

การพัฒนาสภาวะทางร่างกาย และรูปแบบกิจกรรมของวัวแดง (*Bos javanicus* d'Alton, 1823)

หลังการปล่อยคืนสู่ธรรมชาติ ในเขตรักษาพันธุ์สัตว์ป่าสลักพระ จังหวัดกาญจนบุรี

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บทคัดย่อ : การติดตามสัตว์ป่าที่ปล่อยคืนสู่ธรรมชาติมีความสำคัญต่อการอนุรักษ์ชนิดพันธุ์ที่สูญพันธุ์ไปจากพื้นที่ การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อติดตามสภาวะทางร่างกาย และรูปแบบกิจกรรมของวัวแดง (*Bos javanicus* d'Alton, 1823) ภายหลังจากปล่อยคืนสู่ธรรมชาติในเขตรักษาพันธุ์สัตว์ป่าสลักพระ จังหวัดกาญจนบุรี โดยใช้ข้อมูลการตั้งกล้องดักถ่ายภาพสัตว์ป่า ระหว่างเดือนกุมภาพันธ์ 2557 ถึงพฤศจิกายน 2560 โดยได้ภาพถ่ายวัวแดงจำนวน 1,879 ภาพ จากการตั้งกล้อง 4,602 คืน เมื่อนำมาวิเคราะห์และให้คะแนนสภาวะด้านร่างกาย (Body Condition Scoring) ของวัวแดงแต่ละตัว พบว่าวัวแดงมีคะแนนอยู่ในช่วง 2 ถึง 5 คะแนน โดยตัวเต็มวัยเพศผู้มีแนวโน้มเพิ่มขึ้นอย่างต่อเนื่องในปีที่ 1 ถึงปีที่ 3 ขณะที่ตัวเต็มวัยเพศเมียมีคะแนนคงที่ในสองปีแรกและเพิ่มขึ้นในปีที่ 3 รูปแบบกิจกรรมของวัวแดงมีการเปลี่ยนแปลงไปในแต่ละปี ในภาพรวม พบว่าวัวแดงมีการเคลื่อนที่มากในตอนเย็น ช่วงเวลา 17:01 น. ถึง 18:00 น. รองลงมาคือตอนบ่าย ช่วงเวลา 14:01 ถึง 16:00 น. คะแนนสภาวะทางร่างกายที่เพิ่มขึ้นแสดงให้เห็นถึงแนวโน้มการปรับตัวที่ดีภายหลังการปล่อยสัตว์คืนสู่ธรรมชาติ และสามารถเพิ่มจำนวนประชากรจากเดิมที่ปล่อย 7 ตัว เป็น 9 ตัว ขณะเดียวการปรับเปลี่ยนรูปแบบกิจกรรมของวัวแดงในแต่ละปีแสดงให้เห็นถึงการปรับตัวให้เข้ากับสิ่งแวดล้อม อย่างไรก็ตาม ควรมีการศึกษาเพิ่มเติมเกี่ยวกับการใช้ประโยชน์พื้นที่อาศัยและความสามารถในการรองรับของพื้นที่ในเขตรักษาพันธุ์สัตว์ป่าสลักพระ เพื่อเป็นแนวทางในการจัดการประชากรและพื้นที่อาศัยของวัวแดงในอนาคต

คำสำคัญ : การปล่อยสัตว์ป่าคืนสู่ธรรมชาติ, วัวแดง, คะแนนสภาวะทางร่างกาย, รูปแบบกิจกรรม, การปรับตัว

Body condition, and activity pattern of banteng (*Bos javanicus* d'Alton, 1823) after reintroduction in Salakphra Wildlife Sanctuary, Kanchanaburi province

