Monitoring the Illegal Killing of Elephants

REPORT AND RECOMMENDATIONS OF THE MIKE DUNG COUNT TASKFORCE

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1. Workshop Objectives

The Chair opened the meeting by welcoming the participants and giving thanks to the US Fish and Wildlife Service for their logistical assistance in providing the venue for this meeting.

The objectives of this meeting were to agree upon the following matters that would impact on the appropriate methodologies for carrying out population surveys of elephants in different MIKE forest sites in Africa and Asia:

(a) Appropriate models for estimation of elephant numbers, distribution and densities through dung surveys;

(b) Required standards for the above models; and

(c) Harmonized protocols for measurement of variables for the estimation of parameters required for the above models

2. Overview of Forest Sites in Africa and Asia

The objective of this agenda item is to familiarize the task force with the range of characteristics (i.e. approximate area, density and distribution, vegetation types and rainfall and its patterns, as and where possible) of MIKE sites where forest populations will be surveyed.

It was noted that some sites have unknown numbers, densities or distributions at this stage and some sites have already begun using one model or another.

The output expected was to obtain a working Site Matrix listing the range of possible MIKE site characteristics which may lend themselves to line transect or recce transect dung survey methods in each sub-region.

A draft site matrix format produced by the MIKE Director was tabled as a proposed way forward on the overview of the MIKE forest sites. It required input into a series of pair-wise comparisons across putative site characteristics (e.g. population levels, vegetation, slope etc.). The proposed input for each pair-wise comparison was:

- Whether the dung count method was appropriate
- And, if appropriate, then which method was applicable

This draft matrix was discussed and it was decided that this approach was not favoured as the task force believed that it was only possible if a matrix categorizing sites in a generalized framework had first been made available.

3. Review of the Analytical Models

3.1 Objectives

The objectives of a review of the various Dung Count analytical models were :

(a) To set out the general theoretical framework and associated statistical problems in the estimation of relevant parameters for estimating dung densities, elephant numbers, distribution and density from dung surveys;

(b) To highlight the strengths and weaknesses of each specific model for estimating population size in forested MIKE sites while considering the following**:**

- Nature of data and covariates required; and
- Ability to detect biologically significant population changes in a reasonable time-frame;

(c) To evaluate the field applicability of the alternative models in the different MIKE sites;

(d) To evaluate the practical issues, including overall costs of logistics and implementation, of applying each model; and

on the basis of the discussions above :

(e) to develop and apply criteria to determine which model should be applied at each forested site; and

(f) to ultimately decide which specific model should be applied under a given set of MIKE site characteristics.

It was noted that a decision was needed whether one model, alone, could meet all MIKE dung survey needs. And, if so, which model would be applicable. If one model alone does not meet all requirements, then, what are the appropriate models for each given combination of forest site characteristics.

3.2 Models and Analysis

Next, a review was undertaken by the task force of the statistical basis and subsequent available models existing for the estimation of elephant densities from dung densities and other techniques that use dung for determining age, sex structure and distribution.

Ken Burnham provided the evidence for a generalized statistical theory for the estimation of elephant densities from dung densities. The central framework here is that the estimated elephant density is a function of dung density, decay and defecation rates. As the amount of dung on the ground is entirely dependent on what has happened in the past and steady state conditions are frequently violated, a retrospective, non-steady state approach is appropriate.

Given the established variation in dung decay rates across sites, site-specific decay rate of dung is a key parameter to be measured. It also has to be clarified through field studies, if the variation in defecation rates is low and therefore can be treated as a constant in model. There are several existing models (and potential ones that can be developed) which can be used for the above approach.

The task force then reviewed existing models using frameworks either conforming to the above framework, or, differing in the methods for the estimation of parameters such as decay rates.

(a) DUNGSURV Model – Hiby and Lovell (1991)

Simon Hedges presented the framework of the Hiby and Lovell's non-steady state model (Hiby and Lovell 1991) and highlighted its advantages and disadvantages (a black box approach that presently provides few details on computations).

He also addressed concerns and issues with measurement of decay and defecation rates, and the precision of Southeast Asian population estimation, largely arising from the WCS surveys in Sumatra (Hedges and Tyson 2002).

(b) Iterative Model – Plumptre & Harris (1995)

Martin Tyson next compared and contrasted marked dung counts and standing crop counts.

