WORKING PAPER

Determining the number of elephants required to supply current unregulated ivory markets in Africa and Asia

Nigel Hunter,[1] *Esmond Martin*[2] *and Tom Milliken*[3]

[1] CITES MIKE CCU, PO Box 68200, Nairobi, Kenya; email: nigelhunter@citesmike.org
[2] PO Box 15510, Mbagathi, Nairobi, Kenya; email: rhino@wananchi.com
[3] TRAFFIC East/Southern Africa, PO Box CY 1409, Causeway, Harare, Zimbabwe;
email: milliken@wwf.sarpo.org

Abstract

The relationship between unregulated ivory markets and illicit trade in ivory in Africa and Asia has been highlighted in a recent series of reports. What is not clearly indicated is the number of elephants that are required annually to service these markets, and the geographical regions from which these elephants are being taken. With the use of various published studies of ivory markets in Africa and Asia, it has been possible to estimate the number of carvers. This is only the first step to knowing the volume of ivory they require annually. This paper therefore attempts to estimate this volume. Although the data are highly variable in availability and precision, a comparative scoring method has been developed to apply and extrapolate these data to derive minimum and maximum estimations of ivory consumption in 25 key countries around the world. This makes it possible to estimate minimum and maximum values for the number of elephants required to support these ivory-carving industries. A surprising result is that unregulated ivory markets in Africa appear to consume a higher volume of ivory than those in Asia. The study also suggests that 4000 elephants or more are required each year to meet the estimated demand from both continents. Determining the source of this ivory is necessary to determine which elephant populations are under pressure. Drawing on preliminary information from other sources, the study raises a concern that the supply of ivory for the unregulated markets in both continents is coming from elephants in central Africa. The analysis undertaken here is presented as work in progress, and suggestions for improving it are welcome as a basis for building MIKE and ETIS links.

Résumé

La relation entre le marché de l'ivoire non réglementé et le commerce illégal de l'ivoire en Afrique et en Asie a été mise en lumière dans une série de récents rapports. Ce qui n'est pas clairement indiqué, cependant, c'est le nombre d'éléphants nécessaires, sur une base annuelle, pour alimenter ce marché, et les régions géographiques où ces éléphants sont prélevés. En reprenant diverses études sur les marchés de l'ivoire en Afrique et en Asie, il a été possible d'estimer le nombre de sculpteurs d'ivoire. Ce n'est que la première étape avant de savoir le volume d'ivoire dont ils ont besoin chaque année. Cet article essaie dès lors de faire une estimation de ce volume. Bien que les données ne soient pas toujours disponibles ni exactes, une méthode de classification comparative a été mise au point pour utiliser ces données ou les extrapoler afin d'en déduire les estimations

maximale et minimale de la consommation d'ivoire dans 25 pays clés du monde entier. Ceci permet d'estimer les valeurs maximale et minimale du nombre d'éléphants requis pour satisfaire ces industries du travail de l'ivoire. Nous avons été surpris de constater que les marchés non réglementés de l'ivoire en Afrique semblent consommer un volume d'ivoire plus élevé que ceux d'Asie. Notre étude tend aussi à montrer que 4000 éléphants, voire plus, sont nécessaires chaque année pour répondre à cette demande sur les deux continents. En se basant sur des sources d'information antérieures, l'étude signale que l'ivoire qui se retrouve sur les marchés non réglementés des deux continents provient d'éléphants d'Afrique centrale. L'analyse entreprise ici est présentée comme un travail en cours, mais on la considère une base de départ pour construire les liens entre le contrôle des massacres illégaux d'éléphants (Monitoring the Illegal Killing of Elephants—MIKE) et le Système d'informations sur le commerce des éléphants (Elephant Trade Information System—ETIS) et toutes les suggestions qui pourraient l'améliorer sont les bienvenues.

Introduction

The Elephant Trade Information System (ETIS) analysis presented to the 12th meeting of the Conference of the Parties to CITES (CoP12) clearly demonstrated a highly significant statistical correlation between the illicit trade in ivory and the presence of unregulated domestic ivory markets in Africa and Asia (Milliken et al. 2002a,b,c). Ongoing serial studies of these ivory markets by Martin and Stiles and more recent TRAFFIC research in India and West Africa have provided 'snapshot' documentation of the number of carvers and other ivory trade dynamics found in various locations around the world at specific times (Martin and Stiles 2000, 2002, 2003; Courouble et al. 2003; anon. 2003).

