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Original article

Reproduction record of captive Sumatera elephant (*Elephas maximus sumatranus*) at Way Kambas National Park, Indonesia

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ABSTRACT

This research aims to determine reproductive data on Sumatran elephants (*Elephas maximus sumatranus*) in the ETC and ERU of Way Kambas National Park, Indonesia during 1988-2021. Data recorded from the elephant population at both locations (ETC and ERU) includes the number, gender of elephants, elephant calves, ages and birth dates. Calving intervals and service periods were calculated from calving records of cows with a minimum parity of two. Data collection produced data on 47 elephant calves from 13 female elephants with at least twice the parity and 12 primiparous cows. Elephant reproductive records at ETC and ERU were: age (37.44 ± 9.03 vs. 29.75 ± 3.30 years), parity (2.78 ± 1.09 vs. 2.50 ± 0.58), and age at first birth (18, 11 ± 3.92 vs. 17.75 ± 0.50 years). While the calving interval was 1857.56 ± 870.81 vs. 1833.00 ± 305.18 days, and service period respectively 1229.44 ± 846.18 vs. 1210.50 ± 283.59 days, respectively. It can be concluded that the calving interval and service period for captive elephants at ETC and ERU were not much different and were within the normal range. Young cows showed better reproductive efficiency than older cows. Monitoring calves is very important. Further assistance is needed to improve elephant mobile veterinary services, increase diagnostic laboratory capacity, and educate camp managers, veterinary assistants, and mahouts about elephant diseases, their monitoring and treatment. In addition, the use of reproductive technology such as monitoring ovulation using ultrasound and carrying out artificial insemination was expected to increase reproductive efficiency.

Keywords: calving interval, elephant response unit, elephant training center, reproductive records, service period

INTRODUCTION

The Sumatran elephant (*Elephas maximus sumatranus*) is a protected animal that is included in the International Union for Conservation of Nature's red list (Williams *et al*., 2020). Elephant reproduction is unique; on average, a female elephant will be pregnant for 20-23 months to calve an elephant weighing 90-120 kg (Brown, 2018). The feces of elephants

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functioned as fertilizer and helped spread plants in the forest. Good forest conditions can be supported by good animal life (Ong *et al*., 2023). Human-elephant conflict occurs as elephant habitat decreases due to the replacement by agricultural land and settlements. This is followed by a decline in the elephant population in the wild. It was estimated that the Sumatran elephant population had decreased from 2,400-2,800 in 2007 to 1,600-2,000 in 2017 (Directorate General of Ecosystem Natural Resources Conservation, 2020).

The Way Kambas Forest area was designated as a protected forest area and elephant training center in 1924 and inaugurated as Way Kambas National Park (WKNP) in 1985 (Wijayanti, 2018). This nature reserve is located in the lowlands covering an area of 1,300 km^2, and is one of Indonesia's Elephant Conservation Centers (ECC). Geographically, WKNP is located between 40°37' - 50°16' South Latitude and between 105°33' - 105°54' East Longitude in the southeastern part of Sumatra island, Lampung province (Rifanz, 2017). In the Way Kambas area, there is also an elephant hospital (EH) of Prof. Dr. Ir. H. Rubini Atmawidjaya, which is the first EH in Indonesia and Southeast Asia. This EH was founded with grant funds from the world conservation organization Australian Zoo together with Taman Safari Indonesia. Since it was founded in 2012 until now, EH has served animals, especially sick elephants, victims of disasters or conflicts. EH serves captive elephants at the Elephant Training Center (ETC) and Elephant Response Unit (ERU) (Islami *et al*., 2016). ETC is a sanctuary for elephants rescued from conflict, where they were trained. Additionally, in this place the elephants breed naturally. Meanwhile, ERU is an elephant training center to help drive away herds of wild elephants that enter the country site so they can return to the forest (Oelrichs *et al*., 2016).