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Abstract : Wildlife monitoring after reintroduction is important to program implementing and improving in the appropriated way. This research is aim to study the body condition, and activity pattern of banteng (*Bos javanicus* d'Alton, 1823) after reintroduction in Salakphra Wildlife Sanctuary, Kanchanaburi province. By camera trapping between January 2015 and November 2017, total 1,879 banteng photographs which accumulated in 4,602 traps-nights were obtained. The banteng's body condition scoring (BCS) was analyzed in individual banteng. We found that the BCS of banteng range between 2 and 5. Adult males group was gradually increased between 1st and 3rd, while adult females group was maintain during two years then step up in 3rd year. The results show fluctuated activity pattern of the banteng. Most activities were found during early evening between 17:01 and 18:00 and afternoon between 14:01 and 16:00, respectively. Improvements of body condition reflect that banteng population trend to increase. After releasing, they are able to increase their population from 7 to 9 individuals in three year later. Meanwhile, their fluctuated activity patterns reflect their responding to the environment. However, habitat utilization of the banteng and carrying capacity of Salakphra Wildlife Sanctuary area also required for guideline habitat and population management in the future.

Keywords : wildlife reintroduction, banteng (*Bos javanicus*), body condition scoring, adaptation, conservation

Introduction

Banteng (*Bos javanicus* d'Alton, 1823) is endangered wild cattle (IUCN 2018). Although banteng is protected under the Reserved and Protected Animal Act B.C. 2535 of Thailand, it remains threatened by hunting and habitat fragmentation in Thailand (Bhumpakphan and McShea 2011). For this reasons, the first officially world reintroduction of banteng was began at Salakphra Wildlife Sanctuary by many stakeholders since 2014. Not only survival, but population self-sustainable after reintroduction is also expected by this program. Hence, monitoring phrase would be progress as how the animal can adapt to the new habitat and how they were responded to natural environment.

The body condition scoring system (BCS) has been applied to the animal visual observations to indicate their health status and reproductive ability (Wemmer 2006; Ezenwa 2009; Soares and Dryden 2011; Prosser et al. 2016). Not only inform about the animal nutrition obtained which population growth factors (Marshal 2008), but BCS explain to their age and mortality (Choquenot 1991; Caslini 2012; Bérubé 2014). The improvement of body condition is related to growth status and fitness of the animal in their habitat (Ezenwa 2009; Soares and Dryden 2011). The body condition score of animal population should implement an information about their responding to the environment (Cook et al. 2004; Bergman et al. 2014), in addition to options for management (Fernando et al. 2009).

In general, banteng was diurnal with periods of feeding alternating with rest periods. Their activity peaks at early morning between hours 5:00 and 7:00 found as foraging and socializing. In mid-morning to early afternoon,

the activity was decreased when they rest and ruminant. The next activities peaks occur at dusk during foraging and socializing again. Then decreases around 20:00–21:00 and increases again at 3:00–4:00 for unknown reasons (Gardner 2014). Phan and Grey (2010) found that the highest percentage of Cambodian banteng encounter show between 18:00–20:00 and two secondary peaks show during 21:00–22:00 and 1:00–3:00. However, wild banteng was found as the significant effect by the impact of human disturbance (Gardner 2014; Gardner et al. 2016). They were found that become rather nocturnal and mostly move in open areas only at night when disturbed by human presence (Halder 1976).

Salakphra Wildlife Sanctuary is one of banteng's habitat before their extirpation over 10 years ago. Supported by unite team; the first official world reintroduction of banteng occurred at November 15, 2014. By soft release technique, four captive-bred individuals trained in the holding captivity at Khao Naumphu Nature and Wildlife Education Center, were translocated to enclosure cage before released into Salakphra Wildlife Sanctuary. After that, three individuals were augmented at July 19, 2016. This research aims to study the body condition and activities pattern of the reintroduced banteng in Salakphra Wildlife Sanctuary by using camera trapping data. This would be benefit to implementing and improving database for the reintroduction program in part of population and habitat management. Furthermore, this research would be an example for future research to monitoring reintroduction program in others sites.

