ORANGUTAN DEVELOPMENT, REPRODUCTION AND BIRTH MANAGEMENT

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Updated by Carol Sodaro (2006)

The physical development of orangutans is quite slow. Males and females show no noticeable difference in appearance through adolescence. Once sexual maturity begins there is a significant size difference between the sexes. Adult males can be almost twice the size of adult females (MacKinnon, 1974, Eckhardt, 1975).

Variation exists in determining age classes for orangutans. Here are three examples of age and sex classifications of wild orangutans:

Age/Sex Class	Rijksen (1978)	Galdikas (1981)	MacKinnon(1974)
male/female infant	0 – 2.5 years	0-4 years	0-2.5 years
male/female juvenile	2.5 – 5 years	4-8 years	2.5-7 years
male adolescents	5 - 8 years	9-12 years	7-10 years
female adolescents	5 – 8 years	9-15 years	7-10 years
male sub adult	8 – 15 years	12-18 years	10-15 years
male adult	13-15 years	18+ years	15+ years
female adult	8+ years	15+ years	8+ years

Male Development

In male great apes there is a large age range of variation within each species at the onset of maturation and the age when full adulthood is reached. Because of this wide range of individual variation and because puberty is reached more rapidly in captive and provisioned animals, it is difficult to isolate a "normal" growth pattern. For orangutans this is particularly true – they have the widest range in variation in timing of maturation among the apes and there is evidence that extended arrest of secondary sexual development occurs in some males, further complicating the picture of their growth patterns. Along with gonadal maturation and the onset of fertility, in male orangutans the maturation process includes the development of marked secondary sexual features. These changes include: large cheek flanges, a specialized laryngeal pouch, distinctive hair growth including a beard and mustache, large body size due primarily to increased muscle mass, and a distinctive odor (Graham and Nadler 1990). Most commonly the first visible signs of puberty in male orangutans are changes in facial morphology. Typically this begins at seven to nine years of age, but may happen as early as five or as late as seventeen years of age. Commonly males

are fully mature by the age of 14 (with functioning primary sexual organs and marked secondary sexual features), however, many males may look "subadult" for years longer (ibid.). Subadult is the term applied to males with arrested secondary sexual maturation. Depending on the individual housing situation, along with morphological changes, adolescent male orangutans may show marked behavioral changes. They may become more aggressive and more sexually active, including increased incidence of forced copulation. Both in captivity and the wild, the maturation process can take as little as a few months or as long as 10 years (MacKinnon 1979; te Boekhorst 1990).

The following five photos document the physical changes of male "Schnitz" at the Brookfield Zoo:

Infant riding on dam's back

Juvenile

Adolescent

Subadult

Adult

Male Suppression

According to Maple (1980), it has been "unwritten zoo lore" that the "complete development of secondary sex characteristics seems to be suppressed" in young male orangutans housed with adult males. However, if the dominant male is removed, the suppressed male begins to develop immediately. Importantly, it has been noted that "the transformation from subadulthood to full adulthood in male orangutans is sudden and dramatic," and in the wild it takes only a few months (MacKinnon 1979). According to zoo lore, aggressive human keepers may cause the same suppression effect (Maple 1980).

To document Maple's anecdotal data, Kingsley (1982) studied the gonadal endocrinology of 20 captive male orangutans ranging from 1 to 16 years of age housed in European zoos. Early morning urine samples were collected from each animal and analyzed by radioimmunoassay. Flange growth was also measured. One year into the study, a pair of cohabiting males, a dominant, flanged male and a subordinate, unflanged male were separated and isolated from one another. Upon separation, the subordinate male developed secondary sexual features. Kingsley found that testosterone levels in suppressed, nonflanged males were intermediate between nonflanged, juvenile and flanged, adult males. High testosterone is required for flange development, which commences a few months after an initial testosterone rise. Kingsley concluded that the presence of a dominant, flanged male indeed suppresses flange growth in subordinate, nonflanged males for a period and that this is not a permanent condition.

In a follow-up study comparing orangutan and gorilla developmental endocrinology, Kingsley (1988) assayed urinary testosterone in 24 males of each species. Kingsley's conclusion was that male orangutans, gorillas, chimpanzees, and humans all have basically the same pattern of testosterone secretion over a lifetime. Juveniles have lower levels than adolescents and adolescents have lower levels than adults. However, in orangutans there is a clear case of developmental suppression and a "subadult" phase with hormone levels intermediate between those of juveniles and developing adolescents. Additionally, she notes that subadult orangutans have fathered offspring in captivity (Kingsley 1988). te Boekhorst and colleagues (1990) have confirmed that the arrest phenomenon also occurs in wild male orangutans. Thus, morphological and behavioral differences between dominant and subordinate male orangutans have been observed both in captivity and in the wild. The arrest of secondary sexual traits is not permanent but is known to last up to seven years in captivity (Kingsley 1988) and for ten years or more in the wild (te Boekhorst et al. 1990).

Maggioncalda, Czekala, and Sapolsky have conducted research on this poorly understood arrest phenomenon. The primary goal of the research was to determine the endocrine profiles of male orangutans at different stages of the life cycle and to isolate the endocrine pathways altered in arrested adolescent males. Urine samples were collected between 1989 and 1992 from 28 male orangutans at 13 American zoos, along with growth histories and other data. Levels of the following hormones obtained by radioimmunoassay were compared between juvenile (3-5 years of age), arrested adolescent (7-12 years of age), developing adolescent (6-16 years of age), adult (15-26 years of age), and aged males (30-39 years of age): 1) growth hormone (GH), the main hormone of growth and development; 2) thyroid stimulating hormone (TSH), which stimulates the secretion of the thyroid hormones which in turn act synergistically with GH to produce normal differentiation and growth; 3) prolactin, which affects growth, inhibits reproductive function, and increases as part of the stress response; 4) luteinizing hormone (LH), which stimulates testosterone production and secretion by the testes; 5) follicle stimulating hormone (FSH), which facilitates spermatogenesis and is required for fertility; 6) testosterone, which is required for sexual function and acts directly on the testes, skeletal muscle and bone during maturation; 7) dihydrotestosterone (DHT), a metabolite of testosterone, which plays a primary role in development of secondary sexual features; 8) adrenocorticotropic hormone (ACTH), which stimulates the production and secretion of cortisol from the adrenal cortex; and 9) cortisol, the primary stress hormone, which if chronically secreted at high levels interferes with many of the body's systems including growth and reproduction (Sapolsky 1989). The results of the endocrine data were used to narrow down the possible behavioral mechanisms of the arrest.

