BHUTAN JOURNAL OF ANIMAL SCIENCE
Rinzin et al. (2017). Roaming dogs in Bhutan: a review on population management. Bhutan J. Anim. Sci. 1 (1): 75-81.

Review paper

Roaming dogs in Bhutan: a review on dog population management

KARMA RINZIN[1]*, IAN ROBERTSON[2] AND HIRUKA MAHAT[3]

[1]Animal Health Division, Department of Livestock, Ministry of Agriculture and Forests, Thimphu, Bhutan
[2]College of Veterinary Medicine, Murdoch University, Perth, Australia
[3]National Centre for Animal Health, Department of Livestock, Serbithang, Thimphu, Bhutan
*Author for correspondence: email-rinzink@gmail.com; ph: +97517369825

ARTICLE HISTORY

Received: 11/12/16
Peer reviewed:12-25/12/16
Received in revised form: 2/1/17
Accepted: 5/1/17

KEYWORDS

Control
Dog
Free-roaming
Population
Rabies
Stray

ABSTRACT

The impounding of dogs, which was undertaken in 2008 was not sustainable due to high maintenance cost and compromise on animal welfare in the pound. A sterilization campaign, which was initiated by the Department of Livestock from 1991 onwards, was not successful in reducing the dog population to a manageable level due to poor coverage. Due to limited funds and poor support from the public and key stakeholders, the annual sterilization and vaccination campaign only covered 15 to 20% of the population. This coverage was not sufficient to effectively control rabies and the dog population. The World Health Organization (WHO) and World Society for Protection of Animals (WSPA) Expert Committee in 2004 recommended that at least 70% of the population needed to be vaccinated to break the rabies cycle and a similar proportion of the population was sterilized to maintain a sustainable dog population. Since 2009, the Department of Livestock and the Humane Society International (HSI) have worked together on a long term National Dog Population Management and Rabies Control Project (NDPM & RCP). The project was implemented in three phases. Through this project, the capture-neuter-vaccinate-release (CNVR) programme was carried out with dogs being captured, neutered, vaccinated and released back to their place from where they are caught. From 2014 onwards, community animal birth control (CABC) was initiated with the aim to involve local communities and relevant stakeholders in carrying out sterilization and vaccination of dogs. Vets and Paravets were trained in all districts who could competently carry out the CABC programme in their respective district. As of June 2016, a total of 78,041 dogs were sterilized and vaccinated covering all the districts. Monitoring and evaluation of the CNVR programme was regularly carried out to assess the impact of the project.

INTRODUCTION

Dogs were the first species to be domesticated approximately 14,000 to 15,000 years ago (Clutton-Brock 1995; Savolainen 2007). Since then people have been intimately involved with domesticated dogs through their use as pets and companions, for hunting, as guard dogs, draught animals, or for commercial purposes (Coppinger and Schneider 1995; Stafford 2006). Dogs now also undertake a wide range of specialized work including the detection of illegal goods, tracking criminals, search and rescue work, and in sporting activities (Murray and Penridge 1992; Stafford 2006). Dogs play an important role in society, enhancing the psychological and physiological well-being of many people (Blackshaw 1996; DiSalvo et al. 2005). Some studies have also suggested that keeping pets can be associated with a higher level of self-esteem in children (Paul and Serpell 1996). Although domesticated dogs offer significant advantages to the general community, unwanted, wild or free-roaming dogs can be a problem to the general public. Free-roaming dogs are those dogs found in public places, irrespective of the level of care and supervision imposed upon them. This term is often used inter-changeably with "free-ranging" or "stray" dogs (WHO/WSPA 1990; ICAMC 2007). This term encompasses both owned and un-owned dogs that are not currently under direct control or are not restricted by physical barriers.

A free-roaming dog population can rapidly increase in size due to a high reproductive potential resulting in a hazard to animals, humans and the environment. Bhutan has a large population of free-roaming dogs, which has been a concern for the general public, including tourists. Rabies is still endemic in the southern part of Bhutan and free-roaming dogs have been implicated as the main source of rabies in the country. As a result, the Royal Government of Bhutan (RGOB) has assigned a high priority for the control of rabies and the dog population in Bhutan. This paper reviews various dog population management strategies implemented in Bhutan from 1970s till date to control rabies and dog population.