He also reviewed the Plumptre-Harris iterative model (Plumptre and Harris 1995, Nchanji and Plumptre 2001), and indicated that, because of serious limitations, the model is not recommended for the estimation of dung density or elephants numbers.

(c) Rainfall Model – Barnes *et al.* (1997), Barnes & Dunn (2002)

Richard Barnes next summarized the framework of the rainfall model he had developed for Western Africa (Barnes *et al*, 1997, Barnes and Dunn 2002).

The greatest advantage of the rainfall model is that dung decay measurements are not necessary. However, Barnes noted the disadvantages of using model due to

rainfall variation within and between sites. Furthermore, the model has not been validated in many sites. Therefore, the requirement that additional rainfall models

might be needed for more sites presents significant add-on costs for MIKE surveys.

(d) Logistic Regression Model – Laing *et al.* (2003)

Bob Burns next provided the framework for a logistic regression model, also known as the retrospective dung decay estimation method, that requires only a binary response (i.e. whether a dung pile is present or absent) dependent on the age of the dung pile and producing an age dependent survival function and mean time for decay (Laing *et al,* 2003).

He emphasized that this approach is retrospective and requires 5-6 visits prior to surveys when fresh dung piles are marked, and the status of marked piles (present or absent) is determined.

(e) Fecal DNA Survey Approach – Eggert *et al.* (2003)

This presentation described a method that adopts an entirely new approach for the estimation of elephant numbers/densities and does not use the framework or parameters discussed earlier.

Lori Eggert described her work in West Africa (Eggert *et al* 2003) where she used a combined fecal DNA and mark-recapture survey method to estimate elephant numbers while measuring dung boli diameters for determining the age structure of her target population. It was pointed out during her presentation that in populations of 200-500, this method could be a viable alternative to dung count methods. This finding required further discussion.

(f) Combined Line Transect/Recce Transect Approach – Walsh & White (1999)

The task force was then presented an overview of the WCS/MIKE initiatives in Central Africa as a case study, in an attempt to highlight the results, and the practical and logistical difficulties in dung surveys using the recce-transect method.

Steve Blake gave an overview of results obtained from recce-transect method, and emphasized the weaknesses of dung density estimation techniques (including reliance on the Barnes' rainfall method) for Central Africa. He emphasized that the large survey areas and frequent low elephant densities and/or clumped distributions, may carry high variances and large cost implications. However, he shared his views that although elephant density estimates are presently imprecise

and possibly unreliable, convincing patterns of relationships between elephant distribution, human activity and law enforcement have emerged from simply walking systematic dung transects in the forest.

Blake and Hedges also introduced the unpublished Walsh "reverse method" (Walsh *et al.* unpublished) for discussion. The approach was considered inappropriate by the task force as it requires a large number of assumptions that are known to be invalid in the first instance and, therefore, trouble-laden to any estimation based on this approach.

3.3 Recommendations on models and analysis:

The general statistical theory exists based on Generalized Linear Models and logistic models was noted.

Guiding Principle

The taskforce considered that because dung-based counts are so difficult and demanding of manpower and resources, it is better to prioritize the quality of surveys over the number of sites. In this regard, the following **recommendations** were made :

(1) There must be a unified statistical approach to the analysis of data across MIKE sites.

(2) Retrospective estimation of dung decay rates should be applied.

(3) Methods of estimating elephant density, which rely on the assumption of steady state are obsolete and should not be used. However, it may be possible to re-analyze data collected previously using other models.

(4) Statistical training is a must for key individuals at all levels. This will mean the development of user-friendly interface software that is MIKE specific.

Rainfall Models

The discussions then centred on the rainfall model, whether there is a need to build additional rainfall models for the analysis, re-analysis or "correction" of existing prospective data. The taskforce agreed on the following **recommendations** :

(1) It should not be not necessary in West Africa to build more rainfall models, however, the use of available rainfall data to go back and "correct or salvage" previous surveys should be encouraged. Otherwise, the collection of data to produce additional rainfall models may distract from attempts and resources for the required retrospective dung decay surveys.

(2) Building additional rainfall models are not a practical priority for MIKE in Central Africa or South Asia

(3) In Southeast Asia it may be necessary where there is not enough time left to do retrospective dung surveys to carry out surveys, and then establish site-specific rainfall models

3.4 Harmonization for Estimation of Relevant Parameters

The taskforce next discussed the need for harmonizing the collection of data on key variables for the estimation of the parameters required for the application of these models, including:

- calculation of dung decay rates;
- estimation of defecation rates; and
- classification of dung piles based on their state of decay, etc.