Theoretically, a number of behavioral mechanisms exist which, alone or in conjunction, could cause the arrest of secondary sexual development in subordinate male orangutans. Pheromones, or olfactory signals, are secreted by one animal to influence the behavior or physiology of a conspecific. Pheromones are commonly used in primates in suppression of growth, development, and reproduction (Keverne 1983; Izard 1990). Dominant male orangutans have a unique odor and a specialized sternal gland which may produce this scent. A pheromone may cause the developmental arrest found in some male orangutans. If the hormone profile for arrested males includes low levels of testosterone, DHT, TSH, LH, FSH, and GH but does not show increased stress hormones, pheromones will be considered as a likely mechanism of this arrest.

An auditory signal may play a role in developmental arrest in some male orangutans. A phenomenon in which auditory signal acts similarly to pheromones has been documented in red deer (McComb 1987). It has been shown that the roaring of stags advances ovulation in hinds – the roar itself has a modulating effect on the reproductive endocrinology of the female. Long calls of dominant male orangutans are produced both in the wild and in captivity, are stereotypic and travel about 800 meters (Mitani 1985). Perhaps dominant males' long calls in some way interfere with secretion of hormones necessary for complete development in subordinate males. As with pheromones, if the hormone profile for arrested males includes relatively low pituitary and testicular hormones but does not show increased stress hormones, auditory signals should be considered as a likely mechanism of this arrest.

Regular aggression or threat of aggression, including signs of an aggressor's proximity can cause chronic stress and impaired growth, development and reproduction in mammals. A number of researchers have suggested that stress is a factor in orangutan secondary sexual trait arrest (Maple 1980; Kingsley 1982; Graham 1988). Subordinate male orangutans are sometimes threatened and attacked by dominant males (Galdikas 1985a, 1985b). Additionally, the odor, sight, or sound of a dominant male may act as a stressor to subordinate males by constantly reminding them of the dominant male's proximity. If arrested males have hormone profiles with comparatively high levels of stress hormones and low levels of pituitary and testicular hormones (due to feedback effects of chronic high cortisol), the aggression and chronic stress hypothesis would be supported.

Results of our research show that developmentally arrested adolescent male orangutans have a distinct hormone profile as compared to other age classes of males (Maggioncalda 1995a; Maggioncalda, 1995b; Maggioncalda, Czekala, and Sapolsky in preparation). Compared to developing adolescents, arrested adolescents have significantly lower levels of testosterone, DHT, LH, GH, cortisol and prolactin. Levels of FSH, TSH, and ACTH are not significantly different between the two types of adolescent male. Arrested males have significantly higher levels of testicular steroids than juveniles and together

with high levels of FSH they are interpreted to be spermatogenetic and fertile. However, arrested males lack the level of testicular steroids required to effectively reach peripheral tissues and lead to secondary sexual development. They also lack GH levels required for adolescent body size growth. Most interestingly, arrested males have a low stress hormone profile compared to males of similar age with secondary sexual trait development. Thus, the aggression and chronic stress hypothesis can be removed from the list of possible behavioral mechanisms. Both the auditory signal and pheromone hypotheses can be supported by this endocrine data, however because it is unlikely that pheromones can travel such far distances and have such an enduring effect in the wild, the auditory signal hypothesis is favored. Experiments could be done to test the pheromone and auditory signal hypotheses by exposing juvenile males near the onset of puberty to dominant male long calls and/or odors.

An alternate male reproductive strategy, in which a male remains juvenilized in appearance for an extended period of time but becomes fertile and sires offspring, has not yet been documented in any other mammal, with the possible exception of male mandrills (Wickings and Dixson 1992). The observed extended arrest of secondary sexual trait development paired with fertility in some male orangutans theoretically has costs and benefits for mature, dominant and arrested, subordinate males. Adult males are known to have higher testosterone and may incur the associated costs of decreased health and lifespan due to metabolic costs of high testosterone and high rates of intrasexual aggression and injury (Dufty 1989). Additionally, attaining and maintaining large body size demands a great deal of metabolic energy. The large, dominant males incur locomotor costs since arboreal travel is more difficult for them than for other orangutans. The benefits to the dominant males are obvious -- they are dominant to all other age and sex classes and they have priority to food sources and fertile females. The costs of arrest incurred by subordinate males are unclear. The necessity to force copulations with females (which is a well-documented subadult male behavior) may appear to be a cost, but if it leads to offspring any cost is offset (Galdikas 1981). The potential benefits of paired fertility and secondary sexual arrest for subordinate males, however, are numerous. By being submissive and unobtrusive, subordinate males are able to gain increased access to females and potentially sire offspring (Galdikas 1985c). Subordinate males avoid injury from agonistic encounters with dominant males and can travel more easily in trees, allowing them to escape predatory cats and to follow females. Arrested males also avoid metabolic costs associated with maturation and high testosterone. Arrested males defer the costs and benefits of dominance until a time when a dominant male becomes old or dies and they can replace him as a range-holder (Galdikas 1981). Based on the endocrine data together with behavioral information it appears that male orangutans have evolved a flexible developmental timeline, whereby subordinate males may postpone secondary sexual

development in order to avoid aggression and stress, but retain timely primary sexual maturation and achieve reproductive success.

Female Development

Females show no obvious secondary sexual characteristics. (Graham, 1981.) Female sexual maturity occurs at about 7 to 10 years of age. Wild orangutan females do not typically give birth until approximately 12 to 15 years of age. In captivity, females have given birth as early as 7 years of age, The earliest documented age of parturition for a captive female is 5 years and 3 months (Markham 1994).

The first menstrual period, menarche, marks the onset of sexual maturity. Adolescent sterility has not been documented in this species. Females should be monitored carefully as they approach sexual maturity if they are in a potential breeding situation.

Adolescent females do exhibit sexual behavior. The SSP© recommends: at five and one-half years (5 ½) years of age, ALL juvenile females housed in a reproductive situation (this includes being housed next to males when separated by mesh)) should be monitored for cycling. This can be accomplished through daily urine collection with Hemastix® for menstrual blood. Hemastix© can be ordered through most pharmacies or via the internet. Once the female initiates menstrual cycling, she should be contracepted (see Birth Control Chapter, this volume).