DOGS IN BHUTANESE SOCIETY

The total dog population in Bhutan is approximately 50,000, of which 32,000 are owned (DOL 2006; DOL/HSI 2009). This number is likely to be an underestimate of the total population of dogs, as the free-roaming population in the Thimphu Municipal area alone has been estimated at 6,000 in March and June 2009 (Rinzin 2009). The recent estimate of dog population using the scientific method is 119,624 (including

owned and stray dogs) (Rinzin et al. 2016). The total owned dog population in the country was estimated at 71,245 with 24.4% of the households in the urban and 40.8% of the households in the rural areas owning dogs. The number of stray dogs in Bhutan was estimated at 48,379 (urban: 22,772; rural: 25,607). The density of owned and stray dogs in Bhutan is 1.70 and 1.26 dogs per km^2, respectively. Dogs are culturally and socially accepted by the Bhutanese community. Although most Bhutanese do not own specific dogs, they do feed them and consider them a friendly presence. This may be associated with the Buddhist belief that people can be reborn as animals, and feeding animals (in this case dogs) can earn good karma (Rinpoche 1993; Anonymous 2012; Knierim 2012). It is also believed that in the usual cycle of rebirths, a dog is closest to attaining human status, and normally a dog's next life would be a human life (Choden 2006). It is because of this reason a large number of roaming dogs are seen in Bhutan. Although Kinzang's Choden book "Dawa: The Story of a Stray Dog in Bhutan" is a fictional novel, it epitomizes the Bhutanese societal value and importance of dogs to the culture. The author made several local references with real places and beliefs in the book, which provides a good understanding about the socio-cultural aspects of Bhutan, thus, helping to make "Dawa" a realistic character.

In rural places in Bhutan, owned dogs are used for guarding crops from wild animals and herding the livestock, while in urban areas dogs are mainly kept as pets and for guarding premises. Over the years, more and more people are keeping dogs as pets in the urban areas as is evident from the registration records maintained at the National Animal Hospital (NAH), Chubachu, Thimphu and other Animal Health Facilities. The NAH, Chubachu registered 4,257 dogs from 2007 to 2011 in the Thimphu Municipal area (NAH 2012). Of the total owned dogs, 1,526 (36%) were foreign breeds (24 different breeds) with Alsatian being the most common breed in Thimphu. The local breeds registered in the Thimphu Municipal area were *Lhasa Apso* (729), *Jobchi* (Tibetan Mastiff) (617), *Damtsi* (414) and other local breeds (971). The free-roaming or stray dogs are mainly seen in the urban areas. Although these dogs are not owned, many of them have a household from where they get their food, however, very few people actually adopt stray dogs from the streets as pets.

PROBLEMS ASSOCIATED WITH FREE-ROAMING DOGS IN BHUTAN

In Bhutan, rabies is endemic in the southern districts that border India. Domestic dogs are the main reservoir of rabies and are responsible for spill-over infection to other domestic species, especially cattle (Rinzin et al. 2006; Tenzin et al. 2010b; Tenzin et al. 2011a; Tenzin et al. 2011d). From 1996 to 2009, a total of 814 cases of rabies were reported in domestic livestock species, of which cattle and dogs accounted for 55 and 39% of the cases, respectively (Tenzin et al. 2011d). Sporadic human deaths have also been reported from the rabies endemic areas. From 2006 to 2016, a total of 18 human deaths due to rabies was reported. An excess of dogs also has implications on the occurrence of other zoonotic infections due to contamination of the environment with faeces. Eggs of *Echinococcus* and *Toxocara* spp. have been found in dogs during routine faecal microscopy in laboratories in Bhutan (Rinzin 2006).

As in other countries, dog bites are common in Bhutan due to the presence of a large number of roaming dogs. A dog bite survey conducted in three hospital catchment areas reported an annual dog bite incidence of 869.8, 293.8, and 284.8 per 100,000 population in Gelephu, Phuentshogling and Thimphu, respectively (Tenzin et al. 2011b). There has been considerable media coverage on the stray dog population, the risk of dog bites and the public nuisance associated with free-roaming dogs. The Kuensel (national newspaper) article "Dog bite numbers go through the roof" on 19th August 2011 reported that Damphu hospital in Tsirang district recorded 216 dog bite cases from January to July 2011 compared with only 30 in 2009 and 62 in 2010 (Gyelmo 2011). The reporting of dog bite cases in Tsirang was as a result of increased awareness following an outbreak of rabies and associated loss of human life in the neighbouring district of Sarpang. This may indicate that many cases of dog bites went unreported (not presented to the hospitals) prior to the awareness campaign.

Although no cases of fatal dog attacks in humans have been documented, deaths due to rabies following dog bites have been reported. Both dog bites and outbreaks of rabies cause considerable loss to the Government. Rabies can also cause substantial losses to farmers due to the death of farm animals as a result of spill-over infection from dogs. The direct outbreak cost during the rabies outbreak in Chukha district in 2008 was estimated to be Nu. 2.75 million (US$ 59,923) (Tenzin. et al. 2010). This included losses from cattle deaths (Nu. 42,000; 15%), and costs for post exposure prophylaxis of humans (1,516,500; 55%) and implementation of the rabies control programme (Nu. 820,000; 30%). There is continuous fear for children, as well as weak and old people, from these free-roaming dogs in the towns. This arises from the reported instances of dog attacks on people during their morning or evening walks in Thimphu city.