Study site

The field observation was established in Salakphra Wildlife Sanctuary area (14° 8' 37.09" N, 99° 20' 33.514"E) The average of ambient temperature is recorded at 28°C, while relative humidity is recorded between 57 and 79%. The annual precipitation average around 1,071 mm. Approximately 858.55 km² of Salakphra Wildlife Sanctuary consist multi-paths of habitats such as mixed deciduous forest (66.51%), dry evergreen forest (7.48%), and dry deciduous dipterocarp forest (7.17%) (Division of Information System on Wildlife Conservation 2010). At least 352 wildlife species, 59 species of mammal, are living in Salakphra Wildlife Sanctuary (Salakphra Wildlife Sanctuary 2011).

Material and Methods

The reintroduced banteng and their offspring

Banteng is sexually dimorphic in both color and size. Bulls' pelage varies from the chestnut to rusty brown color, while cows and calves have chestnut color coat. Both sexed shared many morphological characteristics such as true horns, a large white patch on the buttocks and white stocking on their lower legs. Adult male weights are between 600 and 800 kg, while adult female is in range of 590–670 kg (Gardner et al. 2014). Seven captive-bred banteng, four adult males and three adult females age between 5 to 7 years-old, were trained for habitual to the transportation boxes before translocation into the enclosure cage. In captivity holding, the captive-bred banteng was feed by wild species alternated with domesticated plants. The water holes and artificial saltlick boxes were provided for their supplement. The weight of individuals was recorded before releasing in ranges 450–500 kg and 300–350

for adult male and adult females, respectively. The first group containing two adult males and two adult females were released into the wild during dry season, while the second group including two adult males and an adult female were released during wet season. Two calves were found by tracks and camera traps captured in two years after the first group released.

Camera-trapping

Camera traps stations were installed in different locations based on tracks and signs of the banteng where nearby animal trails, water sources, and saltlicks. The appropriate trees which girth about 15 cm and provide a clearly view of photographs were chose for camera traps mounting at approximately 50 cm above the ground followed suggestion for large mammal species (Suzuki et al. 2017). The positions of all camera trap station were recorded by GPS tools. All camera traps were set to capture the animals while their moving by low sensitivity, 1 second delay, and night time flash with automatically stamped the date and time. Each camera trap was checked for functioning include to batteries and memory cards changing every 45 days. All photographs were obtained during January 2015 to November 2017 by the Department of National Park, Wildlife and Plant Conservation of Thailand permission.

Body condition scoring

Each banteng's photograph was categorized to individual profiles by obvious morphological characteristics such as scars, curve of horns and forehead, and collars. The images' brightness and contrast were adjusted to clarify the seven part of banteng's body namely neck, dewlap, shoulder, ribs, vertebrae, hindquarter, and tail head for scoring. The body condition score criteria of the reintroduced banteng was developed from the scoring index of Bornean banteng and Bali cattle (Prosser et al. 2017; Soares and Dryden 2011). The 5-point pictorial scoring was used to score the seven body parts of banteng according to Table 1. Each individual captured was selected for body condition scoring separate by year. All BCS of individuals were analyzed into boxplot separated by sex group. Difference of BCS between groups was test by Wilcoxon Signed Ranks test which used for two-related samples.

Activity pattern

The activity pattern recorded by banteng's presence on photo captured. Date and time of all banteng's photographs were recorded into their active periods in each hour. Then the frequency of banteng's captured were plot into the graph by percentage.

Result and Discussion

The 1,879 photographs of 191,748 photographs by 12 camera trap stations (Figure 1) during 4,602 trap-nights were identified as banteng's captured. Nine individuals of banteng which found in this study were identified by camera captured is shown in Figure 2. Total 43 banteng's photographs of were used for individuals body condition score. The body condition levels of individual banteng each year is shown in Figure 2. Both sexes show the graduals increased BCS after reintroduction. Compared by groups, the higher score increased during three years

was found in adult males group (Figure 3). While the BCS of adult females group was found as maintain during two years and increased in 3rd year. BCS of adult males group was significantly higher than adult females group (Wilcoxon test, $p < 0.05$).