A prime objective of the site-based CITES Monitoring the Illegal Killing of Elephants (MIKE) programme is to provide information on the amount of illegal killing of elephants presently occurring in elephant range states in Africa and Asia. To meet this objective, the MIKE programme needs to have some sense of the magnitude of the ongoing trade in terms of how many elephants are potentially being killed to service the ivory requirements of the carvers supplying the unregulated markets identified in the reports mentioned above. The first purpose of this paper, therefore, is to present available data in an attempt to determine the number of carvers and the annual rate of turnover of raw ivory they use in their production. This will then form the basis for assessing how many elephants are required to support such a supply.

The second purpose is to link the demand for such elephants with possible sources of ivory supply and patterns of illegal killing, on the basis that most of the ivory supplied to these domestic markets is illegally obtained. Thus, using different sources of information, this paper will also assess whether any evidence exists to suggest where elephant poaching is currently most acute. As the CITES MIKE programme progresses, it should be possible to achieve this second objective with greater certainty and precision.

Developing and using early warning flags is seen as an important step in the evolution of MIKE and ETIS as effective monitoring programmes for elephants.

Methods

Through a review of recent published literature, the number of carvers identified at various locations is summarized in table 1. In addition, table 1 includes a number of African and Asian countries that traditionally had ivory-carving industries in the recent past but do not appear to have active industries today. In such instances, the number of carvers is designated '0'. However, there are certain gaps. In Africa, Angola, Benin, Congo (Brazzaville), Ghana, Malawi, Namibia, Togo and Zambia are countries that have had, or continue to have, minor ivory-carving industries but have not been surveyed in recent years. For this reason these countries are not included in this analysis but should be added in the future if information implicating them becomes available.

The method generally used in the reported surveys draws on interviews and questionnaires from which the estimated number of carvers is derived. It is extremely difficult either to visit all carvers in the course of a survey or to verify precisely all information on their existence. Thus some margin of error exists in the estimation, particularly where the estimate is significantly higher than the number actually observed or interviewed. Nevertheless, the estimated number of carvers provided by these reports has been

Table 1. Estimated number of ivory carvers in Africa and Asia

Subregion/ country	Location	Estimated no. carvers
AFRICA		
West Africa		
Cote d'Ivoire	Abidjan	88
Nigeria	Lagos	38
Senegal	Dakar	26
	Subtotal	152
Central Africa		
Cameroon	Douala	44
Cameroon	Yaounde	6
CAR	Bangui	22
DR Congo	Kinshasa	116
Gabon	Various	10
Tchad	Ndjamena	0
	Subtotal	198
North Africa		
Egypt	Cairo	110
	Subtotal	110
East Africa		
Djibouti	—	0
Ethiopia	Addis Ababa	15
Sudan	Khartoum/Omdurman	19
	Subtotal	34
Southern Africa		
Mozambique	Maputo	100
South Africa	Durban	2
Zimbabwe	Harare	30
	Subtotal	132
	Total in Africa	**626**
ASIA		
South Asia		
India	Various	525
Nepal	Kathmandu	4
Sri Lanka	Various	14
	Subtotal	543
East Asia		
China	Various	190
Hong Kong	—	5
South Korea	—	0
Taiwan	—	1
Japan	Various	107
	Subtotal	303
South-East Asia		
Cambodia	Phnom Penh	30
Laos PDR	Vientiane	5
Myanmar	Mandalay	45
Myanmar	Yangon	10
Singapore	—	0
Thailand	Phayuha Kiri	55
Thailand	Bangkok	20
Thailand	Chiang Mai	6
Vietnam	Hanoi	20
Vietnam	Ho Chi Min	2
	Subtotal	193
	Total in Asia	**1039**

used as the maximum figure for the countries in question. With more funds and more time, researchers conducting future surveys of the ivory markets in question could increase accuracy by increasing the level of direct observations.

There is also a need to better understand a variety of other related factors when deriving estimates of ivory carvers and their turnover. For example, the report on India estimates 525 carvers (anon. 2003). Given the size of India and its population, it may well be that the figure is reasonable. In a climate of active suppression, however, ivory carving in India today is undertaken in secret on a part-time commissioned basis with few, if any, observable workshops or retail or wholesale outlets. In other words, most craftsmen turn their hand to carving ivory when requested to do so, but they usually rely on other income-earning activities (S.S. Bist, director, Project Elephant, pers. comm. 2004). Compare this with the Democratic Republic of Congo (DR Congo), for example, where there are active full-time workshops and active retail markets in Kinshasa. Therefore in a situation like India, it should be noted that deriving an ivory turnover per carver may produce a reasonable average, but this may mask the reality that a few carvers have a relatively high turnover in any one year, whereas the majority may have none.