Estrous Cycle

The length of the menstrual cycle is calculated from the onset of menses in one cycle to the onset of menses in the next cycle. Menstrual cycles have been reported from 23 to 33 days in length in mature, captive individuals (11-22 years old) with a mean of 27.8 days (Nadler 1981)**.** Most sources list normal cycles between 28 to 30 days, but the sample sizes are small.

Markham (1990) notes that menstrual cycles tend to be longer in the first two years after menarche. She also documents the irregular cycles of "Mawas" a female orangutan in her late 40s. Mawas' cycles varied in length from 19 to 44 days. At 48 years of age, Mawas was not menopausal but her cycles were shorter than those of younger conspecifics (Markham 1990).

Menses last from one to four days. The flow of blood is slight and only seldom apparent. Hemastix® are the most reliable method of detecting menses. A clean urine sample should be used since contamination with feces may indicate a false positive for occult blood (Wells et al. 1990). Cycle status should be regularly recorded for all potentially breeding females. An example of a chart kept to monitor cycling is shown below. A blank copy of this chart is available in the appendices of this chapter.

Menstrual Cycle/Reproductive Chart

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	n	n	N	Nls								
2	n	n	N	Nls								
3	n	n	N	Nls								
4	n	n	N	Nls								
5	n	n	N	Nls								
6	n	n	N	Nls								
7	n	n	N	Nls								
8	n	n	N									
9	n	n	N									
10	n	n	N									
11	n	ns	C									
12	cps	cps	Ps									
13	cps	ps	N									
14	cps	c	N									
15	n	n	N									
16	n	n	N									
17	n	n	N									
18	n	n	N									
19	n	n	N									
20	n	n	N									
21	n	n	N									
22	n	hm	N									
23	n	hl	N									
24	n	n	N									
25	hs	n	N									
26	hl	n	N									
27	hl	n	N									
28	n	n	N									
29	n	n	N									
30	n	n	N									
31	n	n	Nls									

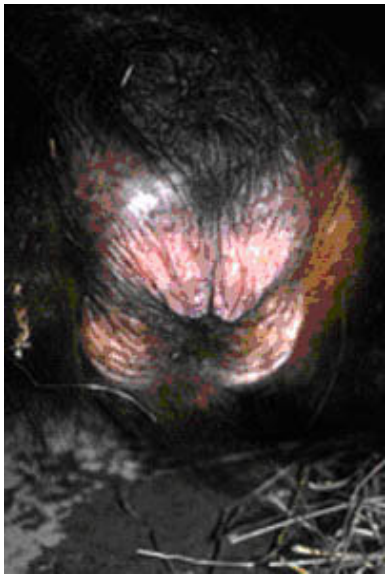
Codes
m = menstruating
ps=prosexual behavior
c=copulation
ls=labial swelling/pregnant
b=birth
ppb=post partum blood

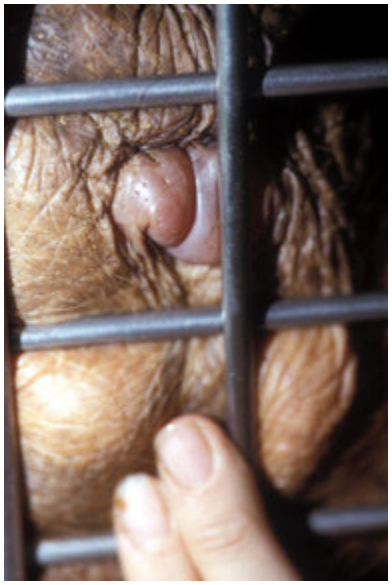
Hemastix Results
n = negative
hs = hemolyzed small
ht=hemolyzed trace
hm=hemolyzed moderate
hl=hemolyzed large

Confirmation of Pregnancy

Labial Swellings

The Orangutan SSP© recommends the best method to confirm a pregnancy is the presence of a labial swelling. This physiological sign of pregnancy is easily observed. The labia majora begin to swell about two to four weeks after conception. The swelling is very pronounced and easy to see. The labia swell abruptly over a one to two day period and may continue to enlarge through the remainder of the pregnancy. The swelling does not disappear until after parturition (Sodaro 1988). Labial swellings vary in appearance and size. See photos below for variations in appearance.





Pregnancy Test Kits

Human test kits can be used to confirm pregnancy. A wide variety of results have been obtained using these tests which confirm human chorionic gonadotropin (HCG) in urine. The following summarizes tests kits that are able to cross-react with orangutan chorionic gonadotropin (orCG):

Test Kit	1st Trimester	2nd Trimester	3rd Trimester
A. OvuQuick ®	yes		no
B. ICON® II HCG	yes		no
C. Cards Q.S.®	yes		no
D. Abbott TestPack Plus™	yes	no	
E. E.P.T.™		no	no
F. Clear Blue Easy	yes		
G. One Step	yes		
H. Osco	yes		
I. Assure	no		

Zoos that used tests:
Brookfield Zoo: A,B,C,D
Kansas City Zoo: F,G,H,I
Chester Zoo: F

The human test kits readily available in drug stores or via the internet are not standardized to guarantee cross-reactivity between ape and human chorionic gonadotropins, but past experience indicates that they are usually close.

It should be known that many of the tests show a cross-reaction between HCG and luteinizing hormone (LH), so a single positive test actually may be detecting the LH released during ovulation. Therefore, Hemastix® should be used to detect whether blood is present. Ovulation test kits, including Ovuquick® have been successfully used at some institutions.

Test kits should be performed with fresh, morning urine, if possible. The urine should not be contaminated with any soap or foreign materials.

Additional Methods to Confirm Pregnancy
Ultrasound can be a useful diagnostic tool to confirm pregnancy. "Jill", an orangutan at the Kansas City Zoo was trained to present her abdomen for weekly ultrasounds performed by zoo staff (Moore 1999). This female was

also trained to allow cooperative blood draws. During this pregnancy, urinary hormone levels were analyzed. This was the first instance that all three testing procedures were used simultaneously to correlate the progression of an orangutan pregnancy (Suedmeyer, 2002).

Physiological Signs of Pregnancy
Labial swellings appear and continue to increase in size throughout the gestation period. Approximately one month after conception, changes occur in the mammary area. The nipples begin to swell and the mammary glands enlarge. Brookfield Zoo reports that a pregnant female's hair appeared thicker (Carol Sodaro 2002: personal communication).

