honey badger include: Brook's gecko (*Hemidactylus brookii*), bark gecko (*Hemidactylus leschenaultia*), brahminy skink (*Mabuya carinata*), Indian rat snake (*Ptyas mucosa*), and the banded racer (*Argyrogena fasciolatus*) (Chauhan and Shingadia 2012). Small mammals that serve as potential prey for honey badgers in Karnataka include: lesser bandicoot rat (*Bandicota bengalensis*), Indian bush rat (*Golunda ellioti*), soft-furred rat (*Millardia meltada*), little Indian field mouse (*Mus booduga*), house mouse (*Mus musculus*), Sahyadris forest rat (*Rattus satarae*), Nilgiri long-tailed tree mouse (*Vandeleuria nilagirica*), jungle palm squirrel (*Funambulus tristriatus*), Malabar spiny dormouse (*Platacanthomys lasiurus*), Etruscan shrew (*Suncus etruscus*), and the Asian house shrew (*Suncus murinus*) (Molur and Singh 2009). There are also four scorpion species found in Karnataka that could provide potential prey for honey badgers, *Hottentotta rugiscutis, Heterometrus swammerdami, Hottentotta tamulus,* and *Lychas tricarinatus* (Nagaraj et al. 2015).

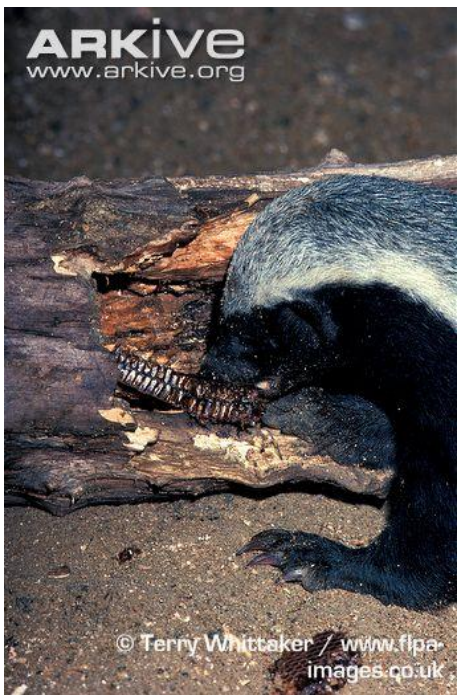

Figure 4 honey badger (*Mellivora capensis*) hunting for food.

Reptiles have the highest percent biomass in the honey badgers diet in South Africa. Small mammals make up the second largest percent biomass in honey badger diet (Begg et al. 2003). Honey badgers find prey underneath the sand by sense of smell (Kruuk and Mills 1983). Female honey badgers need to consume 0.9 kilograms of food a day, while male honey badgers need to consume 1.3 kilograms of food per day (Begg et al. 2003). It has been shown

that females consume less grams per foraging minute when they have a dependent cub with them. The number of grams eaten per foraging minute decreases by 1.5 grams per foraging minute when a female has a dependent cub (Begg et al. 2003). While the female consumption rate declines, their digging success increases by 1.6%, this makes the female digging success more comparable to that of males, 41.6% and 49%, respectively (Begg et al. 2003).

Habitat

Honey badger habitat is described as open woodlands, desert, high mountains and coastal shrubs (Sillero-Zubiri and Marino 1997). In Assam, India badgers have been observed to inhabit scrub jungle and tall elephant grass (Choudhury 1997). Honey badgers are burrowing mustelids (Gupta et al. 2012), because of this they need specific habitat to create their burrows. In India, honey badger burrows are found on the banks of streams, rock cavities, and thick brush and in the spaces naturally formed by tree roots (Gupta et al. 2012). In a habitat suitability model performed, in western India, by Gupta et al. (2012) found that honey badger habitat was positively correlated to distance to water and *Zizyphus* mixed forest. These needs do not change when offspring are produced (Gupta et al. 2012). Of the 144 square kilometers in the study area for the habitat suitability model in India, only 25% of the habitat showed to be of medium or high quality for honey badgers (Gupta et al. 2012).