Captive Sumatran elephants in the WKNP are still mated naturally. Data on elephant reproduction in the ETC and ERU areas only recorded calving dates. The system of foraging from morning to evening makes it possible for wild male elephants to mate with ETC female elephants. A cow at ETC named Bunga contributed five Sumatran elephant calves to the population during 1999-2019 (Salsabila *et al*, 2017). There are no records regarding the reproductive efficiency of elephants. Therefore, this study aims to determine the calving interval and service period of Sumatran elephants (*Elephas maximus sumatranus*) in the ETC and ERU of Way Kambas National Park.

MATERIALS AND METHODS

Study was conducted at ETC and ERU at the National Park Way Kambas ETC. WKNP is located in Labuhan Ratu district, the Lampung Province, Indonesia (Figure 1), latitude -4° 54' 59.99" S, and longitude: 105° 44' 59.99" E and the map scale of WKNP is about 1:25000 km (Latitude, 2023). The landscape covers 125,621.30 ha of swamp and lowland rainforest. In the rainy season, the temperature is 23-30°C, with a humidity of 70-100%; in the dry season, the temperature is 29-35.2°C, with a humidity of 57-94% (MCGC, 2022). Sumatran elephants at ETC and ERU have their own books to record all care and treatment. Data was obtained from elephant recording books at the elephant hospitals and interviews with doctors, paramedics, and mahouts. Data from elephant populations are presented separately based on breeding location (ETC and ERU), age and gender of elephants. Evaluation of calving interval and service period was based on calving records for elephants with a minimum parity of two, with records of the cow's name, mahout's name, birth year, age and calving date. The calving interval and service period of elephants in 1988-2021 in the WKNP were displayed descriptively. Calving Interval is the time interval between the birth of one calf and the subsequent birth of the next calf from the same cow (Muslimiah *et al*., 2023). The service period is the period of time between the date of calving and the date of successful conception (Temesgen *et al*., 2022). Additional data was also recorded regarding the feed and supplements given to the elephants. The collected data was then presented

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to doctors, paramedics, trainers, mahouts, and the Head of Section III, Kuala Penet, for validation.

