

## Fetal Growth Rate and Determination of Weaning Time for Adoption of Kittens in Free-Roaming Cats

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(Received: December 05, 2014 / Accepted: January 19, 2017)

**Abstract :** The aims of the present study were to determine the weaning time for adoption of kittens, and to evaluate the fetal growth rate during pregnancy in free-roaming cats. This study was conducted on three pregnant free-roaming cats (one feral cat and two stray cats). Radiography and ultrasonography were performed on the feral cat and on one of the stray cats. In the feral cat, fetal head diameter was measured once during pregnancy to determine the cesarean section (C-sec) time. In the stray cat, serial fetal head diameter was measured from capture to parturition. The body weight of the feral cat's kittens was measured from 4 weeks postpartum because of their wildness. That of the stray cats' kittens was measured immediately after birth. In the feral cat, scheduled C-sec was performed at predicted parturition day by measurement of head diameter, and six healthy kittens were delivered. The stray cats had five and six kittens by natural delivery, respectively. In the body weight gain of feral and stray cat's kittens, two female kittens of the feral cat lost weight rapidly after they were separated from their mother, so they were returned to their mother for 1 more week. After that, the female kittens grew up without difficulty. Body weight gain of the ten kittens born to the two stray cats consistently increased, by approximately 14 g every day, until they were adopted. The body weight of kittens born by natural delivery was on average 77.5 g greater than that of kittens born by C-sec. However, the gap decreased with time. During the stray cat's pregnancy, fetal head diameter increased by 0.042 cm every day. Maximum head size before parturition was 2.43 cm. These results indicate that the weaning time for adoption of kittens was 5-week-old postpartum.

**Key words :** free-roaming cat, pregnant, adoption, weaning time, TNR.

### Introduction

The population of free-roaming cats is composed of two groups, feral and stray cats, which differ in their socialization status. Feral cats are not socialized to people: they have never had contact with humans, or their contact with humans diminished over time, and, therefore, they are afraid of people and survive on their own outdoors. Stray cats have been socialized to people at some point in their life, but left or lost their domestic home, along with most human contact and dependence (5).

Populations of free-roaming cats without owners exist throughout the world. Concern about the impact of free-roaming cats on the environment and public health, as well as consideration of the welfare of the cats themselves, led to various efforts to reduce their numbers (3,7,11,16). Many methods to control the population of free-roaming cat colonies have been attempted, including trapping, poisoning, shooting, and introduction of infectious diseases (3,14,15). Traditional methods, such as trapping and removing cats permanently, often result in a new group of cats moving in to fill the void, unless the cats are in a geographically restricted

area such as on an island (12). Considerable controversy surrounds methods for controlling free-roaming cats, particularly identification of the option that is most practical, effective, and humane. Trap-neuter-return (TNR) programs are intended to halt reproduction without causing harm to the cats (13,15). In these programs, cats are trapped, neutered, and released, or adopted cats are part of the trap-neuter-adoption (TNA) program rather than the TNR program. Kittens still young enough to be socialized, and friendly adult cats, are typically placed in foster care for eventual adoption into homes as companion animals, rather than returned to the outdoors (4).

One peer-reviewed study (8) documented a reduction in numbers of free-roaming cats due to TNR and TNA programs by 66% over an 11 year period. Furthermore, no kittens were observed in the study area within 5 years of starting the TNR and TNA programs. However, according to some claims, TNR was ineffective because feeding locations attracted even more feral cats while also providing a convenient place for people to dump unwanted cats illegally (9).

The characteristics of free-roaming cats were evaluated in a TNR program (10,13): adult cats represented 85% of the population, and 57% were female. Overall, 19% of adult females were pregnant, and mean litter size was 3.6 fetuses. Pregnancy rate peaked at 36-47% of all females evaluated in March and April, and decreased to  $\leq 4\%$  from October to

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January. Cats produced a mean of 1.4 litters/year and a median of three kittens/litter. In other words, quite a high percentage of trapped female cats are pregnant.

In Korea, the queens were returned without any action because of difficulties in program management. In this case, kittens born from released queens also contribute to increasing numbers of free-roaming cats. If a TNR program for free-roaming cats is to reduce the population and prevent overpopulation by free-roaming cats, a design (protocol) is needed to improve TNR program management for queens.