The 1,548, 231 and 100 photographs of banteng were captured in 1st, 2nd, 3rd year, respectively. The active period including foraging, moving, and socializing were found in field of view of photographs. The results of banteng captured separated by year show their fluctuate pattern (Figure 4). In daytime period, the reintroduced banteng individuals were active both day and night time. The less fixed rhythm of their daily activity alternate between active and resting periods vary from 1 to 3 hours interval. The 1st year captured shows that the highest and secondary peak of banteng activity occurred during early evening between 17:01 and 18:00 and afternoon between 14:01 and 16:00, respectively. Then the patterns were change in 2st and 3rd year with lower percentage of detection. Their active periods were early morning (5:01-8:00), midday (11:01-13:00), and late afternoon (14:01-17:00) in two years after.

Conclusion

Increasing of BCS indicate that the banteng able to improve their body in part of soft tissue and fat which covered the skeleton prominent. High score ranking of males group reflects that their dominant feature. High level of testosterone effect on anatomy features of mature male banteng, such as larger size, rapid bulk up, and aggressive behavior may influent to BCS score especially during mating period (Hinch and Thwaites 1984). Meanwhile, slower body growing in females group may assume that relate to reproduction such as pregnancy and postpartum period. The individual identification of the nine reintroduced banteng provided important data for next step of photographs analysis, the precision of individual identification by camera trapping depend on either quantity or quality of photographs though. In this case, a short series of photographs of each individuals would be implemented by future capturing of the same individual for improve their profile. However, the individuals of the reintroduced banteng features should be recorded and captured both before and after reintroduction for their initial profiles.

Less captured of banteng during day time was hypothesized that they disappear when entering into canopy for avoiding hot temperatures likely to the natural population in other population (Pudyatmoko 2005; Gardner et al. 2018). Rumination process maintaining and energy saving are hypothesized to reasons of their resting time similar to others large herbivores (Santiapillai et al. 1984; Katugaha et al. 1999; Soriani et al. 2013). Nevertheless, their altered patterns may effect by reproduction period that seen of two calves in two years after.

In summary, this study demonstrated the responding of banteng after reintroduction into Salakphra Wildlife Sanctuary throughout their body condition and activity pattern. An upward trend increasing of banteng is the evidence to support that the banteng able to growth and reproduction in their new habitat after reintroduction. Their flexibility pattern of activity show ability of environment responding. Our findings would be databased for the program implementing and others program guideline. As a monitoring phrase, body condition score would inform the managers to decide that more or less animal should be released in the next periods. Responding to the

environment of banteng exposed to their habitat quality, as far as the ecological function provided for banteng population would point to habitat management for banteng population.

Recommendation : Habitat utilization and carrying capacity in Salakphra Wildlife Sanctuary should be further research to provide the appropriate plan of reintroduction program such as the number of the animal to release, the alternate site for releasing, and supplement allocation such as artificial water sources and saltlicks. Broader information about their forage species and habitat structure should be the study for detail their resource supply of Salakphra Wildlife Sanctuary. Moreover, continue monitoring also required for adaptive management of reintroduction program in long-term period.