Despite Bhutan being one of the most sought after tourist destinations, the presence of too many free-roaming dogs and incessant barking of the dogs during the night can have an adverse effect on tourism (TCB 2010, 2011). Although local residents of Thimphu are used to the nightly canine howling, it is the unfortunate expatriate community and tourists, who are not used to this noise.

The free-roaming dogs have serious impact on wildlife through preying on young and small animals as well as through transmission of infectious diseases to other wild carnivores (Butler et al. 2003; Manor and Saltz 2003; Cleaveland et al. 2007). The recent investigation of feral dog problems in Lunana *geog* in Gasa district reported dogs attacking blue sheep and musk deer. There are also reports on attack of free-roaming dogs on deer in Thimphu and displacing the wildlife from their normal habitats. In addition to this, free-roaming dogs cause many other problems by fouling the public places with excreta, causing road accidents and putting pressure on the road users (Robinson 1974). The presence of a large number of dogs also causes welfare problems to the dog themselves. The Kuensel issue on the 11th September 2011 reported the treatment at the National Animal Hospital, Chubachu, Thimphu of 64 dogs that were injured as a result of motor vehicle accidents between January and August 2011 (Pelden 2011). This is likely to be an underestimate of the real number as many dog injuries are likely to go unreported.

DOG POPULATION CONTROL STRATEGIES INITIATED IN BHUTAN

Considering the previous mentioned problems, several control measures have been attempted since the 1970s to control rabies and restrict the dog population in Bhutan. The free-roaming dog issue has been discussed in various forums starting from the highest decision making body, such as the National Assembly of Bhutan, to informal discussion at various levels (NCAH 2006; UNDP 2008; Wangmo 2010). The issue has also been discussed in the United Nations Development Programme

(UNDP) coordinated e-forum "Solution Exchange" (UNDP 2008). The issue "Grappling with Stray Dog Problem in Bhutan - Advice; Experiences" was put forward by the GNH Commission to the e-forum and many members contributed on this pertinent issue. The RGOB has initiated five major approaches towards the control of rabies and dog population in Bhutan.

KILLING OF DOGS

The frequent outbreaks of rabies in the mid-1980s in many parts of the country prompted the RGOB and WHO to initiate rabies control programmes that involved mass killing of stray dogs (NCAH 2006; UNDP 2008). WHO supplied dart guns, syringes and drugs to cull free-roaming dogs. This equipment was distributed to all districts and a few livestock staff were also trained in handling the equipment. Some trained dog shooters were also appointed to shoot dogs in the urban areas. Dogs were shot by these shooters in public places as part of the rabies control programme; however it was considered inhumane and was strongly opposed by the general population. The hearing of gun fire and the sight of dead dogs were reported to have caused psychological trauma to young children (Wangmo 2010).

Dogs were also poisoned using strychnine as part of the rabies and dog population control programme (NCAH 2006). The strychnine tablets were placed in raw meat and fed to the dogs. During the implementation of this programme, people were recommended to restrain owned dogs to their homes and release them only once the dog control team had left the area (NCAH 2006; Wangmo 2010). From 1990 until recently, mass culling of free-roaming dogs was undertaken only in the rabies outbreak area as and when rabies outbreaks were reported (NCAH 2006; Rinzin et al. 2006; Tenzin et al. 2010b; Tenzin et al. 2011a; Tenzin et al. 2011d). In-contact free-roaming dogs were culled in areas with outbreaks of rabies as the vaccination coverage had been low and the immune status of the dogs was not known. Moreover, those free-roaming dogs that were vaccinated could not be identified as there was no permanent identification marks of the vaccinated dogs. The mass culling of free-roaming dogs during the rabies outbreak in June 1999 in Paro town, despite the religious pressure, managed to control rabies without the spread of the disease to other places (UNDP 2008; Tenzin et al. 2011d). Similarly, the outbreak reported from the southern border region of the country was controlled by the immediate culling of in-contact free-roaming dogs in the area. The major rabies outbreak that occurred in Chukha district in the south-western part of Bhutan between January to July 2008 was also controlled by culling of in-contact free-roaming dogs in the outbreak areas (Tenzin et al. 2010b). The outbreak continued for almost seven months in three sub-districts in the Chukha district, as there was a delay in culling of in-contact free-roaming dogs as killing is prohibited in two auspicious Bhutanese months i.e. the first and fourth Bhutanese months. From this experience, the importance of culling in-contact, free-roaming dogs in a rabies outbreak area where the vaccination and immune status of the dogs was not known, was recognised. However, with the subsequent adoption of ear notching of vaccinated and neutered free-roaming dogs, the likely immune status of dogs is now easier to assess. Furthermore, it is acknowledged that elimination of vaccinated dogs will result in encroachment of un-vaccinated dogs from adjacent places. To avoid creation of a vulnerable population to rabies, the elimination of ear notched dogs at the time of rabies outbreak is now discontinued and instead booster vaccination at the time of rabies outbreak is encouraged.