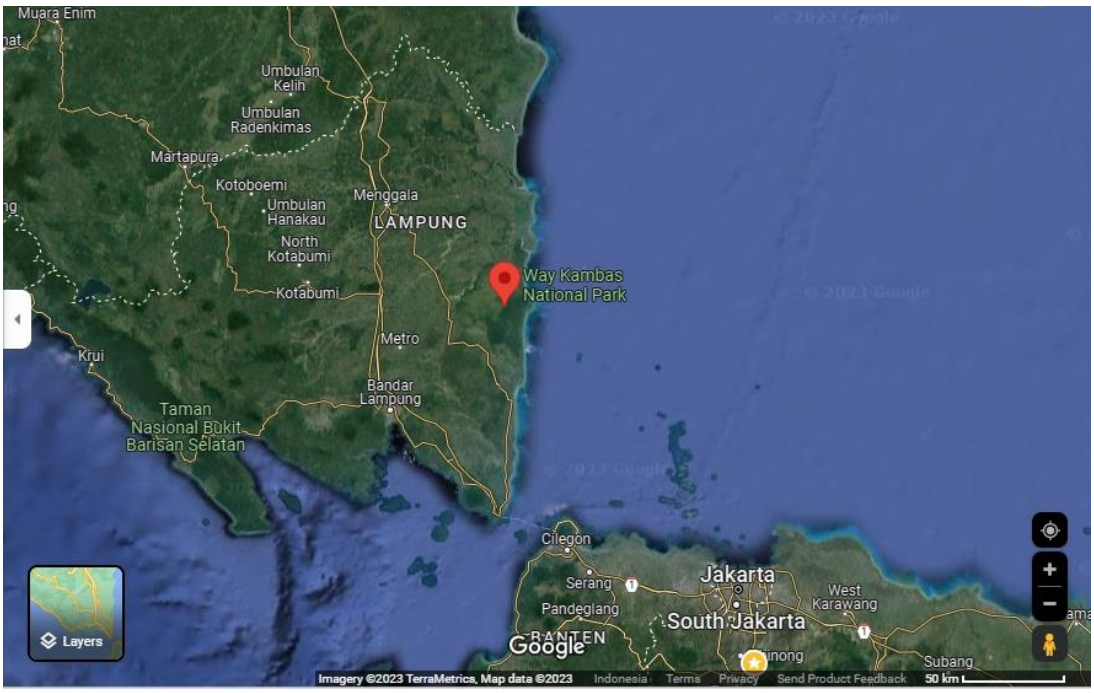

Figure 1 Map of the Way Kambas National Park (WKNP), located in Labuhan Ratu district, the Lampung province, Indonesia. Latitude: -4° 54' 59.99" S; Longitude: 105° 44' 59.99" E (Google Maps, 2023).

RESULTS

The population of Sumatran elephants in ETC and ERU in 2021 totaled 64 individuals consisting of bulls, cows, male and female calves (Table 1). The oldest cow was Umri (born 1967), and the first elephant calving in WKNP in 1988 (Table 2).

Table 1 Number of captive elephants at the Elephant Training Center and Elephant Response Unit in Way Kambas National Park

location	bulls	cows	elephant calves		total
			male	female	
ETC	15	9	8	6	37
ERU	12	6	4	4	27
total	27	15	12	10	64

In WKNP, the first birth occurred in 1988, and until 2021, 25 cows were recorded calved to 47 calves, consisting of 13 cows with a parity of at least two (producing 35 calves) and 12 primiparous cows. Data from the 13 multiparous cows (Table 2) were used to calculate the calving interval and service period. Female elephants calve for the first time at the age of 11-24 years. The average age, parity, and age at first parturition (years) of elephants in ETC and ERU are presented in Table 3. The shortest calving interval for cows in WKNP was three years, and the longest was 12 years. The shortest service period for cows in the WKNP was one year, and the longest was 10 years. The average calving interval was 5.22 years (63 months), and the service period was 3.22 years (39 months), in cows aged 16-40 years. For details, the data is presented in days (Table 4).

Some calving occurred in the 1988-2019 period. However, no calving occurred in 2020-

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2021. Thirteen cows gave birth to 35 calves and 12 cows gave birth to calves for the first time. A total of 47 calves were born in WKNP. Some calves under the age of nine died due to infection with herpes virus (Elephant Endotheliotropic Herpes Virus) infection in 2014. The death of these calves also occurred because they were killed by their mothers who had just given birth for the first time. Currently, the preferred approach is to start treatment before clinical symptoms appear; otherwise, it is usually considered to exceed the optimal time period.

Table 2 Data of WKNP Sumatran cow elephants with a minimum parity of two

	name of cow/handler	year of birth	date of calving
ETC			
1	Kartijah/ Suharno	1981	18 Oct 1994 3 Aug 2001 24 Apr 2009
2	Pleno/ Sugiono	1990	30 Oct 2008 8 Aug 2013 31 May 2017
3	Bunga/ Dwi	1979	19 Feb 1999 16 Jun 2002 7 Jun 2009 15 Feb 2014 28 Mar 2019
4	Mela/ Bakat	1991	1 Mar 2011 16 Jan 2014
5	Meli/ Mujiono	1993	24 May 2013 26 Feb 2019
6	Dona/ Eko	1980	4 Feb 1999 16 Jun 2002 1 Jun 2005 27 Mar 2017
7	Rahmi Hikmah	1994	18 Dec 2012 26 Apr 2015
8	Umri/ transfer	1967	25 Oct 1991 15 Oct 1995
9	Karsi/ transfer	1977	28 Apr 1988 15 May 1993
ERU			
1	Suli/ Supri	1989	7 Sept 2006 2 Feb 2012 29 Jun 2016
2	Dita/ Bahtiar	1993	31 Mei 2011 10 Oct 2016
3	Riska/ Reflianto	1995	13 Apr 2013 20 Mar 2017
4	Gunturia/ Ashadi	1988	21 Nov 2006 31 Jun 2011 21 Oct 2017

Therefore, it is important to monitor all calves regularly. Therefore, further assistance is needed to increase the provision of mobile veterinary services for elephants, increase the quantity and capability of diagnostic laboratory facilities, and educate elephant owners, camp managers, elephant curators, veterinary assistants and mahouts about this disease, its monitoring and treatment methods. Therefore, this will assist in future initiatives aimed at tackling the increasing incidence of fatal acute hemorrhagic disease in Asian elephants and the potential long-term impacts on the reproduction and survival of this critically endangered species. The elephant calves were dominated by 27 male elephant calves compared to 14 female elephant calves (Figure 2).

