PD-ABM-858 Annex VIII

Proposition for a phase II of the DZANGA CLEARING FOREST ELEPHANT STUDY

Submitted to the US Fish and Wildlife Service for funding under the African Elephant Conservation Act

March 1 1993

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Proposition for a phase II of the
DZANGA CLEARING FOREST ELEPHANT STUDY

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January 10, 1993; revised 2 March 1993

Part I. Summary

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Dzanga Clearing Forest Elephant Study

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Project Cooperators: Wildlife Conservation International, World Wildlife Fund-US, the European Economic Community, in past USFWS.

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Government of CAR Mr. Gonifei Ngai Bonanu, Minister of Eaux et Forêts, BP 1053, Bangui, Central African Republic (CAR).
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Project Executant and Location:

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Project Period: July 1993-July 1994. There is a good possibility that the project will continue beyond the first year tranche.

Budget (in USD)

Fiscal 1992-1993 (through June)		
	Total	105,000
	EEC	80,000
	WCI	15,000
	WWF	10,000
Fiscal 1993		
	Total	71,900
	USFWS	45,900

For additional aspects of the work continued funding will be sought from all of the above organizations.

Part II. Objective.

The objective of this request to the USFWS is to continue a study of forest elephants which has been ongoing in the Dzanga clearing of the Dzanga-Sangha Reserve since 1990. Data are being collected on the size, demographics, morphometrics, genetics, social structure, social behavior and ecology of a single forest elephant population in

the Dzanga clearing in the Central African Republic. A complete graphic record for individuals and groups that visit the saline is established. Focal observations by group as they enter the saline are taken. Skin biopsy samples are taken from identified elephants for genetic analysis. Dung samples are analyzed to assess the role of forest elephants as dispersers in the forest environment and how frugivory affects elephant movements.

This study has two major implications for elephant conservation. 1) The Dzanga elephant population, which is the same as that which ranges in the Nouabale-Ndoki Forest of Congo, is one of the largest free ranging populations left in Africa. Precise population and ecological data are needed for management of this population. The data being collected at the Dzanga clearing are going well beyond anything that has been previously been done on African elephants, except for studies on the Amboseli population. These data are invaluable for herd management. 2) The constant monitoring of the Dzanga herd and presence of a permanently manned research station in the very sensitive area around the Dzanga clearing is a major impediment to poaching of elephants in the area. The Dzanga clearing may be the best viewing place in all of Africa for elephants and is the focal point and raison d'être of the entire Dzanga Sangha Reserve. Its protection and constant monitoring are an integral part of the protection of the Dzanga-Sangha herd because it is where elephants are most vulnerable.

Specific objectives:

1) Objective: Assessment of the elephant population size visiting the saline.

As of 26 Oct. 1992, 1336 elephants had been identified, named and cataloged in the card file. Identification is done opportunistically as individuals present themselves, or are identifiable. Of these, 1336 elephants 433 were adult females, 434 were adult males and 469 offspring (non-adults). Of the adult females 328 were recorded as mothers accompanied by at least one offspring. Over 75% of the individuals have been sighted more than once, and many have been seen over 20 times. In the past several months identification has become almost routine in the clearing. Those identified are reaching about 80% of the maximum number observed in the saline on any day. On Oct 23, 1992, 60.6% of maximum number were identified, on Oct 24, 1992, 116.3% of maximum were identified and on Oct 25, 1992, 81.6% of maximum were identified. Most of these individuals had been identified previously. The number of new elephants censused in the clearing has dropped significantly in the past two months which has permitted more detailed work on social structure and relationships of individuals.

Using the phase two methodology (discussed below) the percentage of unknown elephants in the population will be determined. Using this ratio and the rate of reidentification of known elephants a precise estimation of elephant population that visits the clearing will be made using software developed for rhino population studies in southern Africa which uses a capture recapture analytical technique.

Output: For the first time a population estimate will be possible for a population of forest elephants that is not based on dung counts. When the project expands to a second clearing in Congo a more general estimate of the regional population will possible.

2) Objective: Determination of social structure of forest elephants visiting the saline.

