The Care and Management of Chimpanzees in Captive Environments

A husbandry manual developed for the Chimpanzee Species Survival Plan

Nutrition of Captive Chimpanzees

Randy Fulk, Ph.D., Michael Loomis, DVM, Diplomate ACZM, Chris Garland North Carolina Zoological Park

Cite Reference:

Fulk, R., M. Loomis and C. Garland (1992) Nutrition of captive chimpanzees. In: *The care and management of chimpanzees in captive environments. Chimpanzee Species Survival Plan – Husbandry Manual.* Fulk, R. and C. Garland, Eds. American Association of Zoos and Aquariums

Wild:

Chimpanzees are primarily frugivorous, but also include leaves, seeds, flowers, pith, insects, and vertebrates in their diet (Ghiglieri, 1984; Goodall, 1968; Reynolds & Reynolds, 1965; Hladik, 1977; Jones & Sabater Pi, 1971; Wrangham 1975, 1977; White & Wrangham, 1988). Chimpanzee diets are highly diverse, Wrangham (1977) estimated that adult males eat 60 different food items each month, and that their diet diversity was stable from month to month. One 'hundred forty plant foods were reported for chimpanzees at Gombe by Wrangham (1977) and another sixty-one identified from the observation files there. The number of plant species used by chimpanzees at Gombe is similar to the 141 plant foods recorded by Hiadik (1973) at Ippasa, Gabon, and the 205 recorded by Nishida (1974) at Mahale, Tanzania. The list of plant foods used by chimpanzees will probably continue to grow with further observations$_1$ and as new foods are added to the diet (Teleki, 1981).

Besides plant foods, chimpanzees include insects and vertebrates in their diet. Animal foods make up a small portion of the diet (Wrangham, 1977), but a wide variety of animal foods are included in the diet. Goodall (1986) reports the inclusion of termites, ants, wasps, caterpillars, beetle grubs, and crickets in the diet, as well as the use of "insect products" such as honey, galls, and termite clay. Feeding on scorpions was observed in Gabon (Hladik, 1977) but not at Gombe. No fish, amphibians, or reptiles were taken at Gombe even though drying fish were encountered on the lake shore and were eaten by baboons. Birds and eggs were eaten occasionally, and usually combined with leaves or bark (Hladik, 1977; Wrangham, 1977). Six mammal species were eaten by chimpanzees at Gombe. Listed in order of the frequency of capture they are: colobus monkeys (*Colobus badius*), bushpig (*Potamochoerus porcus*), bushbuck (*Tragelaphus scriptus*), redtail monkeys (*Cercopithecus ascanius*), blue monkeys (*Cercopithecus mitis*), and baboons (*Papio anubis*) (Wrangham, 1977). To this list can be added black and white colobus monkeys (*Colobus polykomos*), green monkeys (*Colobus sabaeus*), vervet monkeys (*Colobus aethiops*), potto (*Perodictucus potto*), greater galago (*Galago crassicaudatus*), and dwarf galago (*G. emidovii*) (Teleki, 1981). Goodall (1986) reports similar predation mammals for a period covering 21 years. The frequency of capture is slightly different, baboons are taken more frequently than redtail or blue monkeys, and 6 observations of cannibalism are reported.

Chimpanzees may spend half of their day feeding, and shift from one food type to another even before the first type has been depleted (Goodall, 1986; Teleki, 1981). Even though chimpanzees seem to like variety, 50% of their feeding time is spent on the top 2 to 5 food types (Wrangham, 1977). Availability seems to determine the amount of time spent feeding on a particular food type. The fact that chimpanzees will leave a patch before it is depleted suggests

that searching for new foods, or for better patches is an important part of their foraging strategy. Different foods are also eaten at different times of the day, with fruit being eaten at the early and late _feeding bouts, and leaves during the middle of the day (Hladik, 1977; Teleki, 1981; Wrangham, 1977). Mammals are taken opportunistically (Wrangham, 1977). Seasonal changes in food also affect foraging patterns, and seasonally abundant foods such as emerging insects or caterpillar aggregations are exploited (Goodall, 1986).

Chimpanzees may spend up to 4 minutes standing on the ground looking up into a tall tree, trying different angles, looking for food in the canopy, or testing fallen fruit beneath the tree. If another adult occupies the tree, already feeding, a chimpanzee will not spend time assessing the quality of the feeding site, but will ascend immediately and start feeding (Goodall, 1986; Wrangham, 1977). If a baboon or young chimpanzee is seen in a tree, an adult chimpanzee will examine the site as if it were unoccupied (Wrangham, 1977). Some food items, such as large fruit, are examined individually before eating, while leaves are usually stripped, chewed and swallowed without individual inspection. One exception is the leaves of the fig (Ficus urceolaris) which are picked one at a time, collected and folded together before they are chewed (Wrangham, 1977). Often leaves are added to soft fruits that have been crushed against the ridged palate of the chimpanzee, and sometimes to eggs and meat. This mixture of leaves and other foods forms a "wadge" that is sucked for 10 minutes or more to extract its juices. A wadge may be held in the mouth as the chimpanzee moves to another feeding site (Goodall, 1986). Usually chimpanzees food where they find it, but they may collect branches or fruits and carry them to a more comfortable or shady spot on the ground (Goodall, 1986; Wrangham, 1977). Chimpanzees seem to have good spatial representations of their feeding sites, returning to productive sites after days of traveling.

One of the most striking foraging techniques used by chimpanzees is “fishing” for termites. The techniques of fishing vary from simple prodding of a leaf or unprepared stem into a hole in the termite mound to careful selection of an appropriate stem, stripping and shaping it before inserting it into the mound. Female chimpanzees at Gombe fish for termites all during the year, and both sexes spend up to 20% of their feeding time fishing for termites during November (Goodall, 1986). A similar technique is used to probe for ants by Mahale Chimpanzees (Nishida & Hiraiwa, 1982). Goodall (1986) suggests the termites are also important in chimpanzee diets in Senegal, and that techniques of fishing similar to those used at Gombe may be used. Besides fishing tools, chimpanzees have been observed to use rocks as tools to break open hard palm nuts (Boesch & Boesch, 1983), but chimpanzees at Gombe have not used this technique (Goodall, 1986; Wrangham, 1977).