The ultrasonic measurement of fetal head diameter is a practical and accurate tool in the assessment of gestational age, and provides a potentially useful indicator of parturition date (1,2,17). Thus, ultrasound was used to estimate parturition date and to assess the condition of fetuses. The objects of this study were to determine the weaning time for adoption of kittens, and to evaluate the fetal growth rate during pregnant in free-roaming cats.

## Materials and Methods

### Animals

This study was conducted on three pregnant free-roaming cats (one feral cat and two stray cats). The feral cat, which was damaging the ecosystem around a study area for reintroduced oriental storks, was captured in a trap by the Eco Institute for Oriental storks in April 2013. She was wild and not socialized; she was adult, but her age was unknown. Two stray cats were captured by hand in April 2014, and both were socialized and friendly to people, and estimated to be 1-year-old.

### Management of pregnant cats

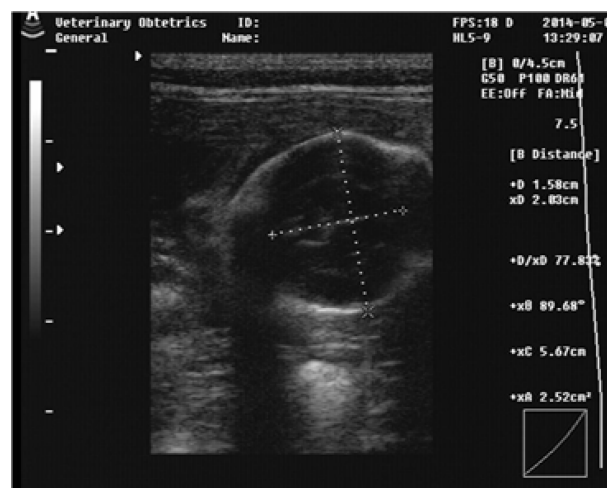
The feral cat and stray cats had to be managed differently. The feral cat was wild and very aggressive, so she was kept in a dark, quiet cage to reduce stress and was appropriately fed during the whole study period. The two stray cats were very meek and mild; one may have been abandoned. So, the stray cats were allowed to have their kittens by natural delivery, after which they were neutered. They were adopted after their kittens had weaned (TNA).

### Ultrasonography and radiography

As one of the stray cats delivery after the capture, X-ray and ultrasound could not be performed on her. X-ray and ultrasound were performed on the other feral cat and on the stray cat. The feral cat was scanned after tranquilization (medetomidine; Dormitor®, Orion Corporation, Finland); the stray cat was not tranquilized.

Ultrasound scanning was performed using a real-time B-mode scanner with a 7.5 MHz linear transducer (SonoAce 8800, Medison, Korea). Fetal head diameters were measured with the electronic calipers of the ultrasound machine from frozen images made at the time of scanning. Image quality was initially assessed by symmetry of the section; later in gestation, it was assessed by the central location of an echogenic line produced by the falx cerebri in the fetal head (Fig 1).

In the feral cat, fetal head diameter was measured once



**Fig 1.** Ultrasound image of a fetal head. Measurements of head diameter were made with the electronic calipers of the ultrasound machine. In this figure, head diameter was 2.03 cm and it means the fetus at 11 days prepartum. The central location of an echogenic line indicate falx cerebri.

during pregnancy. The parturition date was estimated from the average head diameter by using a published formula (2). In the stray cat, serial ultrasonographic examinations were performed daily from initial examination to parturition. The average of two fetal head diameters was used to draw a simple linear graph and to produce an average simple linear regression equation that summarized changes in head diameter through pregnancy.

X-ray images (ventral-dorsal, lateral view) were taken to determine the number of fetuses on about day 50 of pregnancy in the feral cat and in one stray cat.

### Management of parturition

In the feral cat, a scheduled cesarean section (C-sec) and ovariohysterectomy were performed on the predicted parturition day under inhalation anesthesia using isoflurane (Terrell™, Piramal Critical Care, Bethlehem). The two stray cats were allowed to progress to natural delivery.