Over 328 "nuclear families" have been identified. This means females with young. Savannah elephant "nuclear families" are fatherless, meaning the male is unknown, which is now confirmed to be the case in forest elephants as well. The maximum number of known offspring is three. This simply means that there are three offspring that are readily identified as young of particular female. When males reach what we are currently calling juvenile state, ca. 8 years old, they often abandon, or are chased from the nuclear family. Females of 10 to twelve years old become much more independent and it becomes difficult, even if they remain with their mother, to say that they are the offspring of a particular female.

Secondary social structure is more difficult to ascertain because of its complexity and instability. Thus far many secondary associations between nuclear families have been recorded. These consist of groups of adult females which have young. There are groups with 2 to 3 adult females, and their young which have been observed on serveral occasions. A database of these relationships has been established and will continue to grow as the consistency of the relationships are observed. Now that the reliability of identification is very high, these relationships are becoming much easier to elucidate. The consistency of these groups varies. Tentatively we describe this as a fission-fusion relationship. When the group comes into the clearing often as many as three adult females together which have been recorded previously together. Once the group enters the clearing they break up and even the offspring in the "nuclear families" are often separated from their mothers. Thus far over forty secondary relationships between adult females that have been recorded. Their consistency over time will lead to more conclusive results.

Our observations indicate that the birthing interval is from two to three years. Determination of birthing interval will really only be possible when we have followed the growth rate of a large number of individuals which is discussed below.

Phase two methodology calls for identification of groups as they enter the clearing. This permits precise determination of social grouping, the integrity of which is quantifiable. As data accrue on the integrity of social groups of different complexity it should be possible to elucidate high order social groupings.

Output: For the first time we will have a precise understanding of the structure of an intact forest elephant society.

3) Objective: Reproduction rate in forest elephants.

Over the past year the heights of over 200 identified individuals has been made using a photographic methodology. One result of this study, which continues, was to show that forest elephants much shorter than the average adult Indian elephant, which are quite a bit smaller than their African savannah cousins. A new technological breakthrough, laser distance finders, will greatly enhance our ability to measure elephants in the saline. We expect to purchase one of these which in tandem with a video camera will produce an easy means of obtaining accurate height measurements of known individuals. This will permit not only a very large library of height measurements which will lead to a size curve in forest elephants, but it will also provide a means to age determination. A catalog of infants born has been established, numbering over 45 individuals thus far. Their sex and growth will be monitored periodically as they are observed. In addition the growth of individuals in all age classes of both sexes will be measured periodically. These measurements, as they are concatenated, will serve as the population from which the age/ height curve will be determined. This curve will be used to estimate the age curve of the entire population. By using this curve to estimate the ages of offspring of individual females it will be possible to determine the birthing interval, especially if we obtain data on infant mortality.

Output: A precise age curve for the entire Dzanga elephant population.

4) Objective: Social interactions of elephants visiting the saline.

The hierarchy of almost all individuals in the population seems to be known by other elephants. These are often tested at the various waterholes. In almost all cases adult males take precedence and displace adult females at a particular hole. Adult males always take precedence over immature males. And depending on the size and "robustness" of particular male, the more imposing usually wins, but not always. It is quite easy to predict who will win. Amongst the larger males competition ensues, but this is usually resolved with a very brief challenge and one of the individuals wins. This sometimes switches from one individual to another. As time goes on, with data accruing on sparring wins, specific relationships between individuals will become clear and the significance of these interactions will be elucidated.

It is thought that much of the jockeying between individuals at the various water holes is not a result of competition for the resource but rather a testing ground for social hierarchy. If this is true it is a very interesting phenomenon. Only further study at the water holes will reveal the real importance of the waterholes in determining dominance hierarchy.

Using phase II, part II methodology quantifiable results on social hierarchy and social relationships should be possible. Until now bouts at water holes have been observed

on thousands of occasions by there has been no sampling of winners vs. losers. After several thousand such encounters are recorded between known individuals, which should be possible over a year, the social hierarchy between individuals and family members will be possible. The relationship between sex, size and age and social order will become very clear. At the same time, if greeting behavior is indeed an indication of filiation it should be possible to add significantly to our knowledge of higher order relationships.