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References

- Bergman, E. J., Doherty Jr, P. F., Bishop, C. J., Wolfe, L. L., and Banulis, B. A. 2014. Herbivore body condition response in altered environments: mule deer and habitat management. *PloS one* 9(9) e106374.
- Bérubé, C. H, Festa-Bianchet, M., and Jorgenson, J. T. 2014. Individual differences, longevity, and reproductive senescence in bighorn ewes. *Ecology* 80(1) 2555–2565.
- Bhumpakphan, N. and McShea, W. J. 2011. Ecology of Gaur and Banteng in the Seasonally Dry Forest of Thailand. In: McShea, W. J., Davies, S. J., and Bhumpakphan, N., editors. *The Ecology and Conservation of Seasonally Dry Forests in Asia*. Smithsonian Institution Scholarly Press. Washington, D.C.
- Caslini, C. 2012. *Wild Red Deer (Cervus elaphus, Linnaeus, 1758) Populations Status Assessment: Novel Methods using Hair*. PhD. Università Degli Studi di Milano, Milan.
- Choquenot, D. 1991. Density-dependent growth, body condition, and demography in feral donkeys: testing the food hypothesis. *Ecology* 72(12) 805–813.
- Cook, J. G., Johnson, B. K., Cook, R. C., Riggs, R. A., Delcurto, T. I. M., Bryant, L. D., and Irwin, L. L. 2004. Effects of summer-autumn nutrition and parturition date on reproduction and survival of elk. *Wildlife Monographs* 155(1) 1-61.
- Division of Information System on Wildlife Conservation. 2010. Forest type map of Salakphra Wildlife Sanctuary, Kanchanaburi province. [Map].
- Ezenwa, V. O., Jolles, A. E., and O'Brien, M. P. 2009. A reliable body condition scoring technique for estimating condition in African buffalo. *African Journal of Ecology* 47(4) 476–481.
- Fernando, P., Janaka, H., Ekanayaka, S. K., Nishantha, H., and Pastorini, J. 2009. A simple method for assessing elephant body condition. *Gajah* 31(1) 29–31.
- Gardner, P. C., Goossens, B., Wern, J. G. E., Kretzschmar, P., Bohm, T., and Vaughan, I. P. 2018. Spatial and temporal behavioural responses of wild cattle to tropical forest degradation. *PloS one* 13(4) e0195444.

- Gardner, P. C., Hedges, S., Pudyatmoko, S., Gray, T. N. E., and Timmins, R. J. 2016. *Bos javanicus*. The IUCN Red List of Threatened Species 2016: e.T2888A46362970. <http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T2888A46362970.en> Downloaded on May 25, 2018.
- Gardner, P. C., Pudyatmoko, S., Bhumpakphan, N., Yindee, M., Laurentius, D., Ambu, N., and Goossens, B. 2014. Species accounts-Javan banteng. In: Melletti, M. and Burton, J., editors. Ecology, evolution and behaviour of wild cattle: implications for conservation. Cambridge, UK: Cambridge University Press.
- Halder, U. 1976. Ökologie und Verhalten des Banteng *Bos javanicus* in Java. Eine Feldstudie: Hamburg, Verlag Paul Parey.
- Hinch, G. N. and Thwaites, C. J., editors. 1984. The growth rates of bulls and steers under grazing conditions in different seasons and years. Australian Society of Animal Production 15(1) 392–394.
- IUCN. 2018. *Bos javanicus*. Retrieved August 7, 2018, from website: <http://www.iucnredlist.org/details/2888/0>
- Katugaha, H. I. E., de Silva, M., and Santiapillai, C. 1999. A long-term study on the dynamics of the elephant (*Elephas maximus*) population in Ruhuna National Park, Sri Lanka. Biological Conservation 89(1): 51–59.
- Marshal, J. P., Krausman, P. R., and Bleich, V. C. 2008. Body condition of mule deer in the Sonoran Desert is related to rainfall. The Southwestern Naturalist 53(1) 311–318.
- Phan, C., and Gray, T. N. 2010. Ecology and natural history of banteng in eastern Cambodia: evidence from camera-trapping in Monduliri Protected Forest and Phnom Prich Wildlife Sanctuary. Cambodian Journal of Natural History 2(2) 118–126.
- Prosser, N. S., Gardner, P. C., Smith, J. A., Wern, J. G. E., Ambu, L. N., and Goossens, B. 2016. Body condition scoring of Bornean banteng in logged forests. BMC Zoology 1(1) 8.
- Pudyatmoko, S. 2005. Freilanduntersuchungen zur Ökologie und Habitatnutzung wildlebender Bantengrinder (*Bos javanicus* d'Alton 1823) im Baluran-Nationalpark in Ostjava, Indonesien: Cuvillier Verlag.
- Salakphra Wildlife Sanctuary. 2011. Master plan of Salakphra Wildlife Sanctuary, Kanchanaburi Province. Areas Regional Office 3 (Ban Pong): Department of National Park, Thailand p. 2554–2558.
- Santiapillai, C., Chambers, M. R., and Ishwaran, N. 1984. Aspects of the ecology of the Asian elephant *Elephas maximus* L. in the Ruhuna National Park, Sri Lanka. Biological conservation 29(1) 47–61.
- Soares, F., and Dryden, G. M. 2011. A body condition scoring system for Bali cattle. Asian-Australasian Journal of Animal Sciences 24(11) 1587–1594.
- Soriani, N., Panella, G., and Calmari, L. 2013. Rumination time during the summer season and its relationships with metabolic conditions and milk production. Journal Dairy Science 96(1) 5081–5094.
- Suzuki, A., Thong, S., Tan, S., and Iwata, A. 2017. Camera trapping of large mammals in Chhep Wildlife Sanctuary, Northern Cambodia. Cambodian Journal of Natural History p. 63–75.
- Wemmer, C., Krishnamurthy, V., Shrestha, S., Hayek, L. A., Thant, M., and Nanjappa, K. A. 2006. Assessment of body condition in Asian elephants (*Elephas maximus*). Zoo Biology 25(1) 187–200.