Distribution

National Geographic Magazine, 2004

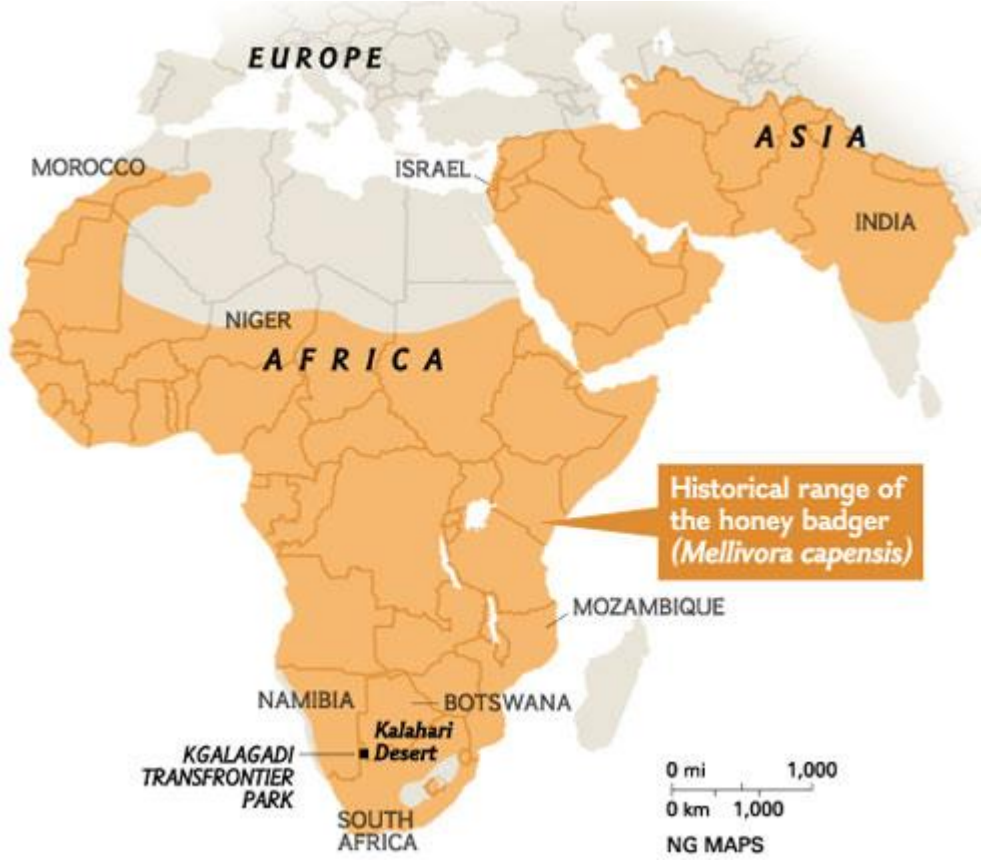

Figure 5 Distribution of the honey badger (Mellivora capensis).

Conservation Needs

Ecological

Deforestation is a threat to honey badger populations in India. The vegetation composition for areas, with documented honey badger sightings, is mainly tropical dry thorn, dry deciduous, coastal shrubs and woodland savannah forests (Gubbi et al. 2014). The study done by Gubbi et al. (2014) shows that Karnataka has potential to sustain high honey badger populations, if suitable habitat is protected. Since 1930, India has lost 243,447 km^2 of wooded area on the continent due to deforestation (Sudhakar Reddy et al. 2015). Costal lands of India are being deforested at higher rate. Since 1930 the coast of India has lost 5,792 km^2 of woodland (Sudhakar Reddy et al. 2015). Over 77% of the coastal area has been deforested (Sudhakar Reddy et al. 2015), which is a large amount of potential honey badger habitat lost.

Honey badger home ranges vary in size from 5.9km^2 to 6.6km^2 (Gupta et al. 2012). Populations within the Sariska Tiger Reserve in western India are very high when compared to those in national parks in Africa. Populations within the Sariska Tiger Reserve range from 3.64 to 9.22 individuals/100 km^2 (Gupta et al. 2012). In 2014, the first photographic evidence of the honey badger in Karnataka was captured by Gubbi and his team (Gubbi et al. 2014). There were 41 separate photos of honey badgers that were taken using trail cameras. The study was conducted in the Cauvery Wildlife Sanctuary in India. As of 2018, there has been no other population estimates of honey badgers in India.

Another ecological issue this species has in India is the lack of space, Karnataka is only 191,790 km^2. If all of this was suitable habitat for honey badgers then the population would reach carrying capacity around ~17,500 individuals ((area of Karnataka/100)*9.22) (Gubbi et al. 2014). There is approximately 38,724 km^2 of protected forests in Karnataka (Karnataka – An Introduction), roughly 20% of the state is forested. Taking into account the only forested areas of the state the new potential carrying capacity of honey badgers is ~3,500 ((area of forested Karnataka/100)*100), this number is assuming all of the protected forest is suitable honey badger habitat and that 9.22 badgers are occupying a 100 km^2 area. A habitat suitability model for honey badger in Sariska Tiger Reserve in India, only found that 25% of available habitat was rated at a level of medium to high suitability (Gupta et al. 2012). If we take the approximate 25% suitability, then only 9,681 km^2 is suitable honey badger habitat, resulting in an estimated carrying capacity of ~850 individuals (Gubbi et al. 2014; Gupta et al. 2012).