Output: Quantification of social hierarchy in the Dzanga population and its determining variables.

5) Objective: Genetic characterization of the forest elephant.

In January of 1992 a total of 60 skin samples was obtained over a two week sampling period. The majority of individuals were identified by name. Well over 90% success in recuperation of a skin sample per shot taken was obtained. Because the current genetic analysis is based entirely on mitochondrial DNA, and mtDNA is transferred only by the female on the X chromosome, an attempt was made to sample only one individual from each nuclear family. This assures a good sampling of mtDNA haplotypes in the population. In addition an attempt was made to sample all of the morphs currently identified in the male population in the clearing. These include savannah, forest, and pygmy. While only a small sample of adult males was obtained, each morph was sampled.

A preliminary haplotype analysis of 34 Dzanga elephants, including "pygmy", "savannah" males and "forest" males shows that they all are members of a closely related group, but quite different from savanna elephants from eastern and southern Africa. The rest will be mostly refinements and an exact analysis of how the Dzanga elephants fit into the big picture.

In the future samples will be taken more selectively. Because mitochondrial DNA is inherited only through the mother it will be possible to exclude individuals as being offspring of a certain female if the mtDNA haplotype does not match. An attempt will be made to sample groups that have more than one adult female to see if indeed these females are of the same haplotype. If they are consistantly, this will be evidence to support that female groups are stable over several decades. In addition very often there are young males which are loosely associated with a particular group. It should be possible to sample a number of these individuals to determine if they are probable offspring of a suspected mother, and at what age they leave the groups both temporarily and permanently.

Output: Genetic characterization of Dzanga elephants on the continental scale.

Output: Verification of filial relationships between suspected related individuals.

6) Objective: Feeding ecology.

Elephant dung analysis in the Dzanga area has been ongoing since early 1990 when Central African students assigned to the World Wildlife Fund project collected data. Since that time this aspect of the study has been ongoing but not constant because it does not take precedence over elephant observations. Lack of qualified personnel has resulted in several holes in the data set over the last three years. Because of the dedication of a small team of expert Pygmy seed identifiers and sorters, however, the data set is of excellent quality. Since 13 Sept 1990 a total of 703 dung samples have been collected and analyzed. Thus far over 100 species of seeds have been identified in the dung. Ca. 30% of this data set has been entered on a data file to be analyzed when the entire 1992 data set has been completed and entered.

Over the next year dung collections will be continued. In addition measurements of fruit morphology will also be undertaken. This will follow a standard methodology which has already been established.

Output: Extensive data base on the level and quality of frugivory of the Dzanga elephants during the year. This is thought to be the driving force in elephant migration in the tri-national area.

7) Objective: Monitoring of Dzanga clearing and surrounding forest for deterrence and signs of poaching.

This occurs on a normal day at Dzanga. If wounded, snared or dead animals are observed in the clearing they are reported to park authorities. Gunshots, signs of poacher activity and unusual movements of animals, in particular elephants, are also reported. When Pygmy trackers collect dung and fish and gather in the vicinity of camp, to ca. 5 km radius, they observe poaching activity. This is reported to park authorities. Over the past two years this monitoring has succeeded in the identification of several poaching problems. In many cases the research staff have led park guards to poaching camps.

8) Objective: Strategy for elephant management in the Bayanga area.

As elephants become more habituated in the Dzanga area, their tactic of avoidance of human beings diminishes to the point where in many cases they have become crop raiders and pests. This problem continues to become more acute yet there is no solid plan for its management. This was made very clear in December of 1992 when an unidentified elephant was shot by park authorities in the village of Mossapoula ca. 15 times with a .458 and was not killed.

The time has come to establish a policy on problem animals and for proposals on the management of the Dzanga herd in view of the considerable political problems that this

presents for the project with the local people. The current solution of shooting an unidentified elephant without success is unacceptable.

Part III. Introduction.

While as much as half of the remaining population of African elephants are found in the forests of Central Africa, not a single study using actual observations of forest elephants has yet been published. The dense vegetation and difficulty of movement in lowland forests in Central Africa have restricted the few previous studies of forest elephants to superficial dung analysis and censuses. This research employs several new field and genetic techniques to study the population characteristics, social structure and genetics of elephants that visit the Dzanga clearing.