### Management of neonatal kittens

Immediately after the anesthesia of the feral cat wore off, her neonatal kittens were placed with her to allow them to feed. To prevent cannibalism, which may have occurred as the wild mother cat was under stress, and so that the mother would recognize her babies, the neonatal kittens were covered with their mother's urine. The kittens were together with their mother and were nursed by her until they were 4 weeks old. Then, the kittens and the mother cat were separated so that the kittens would not become wild like their mother, and the mother was released as soon as possible so that she would remain feral. Thereafter, the kittens gradually became accustomed to eating soaked, wet, and dry feed. The weight of each kitten was quantified, and growth graphs were drawn regularly to monitor whether they grew normally. Once the kittens were able to eat dry feed themselves, they were ready for adoption.

The neonatal kittens of the stray cats nursed from their

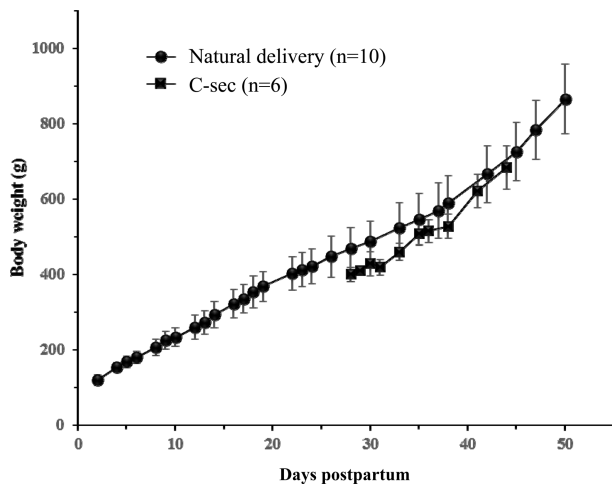
mother immediately after birth. From the day of birth, the weight of each kitten was quantified, and growth graph were drawn regularly to monitor whether they grew normally. These kittens began to eat soaked or wet feed when they were 5 weeks old. They were not isolated from their mothers or put under pressure to wean. Once the kittens were able to eat dry feed themselves, they were ready for adoption.

### Management of the queens

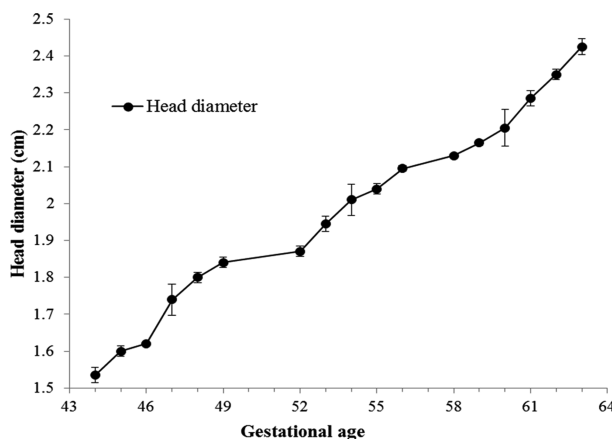
The feral cat, according to the principle of TNR, was returned to the study area after her recovery from surgery. The stray cats that had given birth by natural delivery were neutered, while their kittens were being weaned, by ovariohysterectomy performed by a veterinarian. Once the surgical site was healed and the cats were in good condition, they were ready for adoption.

### Statistical analysis

All data were summarized as mean  $\pm$  standard deviation (SD). Head diameters were explored with linear regression analysis by Pearson's correlation procedure of SAS.



**Fig 2.** Comparison of the body weight gain of kittens born by cesarean section and by natural delivery.



**Fig 4.** Serial measurements of fetal cat head diameter, taken by means of ultrasound.

## Results

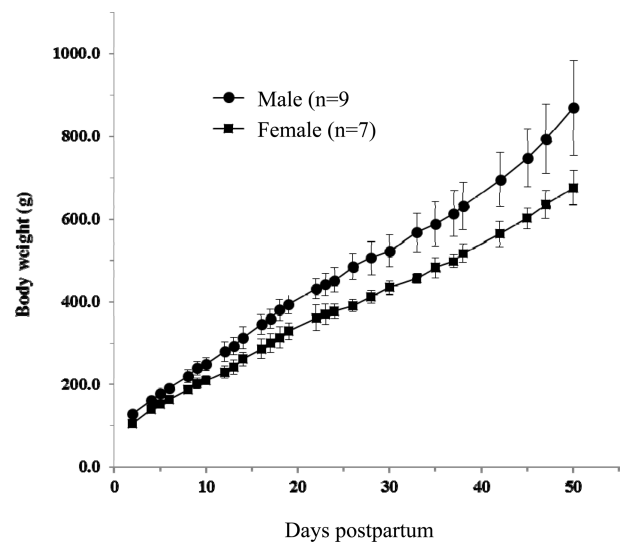
### Parturition

The feral cat had a C-sec and ovariohysterectomy on her predicted parturition day. Six kittens (three males and three females) were born; all were of normal weight and grew up as normal in their mother's care.