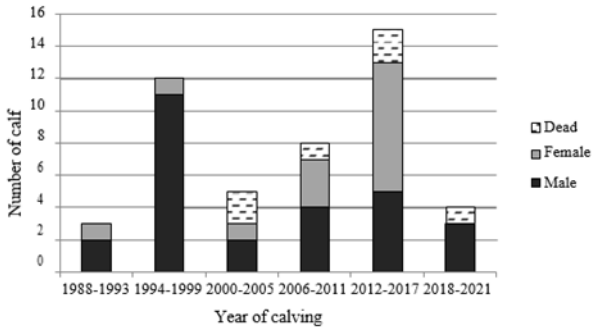

Figure 2 Distribution of elephant calving every six years between 1988-2021.

The food that Sumatran elephants (*Elephas maximus sumatranus*) get when foraging was elephant grass (*Pennisetum purpureum*), deluwak (*Microcos paniculata*), coconut (*Cocos nucifera*) frons, laban (*Vitex pinnata*), pulai (*Alstonia scholaris*), meranti (*Shorea leprosula*), jabon (*Anthocephalus cadamba*), kaliandra (*Calliandra calothyrsus*), merawan (*Hopea*

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odorata Roxb), salam (*Syzygium polyanthum*), bungur (*Lagerstroemia speciosa*), palm (*Livistonia rotundifolia*) leaves, ketapang (*Terminalia catappa*), reeds (*Imperata cylindrica*), swamp grass (*Laticilla cinerascens*), mistletoe (*Viscum album*), putri malu (*Mimosa pudica*), pule (*Alstonia scholaris*) leaves, bamboo (*Bambusa* sp), nulangan grass (*Eleusine indica*) and other wild plants. There was no feed difference between ETC and ERU elephants; it was just that in the ERU area, there was more hay because it was close to settlements. Sumatran elephants (*Elephas maximus sumatranus*) also received corn (*Zea mays*) leaves, soybeans (*Glycine max*), green beans (*Phaseolus vulgaris*), rice (*Oryza sativa*), brown sugar, and bran as supplements.

Table 3 Age (years), parity, and first parturition age (years) of elephants at ETC and ERU

location	age	parity	first parturition age
ETC			
means ± SD	37.44 ± 9.03	2.78 ± 1.09	18.11 ± 3.92
ranges	28 - 54	2 - 5	11 - 24
ERU			
means ± SD	29.75 ± 3.30	2.50 ± 0.58	17.75 ± 0.50
ranges	26 - 33	2 - 3	17 - 18

Table 4 Calving interval (days) and service period (days) of elephant cows at ETC and ERU

location	calving interval	service period
ETC		
means ± SD	1857.56 ± 870.81	1229.44 ± 846.18
ranges	859 - 4317	259 - 3627
n= 25		
ERU		
means ± SD	1833.00 ± 305.18	1210.50 ± 283.59
ranges	1468 - 2306	868 - 1661
n= 10		

n= number of calving

DISCUSSION

Female elephants can reproduce from the age of eight to ten years (Nancy, 2019). Meanwhile, male elephants are ready to mate at the age of 12 to 15 years (Brown, 2014). Gestation period in Asian elephant was 623-729 days (Hildebrandt *et al*., 2007). Elephants can reproduce until they are 50 years old (Brown, 2014). The optimal age for female elephants to reproduce is 15-30 years (Thitaram, 2012). The captive Way Kambas elephant first calved at the age of 11-20 years. Elephant mating was carried out with the help of mahouts. Unfortunately, the matings were not recorded in the ETC. Meanwhile, in ERU, only a few mahouts collected data on matings. As written in the mating records, an ERU mahout stated that the elephant Riska mated once in 2019 and four times in 2020 after calving in 2017 (Personal communication, 2023). Foraging in the forest allows captive elephants to mate with wild