Table 1 The scoring criteria for seven body composition of the banteng developed from Prosser et al. (2016) and Soares and Dryden (2011) and illustration of each score.

Body composition	Body condition scoring system (BCS)				
	1	2	3	4	5
Neck	Very flat	Starting to round appearance	Slightly rounded	Rounded	Full and rounded
Dewlap	Non-existent	Present but very small	Present	Present with fat apparent	Full of fat, A large flap of skin
Shoulders	The shoulder bones are prominent	Covered with soft tissue in some part	Almost covered with soft tissue	Well covered with soft tissue	The shoulders and forequarters are very well covered with soft tissue
Vertebrae	Prominent all along backbone	Easily to seen	Visible with some tissue covered	Covered with soft tissue, but the shadows can be seen	Not visible, and covered with soft tissue
Ribs	Very prominent	Easily to seen but covered by some tissue	Can be seen but covered by soft tissue	Rarely visible	Not visible
Hindquarters	The top is flat while pins and hooks may be prominent hollow or dishd	The top is flat with obvious hooks and pins	The top is flat or slightly rounded but hooks still visible	The top is flat or slightly rounded	The top is rounded, the hook may slightly visible but flushed with tissue, and hind legs below are very full
Tail head	Very flat	Flat	Slightly rounded	Rounded	Rounded and has small mounds of soft tissue
					