There is one major disease affecting honey badger populations in Africa, which is rabies (Pastoret et al. 1988; Pfukenyi et al. 2007). Of the 52 badgers studied by Pfukenyi et al. (2007), 51.9% of the badgers tested positive for the rabies virus. Rabies is a fatal neurological disease in mammals (Center for Disease Control and Prevention 2011). Rabies is a zoonotic disease, which means that it can be passed to humans and their domestic pets (Pastoret et al. 1988). This disease is not only an ecological issue for honey badger populations, but also a sociocultural threat. Of the 51.9% of badgers infected with the rabies virus, 59% were observed biting humans, if badgers are potentially infecting humans and their domesticated pets with this virus then it will be hard to change public perception in Karnataka in order to increase badger populations (Pfukenyi et al. 2007).

The main ecological concerns threatening honey badger populations in Karnataka include deforestation, lack of space and disease. The honey badger is not likely to exist outside of protected areas (Ngwenya 2001) due to lack of space (Gupta et al. 2012), decline in resources

due to urbanization and human presence (Gubbi et al. 2014). If these organisms do not have enough space diseases, such as rabies, are potential threats to their populations (Pastoret et al. 1988; Pfukenyi et al. 2007). These organisms have large home ranges where only a single badger will exist, for these reasons large amounts of habitat, suitable for honey badgers, needs to be protected (Gupta et al. 2012).

Sociocultural and Economic

Current sociocultural threats to honey badgers in Africa include bush meat trading and medicinal uses (Carpaneto and Fusari 2000; Colyn et al. 2004). Though these threats are highest in Africa they put the honey badgers safety at risk in India as well. If people are willing to pay money for these organisms on the black market or the organism is valuable in trade, taking the organism from another country where the populations are higher and the species is more prevalent could become a problem for honey badgers in India.

The honey badger is being taken infrequently by bush meat hunters, but is still being taken enough to cause concern. Honey badger is not the preferred bush meat (0.01%, n=75) of hunters, but will be taken when needed (Carpaneto and Fusari 2000; Colyn et al. 2004). One specific threat to the honey badgers being taken as bush meat is that it has the highest average weight of any other bush meat species taken (Colyn et al. 2004). In another study done in Tanzania, honey badger accounted for 1.27% of the total percentage of bush meat taken during the study period. Honey badgers fall under the taxonomic group of *Carnivora*, which accounted for 22.88% of all bush meat taken in this study (Carpaneto and Fusari 2000). Carpaneto and Fusari (2000) also produced a poaching assessment of official data from the last two years and data collected in their nine week field study. This shows that in the last two years the official data shows no poaching records of honey badger, but in their short nine week study three honey badgers were taken illegally. This helps support that not enough is known about the conservation status of this species. Although all instances of bush meat trade occur in Africa, there is still a potential threat to honey badgers in India. If people are willing to pay money for these organisms there will always be someone willing to poach and import the animal.

Honey badger skin being illegally traded is also a sociocultural threat to the conservation of this species. The honey badger is in high demand for traditional medicinal use in Kwazulu-Natal (KZN) in Africa. Honey badgers are used in traditional medicine because of their known fearlessness, locals believe that this can be transferred to them if they use the honey badger parts (Ngwenya 2001). Honey badgers are requested at a frequency of 18% on the black market (Ngwenya 2001). The honey badger is hunted, illegally, for its skin. On the black market pieces of the honey badger skin will sell for up to 35.00 R (South African Rands) (Ngwenya 2001). Honey badgers are one of the many species that Ngwenya (2001) cites as potentially threatened by the black market trading due to their conservation status and that very few survive outside of their protected areas (Ngwenya 2001). Honey badger pelt is worth money for traditional African medicine, if laws begin being enforced heavily in Africa poachers may start traveling to India to take these animals.

Conflicts between beekeepers and honey badgers in Africa are high, as high as 82% (Begg 2001). Of the 82% of beekeepers reporting an issue, 50% of these individuals admit to illegally killing a honey badger to protect their hives. There is speculation that more than 50% of beekeepers actually took a badger illegally (Begg 2001). There are proven, cost effective solutions, for beekeepers to protect their hives, but 22% still refuse to use these practices for

unknown reasons. Cost effective solutions for beekeepers to protect their hives from honey badgers include: wire wrapping (~15R), steel strapping (~3R), timber poles (~10+R), and steel pipes (~150R) (Begg 2001). The most common, cheapest, and easily maintained method is wire wrapping. This consists of wrapping wire around the lid of the hive and posts are placed on the four sides of the hive to prevent badgers from getting into the hive (Begg 2001).