Elephants congregate in the Dzanga clearing to drink water rich in minerals and to socialize. It is the only place known where large numbers of forest elephants come into the open routinely. Here individuals can be identified, and group structure and interactions observed and photographed, or videotaped. On average over 100 elephants now visit the saline daily, with frequent visitation of over 150 individuals.

In 1990 M. Fay and A. Turkalo undertook a pilot study to investigate the possibilities of identification of individual elephants at the clearing. Methodologies similar to those used by others to identify elephants in east Africa (Douglas-Hamilton 1972, Moss 1988) were employed. Using a simple index card system, in which elephants were classed by sex, maturity, with schematic drawings of tusk morphology, and scar, rip and break patterns on ears, tails and sides, it was discovered that most mature adults could be readily identified and reidentified. The confirmation that this methodology worked led to a full-time study undertaken by Andrea Turkalo, financed by the United States Fish and Wildlife Service in 1991 through a grant to the Dzanga-Sangha Dense Forest Reserve Project. Funding was continued in 1992 through a grant (#301) from the "Ecology in Developing Countries Programme" of the European Community and administered by the Environment and Development Group and Wildlife Conservation International, New York Zoological Society.

Currently the Dzanga Clearing Forest Elephant Study enjoys the logistical and administrative support of the World Bank Funded Dzanga-Sangha Dense Forest Reserve Project and the Government of the Central African Republic. Andrea Turkalo is a Research Fellow of The Wildlife Conservation Society and has access to all resources available at the NYZS/The Wildlife Conservation Society. Turkalo works closely with J. Michael Fay, Director of the adjacent Nouabale-Ndoki (Congo Forest Conservation Project). Fay travels regularly to Dzanga (ca. every 3 months) to monitor progress on the research. Turkalo collaborates closely with the Dept. of Biology at Washington University for genetic analyses. Laboratory work is being carried out by Nick Georgiadis, also a grantee of The Wildlife Conservation Society.

Funding for the Dzanga Clearing Forest Elephant Study is assured through June of 1993. At this time it will still receive full endorsement from the Dzanga-Sangha Dense Forest project, the government of the CAR, The Wildlife Conservation Society, the Congo Forest Conservation Project, with all of the technical assistance needed to achieve project goals. Additional funding will be needed to assure a stipend for Turkalo and for camp operations.

If funding was provided by USFWS to support the work it would be administrated by the NYZS/The Wildlife Conservation Society.

References

Douglas-Hamilton, I. 1972. On the ecology and behaviour of the African Elephant. D. Phil. Thesis, Univ. of Oxford.

Moss, C. 1988. Elephant Memories. Ballantine, New York.

Part IV. Justification

Criterion 1. The Dzanga clearing forest elephant study has been an integral part of the Dzanga-Sangha project since 1990. This project is run by the Ministry of Eaux et Forets with technical assistance from WWF-US. In the past year we have met with the Minister of Eaux et Forets and with other ministry officials on several occasions and support for the project is very high. Mr. Doungoube, who is now the Dzanga-Sangha Project Coordinator is a strong proponent of the project. The relationship between the current Dzanga-Sangha staff and the elephant study personnel is excellent.

Criterion 2. While the personnel of the Dzanga elephant study do not actively engage in antipoaching, their presence in the area has a very important deterent effect on the poaching in the area. The Dzanga clearing is important for several reasons. Ecologically it attracted a large percentage of the individuals that live in the reserve and those that live in the adjacent Nouabale-Ndoki Reserve. It is a place which is unique in the forest. Also it is the main attraction of the Dzanga-Sangha Reserve from a tourism point of view. As such, it is imperative that the Dzanga clearing area receive constant surveillance. The Dzanga clearing elephant study provides the only permanent surveillance of the clearing and the sensitive area surrounding the clearing. In addition the employees of the research project make regular reconnaissance walks of the region around the clearing looking for any sign of poaching.