Behavioral Changes Associated with Pregnancy
Changes in behavior have been reported in association with pregnancy include: loss of appetite, lethargy and personality changes. Females have been reported to self nurse prior to birth. Pregnant females may continue to participate in sexual behavior. Maple (1980) describes the behaviors of female orangutans in the Berlin Zoological Gardens to be rather unpredictable and sometimes aggressive during the first months of pregnancy. A female at the Brookfield Zoo tended to act more docile and subdued during the first trimester of 3 of her pregnancies (Carol Sodaro 2002: personal communication). Behavior among group members should be monitored carefully and changes in behavior should be recorded in the animal's records. In the later stages of pregnancy, females may appear agitated, restless, and lethargic, avoiding interactions with conspecifics. Loss of appetite and constipation have also been noted.

Medical Problems Associated with Pregnancy
Problems related to pregnancy in orangutans are varied. Abortion, *placenta previa*, fetal septicemia, dystocia, and maternal/fetal incompatibility have been reported. As in humans, diabetes or obesity can be associated with significant medical complications during pregnancy. These cases and other related disorders are covered in *Medical Management of the Orangutan* (Wells et al. 1990). A prenatal ultrasound examination, with routine blood tests to check hematology/serum chemistry status, can provide valuable information to confirm the health of the mother, fetus, and normal placental placement. It also allows potential problems (such as hypocalcemia or anemia) to be identified and corrected proactively.

Gestation
Gestation ranges are have a range of 245 $\pm$ 12 days. This is an average of 35 weeks or 8.16 months . Twinning does occur, at least in captivity, but it is a rare event, having occurred in less than 1% of recorded (Lori Perkins personal communication: 2003)

Diet Changes and Vitamin Supplementation
Proper nutrition during pregnancy is essential for the health of both the mother and the developing fetus. Intake of a well-balanced diet (see Nutrition chapter, this volume) should be assured, with special attention to adequate levels of protein, energy, calcium, and other vitamins and minerals (especially folic acid). The appropriate quantity of food is best determined by observation of the animal, maintaining adequate condition and avoiding excessive weight gain (i.e., obesity can cause significant medical problems during pregnancy and labor). As a general rule, the developing fetus is so small that a significant increase in food is not necessary until lactation begins (lactation can double or triple metabolic needs). Oral supplementation with any standard human prenatal vitamin is recommended during pregnancy and lactation.

Social Housing During Pregnancy
It is not necessary to alter a pregnant females housing situation during pregnancy unless there is a risk to the female or her infant. Some zoos separate pregnant females from adult males overnight as the parturition date nears (See example of a case history of a separation in appendices at the end of this chapter). Adult males have been present during a delivery and normally do not interfere with the process. However, some males have become aroused and attempted to copulate with a female during labor (Caine 1979). Zoo staff familiar with the adult male's behavior during the birthing process should make the decision how they want to house their pregnant female during labor and delivery. The pros and cons of this decision should be carefully weighed prior to implementation. If females with infants have been separated from their social group, they should be housed with auditory and visual contact to their group. After birth, reintroduction to conspecifics should take place, based on the institutions post partum management plan. Animals should be monitored closely during this period. Institutions needing guidance should contact the SSP© Husbandry Advisor, Carol Sodaro casodaro@brookfieldzoo.org

Development of a Birth Management Plan
It has been well documented in the literature that the mother-infant relationship forms the basis of nearly all social behavior in animals. A lack of conspecific mothering during infancy has been linked to deficiencies in both sexual and maternal behavior in adulthood (Maple 1980). Management practices that involve the removal of the infant from its mother at birth or at a very young age (under 5 years of age).should be avoided.

Thorough planning for an impending birth is critical to lessen the necessity of an infant being removed from its mother for hand rearing. All institutions should contact the Orangutan SSP© Husbandry Advisor, Carol Sodaro casodaro@brookfieldzoo.org to discuss a birth management plan for their female as soon as the pregnancy is confirmed.

A sound birth management plan will address the following:

Review of the social, reproductive and medical history of the pregnant female

Development of an action plan based on a set of guidelines that is driven by the animal management review of the orangutan(s) involved. This will also include staff assignments, determination of due date, prepartum plan, birth day plan and any other considerations relating to the birth.

A birth management plan helps to prepare staff and animals for the impending birth. All animal care staff who are involved with the pregnant female should familiarize themselves with the birth management plan in advance of parturition. See appendices at the end of this chapter for a detailed example of a birth management plan. This example also includes considerations for a female that was in a maternal skills training program.

History of the Expectant Female

One of the most important aspects of developing a sound birth management plan is to know the complete history of the female involved. This can be accomplished through a careful review of house records, records from prior institutions housing the animal and review of their APES profile. An in-depth review will allow staff to make appropriate preparations to promote maternal care and ensure the well-being of the infant.

A pregnant female may fall into one of the following categories:

- nulliparous female who has had no prior exposure to infants

considerations: if the female is young (under 10 years old) and/or was hand-reared, it is recommended to begin a positive reinforcement training program to promote maternal care giving skills

- nulliparous female who has been present at a birth(s) and/or who has had exposure to females with infants who exhibit proper maternal care. considerations: this animal may have a better chance of being a competent mother due to exposure to proper infant care in the past
- primaparous female who has successfully raised infants

considerations: this female should continue to care for future infants unless there is a change in her health status or the infant has medical concerns

- primaparous female whose infant required intervention

considerations: the nature of the intervention required will dictate your next birth management plan. Review discussion of intervention types in the next section.

Discussion of intervention types

Females who consistently neglect their offspring should be considered for a positive reinforcement maternal care giving skills training program. Careful

evaluation of past circumstances surrounding neglect should be closely reviewed. The following should be included in the review:

- ✓ housing situation during prior birth(s)
- ✓ review conspecifics present for prior birth(s) and any behavioral interactions that may have impacted the female's behavior towards the infant
- ✓ age of parturition
- ✓ how was the female reared (dam-reared, hand-reared, peer-reared, foster-reared, surrogate-reared or unknown)?
- ✓ were all the necessary preparations made for this birth (bedding available, proper diet, proper environmental conditions)?
- ✓ was she in good health?
- ✓ was the infant healthy?
- ✓ was the birth difficult?

By closely reviewing all of the above, you made be able to determine factors that affected the successful rearing of her past infants as well as implement changes for the future.