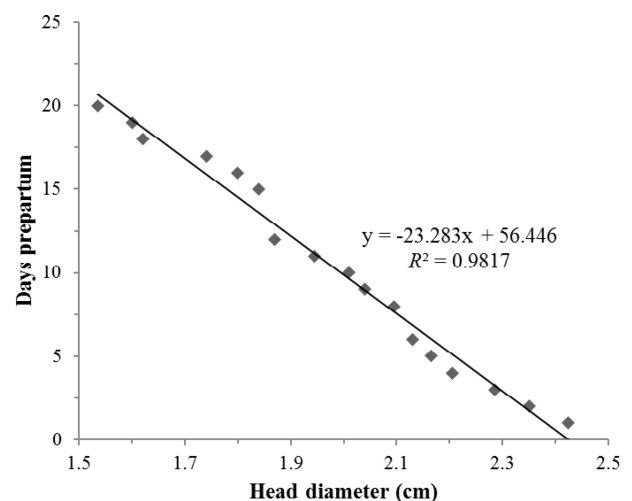
One of the stray cats gave birth to six kittens, and the other to five kittens, by natural delivery. Five were females and six were males, but one of the female kittens died 3 days after birth.

### Body weight gain of kittens

The body weight gain of the kittens is shown in Fig 2 and Fig 3. Because of the wildness of the feral cat, her kittens were weighed only from the age of 28 days, when they were separated from their mother for weaning. Three days after separation, two female kittens started to lose weight rapidly,



**Fig 3.** Comparison of the body weight gain of male and female kittens.



**Fig 5.** Regression equation and line describing the relationship between a stray cat's fetal head diameter and the number of prepartum days. Y = days prepartum; X = head diameter.

so they were returned to their mother for 1 more week. After that, the female kittens grew without difficulty. The kittens became friendlier towards people after they were separated from their mother, and all of them were adopted through a cat lovers' club or by acquaintances when they were over 7 weeks old.

The ten kittens born to the two stray cats were weighed after their birth. Their average weight consistently increased, by approximately 14 g every day, until they were adopted. All the kittens of the stray cats were socialized from birth and were adopted successfully.

Comparing the weight of the kittens from 28 days old when they began to wean shows that the kittens born through natural delivery were on average 77.5 g heavier than the kittens born under C-sec. However, the gap decreased as the days went by.

There were no systematic differences between the weight of male and female kittens immediately after birth. Once they began growing, males gained, on average, 3 g more each day than females, but the weight of both males and females steadily increased (Fig 3).

#### Predicted parturition date with measurement of fetal head diameter

In the feral cat, fetal head diameter was measured two times by ultrasound to allow the prediction of the parturition day. At the first measurement, the fetal head diameter was 2.12 cm. This corresponds to day 56 of gestation. C-sec was planned for day 63 (2) as predicted from fetal head diameter, and six kittens were born.

In the stray cat, serial measurements of fetal head diameter by ultrasound are shown in Fig 4. Fetal head diameter increased by, on average, 0.043 cm each day, and maximum head size before parturition was 2.43 cm. Fetal head diameter was plotted, and the regression equation for the prediction of parturition day by measurement of fetal head diameter was

$Y = -23.283X + 56.446$  (Y: days prepartum; X: head diameter (cm);  $r^2 = 0.98$ ) (Fig 5). The predicted parturition date based on regression equations derived from the calculated fetal head diameter in this study was accurate to within just 1 day (Fig 5 and Table 1).

## Discussion

When a free-roaming cat is captured, a decision must be made to allocate it to TNR or TNA (4,8,13). In this study, the feral cat was so wild that we decided on TNR, but the stray cats were so friendly towards people that we decided on TNA. The feral cat was released after C-sec and ovariohysterectomy. In total, three free-roaming pregnant female cats (queens) were captured: one feral cat that gave birth through C-sec and then entered the TNR program, and two stray cats that gave birth naturally. Parturition dates were predicted from fetal head diameters measured by ultrasound. All kittens were born normally, but one neonatal kitten expired soon after birth. All 16 others grew gradually and were successfully adopted. The feral cat was released, and the two stray cats were adopted.