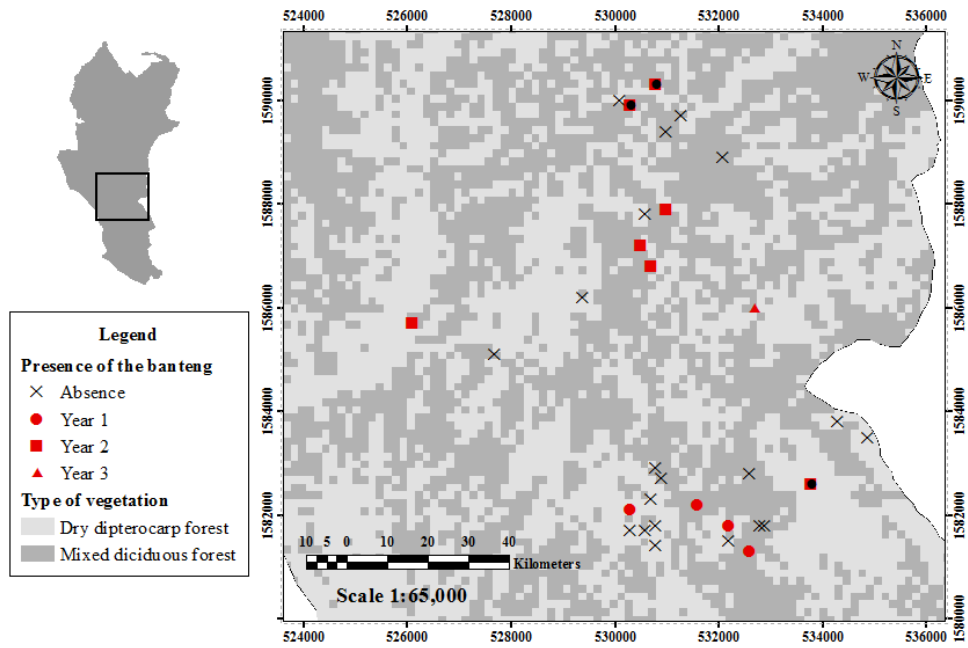


Figure 1 Presence of the banteng after reintroduction at 12 camera trap stations separate by year: the map of Salakpra Wildlife Sanctuary comprising two types of forest; dry dipterocarp deciduous forest and mixed deciduous forest.

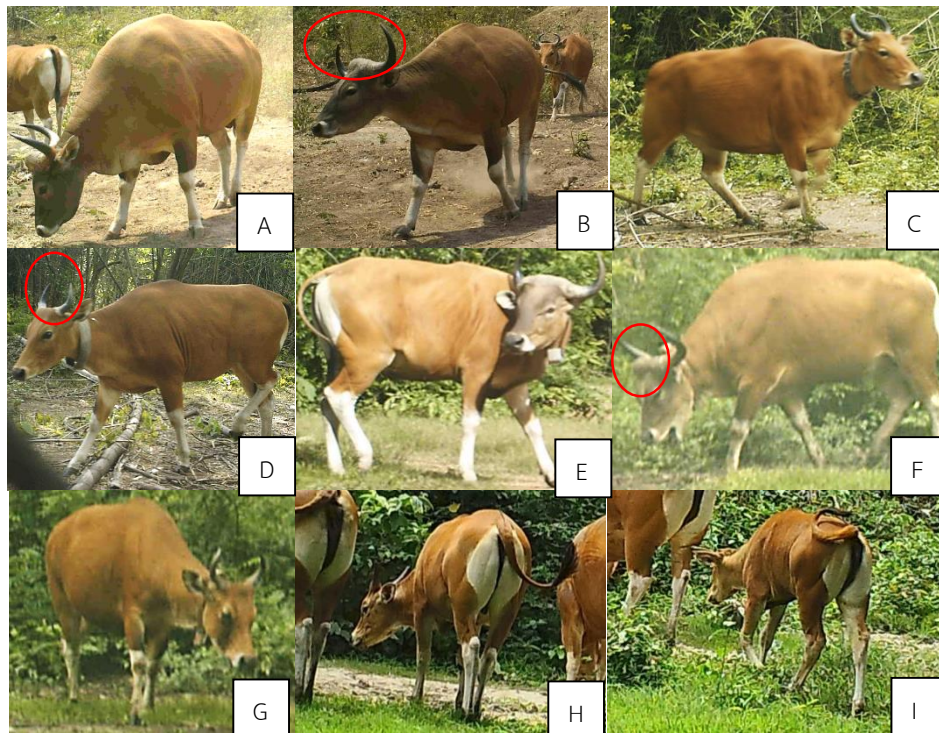
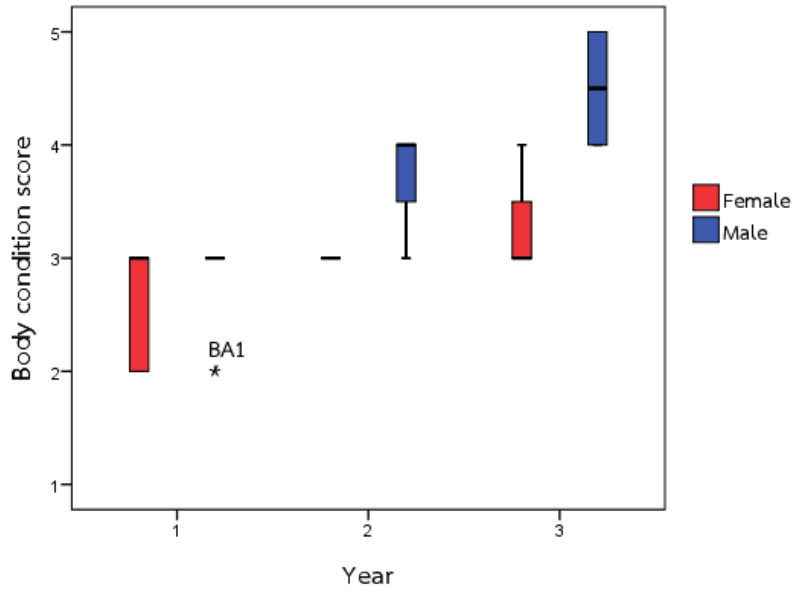