Hunting by chimpanzees seems to be opportunistic, occurring when potential prey are sighted, but it is not haphazard, and often involves the coordination of several individuals (Goodall, 1986; Teleki, 1973, 1981; Wrangham, 1975). Cooperative hunting may have social as well as dietary advantages (Teleki, 1981). Hunting techniques differ depending on the species being hunted. For example, when hunting red colobus monkeys, chimpanzees spend a great deal of time on the ground looking up into the canopy, searching for prey. Wrangham (1975) reports that red colobus are not usually pursued in closed canopy but are if the canopy is discontinuous. Sometimes individuals climb to chase monkeys, but often two chimpanzees act together to begin the hunt. Aggressive defense by the attacked monkeys is often sever, and they may rescue troop members from capture by chimpanzees. Of the 217 monkey hunts observed at Gombe between 1973 and 1981, on average 49.2% resulted in one or more monkey being captured. Bushpigs were captured with a success rate of 66.7%, based on 27 observed hunts

(Goodall, 1986). Cooperation among male chimpanzees during hunting is. evident from the tactics used to hunt various species including colobus monkeys and baboons. The coordination of several individuals positioning and repositioning themselves in stalking and encircling their prey (Teleki, 1973, 1981). The advantages of group huriting are contriversial (Busse, 1978) as single individuals are often successful hunters, but further research may elucidate the social and diatery consequences of cooperative hunting (Suzuki, 1975; Teleki, 1981). Sex differences bxist in the foraging strategies of chimpanzees at Gombe, and probably elsewhere. Males concentrate on hunting mammalian Species, and females on social insect prey (Goodall, 1986; McGrew, 1979). The high sociability of males, and the relatively unsociability of females may influence the sex differences in foraging strategies. McGrew (1979) suggests that sex-typical foraging specializations of chimpanzees mirrors that of human hunter-gatherer societies, and may represent an evolutionary preadaptation for human social structure.

Foraging behavior and the distribution of food influence the social structure of chimpanzees, especially party size. Competition among chimpanzees feeding at the same site does not usually involve overt aggression or displacement of individuals, but the foraging success of individuals is affected by exclusion from a feeding site by other chimpanzees. Males are dominant to females, and some males are dominant to other males at feeding sites. Individuals occupying prime sites may be able to feed with minimum effort, just reaching out and pulling the food in, while others may have to expend energy in moving about to gather food (Goodall, 1986). Individuals feeding together tend to space themselves evenly, often about an arm's length apart. Individuals forage closer together when the food is densely packed, as in dense collections of palm nuts (Wrangham, 1977).

Party size varies with food type (Ghiglieri, 1984), with smaller parties found at palm-nut sites than at sites where the food is less densely distributed. the probability of feeding decreases as party size increases (Wrangham, 1977), and suggests that females and their young are more likely than males to feed alone in order to avoid competition from dominant males, and other females. Parties formed at feeding sites are likely to stay together when they leave the site. Larger traveling parties could be the promoted by collective feeding on a rich, and evenly distributed food source. Food calling serves as a long-distance signal advertising the location of a rich food source. Only males emit food-calls, both males and females respond to the calls and aggregate at the food site. Males may benefit from the aggregations. by Increasing their contact with females in estrus, and by forming larger parties that can more successfully defend the community boarders (Goodall, 1986; Chiglieri, 1984; Wrangharn, 1977). Differences in the distribution of food used by *P. troglodytes*, *P. paniscus*, and *Gorilla gorilla* contribute to the differences in social organization of the species. Gorillas feed on an evenly distributed, relatively abundant food source (Reynolds, 1979). The even distribution of food allows male gorillas to sequester females into harems, because of the capacity of small areas to sustain a number of females. The patchy distribution of resources available to *P. troglodytes* makes it necessary for females to range widely within a community's boarders, and males are unable to sequester and defend groups of females. Spider monkeys (*Ateles paniscus chamek*), faced with similar ecological conditions, exhibit similar form of multi-male defense of a number of females within a large communal range (McFarland, 1986). *P. paniscus* tend to feed in larger patches than do *P. troglodytes* which reduces competition among females, and is perhaps due to greater availability of large patches to *P. paniscus*. The large patches of *P. paniscus* may have promoted cooperation among females, and may be part of the explanation of the higher degree of female sociability of *P. paniscus* than *P. troglodytes* (Wrangham, 1988).

Captivity:

Chimpanzee diets in captivity have changed dramatically over the course of the last 90+ years. The lack of adequate foods to meet the nutritional needs of the species was a major contributing factor to chimpanzee mortality in the early years of zoo management. The development of what was thought to be a nutritionally complete primate diet, or monkey chow, has enhanced the health and longevity of zoo chimpanzees.

The specific nutritional requirements for chimpanzees are still not completely understood. Most diets analyses are based on human recommended daily allowances (RDA). As with humans, the nutritional requirements of chimpanzess change with age and various physiological states. For an approximation of chimpanzee nutritional requirements, consult human RDA tables

Diets serve two functions in captive environments. First and foremost, diets, when properly designed, meet the nutritional requirements of the species. They also, when properly designed, can be a valuable source of environmental enrichment for chimpanzees and educational facilitators for the public. As was indicated previously, the majority of a wild chimpanzee's day is spent foraging for food. The foraging techniques performed by wild chimpanzees can be considered to be definitive species-typical behaviors. The aim of an SSP is to ensure behaviorally representative as well as genetically representative populations in zoological institutions.

Diversity of items within a chimpanzee diet and diversity in the ways in which the diet items are presented to the chimpanzees provides a great deal of environmental enrichment. Diet items that require long processing times have been shown to successfully reduce the incidence of agonistic and abnormal behaviors (Bloomsmith et al., 1988). Foraging for diet items that are small and widely dispersed tends to occupy longer periods of time than consuming items fed in a more "concentrated" fashion. This increased time spent foraging is more typical of a wild chimpanzee's daily activities, and as such helps in providing a more accurate educational experience for the public. The time and behaviors surrounding the search for, preparation of, and consumption of food items are an integral part of chimpanzee social dynamics, physiological and psychological development and psychological well-being.

Novelty in the diet provides important stimulation for the chimpanzees. However, diet items need to be evaluated and approved by the staff veterinarian before being offered to the chimpanzees. Diets, in general, should be evaluated regularly as part of an overall preventative health program for chimpanzees. Nutritional assays should be performed to determine the beneficial and detrimental aspects of an institution's chimpanzee diet, and any major change to the diet should be followed by an additional nutritional assay.