In light of the decision that retrospective, non steady state approaches will be used to estimate elephant densities from dung counts, and the concerns expressed over the lack of uniformity in existing methodologies for designing decay studies, estimating defecation rates and measuring dung densities, it was therefore decided that a set of clear recommendations for the harmonization of parameter estimation were required and set out as follows.

3.4.1 Dung Decay Rates:

Overall Recommendations

The **overall recommendations** for measuring dung decay rates were agreed as follows :

(1) The use of retrospective dung decay sampling (Laing *et al*, 2003; Hiby & Lovell 1991) is essential.

(2) Monitoring of dung decay rates should begin in advance, so that the time interval between the start of the dung decay monitoring and the estimation of dung densities should roughly correspond to a period taken for 90 % of marked dung piles to decay. As this varies across sites, one will have to guess this period for a site. Dung piles should then be visited a minimum of 5-6 times to replace damaged markers, and if necessary, fresh piles be marked before a final assessment of whether marked dung piles are decayed or not decayed is made.

(NB: Following the TAG discussions in December 2003, this sampling regime is being revisited by Bob Burn and may, subsequently, be revised.)

Designing a Decay Study – How to determine a representative sample for decay experiments?

The following **recommendations** were agreed upon :

(1a) Strive for "representativeness" with regard to site characteristics and hence, probability of decay as a function of age (i.e. rainfall, slope, canopy cover);

(1b) One way to do this might be to establish three or four sites that are likely to encompass as many of the factors likely to affect dung decay rates and elephant distributions;

or, if this is just not feasible,

(1c) Find a concentration of elephants (and therefore dung) and establish dung decay plots by moving dung to a "control" plot and then following them under known conditions.

Is it desirable to strive for "representativeness" with regard to other factors likely to affect dung decay rates?

The following **recommendation** was agreed upon :

(1) As and where possible (and practical), the collection of other co-variate data (i.e. presence/absence of termites and other dung-disturbing species) should be carried out.

NB: Seek advice on how to deal with the establishment of a representative sample for dung decay –e.g. establish some sub-transects/plots/strata broadly thought to be "representative" and then search them at monthly intervals. The ideal would be sets of plots each representing the effects of: (1) rainfall (2) vegetation (3) slope (or combinations of these). For example, one possibility in data analysis is to use weighted averages of decay rates of dung piles monitored across strata. Here, the weights could reflect the relative influence each factor (existing within the strata) could have on the decay process. Thought has to be given as to how these weights are obtained, although GIS maps having layers for slope, vegetation, rainfall etc. would be very useful.

How to define fresh?

On the definition of "fresh" dung, the **recommendation** that was agreed upon was that :

(1) 1-2 days old but certainly less than 4 or 5 days old

How to ensure consistency across transect teams and decay monitoring teams?

The following **recommendations** were agreed :

(1) Rotate people between the two teams to reduce inter-observer bias.

(2) Design the transect/dung decay surveys to look at inter-observer reliability/consistency for the purposes of later analysis (and correction) for any observer bias – methodology to be determined at a later date if this is required.

(3) Establish blind tests for inter-observer reliability (introduce several observers to dung piles and look at variance in classification).

(4) Develop guidelines and tools for field identification. (photos, diagrammes)

How to mark dung piles for later relocation (possibly two years hence)?

The **recommendations** were as follows :

(1) Do not use wooden or other stakes that can be destroyed or decay.

(2) Use multiple markers, metal stakes, flagging or other long-lasting substances and if possible GPS log the position.

(3) Although not necessary for the theory, there are practical reasons to revisit the earlier marked piles, so always take the opportunity to replace damaged markers (and mark new piles).

3.4.2 Dung pile classification

After reviewing the existing systems of dung pile classification used in Africa and Asia and noticing that there was variability across these, that could potentially lead to difficulties in comparisons of dung densities across sub-regions, the task force decided to address and make recommendations for the following questions.