Many beekeepers were also not aware of the honey badgers protected status in Africa (Begg 2001). Beekeepers are individuals who come into contact with honey badgers frequently, for them to not known the status of the species is shocking. Not only is killing honey badgers, who attack beehives a cultural normality, but the badgers are causing economic damage to the beekeepers livelihood, making this an economical issue as well. One of the beekeepers states that the R1000 fine for trapping honey badgers is inconsequential because the badgers cause so much damage to their beehives every year (Begg 2001). The total estimated cost of a single beehive being raided by a honey badger was in total of R706, this equivalents to $60 every time a single hive is raided (Begg 2001). Beekeepers reported spending between one to two full days a week completely dedicated to dealing with problem honey badgers near their hives (Begg 2001). Honey badgers are costing beekeepers money in Africa, they have the potential to pose the same risk to beekeepers in Karnataka as well.

Legal

The Indian Wildlife (Protection) Act of 1972 (No. 53 of 1972), gives the honey badger an extremely high level of protection in India as a Schedule 1 organism (Gubbi et al. 2014; Parliament of India 1993). This act protects other species as a Schedule 1 organisms including: clouded leopard (*Neofelis nebulosa*), Indian elephant, rhinoceros (*Rhinoceros unicornis*), and the snow leopard (*Panthera uncia*). Being a Schedule 1 organism in The Indian Wildlife (Protection) Act of 1972, protects these organisms from being hunted (No. 53.29.29-A of 1972). If any person(s) breaks The Indian Wildlife (Protection) Act of 1972 and illegally takes a Schedule 1 organism, without proper permits or exceptions, then the act is punishable by imprisonment up to three years and a fine of up to twenty five thousand rupees, or both (No. 53.29.29-A of 1972) (Parliament of India 1993).

Statement of Need

The need for the honey badger to be managed stems from ecological, sociocultural and economic issues, as outlined above. Honey badgers have the potential of becoming a flagship species in Karnataka, India. This will not be achieved if the badger populations are not managed. Honey badger populations are currently declining and will continue to decline until something is done (Do Linh San et al. 2016). Issues including being traded as bush meat, being used in traditional African medicine and conflicts with beekeepers trying to protect their hives are threats to the honey badger population (Carpaneto and Fusari 2000; Begg 2001; Colyn et al. 2004). Honey badgers are also causing economical damage to beekeepers hives (Begg 2001). This species of badger needs protecting in Karnataka, India before these populations are threatened by the same challenges as the populations in Africa. Managers must confront these problems in Karnataka before they become widespread.

Management

Goals and Objectives

Goal: Increase and stabilize honey badger populations in Karnataka India, in order to make this a flagship species for the state from 2018-2048.

Objective 1- Increase protected honey badger habitat, by 10% in ten years.

Objective 2- Increase understanding of honey badger ecology in Karnataka in eight years publishing four, peer reviewed scientific articles.

Objective 3- Evaluate 85% of honey badger populations in Karnataka in five years.

Objective 4- Have a honey badger acceptance rate of 70% by human populations in thirty years

Actions

Objective 1- Increase protected honey badger habitat, by 10% in ten years

Action 1.1- Find suitable habitat in Karnataka using geographic information system (GIS) techniques and information provided by (Gupta et al. 2012) habitat suitability model. Determine if there is enough suitable habitat to support an increased number of badgers in the area, given their large home ranges as described by Gupta et al. (2012). Assess availability of suitable burrowing habitat in Karnataka, for honey badgers, by employing GIS techniques. Once areas are identified, assess if they are distributed properly to support the honey badgers large home range size, as described in Gupta et al. (2012) (Store and Kangas 2001). Employing GIS techniques, overlay suitable habitat with availability of burrowing habitat to assess which areas of Karnataka have all key features to support honey badger populations, as described in the *Habitat* section of this report (Store and Kangas 2001). A focus should be made on habitat that mothers need to support their cubs. Increasing cub survivability will have the largest impact on increasing populations (Appendix D). This should be completed during the first three years of the project.

Action 1.2- Once areas are identified, as described in Action 1.1, these areas should then become protected habitat for honey badger populations. These lands should aim to become a part of the World Land Trust, those proposed protected areas with water should follow Karanth (2014) for more information on establishing protection for areas with bodies of water. McDonald et al. (2007) found success in protecting land to preserve biodiversity and saw an increase in target species populations.