If a maternal skills training program is unable to be implemented and/or is not successful, consideration can be given to placing the infant with a foster or surrogate mother. Contact the Species Coordinator, Lori Perkins, (lori410@mindspring.com) well advance of the parturition date to discuss this option.

Females who have shown competent mothering skills but failed to allow nursing with previous offspring should be considered for a positive reinforcement training program that focuses on promoting nursing. A training program of this nature may include breast desensitization and manipulation of breast with a breast pump prior to parturition

There are reports of females who consistently neglect or abuse their offspring. If possible, these individuals should be housed in an environment that may promote and/or improve maternal skills. Females who are known to abuse their infants require special monitoring and considerations immediately post partum Cheyenne Mountain Zoological Park described an attempt to improve the mothering skills of a female, who had failed to raise her own offspring, by successfully introducing an unrelated 4 year old.

If a female has rejected past infant(s), a positive reinforcement training program that promotes infant caregiving behaviors should be initiated during pregnancy. This was successful at the Chicago Zoological Park, Houston Zoological Gardens, Gulf Breeze Zoo and Henry Vilas Zoo. Contact the SSP© Husbandry Advisor, Carol Sodaro (casodaro@brookfieldzoo.org) for information on how to set up a maternal training program.

Labor and Delivery

The reports on the length of labor vary. Graham-Jones and Hill (1962) note that labor lasted for approximately 25-30minutes for a primparous captive orangutan. When twins were born, labor lasted approximately 3-4 hours for the first twin and approximately another hour for the second (Heinrichs and Dillingham 1970). Labor for an ex-captive, primaparous orangutan at the Sepilok Game Reserve lasted 3 hours. A discharge of amniotic fluid was observed 5 minutes before birth occurred. During the birth she adopted a squatting posture and whimpered; "tears were visible" (DeSilva, 1972). In the first stage of labor, there is usually a clear vaginal discharge. The female may show signs of discomfort and her activity level increases.

Stage two encompasses the birth process. The female may assume a lateral- or dorsal-recumbent position. The frequency of contractions increases and the infant's head appears. In one observed birth, the female rested on her right forearm and knee and grasped the infant's head with her left hand. She appeared to be assisting in expulsion of the infant, which took thirteen minutes (Schwartz 1988). In another described birth posture, the female placed her head of the floor, leaning on her lower arm and elbow. Her legs were extended so that her pelvis oriented upward. There is one reported instance of a male assisting a female in this posture during parturition (Schwartz 1988).

The infant is normally born in a head-first presentation. Anterior (breach) presentations have been reported and successfully delivered.

The third stage is the expulsion of the placenta . The placenta may be passed immediately after the second stage of birth but is usually passed within a few hours. The umbilicus is broken by the female chewing through the cord. Females typically consume the placenta. Conspecifics present at the birth may also consume part of the placenta. If the female does not chew through the umbilicus or consume the placenta, continue to closely monitor the umbilical site. Staff must also carefully monitor the position of the umbilical cord in relation to the infant's body to ensure it does not constrict the infant's body in anyway. Any placenta tissue that is not consumed and easily retrievable should be submitted in a sterile container (if possible) to veterinary staff for examination.

Contractions may continue to be observed post delivery. Vaginal bleeding may also occur for several days after delivery. This should be reported to veterinary staff. But as long as the amounts are small, the discharge is not abnormally odiferous or discolored, and the animal acts healthy, this is usually normal.

Housing during labor
This will be dependent on your institution's animal management plan. Females should be given as much choice as possible to move around and choose the birth location. It is recommended to heavily bed the cages the female gives birth in with at least 8 to 10 inches of bedding. Bedding types may include: timothy hay, straw, shredded paper or wood wool. By providing a deep layer of bedding, you are ensuring that the female will be comfortable. If the birthing female does not carry the infant, bedding will help prevent the infant from laying on a cold hard surface (the floor), may delay hypothermia, and may prevent a falling related injury.

Problems associated with birth and delivery
Difficult birth (dystocia) is not common in orangutans, but it can occur. Veterinary staff should be prepared for any eventuality, and should be alerted when birth is expected. Ideally, a consultant MD with ob-gyn experience should be available for consultation if complications should occur. The SSP© Veterinary Advisor can also be consulted). Pre-existing medical problems (such as urinary infection, diabetes, hypothyroidism, obesity or malposition of the placenta) can complicate pregnancy and delivery. These cases and other related disorders are covered in Medical Management of the Orangutan (Wells et al. 1990).

Physical appearance of the newborn
Newborn infants are typically wet and appear small in size. Most zoo staff are surprised at the small size of an infant orangutan. Reported infant weights vary dramatically. Seitz (1969) reports the average birth weight of 7 male infants to be 1740 grams (range 1590 to 2015 grams). Five females in his study ranged from 1420 to 2040 grams with the average being 1694 grams. The average birth weight of the 12 infants total was 1720 grams. The head may be slightly misshapen from passage through the birth canal. The rib cage is prominent and the abdomen may appear sunken. You may not observe the newborn to defecate or urinate immediately. Often times, the first bowel movement of the newborn is dark in coloration. Typical feces color of a mother-reared infant is pale yellow.

Male infant genitalia and umbilical area at 48 hours of age

Post-partum behavior
Immediately post-partum, females have been known to insert their fingers into the infant's mouth or suck on the infant's face to remove mucus from the oral and nasal cavities**.** In one instance, a female was seen breathing into the infant's mouth (Graham-Jones and Hill 1962).

Females may inspect the ano-genital area of the newborn. Sexual behavior exhibited by the females towards an infant may include: dorsal-dorso mounting, oral-genital inspection and manipulation and insertion of fingers into ano-genital areas.

After giving birth, a female may spend more time than usual resting. Her appetite may be increased or decreased. Females carry infants continuously after birth. Both in captivity and in the wild, the infant is carried in a side ventral position or on top of the head or upper back. The side-ventral position does not interfere with the female's ability to move through the trees in the wild (MacKinnon 1974). Inexperienced females may carry an infant upside down or in a seemingly awkward position. If the infant appears to be healthy and is nursing regularly, there is no cause for concern.

Lactation and Nursing
Before birth, milk production, and even milk expression (called "milk let down") can occur. Self-nursing during pregnancy and after birth has been frequently observed, and has not been correlated with any medical problems to date (although the phenomenon has not been well-studied). Although milk is typically present immediately after birth, the breast tissue (especially in primiparous animals) may not appear full or engorged for a

few days. Colostrum (the first milk, which contains essential immunoglobulins for protection against disease) as well as milk, are typically thin and watery in appearance.