Classification Systems of Dung Pile

In considering whether it is necessary to classify dung piles according to stages or whether it would suffice to simply use the binary presence/absence approach, the following **recommendations** were agreed :

(1) Utilize the binary presence/absence classification system. A consideration needs to be borne that due to the problems of inter-observer reliability not only within sites but between sites, there may be added problems by having multiple stage classification systems. If it is accepted that the presence/absence classification system will be applied as a global standard, and the cut-off point between

presence and absence should be at a later stage (rather than earlier), then several constraints must be also be acknowledged and accepted :

- Short durations for decay in low density populations could eliminate dung surveys as an option by lowering sample sizes to an unacceptable level during the survey;

- As it is unrealistic to carry out empirical studies to establish how much compromise there would be (on whether an earlier rather than later stage is used), it would be better to go back and look at empirical data to establish the tradeoffs of time and sample size.

(2) The Hedges and Tyson definition of transition from D to E could be consistently measured and adopted as the cut-off for presence/absence as the global standard.

(3) Finer resolution of classification of stages should be developed at the site-specific level. A consideration needs to be borne in mind that there are advantages in reporting more finely-graded stages, as boli may have different visibility profiles. If practitioners want to have finer classifications, they should be allowed to do so but the essential information and global standard will be presence/absence.

(4) At each site there would have to be adaptive work to feedback on issues for modification and improvement of the method (from site to MIKE Subregional Support Officers /Regional Representative then to the MIKE TAG)

3.4.3 Defecation rates

Simon Hedges and Martin Tyson presented a table of published defecation rates across Africa and Asia and discussed methods of data collection and reliability of each value. It was also pointed out that variation in defecation rates within and across the two continents was not enormous. However, there were obvious, though unstudied, causes of variation (e.g. feeding during fruiting seasons in Central Africa) that needed to be considered.

This background was helpful in stimulating the following **recommendations** :

(1) Continue to use 18/day for near future and until additional studies have been completed. It is particularly likely to be a reliable estimate in a stable, constant environment.

(2) There are good opportunities for more work in both Southeast Asia and South Asia – for the tracking of captive elephants when they are foraging in the wild.

(3) At least one more site in Southeast Asia (Myanmar or Thailand) or South Asia could be studied, preferably in a highly seasonably variable environment.

(4) At least one more site in a stable forest environment somewhere else in Southeast Asia.

(5) At least one more site in Central Africa (Lopé or Gamba in Gabon).

3.4.4 Estimating Dung Pile Density

Recommendation *while designing the line-transect survey*

(1) Rather than seeking an *a priori* representation, it would help to measure slope on transect for post hoc analysis.

While we assume that the dung pile density estimate is instantaneous, in fact, it is not. Therefore, the ***recommendations*** *were agreed as follows :*

(1) The dung density estimate is implicitly associated with a discrete point in time (there are a number of ways to establish this point in time – i.e. take the mid-point of the dung survey).

(2) Aim to complete a survey in a three-month period. If the area is too large, it should be stratified and each stratum should be surveyed in a six month period.

Recommendations for using line transects and "recce" transects for estimating dung pile densities:

Line transects:

(1) Estimation of dung densities by distance sampling of line transect data should form the basis of all dung density estimates and should be correctly done following the MIKE standards. This involves returning to fixed transects in subsequent surveys. Therefore transects need to be marked and GPS logged.

(2) Basic principles of survey design should be included in training of survey teams.

Recce transects:

It was noted that the status of their use within MIKE is unclear – i.e. has there been a decision on the use of "recce" counts or not? Two distinct forms were defined:

Travel recces (i.e. for use in collecting auxiliary information): Useful for collecting additional information but difficult, if not impossible, to analyze in terms of elephant density estimation because we do not know about the detection probabilities.

Recce-transect recces (RTR's) (i.e. for use in improving precision of line transect dung counts): the contribution to improve precision is not likely to be very great. However, you may get added value on determining distribution.

The following **recommendations** were made on recces :

(1) Travel recces should be done. Any law enforcement data from these recces must feedback into the MIKE law enforcement monitoring database (which will be used in the measure of law enforcement effort).

(2) The use of recce-transect recces for improving precision is still under investigation and clear instruction cannot yet be provided. On the basis of this advice, future decisions will be made. MIKE TAG would need to wait for the results of the Central African sites before concluding and finalizing standards on RTR's for other sites.

[NB: It was subsequently determined that RTR's, in the specific form of what are referred to as "comprehensive or guided recces", are carried out for other reasons as well, including the conducting of great ape surveys in CA and not just for the purpose of improving precision on the dung density estimates]

(3) If RTR's are going to be used, then MIKE should provide standards for them .