TRANSLOCATION OF DOGS

Although translocation of dogs has not been a recommended strategy to control the dog population in Bhutan, it was implemented in some districts (NCAH 2006; UNDP 2008). Dogs were caught from public places, loaded into trucks and transported to another district. *The vehicles belonging to the armed forces were often blamed by the public for carrying the dogs as these vehicles are not inspected at the strategic police check points* (Dorji 2008 *Personal Communication*). One of the characters in "Dawa: The Story of a Stray Dog in Bhutan", the grisly old dog in Mongar, tells Dawa *"I am one of the dogs who were deported from Bumthang. One fine day, we were just going about as usual, minding our own business, when we were rounded up and loaded on a truck before we could say 'haw haw' in surprise or protest. We were dumped here"* (Choden 2006). This again highlights the factual nature of "characters" in this book.

Translocation of dogs had an extremely detrimental effect with dogs turning wild and preying on livestock and wildlife. There was a report of dogs being dropped at Sengor in Mongar district by the Bumthang District Authority (Tshering 2007 *Personal Communication*). These dogs subsequently attacked and killed some sheep in Sengor, which led to a dispute between the Bumthang and Mongar district authorities. The dispute was later settled and the Bumthang district authority was required to pay compensation to the farmers in Sengor for the sheep that were killed.

IMPOUNDING OF DOGS

The increasing stray dog population issue was discussed in length during the 87th session of the National Assembly in June 2007 and it was resolved to build dog pounds in all 20 districts to render the towns free of stray dogs by December 2007 (UNDP 2008). This decision was made as 2008 was the year for the coronation of the fifth *Druk Gyalpo* (Dragon King) and celebration of the centenary of Monarchy reign in Bhutan. Separate dog pounds were built in all districts and impounding of dogs in most of the districts was initiated. The impounded dogs were fed and looked after by paid caretakers. This initiative invited extensive media coverage and criticism from both national and international animal welfare organisations (Jangsa 2008b; Choki 2009; HSI 2010; Pelden 2011). It was realized that impounding of dogs was not the best solution to control the dog population as it was not affordable and could result in serious welfare issues for the dogs. This approach was discontinued in February 2009 as it was not sustainable.

During the major rabies epidemic in eastern Bhutan in 2005 and 2006, 900 in-contact free-roaming dogs were caught and impounded in 12 temporary shelters constructed in three districts in an attempt to prevent the spread of rabies due to the movement of free-roaming dogs (Tenzin et al. 2011a). The impounding of the in-contact free-roaming dogs was adopted in this outbreak in response to religious aversion to the mass culling of dogs by the community in eastern Bhutan. However, some in-contact free-roaming dogs escaped from the pounds, which lead to the spread of rabies to other places. As such the rabies outbreak, which was first reported in May 2005 in Toedtsho subdistrict under Tashi Yangtse District, started spreading to many places including two adjacent districts (Mongar and Trashigang) with a peak number of cases in January and February 2006.

There are a few local non-government animal welfare organizations that run treatment shelters in Thimphu and Tashigang districts. The Royal Society for Protection and Care of Animals (RSPCA), Thimphu, runs an Animal Welfare Treatment Centre in Serbithang, Thimphu (RSPCA 1999). The

initial plan of this centre was to rescue the weak and sick dogs from the street for care and treatment in the centre and subsequently release them back to their place of origin once they were healthy. However, most of the dogs brought for treatment remained in the centre as they were continuously fed and given care. The RGOB also officially approved the Bhutan Karuna House Program in June 2008 and granted one acre of land for building facilities to keep and care stray dogs in Tashigang district (Karuna 2008). After three years, Karuna House had provided refuge for approximately 50 stray dogs in a hygienic and safe environment. The construction of four fully equipped kennels was completed in 2011 and increased the capacity to house up to 300 stray dogs.

When hundreds of dogs were pounded in Memelakha dog pound in Thimphu in 2008, there was criticism by animal welfare organizations and the local community as the pound was overcrowded and did not segregate dogs into different categories such as puppies, lactating bitches, sick, weak and old dogs (Jangsa 2008a). This prompted the Brigitte Bardot Foundation to provide funds to the Jangsa Animal Saving Trust (JAST) for the immediate construction of a rescue shelter and the purchase of a vehicle to transport the dogs recovered, particularly the old, disabled and injured animals, and to undertake a food drive in the neighbourhood (restaurants, schools, local donors). The JAST constructed a treatment shelter adjacent to the RSPCA shelter on land provided by the Government. The shelter is still used for the treatment and care of sick and weak dogs, which are subsequently released back to the street once they are healthy.