Action 1.3- Minimize deforestation of honey badger habitat by cutting timber in habitat that is less suitable for honey badger (see Gupta et al. 2012).

Although this action would help stop habitat loss for honey badgers, it is unrealistic to expect all timber cutting in habitat suitable for honey badgers to cease. Honey badgers are found in open woodlands (Gupta et al. 2012) which is where larger trees are found, these are the trees desired by foresters (Sudhakar Reddy et al. 2015). Forest products in India have increased from 199.14 million cum to 248.58 million cum, and is only projected to increase in the coming years (Malik and Dhanda 2003).

No Action- Without assessing suitable habitat and burrowing habitat it is unknown if Karnataka can support an increased number of honey badgers. This could lead to an attempt to increase the populations when, potentially, the populations have already hit carrying capacity for the ecosystem. Without understanding potential habitat for honey badgers, and possible locations, future research on the organism would be unattainable, along with the possibility of increasing tourist sightings of these animals.

Final Course of Action: Actions 1.1, 1.2

Assessment Protocol: Creation of protected lands, as outlined in the above actions, will be considered successful at completing objective 1, if protected habitat, suitable for honey badgers, is increased by 10% in ten years. This percentage will be assessed by employing GIS techniques to evaluate current protected habitat for badgers, and protected habitat in ten years. If the is analysis shows a 10% increase in these protected lands in ten years then this objective will have been completed successfully. This objective is crucial to the success of honey badgers in Karnataka since honey badgers are unlikely to live outside of protected areas (Ngwenya 2001). Honey badger habitat is described as open woodlands, desert, high mountains and coastal shrubs (Sillero-Zubiri and Marino 1997), this is the type of habitat that should be protected for honey badger use.

If this objective is not met within the ten year timeline, the first step is to assess why this objective failed. Once a conclusion is met as to why this objective was not achieved the next step would be conservation easements from private landowners who own more than 100 acres (Merenlender et al. 2003). Another option for private landowners is to opt into a land trust, so the habitat cannot be developed on (Merenlender et al. 2003). The overall goal of this objective is to increase protected lands to stop development of areas honey badgers need, if a model of state land, as seen in the United States of America, is not plausible the next option would be having private land owners opt into land trusts or conservation easements.

Objective 2- Increase understanding of honey badger ecology in Karnataka in eight years publishing four, peer reviewed scientific articles.

Action 2.1- Assess the small mammal populations, in suitable areas, using track tube indices, live trapping small mammals in Sherman Box Traps and mark recapture population estimates (Wiewel et al. 2007), to determine if there is enough prey abundance to support honey badger food needs. Potential small mammal species honey badgers could consume (see Diet, page 6).

Action 2.2- Assess the herpetofauna populations in areas deemed appropriate for honey badger habitat, as decided in objective 1. Potential herpetofauna species honey badgers could consume can be found in the *Diet* section of this report. Assessment should be done using fenced pitfall trap lines, as described in How (1998) to determine if there is enough prey abundance to support honey badger food needs.

Action 2.3- Using live video feed in known badger dens would be an appropriate way for more data to be collected on honey badger ecology. Placing cameras into the burrows of honey badgers could provide an insight to researchers on behavior in the den. Jones et al. (1997) had success understanding marten ecology when remotely activated cameras

where used to monitor maternal dens. A study done by McKinnon and Bety (2009), found that there was no increased risk of predation on shorebird nests when camera monitoring was used, increased predation on the burrows of honey badgers would be of large concern when implementing this action.

This action will not be implemented into this plan due to cost of cameras, void of knowledge in location of honey badger burrows and time associated with setting this action up appropriately. This action however should be considered at the conclusion of the management plan, if an updated one is constructed.

No Action- If no action is taken there will be a void of knowledge specific to honey badger ecology in Karnataka. These organisms could be challenged by different threats then those of other badger populations. To truly understand and protect the organism it must be evaluated in the habitat, and geographic range, management is being attempted in.

Final Course of Action: Actions 2.1, 2.2

Assessment Protocol: Increasing understanding of honey badger ecology in Karnataka will be considered successful in completing objective 2 if understanding of honey badger populations is increased by publishing four peer reviewed scientific articles in eight years. This will be assessed by performing a thorough literature review and examining all scientific, peer reviewed publications, on honey badger diet, habitat, and reproduction status specifically in Karnataka (Wicherts 2016). Researchers in the state of Karnataka who study the honey badger should also be questioned on information they have gained, specific to honey badger ecology in Karnataka.