3.4.5 Ageing Elephants using Dung-bolus Measurements:

The dung bolus measurements could provide potentially valuable information as an index of recruitment and differential mortality, for use in understanding trends. There are five "age" classes should be possible: e.g. juvenile, sub-adult, adult, +…. age classes. This can be a post hoc classification.

However, this may well be unnecessary as all that is needed are comparisons of bolus size distributions across time. If it is found that the average size reduces, then the average age is reducing. Otherwise, the average age would be increasing.

The following **recommendations** were agreed :

(1) This should be done for all intact dung piles within a meter of the centerline (measure 3 boli for each pile) at all MIKE forest sites.

(2) Where defecation rates are being worked on, the shoulder height and dung size of elephants of known age and sex should also be measured and analyzed to establish relationships between dung size and age. .

(3) The implication of using dung boli data for assisting in determining age structure from surveys still needs to be determined – in other words, there is still the need to determine the best way of analyzing the boli data to gain better resolution and to maximize the use of information on elephant age structure.

3.4.6 Combining bolus and DNA techniques

The impact of poaching on sex and age structure is necessary, however:

- Bolus method alone would not reliably provide information on the age and sex structure of a population.

- DNA technique alone would provide the sexing, therefore it is particularly useful in the context for Asian population demographics.

A combination of both methods could allow one to look at correlations between temporal changes in sex ratio, demography and boli measurement (and hence age specific recruitment), which could not be done by measuring dung alone.

The following **recommendation** was agreed :

(1) Possibly some pilot work on the combined method should be carried out in two sites in either West Africa or Central Africa (one heavily poached and one not) and two in Southeast Asia (with the same variation of conditions). This will lead to further recommendations regarding the use of this combined technique in other MIKE sites.

3.4.7 General recommendations

a) Line Transect or Mark/Recapture DNA methods?

The taskforce considered the situations where line transects, mark/recapture DNA or other methods might be most appropriate for estimating elephant numbers following initial systematic, low intensity reconnaissance surveys. The following **recommendation** was made :

(1) For West Africa, Southeast Asia and South Asia, the mark-recapture/dung DNA should only be considered if a population :

- is small (<200-300) or
- is likely to be <.0.05/km2 or
- there is a sex ratio distortion.

Preferably this method is applied in “closed” populations.

Otherwise, line transect dung counts are the default for all other sites but feasibility is a question of cost and capacity (financial and human resources).

b) Central Africa Forest Sites

The taskforce then considered whether there is a special case for the application of line transect dung counts in the Central African forest sites. The discussions are summarized as follows :

Although dung counts become very costly in very large areas with low densities of dung piles/elephants, sub-sampling with extrapolation may be possible. However, elephants move alot which may cause problems for sub-sampling.

Where cost becomes prohibitively high especially in large areas such as found in Central Africa, achieving "representativeness' is difficult, it may simply not be possible to produce population estimates, but, other monitoring activities would still be desirable. In fact, there is **ALWAYS** value in having survey practitioners out on the ground doing some survey work, even if the data does not provide a precise measure of population estimation. Therefore, even though elephant numbers are very important to the MIKE process, if present surveys do not give precise estimates, there is still great merit in having people doing line transects as a huge amount of information (e.g. the distribution of elephant activity and the effect of human activity on elephant distribution) emerges.

Given the issues facing surveys in the CA forest sites, it is probably necessary to consider this work as being a "reconnaissance" phase, and to speak of it as such, and not create any greater expectation.

In sites with significant swamp areas, there is a conundrum. Dung methods will underestimate by an unknown amount. Retrospective methods may preclude the ability to survey in seasonally flooded areas. Seasonally flooded areas can be more easily dealt with, but, permanently flooded areas pose real problems.

Therefore, the issue of what to do in forested areas, which have portions that are seasonally or permanently flooded needs to be tackled. The following **recommendations** were agreed by the taskforce in this regard :

(1) There is still need to get some kind of idea of habitat utilization/selection to correct for this problem – this could be initially investigated through the use of GPS collared elephants. However, sample sizes are likely to be low with this method.

(2) Try to conduct subsequent surveys during periods with similar environmental conditions; preferably, for seasonally flooded areas, this could be in the dry season.

(3) Encourage others to develop new methods such as acoustical aids and camera traps.