Since the establishment of the camp on the Modoubou creek, which is two kilometers from the clearing, and daily observation at the clearing no elephant poaching has been noted in the area. In the year before the establishment of the camp there were three carcasses of elephants found in the vicinity of the saline which would indicate a high level of poaching. In the past two years incidents of gun shots and of signs of poaching

activity have been reported frequently to the reserve guards which has resulted in some very punctual control of poaching activity around the clearing.

In addition constant monitoring of the Dzanga clearing is a good measure of the amount of disturbance in the area. When few elephants are present in the clearing or other species enter the clearing with snare wounds this information is given to the reserve managers.

Finally the presence of the camp and monitoring activity is known to all potential poachers in the area. While it is hard to measure there is no doubt that this constant presence has a very large dissuasive effect on potential poachers because they know that the possibility that they will be caught is great.

Criterion 3. The Dzanga clearing forest elephant study is one of the projects highlighted in the Central African Republic elephant conservation plan. It appears under project number 63 and is entitled "Etude génétique et comportement des éléphants de forêt" in the section recherche et suivi. This is a good indication of the great importance that the government attaches great importance to the project.

Criterion 4. There is no doubt that the Dzanga clearing is unique in the central African forests for the large concentrations of forest elephants that exhibit natural behaviour and have a normal population structure. If there is a priority site and population in the tri-national region, Dzanga is it. There is no better place to gain an understanding of forest elephant biology and ecology in the central African region. In addition the in depth study of this population will be essential in the management of the reserves and may be useful in the management of other reserves.

Criterion 5. WCS and WWF have a long standing relationship in the Dzanga-Sangha reserve. It was a combination of funding from the two NGO's starting in 1985 that started the initiative. This relationship has continued until the present day. The reserve is currently run by WWF with a grant from the World Bank and WCS has three different researchers working on various mammals in the reserve, including the elephant study. WCS runs the adjacent Nouabale-Ndoki Reserve, a project which started in 1991. A good collaboration has developed between these two projects in the past year.

The Dzanga elephant work has been funded for the past year through a grant from the EEC. Because of the size and complexity of the EEC bureaucracy however it is difficult for them to deal with financing a small grant. Reimbursement has been very slow or non- existent and WCS has been required to advance a large sum of money to the project. If this process can be streamlined EEC funding will continue to be sought. Another problem with this grant money is that there is no guarantee that the program will continue.

In the past the USFWS has supported the elephant study at Dzanga, but subsequent funding to the Dzanga-Sangha project has been used to support reserve guards.

Private grants have been of help in supporting the research project. National Geographic Society has encouraged a proposal for support of this work.

If USFWS funding is provided it will be used to fund core activities for the research project.

Part V. Procedures/Activities

Part I

Because it is now possible to identify the majority of elephants that come into the clearing, which was the primary objective of phase I of our study, we can permit ourselves to become more systematic in our data collection.

Previously, elephants that are in the clearing as one arrives are usually identified and this procedure continues throughout the observation period. In order to make this data collection more systematic the following procedure has recently been applied with success and will be used exclusively in the future.

The observers, Andrea Turkalo and one Pygmy spotter, arrive at the clearing around mid-day in order to minimize the number of elephants in the clearing when the observation period starts. Upon arrival a total count of elephants in the clearing is made and identification of elephants present in the clearing proceeds for 30 minutes. At this point only elephants entering the clearing are identified, whether it has been identified or not earlier in the observation period. If an elephant is not identifiable by name, its sex is determined and its age estimated. Identification is based on group, thus if a group of four elephants enters that are identifiable by name this observation will be recorded. A constant tally of time, group (even if single), names of individuals (or sex and age of each), and location from which they entered is maintained in a data base. These observations serve as sampling units.

Part II.

After a group or individual enters the clearing the "alpha" or single individual is followed until the next individual enters the clearing, which is signaled by an expert Pygmy observer. Continuous sampling is undertaken on the individuals that the focal animal encounters as it moves about the clearing. The type of encounter is recorded and the 'winner' of competitive bouts is recorded. If the individual encountered is not identifiable by name, its sex and size in comparison to the focal individual is recorded.

Specific methodology by objective:

1) Assessment of the elephant population size visiting the saline.