Having established an estimate of the number of operational carvers, we then attempt to determine the annual turnover of raw ivory for each carver, based on reported or observed information at the time various markets were surveyed. We emphasize that the method used here is based on determining the amount of ivory being carved each year, not the amount being sold through wholesale or retail outlets. Data concerning rates of retail and wholesale turnover are generally poor and assumptions with regard to stockpiling in the marketplace are complex, making estimation of turnover difficult. Wherever possible, however, retail data for comparison and verification have been considered.

The estimated rate of turnover for each carver is presented in kilograms in table 2 in columns 3 and 4. However, some explanation of our basic assumptions is necessary.

- As stated, the data concerning the number of carvers and their rate of turnover are variable. Some data are based on surveys conducted in 1997 and 1998, for example those for Omdurman and Khartoum, Sudan, and Cairo, Egypt, while the most

Table 2. Provisional estimate of the number of elephants required to supply ivory carvers in Africa and Asia

1	2	3	4	5	6	7	8	9	10
		Turnover							
	Estimated no.	(kg/carver per year)		Quantity of ivory (kg)		No. of elephants[a]		Main source	
Subregion/country	of carvers	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	of ivory	Source of data
AFRICA									
West Africa									
Cote d'Ivoire	88	48	121	4,224	10,648	612	1,543	Africa	4, 1
Nigeria	38	62	156	2,356	5,928	341	859	Africa	1
Senegal	26	44	111	1,144	2,886	166	418	Africa	4, 1
Subtotal	152			7,724	19,462	1,119	2,821		
Central Africa									
Cameroon	50	62	156	3,100	7,800	449	1,130	Africa	1
Central Afr. Rep.	22	48	121	1,056	2,662	153	386	Africa	1
DR Congo	116	66	166	7,656	19,256	1,110	2,791	Africa	1
Gabon	10	40	101	400	1,010	58	146	Africa	1
Subtotal	198			12,212	30,728	1,770	4,453		
North Africa									
Egypt	110	44	111	4,840	12,210	701	1,770	Africa	6
Subtotal	110			4,840	12,210	701	1,770		
East Africa									
Ethiopia	15	46	116	690	1,740	100	252	Africa	1
Sudan	20	40	101	800	2,020	116	293	Africa	5
Subtotal	35			1,490	3,760	216	545		
Southern Africa									
Mozambique	100	46	116	4,600	11,600	667	1,681	Africa	1
South Africa	2	32	81	64	162	9	23	Africa	1
Zimbabwe	30	38	96	1,140	2,880	165	417	Africa	1
Subtotal	132			5,804	14,642	841	2,122		
Africa	627			32,070	80,802	4,648	11,710		
Minus Zimbabwe	597			30,930	77,922	4,483	11,293		
Minus southern Africa	495			26,266	66,160	3,807	9,588		

Table 2. (continued)

1	2	3	4	5	6	7	8	9	10
		Turnover							
	Estimated no.	(kg/carver per year)		Quantity of ivory (kg)		No. of elephants[a]		Main source	
Subregion/country	of carvers	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	of ivory	Source of data
ASIA									
South Asia									
India[b]	525	1	3	525	1,575	66	197	Asia	8
Nepal	4	1	3	4	12	1	2	Asia	2
Sri Lanka	14	1	3	14	42	2	5	Asia	2
Subtotal	543			543	1,629	68	204		
South-East Asia									
Cambodia	30	2	5	60	150	8	19	Asia	2
Laos PDR	5	2	5	10	25	1	3	Asia	2
Myanmar	55	6	16	330	880	41	110	Asia	2
Thailand	76	9	22	684	1,672	99	242	Africa	2
Vietnam	22	2	5	44	110	6	14	Asia	2
Subtotal Africa[c]	76			684	1,672	99	242		
Subtotal Asia[c]	112			444	1,165	56	146		
S/SE Asia from African elephants[c]	76			684	1,672	99	242		
S/SE Asia from Asian elephants[c]	55			987	2,794	123	349		
East Asia									
China	190	34	86	6,460	16,340	936	2,368	Africa	3, 7
Hong Kong	5	24	59	120	295	17	43	Africa	3
Japan	107	47	117	5,029	12,519	729	1,814	Africa	3
Taiwan	1	21	53	21	53	3	8	Africa	3
Subtotal	303			11,630	29,207	1,686	4,233		
Asia from Asian elephants[c]	655			987	2,794	123	349		
Asia from African elephants[c]	379			12,314	30,879	1,785	4,475		
Asia from African elephants minus Japan[c]	272			7,285	18,360	1,056	2,661		