The Pittsburgh Zoo has successfully used the drug Reglan® to stimulate lactation in a female orangutan. This drug has been used to increase maternal milk supply in humans (Wight 1995); information is available through the La Leche League.

Nursing bouts are normally frequent and of short duration. In the wild, nursing takes place during short rest periods on the part of the mother. The intervals, on average, are forty minutes apart during the first year of life (Rijksen 1978). Suckling usually occurs within four to six hours after birth. Occasionally up to two days will pass before nursing takes place. The decision to remove an infant from its mother should be based on the physical condition and behavior of both the infant and the mother.

Diet and Supplementation during Lactation
Energy needs typically double or even triple, over the period of lactation. The diet composition should remain balanced, and should be gradually increased in correlation with the animal's general condition, weight, and activity. It is essential that adequate levels of total calcium, with a ratio of at least two parts calcium: one part phosphorus, be provided throughout lactation.

When to hand rear
A goal of the SSP© is to promote maternal care of infants. This can be accomplished in a variety of methods including: maternal training for females that have been identified as potential risks to exhibit inadequate maternal care, infant reintroduction to a dam at a later date, and by surrogate mothers.

Successful mothering is comprised of learned behaviors and it is thought that females are more likely to rear successive offspring if given as much time as possible to establish a relationship and perform some maternal care with the present infant.

However, in some cases, due to the health and welfare status of the mother and/or the infant, the need to hand rear an infant may be necessary. Post-partum observations by experienced staff are essential to carefully evaluate the relationship between mother and infant. Prior to the birth, staff should familiarize themselves with mother/infant behavior so they are able to accurately assess the animals' behavior (see Behavioral Biology-Chapter, this volume for more information). Monitoring with minimal disruption is recommended. The female is likely to respond positively to the caregivers' encouragement.

The decision to hand rear an infant should be based on the health status and behavior of both the mother and the infant.

Frequent evaluation of the above criteria by animal care staff is essential. If the infant's physical condition is questionable, such as dehydration, hypoglycemia/weakness, hypothermia, and/or if the mother exhibits complete disinterest or abuse that is determined to be life threatening, removing the infant may be justified. Other potential problems include lack of adequate maternal milk production or let down, mastitis, or critical maternal illness/weakness. As a general rule, infants do not need to nurse for approximately 12 hours, but the infant should not appear weak or unresponsive. Signs of infant weakness may include:

- Not being able to hold its head up (head dropping back)
- Eyes glazed in appearance
- Loss of grip on mother –infant should have a strong grip and be able to hold on without support from the mother
- Appearance of skin folds which may indicate dehydration
- Loss of ability to suckle properly – during nursing, infant fails to move jaws while on nipple
- Excessive crying (an indication of inadequate milk intake)

In some cases, transient hypothermia, hypoglycemia, and/or dehydration can be quickly evaluated and medically treated (warmth for hypothermia; subcutaneous fluids for dehydration; subcutaneous fluids and dextrose for hypoglycemia), and the infant may be successfully re-introduced to its mother. Such situations require careful evaluation, teamwork, and constant attention to ensure that the problem(s) are adequately resolved.

Detailed information on handrearing is given in the Handrearing Chapter, this volume.

Infant death

If the infant is stillborn or dies during birth or shortly after, the female may attempt to carry or nurse the dead infant. If possible, allow the female to keep the infant as long as she wants. Do not force her to give up the dead infant. It is advisable during this time to keep the animals out of public view.

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Appendix I– Menstrual Cycle/Reproductive Chart

Month/Year_____

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
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Codes
m=menstruating
ps=prosexual behavior
c=copulation
ls=labial swelling/pregnant
b=birth
ppb=post partum bleeding

Hemastix Results
n=negative
hs=hemolyzed small
ht=hemolyzed trace
hm=hemolyzed moderate
hl=hemolyzed large

Appendix II

Case History of a Separation Example

Sophia became pregnant by Ben in 1992. Although Sophia had previously given birth at another institution, she rejected her offspring. To our knowledge, Ben had never been present for the birth of an infant. With other pregnancies at Brookfield Zoo, we experienced no problems when adult males where housed with the female during labor and delivery. When Sophia was confirmed to be in labor, Ben appeared curious and excited (agitated). Once the infant was born, Ben closely inspected and then began to roughly flick his fingers at the infant. Staff decided to separate Ben from Sophia. The animals had been trained to routinely and comfortably separate in the past. Sophia did not exhibit proper maternal care for her infant so the animals remained separated for a few days. Once proper maternal care was observed, the animals were reintroduced without any problems. With subsequent pregnancies, staff implemented routine overnight separation of Sophia and her juvenile offspring (sired by Ben) 4 to 6 weeks prior to giving birth. This is a routine the animals have become comfortable with and allows staff better control of the situation if a problem arose.

Appendix III

Birth Management Plan for Sophia

Overview

0.1 orangutan Sophia is presently housed with 0.1 Kutai, age 5 (her daughter). At times they have creep access to 1.0 Otis (sire of infant to be born), or 1.0 Ben (sire of Kutai). At times, Kutai has creep access to 0.1 Maggie (adult female) and her adopted son Mukah (juvenile male).

Sophia is pregnant and estimated to give birth between the end of April and the end of May 1998. This estimated date is based on copulation dates (28,29 August 1997) with 1.0 Otis and cessation of menstruation after these dates. Her last gestation period when she was pregnant with 0.1 Kutai was approximately 250 days. Documented gestation range for orangutans is 225 to 273 days. Based on a 250 day gestation, she would be due to give birth on 5 May 98.

The primary priorities for the upcoming birth of Sophia and her infant are:

- ✓ to encourage Sophia to care for her infant naturally
- ✓ to have an action plan in place if Sophia does not care the infant properly

The secondary priority will be:

- ✓ to manage Kutai's interactions with Sophia and the infant if a problem should arise

Keeper staff feels fairly confident that Sophia will be exhibit proper maternal behavior towards her new infant. Sophia did not immediately show adequate maternal behavior towards Kutai during the first 48 hours post-partum. However, after this time, she exhibited proper maternal behavior. Keeper staff has decided to give Sophia a "refresher course" in her maternal skills training program (initially begun prior to the birth of Kutai). The training goals are:

- ✓ to refresh Sophia on her past maternal training program behaviors (in case of any unforeseen problems)
- ✓ to be able to comfortably separate Sophia from Kutai if the need arises

Carol and Nava are Sophia's primary trainers. Jen and Dawn are Kutai's primary trainers. If time allows, all of the full-time orangutan keepers (Carol, Nava, Jen, Dawn and Laura) will be cross-trained on Sophia and Kutai's behaviors.