The best chimpanzee diets will combine food items that meet all the nutritional needs of the chimpanzee with items that are stimulating and that enhance the environmental enrichment of the space the chimpanzees live in.

These twin goals are not necessarily mutually exclusive. Items like Monkey Chow provide a complete balanced nutrition source, but provide limited stimulation unless widely disperesed or "hidden" in hay or straw (besides that, they just don't taste very exciting). There are, however, a number of food items that are both nutritionally beneficial and stimulating. The following tables list the food items that are currently fed to chimpanzees, the number of institutions that feed them, and the percentages of the total number of responding institutions that feed a given food item. N=27

Table 3.3 Vegetables

Vegetable Type	# of Inst	% of Inst	Vegetable Type	# of Inst	% of Inst
Beans, Green	7	26%	Onions	11	41%
Beets	3	11%	Parsnips	1	4%
Broccoli	10	37%	Peas, Hulled	2	7%
Brusel Sprouts	1	4%	Peas, Snow	3	11%
Cabbage	6	22%	Peppers, Bell	4	15%
Carrots	20	74%	Pomegranate	1	4%
Cauliflower	4	15%	Potatoes, Sweet/Yams	20	74%
Celery	11	41%	Potatoes, White	11	41%
Chard	1	4%	Pumpkins	1	4%
Corn on the Cob	9	33%	Radishes	1	4%
Cucumbers	4	15%	Rhubarb	1	4%
Eggplant	2	7%	Rutabagas	2	7%
Endive	2	7%	Spinach	8	30%
Escarole	2	7%	Sprouts, Bean	1	4%
Greens, Beet	1	4%	Sprouts, Soybean	1	4%
Greens, Collard	3	11%	Squash, Acorn	2	7%
Greens, Mustard	3	11%	Squash, Butternut	1	4%
Greens, Turnip	1	4%	Squash, Generic	1	4%
Kale	8	30%	Squash, Spaghetti	1	4%
Kohlrabi	1	4%	Squash, Yellow	4	15%
Leaks	1	4%	Squash, Zucchini	4	15%
Lettuce	18	67%	Tomatoes	10	37%
Mushrooms	1	4%	Turnips	5	19%
Okra	1	4%	Vegetables, Frozen Mixed	3	11%

Table 3.4 Fruits

Fruit Type	# of Inst	% of Inst	Fruit Type	# of Inst	% of Inst
Apples	24	89%	Mangos	3	11%
Apricots	3	11%	Melon, Cantaloupe	7	26%
Avocados	2	7%	Melon, Honeydew	4	15%
Bananas	20	74%	Melon, Water	5	19%
Blackberries	1	4%	Nectarines	3	11%
Blueberries	1	4%	Oranges	22	81%
Cherry's	2	7%	Papayas	4	15%
Cocoanuts	2	7%	Peaches	4	15%
Cranberries	1	4%	Pears	6	22%
Dates	2	7%	Persimmons	1	4%
Figs	3	11%	Pineapples	4	15%
Frozen Fruits	1	4%	Plums	4	15%
Fruit Juices	1	4%	Prunes	1	4%
Grapefruits	4	4%	Raisins	12	44%
Grapes	15	56%	Raspberries	2	7%
Guava	1	4%	Strawberries	3	11%
Jicima	1	4%	Tangelos	2	7%
Kiwi	1	4%	Tangerines	3	11%

Lemons	3	11%	Ugli Fruits	1	4%

Table 3.5 Cereals

Cereal Type	# of Inst	% of Inst
Bread	3	11%
Cereals, Generic	4	15%
Cherrios	1	4%
Crispix	1	4%
Oats, Rolled	1	4%
Rice, Brown	2	7%
Rice, Cakes	2	7%
Rice, Checks	2	7%
Rice, Puffed	2	7%
Wheat, Chex	1	4%
Wheat, Puffed	2	7%

Table 3.6 Miscellaneous Food Item.

Miscellaneous Type	# of Inst	% of Inst	Miscellaneous Type	# of Inst	% of Inst
Bamboo	1	4%	Peanut Butter	2	7%
Chicken Scratch	1	4%	Peanut Butter Sandwich	1	4%
Cottage Cheese	2	7%	Popcorn	2	7%
Egg, Generic	1	4%	Primate Diet, Canned	1	4%
Eggs, Hard Boiled	3	11%	Primate Pellets, Dry	22	81%
Granola	1	4%	Rice, Meat, and Vegetable Stew	1	4%
Jello	4	15%	Seeds, Generic	3	11%
Milk	2	7%	Sugar	1	4%
Muffins	1	4%	Sugar Cane	3	11%
Mustard	1	4%	Torillas	1	4%
Nuts, Generic	1	4%	Yogurt	3	11%
Nuts, Peanuts	6	22%			

The frequency with which food items are fed varies from institution to institution. Some feed the majority of the daily diet at one time, using forage items such as cereals and berries for behavioral enrichment during the day. Some zoos divide the daily diet into several feedings, typically A.M., Noon and P.M. Still others, cut the daily diet into small pieces, Usually with the exception of dry primate diet, and spread the diet throughout the environment in an attempt to simulate wild foraging conditions. The method used to feed the diet is best determined through consideration of the to main goals of a diet, nutrition and enrichment, along with the other aspects of the care routine such as, moving the group from one location to another (exhibit area to holding area), the social dynamics of the group, the educational value to the public, and the methods used to maintain a clean, healthy environment.

Nutrition-related problems are fairly uncommon in chimpanzees today. However, hypercholesterolemia (serum cholesterol >200-250 mg/dl) occurs in many chimpanzee collections. Cholesterol levels in excess of 400 mg/dl have been reported. Although the cause of hypercholesterolemia is multifactorial, feeding low cholesterol diets to chimpanzees with hypercholesterolemia has significantly reduced serum cholesterol in some individuals.

Another diet-related problem frequently seen in adult female chimpanzees is iron deficiency

anemia. Iron supplementation should be considered in female chimpanzees with hematocrits below 35% provided no other cause of anemia can be detected.

Dry skin responsive to increased fat content in the diet has been reported in several chimpanzees. If the dietary fat content is to be increased, a source of polyunsaturated fat containing a high proportion of essential fatty acids (such as safflower oil) should be used. All of these items, whether health related, behavior related, or procedural, factor into a decision of when and how to feed the daily diet. Balancing them appropriately enhances the experience of the public, the effectiveness of husbandry practices and most importantly$_1$ the health and well being of the chimpanzees.