Table 2. (continued)

1	2	3	4	5	6	7	8	9	10
		Turnover							
	Estimated no.	(kg/carver per year)		Quantity of ivory (kg)		No. of elephants[a]		Main source	
Subregion/country	of carvers	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	of ivory	Source of data
Summary									
All elephants									
Africa				32,070	80,802	4,648	11,710		
Africa minus Japan, South Africa and Zimbabwe				25,837	65,241	3,744	9,455		
Asia				13,301	33,673	1,908	4,824		
Asia minus Japan				7,285	18,360	1,056	2,661		
Asian elephants									
Asian demand for Asian elephants				987	2,794	123	349		
African elephants									
Asian demand for African elephants				12,314	30,879	1,785	4,475		
Asian demand for African elephants minus Japan				7,285	18,360	1,056	2,661		
African demand for African elephants				32,070	80,802	4,648	11,710		
African demand for African elephants minus Zimbabwe				30,930	77,922	4,483	11,293		
Total demand for African elephants				44,384	111,681	6,432	16,186		
Total demand for African elephants minus Zimbabwe and Japan				38,215	96,282	5,538	13,954		
Total demand for African elephants minus southern Africa and Japan				33,551	84,520	4,862	12,249		

Source notes: 1. Martin and Stiles 2000; 2. Martin and Stiles 2002; 3. Martin and Stiles 2003; 4. Courouble et al. 2003; 5. Martin 1998; 6. Martin 2000; 7. Daniel Stiles, pers. comm. 2004; 8. anon. 2003

[a] average 6.9 kg per African elephant and 8 kg per Asian elephant

[b] see text in paragraph 3 of Methods section (page 2)

[c] the reference to Africa and Asia distinguishes the markets using African and Asian ivory

recent observations of West African and East Asian countries were in 2002. Although acknowledging that the literature on various ivory markets at particular times characteristically illustrates wide fluctuation in the number of ivory carvers over relatively short periods, we use a static model for this analysis. In other words, we assume that all data are indicative of the current situation regardless of the year from which they derive.

- Another issue with using carvers as the basis for estimating consumption volumes is that this methodology probably fails to some extent to pick up the existence of 'closed', secretive and highly illegal carving operations that are based on the export of worked and semi-worked products into foreign markets. The presence of African-based, Asian-run ivory-processing operations has been established for some time (Dublin et al. 1995). To illustrate, countries such as Kenya have no domestic ivory market whatsoever, and consequently no identifiable ivory carvers, but seizure records in ETIS indicate that successful law enforcement against Korean-run processing operations in 1993 led to the seizure in Nairobi of nearly 350 kg of worked ivory products. Similarly in 2002, a single illegal consignment of ivory from Malawi contained over 41,000 processed ivory pieces, weighing over 1500 kg. Such large-scale, export-oriented operations become apparent only when exposed through law-enforcement action, and their effect is not necessarily captured when the basis of analysis relies on an evaluation of ivory carvers in more transparent markets. Indeed, neither Kenya nor Malawi features in this analysis.
- There are no empirical assessments of rates of consumption by the carving industry, only reported information. The best data for Africa stem from the Martin and Stiles (2000) report where, for example, an estimate of 166 kg of ivory per carver per annum was given for operations in Kinshasa, DR Congo, in 1999. This estimate is used as the starting point for assessing other markets in Africa. Reasonable data on the rate of consumption are also found for Japan and Thailand, and they are used as a baseline for assessing Asian countries that predominantly use African elephant ivory in their carving operations. The data for Cambodia, Laos, Myanmar, Nepal, Singapore, Sri Lanka and Vietnam in South and South-East Asia are also believed to be quite accurate, as multiple surveys have been carried out in these countries. Their data are used as the baseline for estimating the rate of consumption of Asian elephant ivory in other Asian countries. The data for China are poor, however, due to the huge size of the country, its large human population, and the increasingly informal nature of the trade and processing industry. Carving operations in Hong Kong and Taiwan have also changed dramatically in recent years, and what remains is small and secretive. However, as these industries generally rely upon African ivory for their limited production needs, it is possible to estimate a rate of consumption using the data from Japan and Thailand.
- Where data on the rate of ivory consumption in key locations are not at hand, it has been necessary to estimate the likely turnover. To do so, characteristics of the ivory markets have been compared so that those with similar characteristics are ascribed a similar rate of consumption as a maximum turnover value. The characteristics examined are as follows:
    1. trend concerning the number of ivory carvers as mentioned in the survey reports used for each country
    2. method of carving, for example whether predominantly by hand or by machine
    3. degree to which carvers, directly or through a wholesaler, engage in the export of the items they carve
    4. degree to which carvers engage in the production of products fashioned from alternative substances, for example wood or bone
    5. extent to which ivory stockpiles are believed to exist in the custody of carvers
    6. degree of access to illicit sources of ivory
    7. degree to which the market is expanding or contracting, with some reference to the time period since the date of the relevant report (for example, Kinshasa is currently seeing an increase in potential buyers, due to the peace process in DR Congo)
    8. legality of the supply of ivory
    9. degree of internal regulation