Staff Assignments

Keeper staff: prepartum preparations for the birth, employing a positive reinforcement training program to encourage maternal behaviors, post-partum behavioral observations, interfacing with Tropic World Managers, Zoo Nutrition Services (ZNS) and Veterinary Services (VS) if the need arises and documentation of all aspects of the birth process

Tropic World Managers: monitoring and providing support for all aspects of keeper staff activities, serving as a liaison to ZNS and VS as needed, approving all action plans that are developed and employed subsequent to the birth

ZNS: to provide nutritional advice and services in case we need to hand-rear the infant or if Sophia is having a problem

VS: to provide medical support and services for all aspects ofthe birth and animal health issues

Pre-partum Preparations

- ✓ notify the night keeper that Sophia will be giving birth any time from the end of April to the end of May - complete by 4/12
- ✓ notify the nutritionist that Sophia is due to give birth – she will provide us nutritional information regarding hand-rearing if the need arises

- ✓ gather all necessary supplies for hand-rearing (bottles, nipples, formula, incubator, thermometer, blankets, scale and nursery records sheets) - complete by 4/12
- ✓ begin heavily bedding Sophia's cage with hay at night - complete by 4/12
- ✓ discontinue overnight housing of Sophia and Kutai with Otis or Ben - complete b 4/12
- ✓ continue daily training sessions with Sophia and Kutai - ongoing

Day/Night of Birth

1. If Sophia goes into labor during the day, keepers will immediately separate her and Kutai from any cage mates.
2. Once the infant is born, we will start a 24 hour watch on Sophia and the newborn. Traffic through her holding area will be restricted during this time as to not distract or disrupt, Sophia, Kutai or the new infant
3. Veterinary Services should be notified once the infant is born. It is preferable that the vet staff not come over to view the infant(unless there is a medical concern) as to not disrupt Sophia
4. If the infant is born at night, the night keeper should immediately notify Carol (Lead Keeper) who will then come in to assess Sophia and the infant's condition and begin a round the clock watch the animals. In Carol's absence, the night keeper will notify Nava.
5. Carol will notify the Assistant Curator and Curator of Primates once Sophia and the infant's conditions are assessed.

Assessing the Condition of the Infant

1. If the infant is strong and alert, a continuous watch will be done through the night
2. If Sophia is not nursing the infant and the condition of the infant remains stable and Sophia and/or Kutai are not harming the infant it can remain in the cage until the morning
3. If nursing has not occurred by morning, then we will use training techniques to encourage Sophia to nurse the infant(please refer to detailed post-partum training plan Appendix V)
4. If the infant's condition appears to deteriorate through the night, we will remove the infant and notify the vets to determine if they want to examine it. At the time of the examination we will allow the infant to nurse from Sophia's breasts and/or feed the infant
5. If the infant's condition seems to improve after feeding, we will put the infant back in the cage and continue to observe the animals
6. If at anytime, Sophia becomes aggressive to the infant and begins to injure it, we will remove the infant
7. If Kutai becomes aggressive towards the infant, we can give her creep access to Maggie and Mukah or to Otis

Additional Considerations

There is the possibility that the infant may be comprised medically. If this is the case, we will wait for the veterinary evaluation of the infant's condition. If it becomes necessary to treat the infant, we will proceed with a reintroduction of Sophia to her infant as soon as possible. During the time the infant is being treated, we will continue to train Sophia focusing on breast manipulation and milk collection (if this behavior is solidly trained by then). This will allow us to feed the infant Sophia's breast milk. If the infant's condition is stable, we may be able to let the infant nurse from Sophia's nipples through the cage front. Unless there is a medical concern, the infant will be housed in an incubator in the holding area as near as possible to Sophia's cage to encourage maternal bonding. We will follow our normal hand-rearing procedures at this stage.

Plan B – If All of the Prior Scenarios Fail

If we are unable to get Sophia to take care of her infant, we have the following options to pursue:

1. Sedate Sophia, put the infant on her breasts to nurse and allow her to recover from anesthesia with the infant clinging to her. During Sophia's recovery, a continual watch would be done to assess the infant's condition and Sophia's maternal skill level.
2. Remove the infant for hand rearing. Begin working with the infant to take a bottle through the cage front. During the infant's training, we would work with Sophia to allow us to feed the infant through the cage front (as we did in the past with Katie and Batik orangutans). This may take several months of hand-rearing and infant training prior to re-introduction. Batik was reintroduced to Katie at 5.5 months of age
3. Consider Pepper as a potential surrogate for the infant (note: this is another adult female at our institution who is a competent mother)
4. Consider Maggie as a potential surrogate (note: this is an adult female at our institution who is a proven surrogate mother but who presently has a 3 year old adopted son)
5. Send the infant to another institution for surrogate rearing

Additionally, a birth plan tracking summary was developed so staff could follow the proper steps as the birth progressed.

SOPHIA BITH PLAN TRACKING SUMMARY

Day of Birth

When labor is confirmed:
-Separate Sophia and Kutai from any enclosure mates
-Keepers begin continuous observations, take detailed notes, possibly videotape birth
-Keepers notify Assistant Curator, Curator, Veterinarians
-Restrict access to holding area to "as needed basis"
-Keepers begin to warm the incubator

*If labor goes beyond regular keeper work day, the Lead Keeper or second in command will stay to monitor labor/delivery/birth

When infant is born:
-continue to monitor Sophia and new infant, take detailed notes
-notify Assistant Curator, Curator, Nutritionists and Veterinarians

After Hours Birth

If the night keeper discovers that Sophia is in labor:
-he will notify the Lead Keeper or second in command who will come in to assess the situation
-begin continuous observations, take detailed notes
-notify Assistant Curator, Curator, Veterinarians
-begin to warm the incubator

If the night keeper discovers that Sophia has given birth:
-he will notify the lead Keeper or second in command who will come in to assess the situation
-begin continuous observations, take detailed notes
-notify Assistant Curator, Curator, Veterinarians
-begin to warm the incubator