In order to determine the entire population size of elephants visiting the clearing it is necessary to be able to identify the elephants. For elephant identification, methodologies similar to those used by others to identify elephants in east Africa (Douglas-Hamilton 1972, Moss 1988) are employed. Using a simple index card system elephants are classed by sex, maturity, with schematic drawings of tusk morphology, and scar, rip and break patterns on ears, tails and sides and eye color. These data provide a positive means of identification and re-identification of most adults and a large percentage of immature elephants. At present the principal observer, on the average, can identify over 80% of the individuals in the clearing on any day.

Using identified individuals we obtain population figures in one of two ways. 1) Simply tally the total number of identified elephants. Over time the number of new elephants diminishes. Based on the figure of total elephants observed a reasonable curve, with a definite asymptote, is observed. Based on a model of the curve, and the ratio of identifiable to unidentifiable individuals, a reasonable estimate of the total population size should be obtainable. 2) Based on the total number of elephants visiting the saline and a ratio between known and unknown, identifiable elephants observed on a daily basis, through a modification of capture-recapture techniques, using phase II methodology based on entrance into the clearing as the sampling unit, a population estimate is possible. A computer software package, called Rhino, for analysis of data of this sort has been developed by Richard Emslie and colleagues in South Africa. We will collaborate with this group for data analysis.

These methods will provide only figures on the population visiting the Dzanga clearing. Eventually we hope to obtain data from a similar clearing or perhaps two clearings to obtain estimates over a geographic area which could be calculated based on the overlap of individuals between the clearings and the distance between them. This method would be particularly useful if data on the ranging behavior is obtained from a number of collared individuals from the population, which is also planned for 1993.

2) Determination of social structure of forest elephants visiting the saline.

Determination of social structure of elephant groups requires competent identification and re-identification of all individuals by "group" The same methodology as above is used for this purpose. In order to identify primary groupings, i.e. "nuclear families", it is necessary to identify groups as they enter the clearing from the forest, where elephants disperse into small groups. The group is identified through identification of each individual and probable relationships between the individuals, e.g. mother-offspring. This is obviously never absolutely certain unless one observes birth, so one has to make certain assumptions about filiation. We are fairly confident about the identification of mother-offspring relationships based on association-especially if we get

the same groupings over several months, and by suckling etc. For secondary associations assumptions about filiation have to be taken one step further, but groups of adult females, with their young as they enter the saline, if they are coherent at least once over time, represent to us secondary groupings. As data on groups as they enter the clearing accrue one becomes more and more confident about the identification of a secondary association. Tertiary association is more difficult to determine. This can be done in one of two ways: 1) Reciprocal associations between different primary associations as secondary associations. For instance if nuclear family (nf) A is observed six times with nf B, and nf A is noted with nf C four times and Bb with C 4 times then this would constitute a tertiary grouping. Over time these relationships become clear, and they follow methods used previously by Douglas-Hamilton (1972) and Moss (1988). The need for long term observation is stressed. 2) Greeting behaviour has been shown previously to be important in determining the relationship between groups (Douglas-Hamilton 1972) and Moss (1988). Greeting behaviour is systematically observed between groups as they enter the clearing and those that are already present. Over time, using phase two methodologies, we will obtain a very clear picture of the affiliation of groups and the structure of grouping in forest elephants and affiliation amongst groups. The results can be compared with savannah elephant social organization. Differences in the two should give us some idea about the ecological reasons for the social organization of elephants.

3) Reproduction in known individuals visiting the saline.

This question can be addressed from two angles. 1) Birth to a particular female and monitoring of the infant over time, especially if we can record a large number of births, will give us the first definite results on reproduction. As time goes on the growth and repeat birthing by the same female will result in a very accurate picture of the demographics in this population of elephants. 2) As height data are collected on large numbers of individuals, and the growth rate, by repeated measure, of individuals of known birth date, as well as a selection of individuals of different sizes, is collected the demographics and age curve of the population should become quite clear. Again the need for long-term observation is stressed. Comparison with results from savannah environments will give insight into the effects of habitat, and growth rate on elephant demographics.

We are in the process of obtaining a laser-gun which will permit precise ranging and height measurements anywhere in the clearing (Annex I). This will clearly reduce the work load and increase accuracy of the height study.