AD HOC STERILIZATION AND VACCINATION CAMPAIGNS

Campaigns have been organized by the Department of Livestock in various districts to sterilize and vaccinate both owned and stray dogs. To increase the effectiveness of such campaigns, cash incentives have been given to people who catch and bring in dogs (NCAH 2003, 2006). The public prefers this method since it does not incur the destruction of dogs. However, the coverage and frequency of the campaigns varied between districts due to a range of constraints. The number of dogs sterilized and vaccinated from 1998 to 2008 is displayed in Figure 1. The overall proportion of dogs sterilized and vaccinated during this period was low, with the exception of 2006. Many dogs were sterilized and vaccinated in Tashigang, which had the highest number of rabies outbreaks of the three affected districts in eastern Bhutan (Tenzin et al. 2011a).

However the general public was concerned about this programme, in particular the poor aseptic conditions of the surgeries. Most surgeries were conducted on the ground and in the open with poor asepsis. The protocol was improved from 2003 when surgeries were performed on a portable surgical table in a screened enclosure under the cover of an umbrella using sterilized surgical instruments (NCAH 2003). Following these improvements, the cooperation received from the general public during the campaigns was significantly improved. Various techniques were used to identify dogs that had been neutered and vaccinated (NCAH 2003, 2006). The advantage of having an identification mark was to avoid wasting time and resources in catching neutered dogs during the follow-up sterilization campaign. In Mongar and Trongsa districts, tail docking was initially done to identify the sterilized and vaccinated dogs (UNDP 2008). This was opposed by the public and animal welfare groups and was subsequently discontinued. In Thimphu, an ear tattoo was used as a permanent mark to identify the neutered and vaccinated dogs (NCAH 2006). However, the tattoo marks were not visible from a distance and required a dog to be caught to determine its neutering and vaccination status, defeating the purpose of using identification marks.

From 2004 to 2008, synthetic collars were used as identification marks (NCAH 2003, 2006); however this method was only useful during short campaigns and was not reliable in the long term as some collars fell off and were missing from some dogs. The synthetic collars were also not suitable for younger growing dogs, which could choke as their body size increased. After trialling different methods of identification, ear notching, which was used by both Vets Beyond Borders (VBB) as well as HSI, was found to be the best method of identifying neutered and vaccinated dogs. The advantage of ear notches are: they are visible from a distance, permanent, quick, can be done when the dogs are under anaesthesia and are approved by the animal welfare organisations.

The sterilization campaign, which was first initiated by the Department of Livestock in the 1980s, was not successful in reducing the dog population to a manageable level due to a poor coverage (NCAH 2006). Due to limited funds and the poor support received from the general public and key stakeholders, the overall annual sterilization and vaccination coverage was estimated to be only between 10 and 20%. This low coverage was not sufficient to effectively control rabies or to have an impact on the free-roaming dog population.

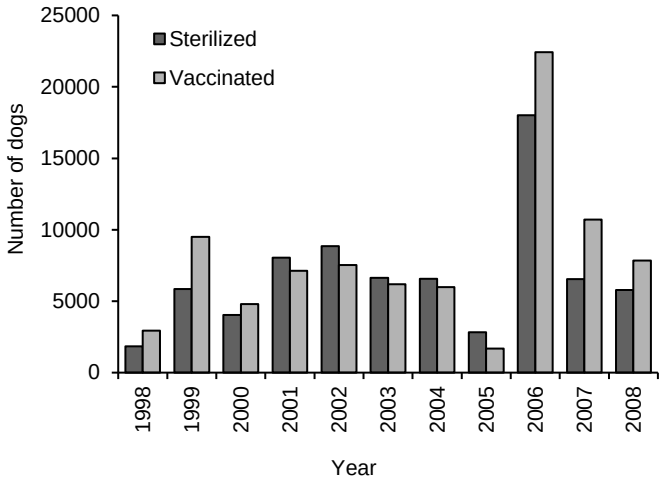

Figure 1 Number of dogs vaccinated against rabies and sterilized in Bhutan (1998-2008) (Source: Veterinary Information System (VIS), NCAH, Serbithang).