(4) Survey practitioners should be made aware of the problem of extensive seasonally and permanently flooded areas in the MIKE sites in Central Africa, because it may have major implications on the results of the dung counts.

c) To get a better idea of application of the Laing *et. al*.(2003) approach it should be applied to Sumatra dataset – Simon Hedges and Bob Burn to work together on this.

d) MIKE should invest in comparing dung count techniques with other standardized techniques in known populations (even dung vs. aerial surveys) for as many populations as possible.

e) To study the effect of co-variates on density estimates, it may be useful to pick out extreme representation of these co-variates to get an idea of their impacts on dung pile density estimates so long as interactions among covariates are also understood.

3.4.8 Prioritizing the Activities

In prioritizing the activities recommended in the event that funding considerations pose limitations for the use of dung counts, several considerations arose. The cost implications of the above recommendations have been considered, but, they need to be calculated more specifically (e.g. the true costs associated with dung DNA methods as well as the cost of retrospective sampling).

It was felt that the cost of retrospective dung decay studies vs. establishing rainfall models is very likely to be less costly.

Nonetheless, it is recognized that carrying out retrospective dung decay studies and the collection of data or actions required in many of the other recommendations above (e.g. the collection of co-variate data while measuring decay rates, the use of dung DNA techniques for both population demographic work and mark-recapture methods) do carry additional costs. These must be built in to the planning and budgeting.

Recommendations :

However, if defensible estimates based on estimated dung densities are to be achieved, then MIKE must have:

(1) One or more additional defecation rate studies in Central Africa. Any additional defecation rate studies are desirable but not required.

(2) Additional dung decay studies are required. In situ studies are the preferred way but they will be costly. As a fall back, we could compromise and do them in a less expensive way (i.e. through controlled plots near base camps).

(3) Three months should be the maximum duration for surveys, given that densities should ideally be measured instantaneously. However in larger sites, the design could break the survey into strata, which will also have cost implications for manpower and resources.

Where you have a situation with serious concerns over age and sex structure, dung DNA can be an important tool for a partial understanding of population dynamics but it clearly carries additional costs.

3.5 South Asia – is parallel methodological development an issue?

In the context of South Asia census techniques, the taskforce considered the question whether there needs to be a parallel methodological development. The **recommendations** were as follows :

(1) If they are using valid techniques (as peer reviewed and through TAG) for providing elephant estimates, then it will not matter which method is used.

(2) Block counts in India, registration method in Assam, waterhole counts in India and footprint counts in Malaysia need to be technically reviewed for validity.

4. Developing MIKE Standards for Dung Counts for Estimating Dung Pile/Elephant Densities

The taskforce agreed that only a single set of standards needs to be developed. The rough outline and the proposed authors was agreed as follows :

1. Theoretical basis – Ken Burnham/Bob Burns

2. Where and when are dung counts appropriate? – Richard Barnes/Simon Hedges

3. Dung classification – Simon Hedges /Martin Tyson

4. Survey Design & Analysis

   Estimating dung pile density through line transects– Steve Blake

   i. Converting dung pile densities to elephant densities and associated dung decay and defecation studies– Simon Hedges/Bob Burns/Martin Tyson /Richard Barnes

   ii. Ageing and sexing populations from dung (including the protocol for the collection of dung samples for DNA – can be an Annex) – Martin Tyson/Lori Eggert

5. Data Management at the site level – Richard Barnes/Steve Blake

6. Data Reporting – Richard Barnes (from MIKE forest standards)

7. Other considerations such as recce transects – Simon Hedges/Steve Blake

8. Annexes

Equipment – all look through draft and come back to Richard with modifications.

The schedule for producing the Draft MIKE Standards was agreed as follows.

(i) All authors should have their pieces to Arun by the beginning of December.

(ii) Recommended options for pulling all the parts together:
(a) Arun by end of December 2003;
(b) Simon draft for review by end of January and WCS paid for the product or Richard by end of April 2004.

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The Dung Count Taskforce were constituted at the MIKE Technical Advisory Group Meeting held in Accra, Ghana on 28th and 29th April 2003.

Taskforce Participants

Holly Dublin, IUCN/SSC/AfESG (Chair/Facilitator)
Arun Venkataraman, CITES/MIKE (Rapporteur)
Kenneth Burnham, Colorado State University
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Richard Barnes, University of California at San Diego
Simon Hedges, Wildlife Conservation Society
Martin Tyson, Wildlife Conservation Society

Invitees :

Karl Stromayer, US Fish and Wildlife Service
Richard Ruggiero, US Fish and Wildlife Service
Lori Eggert, Smithsonian Institution