Although all kittens of the stray cats were born with normal body weights, the lightest kitten expired 3 days after birth. It was believed that this kitten was unable to compete with its littermates for access to nipples. The average weight of kittens at 4 weeks old is  $382 \pm 11$  g (6). In this study, the average weight of the feral cat's kittens was 399.5 g and that of stray cats' kittens was 467.3 g. The weight of the lightest kitten was 370 g. This indicates that all the kittens gained body weight normally. The kittens born naturally were heavier than those born by C-sec, perhaps because the C-sec was scheduled earlier than the actual parturition day of the feral cat, due to individual differences in the parent cats, or because the feral cat became anxious during trapping (2). In this study, kittens were removed from their mothers to start weaning when they were 4 weeks old, but two female kittens of the feral cat rapidly lost weight. They failed to adapt to their new circumstances without their mother and to the sudden change in their feed (from milk to wet feed). These kittens needed more time to suckle until they were 5 weeks old and could gradually change their feed. If rapid weaning was essential, kittens could be fed artificial milk replacer (formula) until they were 5 weeks old.

When captured free-roaming cats are already pregnant, the exact date of mating cannot be known. Thus, it is useful to predict the parturition date by the measurement of fetal head diameter through ultrasound (2). This prediction makes it possible to set the date to perform a C-sec, or to prepare for a natural delivery. This is especially important when a C-sec is indicated because fetuses must be born when they are fully developed. Knowing the parturition date and setting the correct date for the C-sec are very important (2).

In the feral cat, fetal head diameter as measured by ultrasound was 2.12 cm. Using the published formula (2), the day of gestation was calculated to be 56, and the C-sec was planned for 7 days later (on day 63 of gestation). Using the regression equations for prediction of parturition date derived in this study (Fig 5), the cat was calculated to be 7 days

**Table 1.** Prediction of the date of parturition from ultrasound measurements of cat fetal head diameter: comparison between predicted and actual days prepartum

HD (mean $\pm$ SD)	Predicted days prepartum*	Actual days prepartum	Predicted minus actual
1.54	21	20	-1
1.60	19	19	0
1.62	19	18	-1
1.80	16	16	1
1.87	13	12	-1
1.95	11	11	0
2.10	8	8	0
2.21	5	4	-1
2.29	3	3	0
2.43	0	1	1

\*predicted days prepartum calculated on regression equations ( $Y = -23.283X + 56.446$ ) of this study.

prepartum, and the C-sec was scheduled for 6 days later. The small difference between the published formula and the equation in this study was probably due to the difference in the sample population. The published formula was based on measurements of domestic shorthair and longhair cat breeds in the USA (2), while the equation in this study was based on measurements from just one cat of a shorthair breed in Korea.

Research showed that a high percentage of free-roaming cats are pregnant (13,17), but there are no plans to control the population through the management of pregnant free-roaming cats. Though 75% of kittens born outdoors die or disappear before they are 6 months old (17), the survivors contribute to the increasing free-roaming cat population. To prevent overpopulation, a program of artificial abortion in the early stages of pregnancy can be applied. However, in the later stages of pregnancy, parturition and adoption of kittens is preferred for ethical reasons (2).

When applying a TNR program to pregnant cats, fetal head diameter should be measured by ultrasound, and the day of parturition should be predicted (2). Mother cats should give birth to kittens through C-sec on the predicted date, or by natural delivery. Then, mother cats should be neutered and returned to their place of capture, or adopted. All the kittens should be adopted once they can feed themselves.

Efforts at managing free-roaming cat populations are often limited by resources: time, finance, and effort are needed for TNR programs aimed at pregnant cats because management requires efforts from prepartum capture to release and adoption (8,15). Nevertheless, one of the goals of TNR is for fewer new kittens to be born, and to achieve this goal, it is valuable to establish TNR protocols for pregnant cats. If, instead of being released, pregnant cats are subject to a large-scale program, it can be expected that numbers of kittens will immediately decrease.

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