PROJECT ON NATIONAL DOG POPULATION MANAGEMENT AND RABIES CONTROL PROGRAMME

The sterilization and vaccination campaigns carried out by the Department of Livestock in the past were not sufficient to control rabies and reduce the dog population to a manageable level. The WHO Expert Committee on Rabies in 2004 recommended that at least 70% vaccination coverage was required to break the rabies cycle and also 70% of animals should be sterilised to maintain a stable dog population (WHO 2004). The Department of Livestock, RGOB and the HSI, USA initiated a pilot project from February to June 2009 to carry out a capture-neuter-vaccinate-release (CNVR) programme in Thimphu (DOL/HSI 2009). During the pilot project, the key stakeholders and decision makers, including the Prime Minister and Council of Ministers, were invited to the CNVR clinic to observe the high quality of the CNVR programme undertaken by the trained project team (Veterinarians and

Paravets). During the pilot project, a total of 2,846 dogs were sterilized and vaccinated.

After the successful pilot project in Thimphu, and with the support of the Government's Cabinet, the RGOB and HSI embarked on a long term project titled the "National Dog Population Management and Rabies Control Programme in Bhutan". The project was officially launched on the 28th September 2009 in Bumthang coinciding with the World Rabies Day. The project is being implemented in three phases: first phase (September 2009 to June 2012), second phase (July 2012 to June 2015), and third phase (July 2015 to June 2018). Through this project, the CNVR programme has been carried out with dogs being captured, neutered, vaccinated and released back to their place of origin. From 2014 onwards, community animal birth control (CABC) was initiated with the aim to involve the local communities and relevant stakeholders. Vets and Paravets in all districts were trained and are competent to carry out the CABC programme in their respective district. As of June 2016, a total of 78,041 dogs were sterilized and vaccinated covering all the districts (Figure 2).

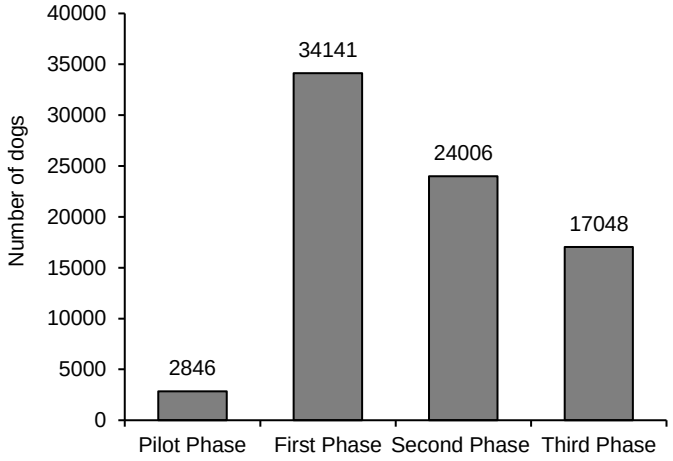

Figure 2 Number of dogs sterilized and vaccinated from February 2009 to June 2016 in Bhutan.

REVISION OF THE POLICY GUIDELINES FOR THE PREVENTION AND CONTROL OF RABIES IN BHUTAN

In 2003, the policy guidelines on the prevention and control of rabies in Bhutan were revisited and major changes were made. These changes focussed on improving the coordination mechanisms during the implementation of the rabies prevention and control activities (NCAH 2003). The revised guidelines contained extensive information on the institutional arrangement, prevention strategies, contingency plan to manage outbreaks and other support plans.

In 2007, WHO provided financial support to implement the Rabies Prevention and Control Project in Bhutan (NCAH 2007). The project activities were planned based on the revised policy guidelines outlined previously. Through this project, an international consultant was employed to draft regulations on rabies and dog population management. The regulations included sections on responsible pet ownership, habitat control and animal birth control, and vaccination of the un-owned free-roaming dog population. The other important activity conducted through this project was three weeks training of Bhutanese veterinarians on animal birth control by staff from Vets Beyond Borders (an Australian based NGO) at Paro Veterinary Hospital in April 2008. Since the start of the first World Rabies Day in September 2007, Bhutan has joined other international communities to observe the World Rabies Day. The major activities undertaken during the World Rabies Day are public awareness campaigns on rabies and dog population control and include walkathons, presentations through mass media, distribution of educational materials, debates among school children, and mass free vaccination of dogs against rabies in Thimphu and in areas where the disease is endemic. In 2016, the national rabies week (28 September to 3rd October 2016) was observed as part of the World Rabies Day Programme. During the national rabies week, all the school children below 15 years of age in the rabies endemic areas were educated on rabies and its prevention including how to prevent dog bites.

The comprehensive report "An overview of rabies with special reference to Bhutan" highlights the epidemiological features of rabies in Bhutan (Rinzin 2006). The master thesis titled "The Epidemiology of Free-roaming Dog and Cat Populations in the Wellington Region of New Zealand" looked at the population dynamics of the free-roaming dogs and cats with emphasis on the control of free-roaming dogs in developing countries including Bhutan (Rinzin 2007). Based on the recommendations of these reports, the long term project on dog population management and rabies control has been initiated in Bhutan.