4) Social interactions of elephants visiting the saline.

Using focal samples and ad libidum notes on groups as they enter the saline until another group enters gives a good deal of insight into the social interactions of groups, which are related to the filiation of groups. When a group enters the clearing the alpha individual is followed and observations of interactions with other individuals are taken.

Each interaction is taken as a bout and is recorded as a single sampling unit. Because there is significantly more interaction between groups as they enter the clearing and those in the clearing, rather than those already in the clearing, it is these individuals which are used for sampling. As soon as another group enters the previous group is dropped. A practical reason for using this method is that data on entering groups is very important for data collection on the social organization of the population. With one expert observer who knows the elephants it is imperative to optimize data collection. Ideally it would be good to have four expert observers working simultaneously but this is not feasible.

5) Genetic characterization of the forest elephant.

Skin biopsies are collected using K-darts and standard Cap-chur carbon dioxide rifle to obtain 4 mm x 15 mm skin plugs. These samples after collection are stored in a heavy brine solution with good DNA preservation. Recent developments in molecular biology now permit extensive genetic data sets to be developed from individual animals using trivial amounts of tissue and tissues which are quite degraded. In general this is possible through the use of the polymerase chain reaction (PCR). Using PCR technologies genetic profiles have been successfully developed for mitochondrial DNA using haplotype analysis. This is the analytical technique used in this study.

6) Feeding ecology.

The feeding ecology of the forest elephant, because of the very obvious limitations on the observers ability to follow, observe and identify what is consumed by an elephant, is almost necessarily limited to dung analysis, if large amounts of data are to be obtained. There are two reasons to be interested in the feeding ecology of the forest elephant: 1) Because elephants are a keystone species in the forest and responsible for a great deal of disersal and they are important modifiers of the forest environment through their bulldozer actions. 2) Because elephant movements, especially in the forest environment, are the result of food availability. Seasonal migrations are probably due to the geographic availability of food resources. The phenology and preference of various food items should elucidate the reasons for elephant movements and help us to better manage the herd, especially as we proceed to classify various areas of the forest as protected areas.

Dung samples are collected on a daily basis, when possible, by Pygmy trackers. These are weighed and every seed is removed, identified by species and weighed. In addition all seed fragments are counted and weighed. Thus far over 900 specimens have been collected and analyzed. We have a goal of 2500 specimens.

7) Objective: Monitoring of Dzanga clearing and surrounding forest for deterrence and signs of poaching.

These data will be collected opportunistically during the course of normal operations of the research project which will be reported to park authorities on a timely basis.

8) Objective: Strategy for elephant management in the Bayanga area.

An African student or students from the local University will be assigned to this project. They will quantify, on a regular basis, in the villages of Yandoumbe, Bayanga, Moussapoula and Babango, crop damage and approximate number of elephant individuals responsible. When possible photographs of problem animals will be taken using a Trail Master photo trap with the idea that problem animals will be identified. This data set will be collected over a complete year.

One interim report will be produced, with initial findings, after six months. A final report will contain recommendations on how to "solve" the elephant problem in the Bayanga region.

Part VI. Budget (fiscal 1993 - July 1993-June 1994)

	Total	USFWS	WCI	Laser Atlanta	NGS
Vehicle					
Running costs	2400	2400			
Insurance	500	500			
Maintenance	2000	2000			
Airfare for PI	3000	3000			
Camp Maintenance	6000	6000			
Employees					
PI stipend	28000	24000	4000		
Camp manager	3000	3000			
Pygmy trackers	5000	5000			
Student stipends	3000		3000		
Food and supplies	4000		4000		
Misc. materials	1000		1000		
Film	5000				5000
Laser gun	8000			8000	
Contingencies	5000		5000		
Total	71900	45900	17000	8000	5000

Budget Justification:

The above budget is considered a minimum for the operation and success of the research project. Additional funds will be sought through National Geographic Society which would allow an expanded program mostly through the hire of additional personnel.

There has been considerable capital investment in the project already. The camp is officially owned by the Dzanga-Sangha Project but built and maintained by project personnel. Materials such as vehicle, computer, video, photographic, scientific, solar and recording equipment all have been purchased with previous grants.