Nutrition Recommendations:

- Chimpanzees should be fed a diet that includes a mixture of vegetables, fruits, cereals, and nutritionally complete dry food. Some of the food items should be fed in a manner that requires preparation and/or search and location by the chimpanzees.
- The daily diet should be fed in a manner that ensures that each individual in the group is receiving the amount and quality of food needed to remain healthy.
- The daily diet should be fed in a manner that provides a significant level of environmental enrichment for the chimpanzees.
- Diets should be evaluated on a regular basis to ensure that the nutritional needs of each group member are being met. This evaluation should be based on a combination of dietary assays, medical examinations and an awareness of the life stages i.e. infant, adolescent, pregnant female, older individual) of the individuals in the group.

Nutrition Suggestions:

- Provide a variety of items to the group. Change diet items frequently to provide maximum novelty (ensure that total daily diet meets nutritional needs of group).
- Chop larger diet items into small pieces and feed food items that are small and easily dispersed to increase the time spent foraging for food items.
- Take advantage of seasonal availability of certain unique food items.

Hand Rearing of Captive Chimpanzees

Ingrid Porton

Infant Care-Taking and Socialization

The strongest bond in chimpanzee society is between mother and infant. Completely helpless at birth, an infant chimpanzee is fully dependent on the care of its mother and for the first four months of its life is in continual contact with her. The infant is typically carried ventrally by the mother who supports the baby until it is strong enough to cling by itself. While walking, the mother usually supports the infant with one hand although when she climbs she may tuck up one leg and cradle the youngster. The age at which the infant begins to ride on the mother's back varies with the individual personalities of the mother and infant. Typically, this begins at five to seven months (van Lawick-Coodall, 1967), but some mothers may encourage youngsters to ride dorsally at an earlier age (Nicolson, 1972). Locomotor independence is reached somewhere between four and six months of age (Mason, 1972). Nicolson (1972) found that independence occurs earlier in a less complex environment, thus captive born chimps may explore their

generally less complex environment earlier than wild born infants.

Flienske and Griffen (1978) noted that for the first 69 days infants spent 6-11% of their time nursing. Nicolson (1972) calculated nursing bouts per hour and found that for the first four months infants nursed three times per hour for an initial average of 3.9 minutes but gradually decreasing to 2.9 minutes per bout. Females assist the infant in locating a nipple by holding the youngster near her breasts. Infants may begin experimenting with solid food as early as 11 weeks (Nicolson, 1972) although 15 weeks is more typical (Coodall, 1990). Infants learn what to eat and how to process the food items by observing their mother and by taking small bits of food from her. Mothers also shape feeding behavior by taking inappropriate food items away from their infant. Weaning is a gradual process, which is generally completed before the birth of the mother's next offspring. At Gombe and Mahale, this occurred when the youngster was five years old (Hiraiwa-Hasegawa, 1989). Weaning is a traumatic time for the young chimpanzee and may lead to depression that lasts for a month to a year (Clark, 1972).

Because of the fluid nature of the chimpanzee's social systems, the infant grows up in a varying and diverse social environment. An infant born to a multiparous female may be in the continual company of a sibling as well as its mother. The extent to which an infant is exposed to other individuals in its community can vary with family size, status and/or sociability of its mother, food availability and dispersal, and individual personality. Goodall (1986) observed that a youngster actively engaged in playing with a peer may refuse to follow its mother and thereby affect its own opportunity to socialize. Alloparental care is common among chimpanzees and most often provided by male and female siblings (Goodall, 1986). However, Nishida (1983) reports that at Mahale unrelated nulliparous females exhibited alloparental care as well. Transfer of the infant to an alloparent is initiated by the infant or the alloparent, not by the mother. Adult males may also exhibit alloparental care, but mothers are more wary of such interactions arid supervise them more closely.

Primate Socialization

It is well known that learning plays a central role in the behavioral development of a primate. Although certain behaviors may be fixed, the appropriate expression of these behaviors is learned through the process of socialization. "Socialization refers to the sum total of an animal's past social experiences which, in turn, may be expected to shape future social behavior. Socialization is that process linking an ongoing society to a new individual. Through socialization, a group passes its social traditions and life-ways to succeeding generations. The socialization process ensures that adaptive behavior will not have to be discovered anew each generation." (Poirier, 1972). Poirier goes on to state "since most primates live a rather complex social life, they must learn to adjust to one another, to get along; compared to most of the animal world, primate societies may have the greatest differentiation of learned social roles."

Although a chimpanzee may be weaned at five years of age, the youngster spends another 7 to 10 years traveling with its mother. Thus over a period of about 15 years, the maturing chimp is learning to live in its ecological and social environment. Feeding, nest building, tool making, sex roles, parental behavior, and the ability to effectively and appropriately communicate with a range of conspecifics are but some of the behaviors learned during childhood and adolescence. Learning occurs not only through interactions' with adults but also with peers and differs between the sexes. For example, maturing males spend considerably more time in rough and tumble play with peers than do females. Such rough play not only prepares them for their future role as adults but also begins to define their relationship to one another. Young males also

spend more time watching adult males, an activity of which the adults are very tolerant. In contrast, maturing females spend more time with their mother and her subsequent offspring. The young female observes her mother care for the infant and spends considerable time handling the infant. Additionally, during this time mothers may actually contribute to shaping their daughters' maternal skills by retrieving infants when mishandled and permitting continued contact when the daughter's interactions are appropriate (Goodall, 1986).

Social Isolation

The effects of socially isolating an infant primate have been well documented. Infants partially or totally isolated for differing periods of time exhibit varying degrees of social disturbances and inadequacies. Harlow's (1962, 1966) work with rhesus macaques demonstrated that sexual behaviors (females presenting to and standing for males; males mounting and copulating with females) were severely and negatively affected when infants were raised in isolation from their mother and peers. " Motherless mothers" ignored or abused their newborn infants. All youngsters raised in isolation exhibited one or more stereotypic behaviors that later in life interfered with their social interactions. The age at which infants were separated from their mothers, and the duration of social isolation affected the severity of disturbances manifested by the macaques.

Davenport and Rogers (1970) studied the effects of socially isolating 16 infant chimpanzees and placing them in one of four environmentally impoverished housing conditions. All 16 infants developed one or more stereotypic behavior such as rocking, rapid twirling, thumb sucking, eye poking, hand shaking, and posturing. Infants developed stereotypic behaviors by one to two months of age and by two years of age some infants spent three fourths of their day performing stereotypic behavior. Berkson, et al., (1963) found that the manifestation of stereotypic behavior in laboratory-raised chimpanzees occurred most often under stressful conditions.