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elephants without their mahout knowing because the guard posts were far from the foraging area. According to ETC and ERU mahouts, captive elephants in Way Kambas mated more than twice in one estrus cycle. Bulls will mate with cows who were in estrus. Pheromones in the urine of cows attracted bulls to mate with cows (Hildebrandt, 2006).

The calving interval for elephants ranged between four to six years, depending on whether the male elephant approached the female herd (Brown, 2014). Captive Way Kambas elephant calves are usually weaned at the age of one to two years. The shortest calving interval for captive elephants in the WKNP was 859 days or around two to three years for elephants aged 16-28 years and the longest was 4317 days or around 12 years for elephants aged 37 years (Table 4). This also confirmed Thitaram's (2012) report that the optimal age for female elephants to reproduce was 15-30 years. Two captive elephants at ETC, aged 30 and 37 years respectively, experienced extended calving intervals (7 and 12 years). The average calving interval for Sumatran elephants (*Elephas maximus sumatranus*) at ETC was 4.5 years (± 54 months) (Hapsari, 2003).

Asian elephants (*Elephas maximus*) from several captivity in Thailand had a calving interval of 4.4 years (± 53 months) and an average abortion/stillbirth rate of 12.4% (Toin *et al*., 2020). This report was similar to a study on the reproductive performance of captive population of Asian elephant (*Elephas maximus*) in Sri Lanka (Pushpakumara *et al*., 2016). Pinnawela elephant orphanage in Sri Lanka is the largest breeding facility for Asian elephants (*Elephas maximus*) in the world with 35 cow elephants calving two, three, four, and five times, each with calving intervals of 5.0 years (± 60 months), 4.8 years (± 58 months), 7.9 years (± 95 months), and 5.8 years (± 70 months) respectively (Medawala *et al*., 2023). As the population of adult elephants in Way Kambas increased, the average calving interval for Way Kambas captive elephants ranged from 4.5 years (± 54 months) to 5.22 years (± 63 months). The calving interval was obtained from the increase in the number of female elephants, the age of the cows, undetected estrus, unscheduled matings, mating after the fertile period has passed, and poor semen quality. The optimum calving interval for elephant was in the range of four to a years (Toin *et al*., 2020). In this study, young elephants had shorter calving intervals and service periods than older elephants.

Female elephants only return to estrus after a lactation anestrus period of eight to 12 months (Brown *et al*., 2010). Way Kambas' captive elephants have an average service period of 3.22 years (approximately 39 months). The shortest service period for elephant cow in the WKNP was one year which occurred in cows aged 16-28 years, and the longest was 10 years in a 37 years old cow. Puberty that is too early caused premature aging too.

Continuous ovarian cycling in unmated cows had adverse and cumulative effects on the reproductive health in captive elephants (Hildebrandt, 2006). Pheromones are intraspecific interacting substances used by female elephants to attract the attention of male elephants. Pheromones were found in urine at the end of the luteal phase and increased gradually during the follicular phase until they reached peak concentrations just before ovulation (Thitaram, 2009). The average elephant estrus cycle is four months, three months for the luteal phase and one month for the follicular phase. The luteal phase was the first point at which the progesterone concentration increased above 0.3 ng/mL and remained at 1-2 ng/mL for at least two weeks (Thongtip *et al*., 2009). A double surge of LH occured during the follicular phase. The first LH surge was not followed by ovulation. Three weeks later, ovulation occured 24 hours after the second LH surge (Kaewmanee *et al*., 2011). In Way Kambas, pregnant captive elephants mated at night. Although female elephants could detect pheromones and were willing to mate with males, pregnancy would not occur if the female elephants did not ovulate. Therefore, monitoring hormones was very helpful to determine the right time for mating. Serum progestagen concentration reached 2 ng/ml within 2 months after AI (June 2005),

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continued to increase to 2–5 ng/ml and persisted for more than 20 weeks, indicating pregnancy. Serum progestagen concentrations started to decline to baseline one month before calving (Brown *et al*., 2004; Thongtip *et al*., 2009).