In 2016, the National Rabies Prevention and Control Plan was revised where major changes were made based on the past experiences and lessons learnt. The plan has taken into consideration the number of studies that were taken as part of the higher degree programme by the Bhutanese scholars in various universities around the world. Detailed epidemiological investigations of previous outbreaks of rabies in Bhutan were undertaken by Tenzin as part of his PhD dissertation and several papers were published in international journals (Tenzin et al. 2010a; Tenzin et al. 2010b; Tenzin et al. 2011a; Tenzin et al. 2011b; Tenzin et al. 2011d, c; Tenzin et al. 2011e). This research also included trends and risk factors for human rabies post exposure prophylaxis and dog bite studies.

CONCLUSIONS

The studies presented in this review paper highlight the need to carry out CNVR programmes at regular intervals in all districts. Each district should independently implement CABC programmes through a coordinated one health approach by involving all relevant stakeholders. The CABC programmes should be closely monitored at regular intervals in each district. Participatory appraisals and behaviour change communication strategies should be adopted to bring positive change to the community's behaviours towards control of rabies and dog population management. Legislation on dog population management and responsible pet ownership should be tailored to meet the needs of the community and the stakeholders, and adequate support is required by the Government to enforce this legislation. National guidelines on sustainable dog population management should be prepared in consultation with all the relevant stakeholders. The guideline should focus on: habitat control (food, shelter, water); legislative measures (responsible dog ownership); reproduction control (animal birth control); education of public (positive behaviour change); and involvement of different stakeholders (one health approach). These guidelines should complement the National Rabies Prevention and Control Plan to achieve eradication of dog mediated human rabies by 2020. The final dog population management programme should be tailored to the characteristics of the local dog population, rather than using a single blanket intervention for all dogs or in all situations. The effectiveness of the CNVR programme should be monitored and evaluated regularly with improved strategy to have a positive impact in the long run.

REFERENCES

Anonymous (2012). A view on Buddhism - Buddhist Karma.

Butler J, du Toit J, Bingham J (2003). Free-ranging domestic dogs (*Canis familiaris*) as predators and prey in rural Zimbabwe; threats of competition and disease to large wild carnivores. *Biological Conservation*, 115: 369-378.

Choden K (2006). Dawa: The story of stray dog in Bhutan. KMT Press, Thimphu Thimphu.

Choki K (2009). Chapter on animal cruelty closed. Kuensel, Thimphu, Bhutan.

Cleaveland S, Mlengeya T, Kaare M, Haydon D, Lembo T, Laurenson MK, and Packer C (2007). The conservation relevance of epidemiological research into carnivore viral diseases in the Serengeti. *Conservation Biology*, 21: 612-622.

Clutton-Brock J (Ed) (1995). Origins of the dog: domestication and early history Cambridge University Press.

Coppinger R and Schneider R (Eds) (1995). Evolution of working dogs. Cambridge University Press.

DOL (2006). Livestock statistics 2005. Department of Livestock, Ministry of Agriculture and Forests, Bhutan.

DOL/HSI (2009). Long tem dog population and rabies control project document. Department of Livestock and Humane Society International, Thimphu.

Dorji P (2008). Translocation of dogs. District Livestock Office, Chukha, Bhutan.

Gyelmo D (2011). Dog bite numbers go through the roof. Kuensel, Thimphu, Bhutan. Kuensel Corporation Limited, Thimphu, Bhutan.

HSI (2010). Street dogs in Bhutan.

ICAMC (2007). Humane Dog Population Management Guidance. International Companion Animal Coalition, 24.

Jangsa, 2008a. Brigitte Bardot Foundation and Jangsa Animal Saving Trust operates emergency rescue of stray dogs in the capital of Bhutan (Thimphu)

Jangsa (2008b). How to save lives of other living beings. Thimphu.

Karuna (2008). Karuna House Programme. Tashigang.

Knierim T (2012). Introduction to Buddhism.

Manor R and Saltz D (2003). The impact of free-roaming dogs on gazelle kid/ female ratio in a fragmented area. *Biological Conservation*, 119: 231-236.

Murray R and Penridge H (1992). Dogs in the urban environment - A Handbook of Municipal Management Chiron Media Mackay.

NAH (2012). Owned dogs in Thimphu National Animal Hospital, Chubachu, Thimphu.

NCAH (2003). National Rabies Control Programme - Operational strategy. National Centre for Animal Health, Department of Livestock, Ministry of Agriculture, Royal Government of Bhutan.

NCAH (2006). A policy and operational strategy: Guidelines for prevention and control of rabies in Bhutan and emergency preparedness plan National Centre for Animal Health, Department of Livestock, Thimphu.

NCAH (2007). WHO Project on Rabies Prevention and Control in Bhutan. National Centre for Animal Health, Department of Livestock, Mnistry of Agriculture, Royal Government of Bhutan, Thimphu.