Eight of the above 16 chimpanzees were' tested at between seven and nine years of age to evaluate intelligence and adaptability. All did more poorly than wild born individuals that were partially mother raised. Socially, the research subjects were "incapacitated." When placed together, the youngsters were fearful and did not seek each other out for comfort or companionship' (Davenport & Rogers, 1970). Sexual behavior was adversely effected in 12 of the above chimpanzees that were studied as adults. Males did not mount or copulate and females did not present when tested with each other. However, when placed with sexually experienced conspecifics, three of the five males and five of the seven females copulated as a result of the persistency of the experienced individuals (Rogers & Davenport, 1969).

Hand-rearing

In the past, the success of a hand-rearing program was measured by whether a hand-reared individual could reproduce, and in the case of a female, raise her own youngster. These criteria are of course important, but they do not in themselves constitute the entire picture. Fritz (1986) does not use copulation as a primary measure of resocialization in asocial chimpanzees. Never the less, most likely because these behaviors are easily measured, (the individual does or does not copulate/raise its young), they have remained the standard criteria by which to evaluate the success of a hand-rearing program.

However, it should now be clear that a captive breeding program must strive to maintain the

full behavioral complexity of a species. Just as we develop breeding programs to maximize retention of the original genetic diversity so should we plan to 'maximize retention of the full repertoire of behavior patterns and intellectual flexibility inherent in a species. To do so requires, at the very least, that infants are raised and socialized by their own kind. (Porton, et al; in prep)

The chimpanzee is an extremely complex and intelligent animal who spends its first ten to 15 years of life learning to become a functioning member of its community. The complexity of the chimpanzee's fission-fusion social system requires that individuals learn how to communicate effectively with a wide range of conspecifics. Hand rearing can detrimentally affect the intellectual, behavioral, and social development of a chimpanzee. **Therefore, the Chimpanzee SSP strongly recommends that all institutions develop breeding programs that increase the likelihood infants will be mother-raised within a social group.**

The Chimpanzee SSP suggests that each institution evaluates, as accurately as possible, the potential of mother-rearing within its breeding group. If certain individuals are assessed as potentially problematic, it is suggested that a two-pronged reproduction management strategy be developed. One strategy would entail the development of a program designed to increase the maternal potential of problem females. The second strategy would be the development of a cross-fostering or hand-raising/resocialization contingency plan.

Methods to Improve Maternal Care

There are a number of techniques that can be employed to facilitate appropriate maternal care by chimpanzees. Hannah and Brotman (1990) detail the results of their study which looked at the effects of allowing ten pregnant, hand-reared, maternally inexperienced females to be housed with a lactating female and her offspring' and/or to be housed with an infant chimp. Two of the females were exposed to infants with which they could interact, three females were exposed to a mother/infant pair and five females. were exposed to both conditions. Nine females in the control group were not exposed to mothers or infants. The authors found that all but one of the females in the experimental group successfully raised her own infant, whereas no female in the control group was able to raise her youngster. The results strongly suggest that the opportunity to observe mothers care for their offspring, or the experience of handling an infant may overcome maternal deficiencies to the extent that females are able to raise their infants.

Thus an institution that does have a potentially problematic female could work with the SSP to:

1. Allow a maternally competent female in the social group to breed and raise her infant prior to breeding the maternally incompetent female.

2. Integrate a maternally competent female into the social group and follow step 1.

3. Move the maternally incompetent female to another social group that includes competent mothers (and their infants).

A less reliable approach is to develop a training program that is designed to teach a female certain maternal skills. Such a program generally entails training the female to respond to a series of commands that will increase the likelihood that she will hold, carry, and/or nurse her infant. It is, of course, difficult to accurately measure the success of a training program because

so many variables cannot be controlled. Joints (1977) trained a female gorilla to gently handle a doll and raise it to her breast; the female successfully raised her next infant. Another training program involving a gorilla (Schildkraut, 1982) was not successful. If being considered, such a program would benefit from the input of a professional animal trainer working closely with the keeper staff to develop a plan that is consistent and based on positive reinforcement and shaping techniques. Females that have shown a. range of appropriate maternal behaviors but have failed to raise an infant due to an identifiable deficiency may prove to be good candidates for a training program.

Alternatives to Hand-Rearing

Following a birth, close monitoring of the mother and infant by staff members familiar with chimpanzee behavior is vital. In the past, infants were often removed from their mother within a day if no nursing or awkward maternal behavior was observed. Competent maternal care is learned and improves with practice. It is therefore incumbent on the staff to carefully evaluate the mother-infant relationship, judge whether the mother's treatment of the infant endangers its health, and then decide whether the infant should remain with. the mother or be removed from her.

Lincoln Park Zoo has developed a 72-hour post-partum observation protocol for gorillas based on their experience that infants can be pulled and successfully hand-reared after 72 hours of not nursing. This protocol can also be applied to chimpanzees as it is known infants can survive three days without nursing (Rogers & Davenport, 1970). This three-day period provides time for the mother and infant to more closely synchronize their behavior and for the manager to evaluate the pair's progress. Obviously this does not apply to a mother who completely ignores or abuses her infant post-partum. A useful guide to rate the mother's behavior in the first 12 hours was developed by Rogers and Davenport (1970; p.363):

1. No observed contact between mother and infant with the mother ignoring or actively avoiding the infant.

2. The mother occasionally inspects and/or pokes at the infant but there is no prolonged contact or holding.

3. Infant in contact with the mother some of the time but is carried inappropriately (upside down or in one hand).

4. Mother carries the infant constantly but at times is inattentive to it.

5. Mother carries the infant on the ventral surface, allows the infant to grasp, and responds to the infant's vocalizations by readjusting, examining, or clasping it.

It is important to note that Rogers and Davenport (1970) found that nursing typically did not begin until day 2 or 3. They rarely observed mothers place their infants directly on a nipple. Rather, mothers respond to their infant's vocalizations by readjusting them which increases the 'likelihood the infant will come in contact with the nipple. Eventually the mother learns that placing the infant onto her chest causes the infant to stop vocalizing and relieves tension in her breast.