Post Partum

If the infant is medically compromised;
-meet with keepers, managers and veterinarians to formulate an action plan

If Sophia is aggressive towards the infant:
-separate infant from Sophia
-meet with keepers, managers and veterinarians to formulate an action plan

If Kutai is aggressive towards the infant:
-separate Kutai from Sophia and infant
-give Kutai creep access to Maggie and Mukah

If creeping Kutai to Maggie and Mukah has no positive effect:
-house Kutai with Otis
-determine an action plan with keepers and animal managers

If Sophia is ignoring the infant or interested in the infant but not carrying it:
-attempt training session to encourage Sophia to pick up the infant and hold it in a nursing position to her breast

If the infant nurses within 24 hours:
-document all bouts/lengths of nursing
-maintain continuous observations, take detailed notes

If the infant does not nurse within 24 hours:
-maintain continuous observations, closely monitoring condition of infant as well as Sophia's behavior, take detailed notes
-notify veterinarians to assess medical condition of infant
-after 24 hours or time to be determined, attempt a training session with Sophia to encourage maternal behaviors (refer to Post Partum Training Plan)

If the infant's condition deteriorates:
-maintain continuous observations, take detailed notes
-separate Sophia from infant
-notify veterinarians to assess medical condition of infant
-feed infant (if there are no medical concerns)
-meet with keepers, managers and veterinarians to decide on how to proceed with the introduction (if the infant is healthy)

If the infant is healthy and a re-introduction could take place:
-re-introduce the infant to Sophia
-maintain continuous observations of infant and Sophia, take detailed notes
-if necessary, attempt a training session with Sophia and infant to encourage maternal behaviors

If Sophia has no interest in the infant:
-sedate Sophia and allow the infant to nurse from both of her breasts (if infant is being bottle fed, do not feed infant prior to this)
-leave infant in cage during Sophia's recovery period
-keepers begin continuous observations, take detailed notes

If all efforts to get Sophia to take care of her infant fail:
-begin hand-rearing process
-house infant in holding area in an incubator in front of Sophia's cage
-determine an action plan with keepers and animal managers

Appendix V

Post Partum Training Plan

Assuming the infant's condition is stable and no nursing is observed the following may occur:
-Infant born at night, keepers' monitor, training session attempted early to mid a.m.
-Infant born in early morning, keepers' monitor, training session attempted in early to mid afternoon
-Infant born in afternoon, keepers' monitor, training session may be attempted later in early evening or may wait to early a.m. dependent on infant's condition.

Behaviors needed to accomplish this follow. *=behaviors to be solidified or shaped #=behavior already trained

<u>Sophia holding but not nursing infant - infant strong/alert</u>
hold hands so arms are away from infant
scratch and touch abdomen
target nipple to cage front
work with two trainers at once so one trainer can do hand hold and other trainer can position infant to her breast (this could be accomplished through half creep door)
Working with surrogate stuffed animal through cage front getting her accustomed to be touched by surrogate, allowing her to touch surrogate in a gentle manner and training her to release her hold on the surrogate on cue

Other problems associated with above scenario:
-Infant carrying position may be improper
-Sophia could be jealous of the attention given to her infant. This could be overcome by feeding and talking to her.

<u>Sophia ignoring infant or Sophia interested in infant but not carrying it</u>
retrieve infant
hold infant (object)

Once Sophia retrieved the infant and held infant at cage front, the trainers would try to position it to her breast.

Sophia carries and nurses infant but is mildly aggressive to infant
Trainers will try to calm Sophia down through stroking, positive keeper interactions and food. If this fails, we may want to consult with veterinarians about the possibility of using a sedative to relax her.

Sophia carries infant, does not nurse infant and is mildly aggressive towards infant
Trainers will try to calm Sophia as above. Sophia will then be asked to bring infant to cage front and two trainers will work with her to position the infant to her nipple.

hold hands so arms are away from infant
scratch and touch abdomen
target nipple to cage front
nipple stimulation
work with two trainers touching her at once so one trainer can do hand hold and other trainer can position infant to Sophia's breast.

Kutai has infant, is harming the infant and Sophia is not interested in infant
Remove infant from Kutai as quickly as possible. Separate Sophia and Kutai from infant. Have veterinarians examine infant for injuries. If no serious injury to the infant, the infant will be reintroduced to Sophia and at some point to be determined, Kutai.

Sophia retrieve and pick up infant, position it to abdomen

Kutai has infant, Sophia wants infant
We would monitor this situation closely as there could be a possibility of injury to the infant if Sophia attempts to take the infant from Kutai.

Sophia feeling poorly after giving birth, exhibiting less than optimal maternal care
We would continually monitor this situation and a plan of action would be dependent on the infant's physical condition and Sophia's behavior. There is a possibility we may have to separate Kutai, if she is interfering with Sophia and/or the infant.

Kutai voluntarily separate from Sophia

Orangutan Trainers Behavior List

Sophia +=priority behaviors to be solidified

+pick up surrogate and put it to breast (Nava)
+hold hands over head on cage front (Carol)
+voluntary separation (Nava/Carol)
+allow breast pump to be placed on breast (Carol)
+allow milk to be expressed from breasts (Carol)
+two trainers at once - one trainer stationing her arms over her head, one trainer doing belly (Nava/Carol)
+target surrogate to trainers target (Nava)
+moving a novel object (post it) around on abdomen (Carol)
+retrieve (Nava)
+remove a novel object from Kutai

Behaviors that are solid:
head
hold hands under cage front
target
trade
nipple stimulation
lift bucket
present
foot
stand
belly
belly, then target baby bottle to abdomen
stand, climb cage front, then target abdomen
stand, climb cage front, then target breasts
other
release
tactile
take it nice
shake bottle
present labia
shoulder
say ah

Kutai +=priority behaviors to be trained
+voluntary separation
+retrieve
+retrieve object and place it in black tub or other designated location
+station to a shelf, so keeper can shut shift door
+carry a novel object on abdomen
+stand
+stand at a designated station (Sophia)

+stand at a designated station and allow Sophia to remove a novel object from body

Behaviors that are solid:
belly
present labia
turn around/present back
rectal swab
lips
foot
finger
hands under cage front
shoulder
open mouth head
tongue

Note: This training plan will be reviewed and updated over the next month. Sophia does not seem as interested in her training sessions as she was when she was pregnant with Kutai. All of her behaviors may not be able to be trained prior to the birth of this infant.