If this objective is not met within the eight year time line then the next step should be assessing why research was not done. The primary reason for lack in ecological research is the lack of funding (Payne and Siow 2003). Payne and Siow (2003) found that an increase in $1 million of federal research funds resulted in 11-18 more scientific articles published. The next step for this objective would be securing federal funds to allocate to honey badger ecology research.

Objective 3- Evaluate 85% of honey badger populations in Karnataka in five years.

Action 3.1- Observations of honey badgers should be done, following the same format as Begg et al. (2003) to assess what badgers are consuming as prey in Karnataka. Observation efforts should also be made to see how many cubs badgers are producing in a year, and how often the badgers are breeding. These observations should follow the same format as described in Begg et al. (2005).

Action 3.2- Assessing honey badger populations with the assistance of thermal imagery in helicopters would be a viable option for completing objective 3. Havnes and Sharp (1998) found this technique useful when locating panthers and deer in the Florida Everglades. Their study showed that using thermal imagery they were able to count 42% more panthers and deer (Havens and Sharp 1998). Another option would be using unmanned aerial vehicles for imagery, drones, as done by Jones et al. (2006).

This action will not implemented into this plan due to cost of helicopters, thermal imaging supplies and costs associated with unmanned aerial vehicles and risks. This action however should be considered at the conclusion of the management plan, if an updated one is constructed.

Final Course of Action: 3.1

Assessment Protocol: Evaluating 85% of honey badger populations in Karnataka in five years will be considered successful in completing objective 3 if there is an increase in observations done, on populations in Karnataka. These observations can be done with camera traps, helicopters, transect studies or by other means. Karanth et al. (2006) used drones for photographic capture-recapture methods, which is expensive but could be a possibility. Honey badgers are also large enough they could be spotted from low flying helicopters, in a similar manner that manatees are spotted from helicopters (Rathbun 1988). This will be assessed by performing a thorough literature review and examining all scientific, peer reviewed publications, on honey badger populations specifically in Karnataka. Scientists in Karnataka should also be communicated with to see what observations have been completed by them.

If this objective is not met within the five year timespan then the next step includes attempting to assess honey badger populations using photographic capture-recapture methods, as described in Karanth et al. (2006). This action is not one already listed above due to the elusive nature of the honey badger, previous studies done using this method did not have great success (Gubbi et al. 2014). This action should only be used if the objective has not been met on the five year timeline.

Objective 4- Have a honey badger acceptance rate of 70% by human populations in thirty years.

Action 4.1- Prior to putting the current management plan into place, communities surrounding proposed protected honey badger areas should be informed of what is happening. This can come in the form of a town hall meeting, mailing out information packets or in the form of public flyer. The sample flyer has been adapted from Project Coyote: Coyote door hanger (Appendix C; 2018), using all of these methods in a combination would be most effective. Public opinion should be taken into account, much like restoring wolves in Yellowstone National Park (National Park Service 2017). A survey should then be sent to homes surrounding, new and established, protected honey badger areas to gain public opinion on this species (sample can be found in appendix A).

Action 4.2- If the majority of the public population is against honey badger population increases then a public forum should be held to specifically address any fears or uncertainties (Slagle et al. 2017). A model to follow would be the United States Fish and Wildlife Service Reintroduction of the Mexican Wolf within its historic range in the southwestern United States, published in 1996.

Action 4.3- A follow up survey should be sent to residents surrounding protected honey badger habitat every year following the establishment of this management plan (Slagle et al. 2017). This survey should allow residents to disclose any concerns they have with the badger populations, if they have had any negative encounters with badgers in the last year, positive experiences they have had and any problems they would like addressed

related to honey badger populations and their property (sample survey can be found in appendix B).

Action 4.4- To assess how the entire population of Karnataka feels about honey badger populations in the state a survey should be sent out (see Appendix A for a sample) prior to the implementation of this management plan to gather public opinion on this organism (National Park Service 2017; Slagle et al. 2017).

Action 4.5- Every five years following the implementation of this management plan a follow up survey should be sent to the residents of Karnataka, this survey should closely resemble the survey distributed in Action 4.3 (Appendix B), without the questions on issues with honey badgers on the residents property (National Park Service 2017; Slagle et al. 2017).

No Action- Honey badger populations should not be increased unless public opinion has been taken into account. If badgers are spreading disease, attacking, or even becoming nuisance animals for residents surrounding the protected areas the public perception of honey badgers will not become favorable. If this begins to happen the public will not support research projects and funding to be allocated to better understand the honey badger populations in Karnataka (see objective 2).