Ovarian activity depended on the hypothalamic-pituitary-ovary axis, with feedback controlling the role of inhibin in FSH secretion by the pituitary. FSH concentrations were highest during week 2 and lowest during week 3 after that increased significantly from weeks 3 to 5 and remained stable until week 16 (Kaewmanee *et al*., 2011).

The elephant training center was established in 1985, followed by ERU in 2014, contributing to a population of 47 Sumatran elephants. The EH had never found a captive WKNP elephant with reproductive problems. Female elephants did not receive special treatment in Way Kambas National Park. 2012-2017 was the year when the most Sumatran elephants were born (14 from 10 cow elephants). Elephant births was dominated by male calves, resulting in a larger population of male elephants in the ETC and ERU areas. The higher number of male elephants compared to female elephants certainly had an impact on the reproductive efficiency of elephants due to the minimal number of females in the area. Male elephants are useful when herding wild elephants back to the forest (Salsabila *et al*., 2017). Not all Sumatran elephants (*Elephas maximus sumatranus*) in the National Park were captive, and their reproduction had been recorded. The EH only has data on individual elephants trained at ETC and ERU. After the elephants are cared for and trained at ETC, the adult elephants would be transferred to ERU to handle human-elephant conflicts. Meanwhile, other trained elephants would be staying at ETC or sent to conservation institutions that need Sumatran elephants.

Captive elephants in the WKNP's are herded into the forest to find food in the morning and evening, and in roam free cage in the afternoon. Elephants eat wild plants from the forest as a source of carbohydrates, fats, proteins, vitamins, and minerals (Resphaty *et al*., 2015; Dhairykar and Singh, 2020). Appropriate food supply and temperature would support increased reproductive efficiency (Ong *et al*., 2023). Captive elephants have comfortable shelter and enough food so they are not too affected by the weather. Meanwhile, wild elephants usually entered the rutting season during the rainy season. The rutting season, which referred to the mating season, usually coincided with periods of abundant rainfall. This was because females entered their fertile phase in the latter half of the rainy season. Male elephants exhibited increased aggression and sexual activity during the mating season due to excessive production of the 'musth' hormone. Calves are born 22 months after mating, coinciding with the start of the rainy season which provided abundant food. Therefore, mother elephants have abundant food availability and are able to produce milk to support the development of their offspring. Therefore, newborn Asian elephants usually weighed around 100kg and grew rapidly in their early years (Dierenfeld *et al*., 2020). Maintaining the Asian elephant population in captivity could be done by increasing birth rates, improving the welfare of rural residents, and ensuring the health, nutrition, environment, and welfare of elephants. This will reduce the death rate for the long-term survival of the population (Pla-Ard *et al*., 2023).

CONCLUSION

The average calving interval and service period for captive elephants in ETC and ERU of Way Kambas National Park were similar and in the normal range. Young female elephants showed better reproductive efficiency than older elephants. The use of advanced reproductive technologies, such as monitoring ovulation using ultrasonography and carrying out artificial insemination, is expected to increase reproductive efficiency.

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AUTHOR'S CONTRIBUTIONS

Keren Jayanti Sofie Adi Putri (KJSAP), Budiarto Budiarto (BB), Hermin Ratnani (HR), Setiawan Koesdarto (SK), Pudji Srianto (PS), Budi Utomo (BU), Suzanita Utama (SU), Nurhusien Yimer (NY).

KJSAP, BB and HR conceived the initial idea and drafting the manuscript. KJSAP collected and analyzed data, and prepared the manuscript. PS and BU read critically and helped revise the manuscript. SU and NY assisted with literature search, data analysis and manuscript editing. All authors read, discussed and approved the final manuscript.

CONFLICTS OF INTEREST

All authors have no conflicts of interest.

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