Figure 2 Photographs of individual banteng which captured by camera trapping in Salakpra Wildlife Sanctuary; A–D: the first group released, E–G: the second group released, I–H: wild born calves; red circles show as identity of individuals banteng such as curve of horns and forehead.



* BA1 = an individual score of male which significantly different from male group

Figure 3 The body condition scores (BCS) of the individuals banteng (BA1-BA9) in Salakphra Wildlife Sanctuary between 1st year (2015) to 3rd year (2017) after reintroduction.

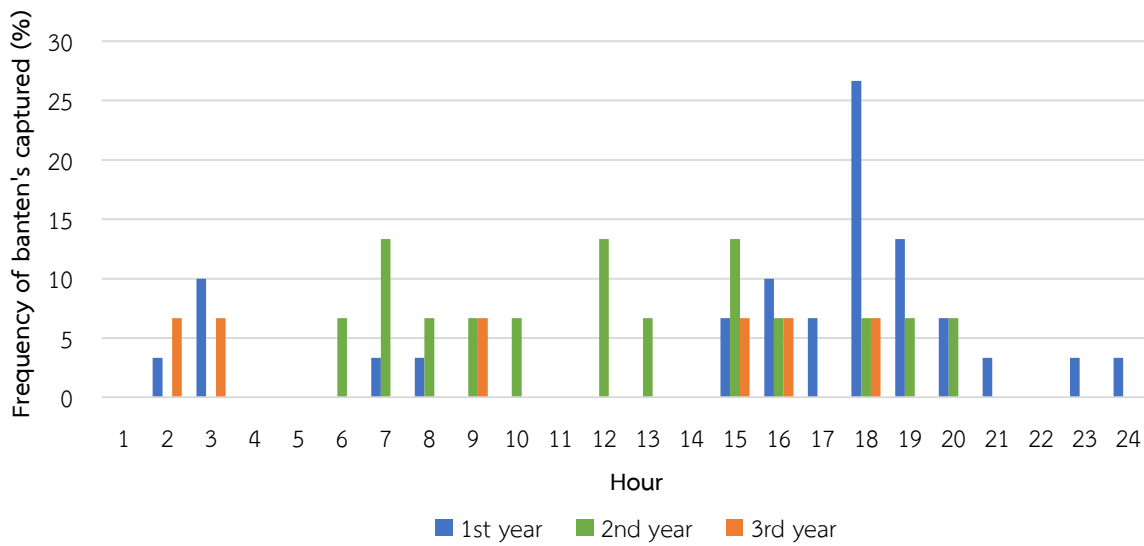


Figure 4 Activity pattern of the banteng recorded from camera traps captured during 1st year to 3rd year after reintroduction in Salakphra Wildlife Sanctuary.