Final Course of Action: 4.1, 4.2, 4.3. 4.4, 4.5

Assessment Protocol: Having a honey badger acceptance rate of 70% by human populations in thirty years will be considered successful in completing objective 4 if there are few (less than 10) negative honey badger encounters per year per protected area. This will be quantified by reviewing the survey's sent out every year to the residents surrounding the protected areas. Objective 4 will be considered successful if in thirty years, 70% of the residents of Karnataka support having honey badger populations present. This will be quantified in a survey that will be sent out to Karnataka residents every five years (Action 4.5.) and comparing those numbers to the initial survey sent out prior to implementation of this management plan (Action 4.4). Filion (1983) found increased success in using human surveys in managing wildlife populations, the surveys where able to assess difficulties and potential sources of error within the management plan.

If this objective is not met within the thirty year timeline the next steps should be mailing out, or emailing, surveys to residents of Karnataka, as described by Conover (1997). Conover received an average of 52% response rate to his mailed surveys, the response rate was higher when the species in question was a species the public came into contact with frequently (i.e. squirrels, mice, raccoons; Conover 1997). This action is a last resort for this objective because honey badgers are elusive, so residents will not come into contact with them frequently, thus making the response rate to mailed surveys less than 50% (Conover 1997).

Conclusion

This management plan specific for the ecosystems in Karnataka, India, due to the distinct ecosystem in this state. Honey badgers have a large distribution and can span into the state of Karnataka, if proper habitat is protected. The public needs to become educated on living near

increased honey badger populations, as soon as possible, in order for this plan to be successful. Increased deforestation, lack of space, disease, bush meat trading, medicinal uses and beekeepers are all reasons that the honey badger populations in Karnataka need to be managed. Without management these populations will not increase, sustainably. By implementing the final courses of actions outlined in this plan (1.1, 1.2, 2.1, 2.2, 3.1, 4.1, 4.2, 4.3. 4.4, and 4.5) the honey badger populations in Karnataka will increase sustainably in order to achieve the ultimate goal of increasing and stabilizing honey badger populations in Karnataka India, in order to make the honey badger a flagship species for the state from 2018-2048.

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Appendix A

Honey badgers (*Mellivora capensis*) in your neighborhood

There is a proposed management plan to increase the populations of honey badgers or ratel in the state of Karnataka. This survey's intended purpose is to gain insight into public opinion about increasing this species in the area and to educate the public on the proposed management practices of the plan.

1. Honey badgers are known to carry diseases, like rabies, do you as a resident of Karnataka feel uncomfortable with an increase in honey badger populations knowing they carry diseases?
   a. YES
   b. NO
   c. In Different
2. How much do you know about the honey badger species?
   a. A lot, previously done research or worked with the animal in a zoo like setting
   b. Some, read current, scientific literature on the animal and stay up-to-date with new findings
   c. A little, read blog posts and watch nature documentaries on the species
   d. None, have only heard about or seen pictures of the species in passing or not at all
3. Honey badgers are elusive, nocturnal omnivores, who are in the same family (*Mustlidae*) as ferrets, otters and weasels. Your interaction with these mammals should be little to none, are you okay with this?
   a. YES
   b. NO
   c. In Different
4. One aspect of the proposed management plan is to increase protected areas for honey badgers to live, do you support this?
   a. YES
   b. NO
   c. In Different
5. What are some concerns you have about increasing honey badger populations in Karnataka? (Circle all that apply)
   a. Destroying personal property (beehives, chicken coops etc.)
   b. Disease transmission to you, your family or pets
   c. Feeling unsafe in your backyard at night
   d. Fear of being attacked
   e. Other _____
6. What are some concerns not previously addressed on this survey that you, as a resident, have?
   _____
   _____
   _____
   _____

Thank you for completing our survey, your opinions are valued and will be taken into account before releasing a final management plan.

Appendix B

Yearly honey badger (*Mellivora capensis*) follow up survey

This survey is distributed yearly to residents surrounding protected honey badger areas. The purpose of this survey is to evaluate if you, as a resident, are experiencing any negative interactions with honey badgers.