OIE (2010). Terrestrial Animal Health Code Chapter 7.7 : Stray dog population control. World Organization for Animal Health (OIE), Paris, France.

Pelden S (2011). Collateral damage of increased traffic. Kuensel, Thimphu, Bhutan.

Rinpoche S (1993). The Tibetan Book on Living and Dying. Harper Collins Publishers UK.

Rinzin K (2006). Influence of Bhutanese lifestyles on the occurence of zoonoses. National Centre for Animal Health, Thimphu.

Rinzin K (2007). The Epidemiology of Free-Roaming Dog and Cat in the Wellington Region of New Zealand. EpiCentre, Institute of Veterinary, Animal and Biomedical Sciences. Massey University, Palmerston North, 105

Rinzin K (2009). Population estimation of free roaming dog in Thimphu municipal area. National Centre for Animal Health, Thimphu.

Rinzin K (2015). Population dynamics and health status of free-roaming dogs in Bhutan. College of Veterinary Medicine Murdoch University, Perth, 268.

Rinzin K, Tenzin T, JTebje-Kelly JBU, Tshering P, and Stevenson MA (2006). Descriptive spatial and temporal epidemiology of rabies in Bhutan In, 11th International Symposium on Veterinary Epidemiology and Economics (ISVEE) conference, Cairns, Queensland, Australia

Rinzin K, Tenzin T, and Robertson ID (2016). Size and demography pattern of the domestic dog population in Bhutan: Implications for dog population management and disease control. *Preventive Veterinary Medicine*, 126: 39-47.

Robinson D (1974). Dog Nuisance vs Dog Control. Journal of American Veterinary Medical Association 165.

RSPCA (1999). Royal Society forthe Protection and Care of Animals

Savolainen P (2007). Domestication of dogs. In: Jensen, P. (Ed.), The Behaviour Biology of Dogs Cromwell Press.

Stafford K (Ed.) (2006). The Domestication, Behaviour and Use of Dogs. Springer Dordrecht.

TCB (2010). Bhutan tourism monitor: Annual report 2009. Tourism Council of Bhutan, Royal Government of Bhutan, Thimphu.

TCB (2011). Bhutan tourism monitor: Annual report 2010. Tourism Council of Bhutan, Royal Government of Bhutan, Thimphu.

Tenzin, Sharma, B., Dhand, N.K., Timsina, N., Ward, M.P., 2010a. Reemergence of Rabies in Chhukha District, Bhutan, 2008. Emerging Infectious Diseases 16, 1925-1930.

Tenzin T, Dhand NK, Dorjee J, and Ward MP (2011a). Re-emergence of rabies in dogs and other domestic animals in eastern Bhutan, 2005-2007. *Epidemiology and Infection*, 139: 220-225.

Tenzin T, Dhand NK, Gyeltshen T, Firestone S, Zangmo C, Dema C, Gyeltshen R, Ward MP (2011b). Dog bites in humans and estimating human rabies mortality in rabies endemic areas of Bhutan. PLoS neglected tropical diseases 5, e1391.

Tenzin T, Dhand, NK, Ward MP (2011c). Human rabies post exposure prophylaxis in Bhutan, 2005-2008: *Trends and risk factors. Vaccine*, 29: 4094-4101.

Tenzin T, Dhand NK, Ward MP (2011d). Patterns of Rabies Occurrence in Bhutan between 1996 and 2009. *Zoonoses and public health*, 58: 463-471.

Tenzin T, Sharma B, Dhand NK, Timsina N, and Ward MP (2010b). Reemergence of Rabies in Chhukha District, Bhutan, 2008. *Emerging Infectious Diseases*, 16: 1925-1930.

Tenzin T, Wacharapluesadee S, Denduangboripant J, Dhand NK, Dorji R, Tshering D, Rinzin K, Raika V, Dahal N, and Ward MP (2011e). Rabies virus strains circulating in Bhutan: implications for control. *Epidemiology and Infection*, 139: 1457-1462.

Tenzin, Sharma B, Dhand NK, Timsina N, and Ward MP (2010). Reemergence of Rabies in Chhukha District,

Bhutan, 2008. *Emerging Infectious Diseases*, 16: www.cdc.gov/eid

Tshering C (2007). Translocation of dogs. District Livestock Office, Mongar, Bhutan.

UNDP (2008). Grappling with Stray Dog Problem in Bhutan - Advice; Experiences. United Nations Development Programme Thimphu, 15.

Wangmo S (2010). The Stray Dog Dillema of Bhutan. New York.

WHO (2004). WHO Expert Consultation on Rabies World Health Organization, 931, Geneva.

WHO/WSPA (1990). Guidelines for dog population management In: Bogel, K. (Ed.) World Health Organization and World Society for Protection of Animals Geneva, Switzerland.