If observations indicate that the infant chimp is not nursing and human intervention is necessary the following alternatives to hand raising should be considered:

1. If the female is exhibiting behaviors 2, 3, or 4 (no abusive behavior occurring) and the infant has not been able to nurse, it may be necessary to provide the mother and infant with more time to coordinate nursing behavior. Additional time could be obtained by removing, bottle-feeding, and returning the infant to its mother. An example of this scenario occurred at the St. Louis Zoo. A 12-year-old nulliparous, hand-raised female who had been exposed to mothers and infants, gave birth to a male infant. The female was attentive to the infant but frequently carried him between her abdomen and thigh; while resting she' generally laid him on her abdomen, well away from her chest. . During the day time observations, the infant was not observed to nurse, so' on the morning of the fourth day he was removed from the female and bottle-fed for 24 hours (first pedialyte, then diluted and finally full-strength Enfamil). He was returned to his mother who was immediately attentive to him, but again, nursing was not observed for the following 36 hours. The infant was again removed for 24 hours, bottle-fed,, and successfully returned to his mother. The next day six nursing bouts were observed, and the female went on to successfully raise the youngster.

2. With a female that prevents an infant from nursing, it may be possible to sufficiently distract the mother to allow the infant to nurse. Alternatively, anesthetizing the female to then permit the infant to suckle 'may stimulate further nursing. Such a procedure may be particularly beneficial if the female's breasts are very full and tender, and milking her will relieve her discomfort.

3. If a female chimpanzee exhibits adequate to good maternal behavior but prevents the infant from nursing or has insufficient milk, a supplemental feeding program may be possible. Such a program was successfully carried out with a female gorilla at the Audubon Zoo. The mother of a two month old gorilla was actively preventing the infant from nursing a sufficient amount. Because the mother would bring the infant up to the wire, and because she could be distracted by being slowly hand-fed, the staff was able to supplement the infant with a bottle.

4. Another alternative to hand rearing is possible if a surrogate mother is available to adopt the infant. Obviously, it would be ideal if the surrogate was lactating. If no lactating surrogate is available, a maternally competent female who would permit the infant to be bottle fed, as described above, should be considered. If the natal institution does not have an available surrogate, it would be advisable to contact the SSP to determine if another participating institution might be able to provide a surrogate.

Hand-Rearing Protocol:

If no alternatives to hand rearing are possible, i.e., the infant remaining with the mother is considered to be life-threatening and there are potential surrogate mothers, a program with the objective to resocialize the infant with other chimpanzees at as early an age as possible should be

designed. A hand-rearing program can basically be divided into two parts: 1. Meeting the physical needs of the infant and, 2. Meeting the -psychological and social needs of the infant.

Physical Needs

Because of their similarity to humans, meeting the physical needs of a chimpanzee infant is greatly simplified. Human formulas such as Enfamil and Similac, which are very similar in composition, have been successfully used to hand-raise great apes, including chimpanzees. Isomil, a soy based formula, can be used if the infant is allergic to milk protein or lactose. The amount of formula fed should be based on body weight; in great apes and humans that ratio is 20 to 25% of the infant's body weight per day. Optimally, feedings should be spread over a 24 hour period, 2 1/2 to 3 hours apart. Not all institutions are able to provide 24-hour care throughout the entire rearing period, but should try to adjust schedules to at least allow continual care the first two weeks. Thereafter, a schedule comprised of seven feedings divided evenly between 6 am and 12 am has been successful (St. Louis Zoo records). Because infant chimps in the wild begin to test solids at about 15 weeks, this would be an appropriable age at which to gradually introduce a variety of food items. The purpose is to allow the youngsters to experiment/play with the taste and texture of different foods while still obtaining nutritional requirements from their formula feedings.

Nursery protocol should include accurate records that include amount fed and consumed at each feeding, stool amount and formation, daily weights, and body temperature. Hand-rearing methods, veterinary care, and notes on infant development and behavior should be included. For more detailed information on hand-rearing techniques and veterinary concerns refer to the series of articles in: Clinical Management of Infant Great Apes (Graham & Bowen, eds.); and Anderson, 1966.

Psychological/Social Needs

The psychological and social needs of infant chimpanzees should be recognized and incorporated into every stage of the hand-rearing process. Initially these needs will have to be attended to by the infant's human caregivers. However, the infant is afforded the best chance of becoming socialized if it is introduced to peers at an early age.

Careful attention should be given to providing the young chimpanzee with a stimulating and challenging environment. Initially that may mean providing a hanging mobile where the infant can see it, stuffed toys (that are safe, i.e., fur not easily plucked and consumed), or other colorful objects. Many of the items people buy human infants are safe and Stimulating for infant apes. More complex toys, cardboard boxes, climbing structures, etc. should be provided the infant as it matures. Opportunities to exercise outdoors should be encouraged.

Traditionally, infant apes that require hand raising in zoos have been taken away from the adult facility, usually to be raised in a “nursery” located in the children's zoo. This approach is beginning to be challenged, as more people realize the value of allowing an infant ape to grow up near adults. Consideration should be given to setting up an area within the actual ape facility should an infant require hand rearing. This was successfully accomplished with an infant gorilla at the Toledo Zoo (Favata, pers. comm.).

There has always been some concern among zoo professionals that hand-raised primates may become imprinted on humans. This concern was supported by Davenport and Rogers (1970) who suggested that human-raised chimpanzees were more socially dysfunctio~a~ than chimps

raised in a lab environment with minimal human contact. However, their data involved infants that were not exposed to peers thereby confounding interpretation. Reanalysis by flissen (Fritz & Fritz, 1985) suggested that lack of peer socialization was the critical variable most responsible for the social inadequacies exhibited by these chimps. Indeed, there are numerous examples in zoos of hand-reared primates that were denied social access to conspecifics during their childhood that, as adults, exhibit inappropriate sociosexual behavior (pers. obs.). Unfortunately, many people often lump "hand-rearing" into one -category, but it is becoming increasingly clear that hand-rearing techniques vary greatly in terms of environmental stimulation provided the infant, extent of human contact, and opportunities for socialization with peers and adults.

Maple (1981) challenged the idea that intensive care provided by humans would detrimentally effect the social development of infant apes. Growing up in their social group, infant apes are in continual contact with or close proximity to their mother or another caregiver during the majority of their childhood. Tactile comfort is always available if the infant is distressed. Maple suggests that the nursery setting can replicate this normal condition by providing the infant with extensive human contact. Such human attention affords the youngster with the security necessary for the development of self confidence and eventual independence. However, intensive contact with humans should be balanced by also exposing the young ape to appropriate conspecifics as soon as possible.