1. Have you had a negative encounter (destruction of property, disease transmission, attacks to you or pets, loss of life human or animal etc.) with a honey badger in the last year?
    a. YES
    b. NO
    c. I have not seen a honey badger
2. How many negative encounter have you had with a honey badger this year?
    a. 1
    b. 2
    c. 3
    d. 4+
    e. None
3. If you have had a negative encounter please rate it on a scale from 1-10, 1 being a minor inconvenience, 10 being loss of life, human or animal. If you have had multiple negative encounters please rate the worst one in the last year.
    1 2 3 4 5 6 7 8 9 10
4. Please describe the negative encounter below, if you have experienced multiple negative encounters feel free to attach additional pages in order to describe as many as possible:
    _____
    _____
    _____
    _____
    _____
5. Have you experienced a loss of personal property due to a honey badger?
    a. YES
    b. NO
    c. In Different
6. Do you feel the honey badger populations are getting too large?
    a. YES
    b. NO
    c. In Different
7. Have you had a positive experience (watching one feed through a window, seeing a mother and a cub etc.) with a honey badger in the last year?
    a. YES
    b. NO
    c. In different
8. If you have had a positive interaction please feel free to describe it below:
    _____
    _____
    _____

Thank you for taking our yearly survey. Your opinion is valued and will be taken into consideration when the management plan is revised.

Appendix C

Coexisting with Honey Badgers in Your Community

In your community there are all kinds of plants, birds and animals. In Karnataka we are trying to increase honey badger populations, in order for this to happen the residents of communities in Karnataka must learn about this species, so we can all live in harmony.

Facts about Honey Badgers

- Honey badgers stand around 250mm tall
- Honey badgers weigh approximately 12kg
- There is a gray or brown hair running laterally
- down their dorsal side, from above the eyes to the base of the tail
- Honey badgers are primarily terrestrial, but possess the ability to climb
- Honey badger diet is classified as "opportunistic omnivore"

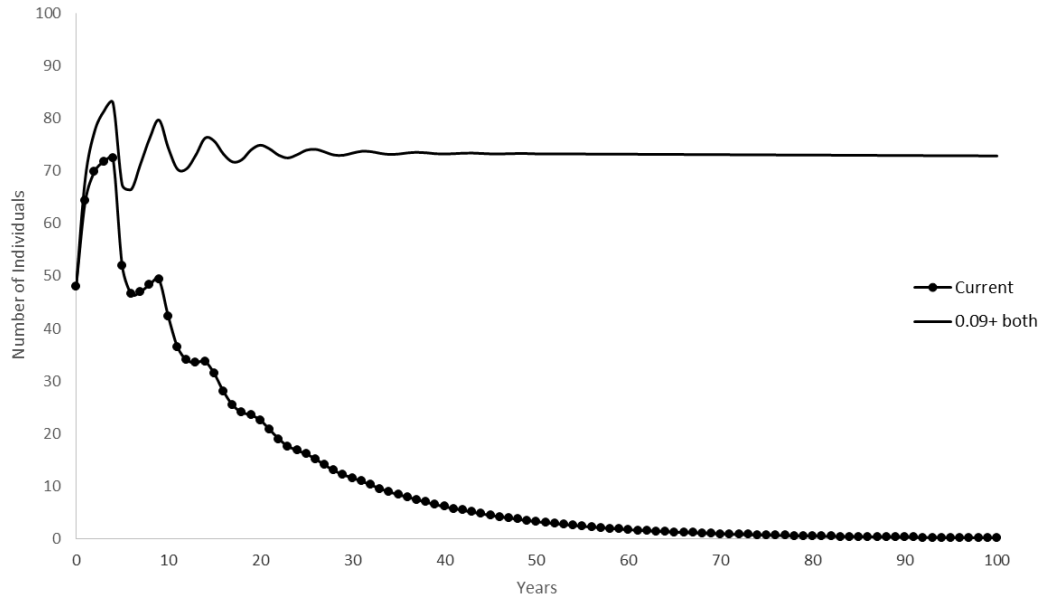
How to Avoid Contact with Honey Badgers:

- Secure all trash at night
- Never leave food scraps outside
- Keep all pet food inside
- Keep domestic pets on leashes after dark
- Never corner the organism, this will make them feel threatened and trigger their fight response

Figure 7 honey badger (*Mellivora capensis*) climbing a tree.

Appendix D
Stage Structured Matrix Model for *Mellivora capensis*

Stage-Structured Matrix Models						
	***F*(dc)**	***F*(dc)**	***F*(c)**	***F*(c)**	***F*(*a*)**	
den cub	0	0	0	0	1	
den cub	0.98	0	0	0	0	
cub	0	0.98	0	0	0	
cub	0	0	1	0.21	0	
adult	0	0	0	0.45	0.43	



Predicted population size compared to the current population size.

	Elasticity matrix				
	***F*(dc)**	***F*(dc)**	***F*(c)**	***F*(c)**	***F*(*a*)**
dc	0	0	0	0	0.170747134
dc	0.17074537	0	0	0	0
c	0	0.17074603	0	0	0
c	0	0	0.170748601	0.049233723	0
Adults	0	0	0	0.170750705	0.097030263

Elasticity matrix for *Mellivora capensis*.