Concern has frequently been expressed regarding the number of human caregivers that can be involved in raising an ape (Maple, 1981; Fritz & Fritz, 1985). Utilizing a number of people often ensures that the infant will receive more attention, although ther is some question whether multiple caregivers detrimentally affect the infant's sense of security. No study has directly compared the effects of few versus multiple caregivers on infant development; however Fritz & Fritz (1985) found no obvious detrimental effect on chimpanzees reared by numerous people. They report that although infants always select a single person to whom they become most attached, they are nevertheless responsive to all caregivers. No social problems have been observed in three gorillas hand-reared by a nursery staff of nine keepers and nine docents. These infants were socialized with each other, exposed to adults at five months of age, and successfully integrated as a trio into an adult group at ages 18-26 months (Porton, et al., in prep.).

If sufficient human caregivers are not available, a dog companion has been shown to be a feasible alternative. Positive behavioral effects have been demonstrated in infant rhesus monkeys and chimpanzees raised with companion dogs (Mason & Kenney, 1974; Fritz & Fritz, 1985; Thompson, et. al., 1991). Besides being an important source of contact comfort, dogs also serve as grooming and play partners for nursery-reared chimps (Fritz & Fritz, 1985). Rocking, stress-related facial expressions, and other stress-related behaviors were significantly reduced in an infant male chimpanzee when provided the companionship of a dog (Thompson, et.al., 1991). Dogs have been observed to chastise chimpanzee infants who play too rough by barking, snarling or snapping at them. Such disciplinary behavior may be very beneficial to nursery-reared, peer socialized chimps that may not normally receive such gentle discipline from humans or conspecifics when exhibiting inappropriate behavior (Fritz & Fritz, 1985; Thompson, et al., 1991). A collie-mix has proven to be an excellent medium-sized dog for this purpose. Infant chimps can be gradually introduced to these dogs under supervised conditions when only a few weeks old and can be housed with them through two years.

Every effort should be made to provide nursery-reared infants with peer companionship. This may require institutions to cooperate by sending out or receiving an infant that requires hand rearing. Because chimpanzees only begin to attain a degree of locomotor independence at

four months of age, peer companionship prior to this age would most likely not serve a useful purpose. Insuring peer companionship by the time the infant is six months old would be ideal. It should, however, be stressed that the age differential between the infants should not be too great particularly if one of the infants is still very young. Individual abilities and personalities should be taken into account when pairing youngsters. Introductions are best carried out in the presence of a caregiver(s) who can offer the youngsters security as they become acquainted with each other.

Peer companionship allows the hand-reared infant to be safely socialized with conspecifics while still dependent on human care. Ultimately, however, the infant should be integrated into a mixed-sex, age-graded group to be socialized by adults and juveniles. This process can begin by allowing the youngster to see, hear, and smell adults while still physically separated from them. Housing the infants near the adults or accompanying them to a play area adjacent the group's display facilitates a more relaxed and gradual -introduction.

The optimal age at which to introduce a hand-reared chimpanzee into a social group has not been established. Hand-reared infants at the M.D. Anderson Cancer Center are not integrated into adult groups until they are two years old, because of the volatile and explosive nature of chimpanzee social life (Bloomsmith, pers. comm.). Bloomsmith recommends that an infant be adopted and well bonded to a surrogate before being introduced to the rest of the group. The surrogate should be socially confident enough to protect the infant from other group members. Although juvenile females may show great interest in infants, they may not be good surrogate candidates if they do not have the social standing in the group to withstand attempts by others to steal or injure the youngster. Experienced adult females would be ideal although gentle males who have exhibited parental care in the past should not be excluded from consideration (Bloomsmith, pers.comm.).

Survey Results

Rearing:

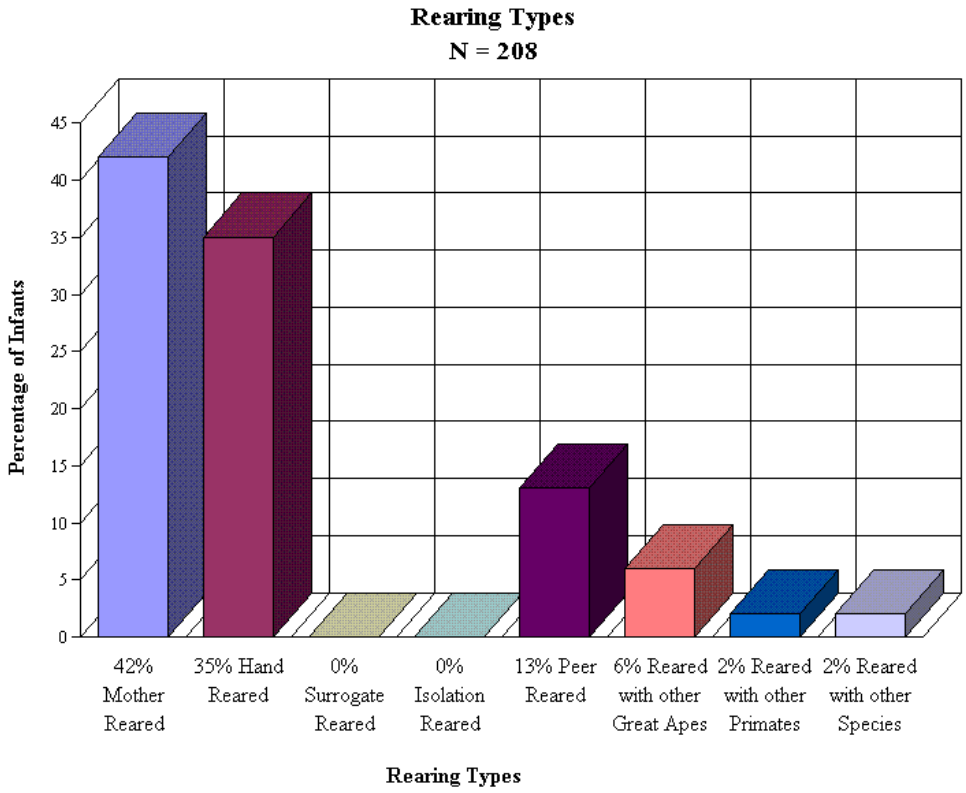

Figure 3.7 represents the percentages of chimpanzee infants that were reared in the manners listed.

- Institutions reported a total of 11 deaths due to maternal neglect 64% (N=11) of which were accounted for by two institutions.

- Institutions reported a total of 3 infant deaths from maternal abuse, each of which occurred at different institutions.

- Institutions reported a total of 2 infant deaths due to abuse by males, each at different institutions.

- Institutions reported a total of 4 infant deaths due to abuse from other females, 2 of which took place at one institution and the other 2 at separate institutions.

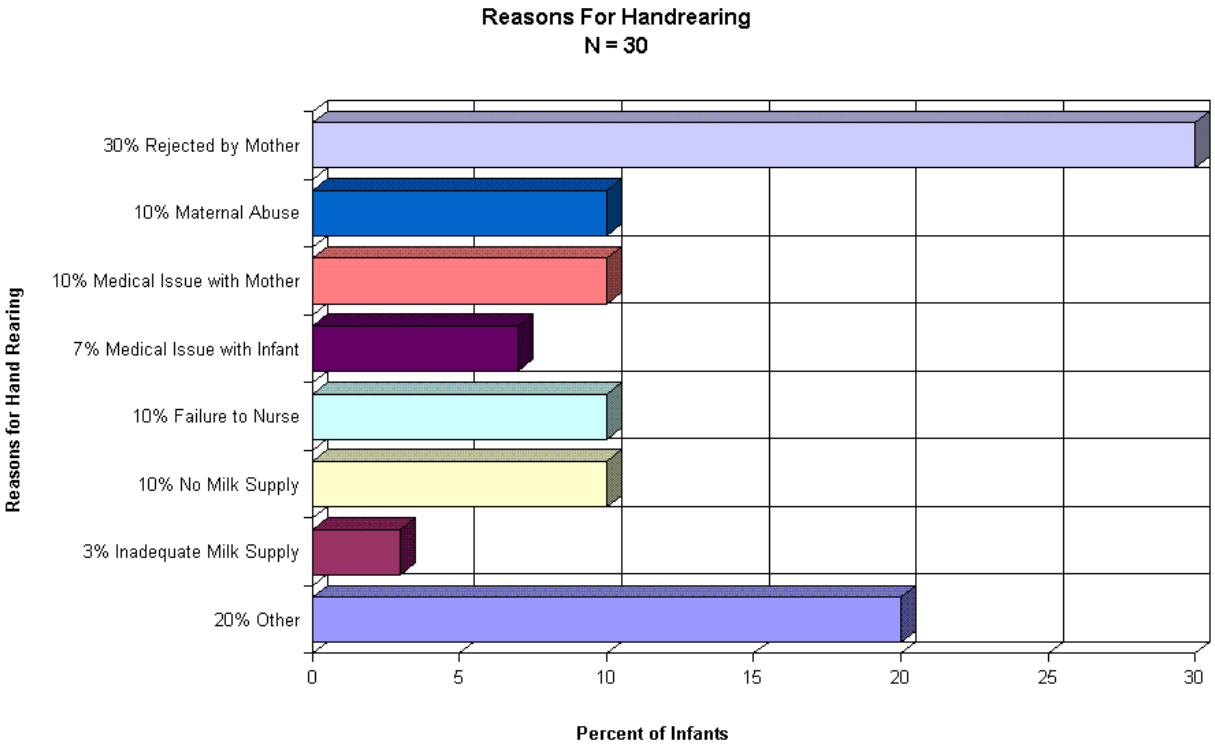

Figure 3.8 represents the percentages of infants that were pulled to hand rear for the reasons listed.

- The reasons for pulling to hand rear that were listed as "other" include: abusive actions of other group members, infant sold to dealer, pulling one of a set of twins, and hand rearing was a policy of the previous management.

- There were no reported cases in which an infant was successfully adopted by another female

- Institutions reported 4 instances in which infants were successfully hand reared using a human surrogate mother and 3 instances in which infants were successfully hand reared using a stuffed animal surrogate mother.

- Almost two thirds (60%, N=15) of the responding institutions indicated that hand reared infants were successfully assimilated into the group. The other 40% indicated that the hand-reared infant was relocated before an opportunity arose to introduce the infant to the group.

- Responding institutions reported a total of 19 captive born, mother raised females that reproduced. The ages of the Dam at 1st offspring birth ranged from 6 to 12 years of age with a mean age of 9.076 (S.D. 1.79) and a median age of 9 (N=15).

- Responding institutions reported a total of 21 hand reared females that reproduced. The

ages of the Dam at 1st offspring birth ranged from 7 to 16 years of age with a mean age of 10.4 (S.D. 2.53) and a median age of 9.25 (N=16). There does not appear to be a statistical difference between captive born, mother reared and hand reared dam age at 1st offspring birth

Hand Rearing Suggestions:

- Institutions should develop breeding programs that increase the likelihood that infants will be mother-reared within a social group.

- Institutions should take steps to improve the maternal skills of those female chimpanzees that have not successfully raised their infant in the past.

- Institutions should make every effort to expose nulliparous females that have not had the opportunity to observe appropriate maternal behavior, to such behavior before being breed.

- Institutions should establish a system to evaluate the maternal behavior of mothers with each birth. This system will aid in determining the most appropriate course of action, e.g., leave infant with mother, supplement food, remove infant from mother to hand-rear.

- Hand-reared infants should be re-socialized as early as possible.

- Hand-rearing/nursery facilities should allow visual and auditory contact between the infant and conspecifics.

- Hand-rearing protocols should be written that detail the types and amounts of food to be fed, a feeding schedule, a weighing schedule, medical examinations to be given, enrichment items to be provided, socialization methods to be employed, and records to be kept.

- Hand-reared infants should have some type of social contact, whether it be peers, conspecifics of any age, caregivers or canines.

Hand Rearing Suggestions

- Refer to "Clinical Management of Infant Great Apes" Graham and Bowen, editors, for specific information on meeting the physical needs of infant chimpanzees that are being hand-reared.

- Provide hand-reared infants with environmental stimuli from removal on. Make sure that enrichment items are safe and developmentally appropriate. Referring to human infant toys may be helpful.

- Evaluate potentially reproductive females on a regular basis. Identify those females believed to be potential "problem mothers". Take steps as soon as possible to attempt

to enhance the maternal skills of these females.

- Refer to Lincoln Park's maternal evaluation system for help in developing a system for your institution.