We developed a scoring system for each of the above criteria (see table 3) and ranked each of the baseline countries accordingly. However, it is important to state that in using the scoring approach, we made no attempt to weight the above criteria. We recognize that a weighting mechanism should be considered for the future, but probably only after the scoring system has been further

Table 3. Criteria used to score domestic ivory markets around the world

Criteria	Score	Definitions
1. Trend for number of carvers	High base increase – 5	Increasing from a base of more than 50 in number
	Low base increase – 4	Increasing from a base of less than 50 in number
	Stable – 3	Stable: less than 10% variation
	High base decrease – 2	Decreasing from a base of more than 50 in number
	Low base decrease – 1	Decreasing from a base of less than 50 in number
2. Method of carving	Highest value machine use – 5	Almost all carvers use machines
	Moderate value machine use – 4	Most carvers use machines
	Mixed (machine and hand) – 3	Mixed; about half and half
	Moderate value by hand – 2	Most carvers work by hand
	Highest value by hand – 1	Almost all carvers work by hand
3. Degree of commercial wholesale export of worked ivory products	Very high – 5	Almost all carved ivory is exported
	High – 4	Most carved ivory is exported
	Medium – 3	Mixed; about half and half
	Low – 2	Most carved ivory is sold through local retail market
	Very low – 1	Almost all carved ivory is sold on local retail market
	Insignificant – 0	
4. Use of alternatives	Very low – 5	Almost all carvers work with ivory most of the time
	Low – 4	Most carvers use ivory most of the time
	Medium – 3	Mixed; about half and half
	High – 2	Most carvers use alternatives most of the time
	Very high – 1	Almost all carvers work with alternatives most of the time
5. Extent of stockpiling	Very high – 5	Over a 2-year supply of ivory generally at hand
	High – 4	Over a 1-year supply of ivory generally at hand
	Medium – 3	A 4-month to 1-year supply of ivory generally at hand
	Low – 2	A 1- to 3-month supply of ivory generally at hand
	Very low – 1	Less that a 1-month supply of ivory generally at hand
6. Access to illicit sources	Very high – 5	Excellent; in-country proximity to large supply; well-developed trade routes; no effective law enforcement
	High – 4	Good; close proximity to some supply; well-developed trade routes; poor law enforcement
	Medium – 3	Fair; moderate proximity to fair supply; developing but not established trade routes; moderate law enforcement
	Fair – 2	Poor; moderate or poor proximity to uncertain supply; uncertain trade routes; good law enforcement
	Low – 1	Bad; distant proximity to uncertain supply; poorly developed trade routes; effective law enforcement
7. Market trend	Booming – 5	Market trend rapidly increasing
	Increasing – 4	Market trend generally increasing
	Stable – 3	Market trend shows little change
	Decreasing – 2	Market trend generally decreasing
	Depressed – 1	Market trend rapidly decreasing
8. Legality of ivory supply	Predominantly illegal – 5	Virtually all ivory is obtained through illicit channels
	Mixed – 3	Some stocks illicit, some from longstanding legal stockpiles
	Predominantly legal – 1	Virtually all ivory obtained through legal sources
9. Degree of internal regulation	Very low – 5	Virtually no regulation at all
	Low – 4	Modest but ineffective attempt at regulation
	Moderate – 3	Some success in attempt to regulate
	High – 2	High regulation with large measure of success
	Very high – 1	Active suppression of ivory market

examined and validated with better data.

By adding the score and dividing it by the number of countries contributing to the baseline data, we derive a single baseline market score for each ivory type (that is, African elephant or Asian elephant) and regional grouping (Africa and Asia). By adding the baseline data on maximum rate of turnover and dividing by the number of countries, we obtain a single baseline value for the volume of ivory consumed. By scoring the other countries individually and dividing the baseline value for volume by the baseline market score, we derive a per unit baseline value. Finally, we multiply the per unit baseline value by the scores for each country to which the baseline unit value is relevant, thus calculating a maximum rate of turnover.

To illustrate, DR Congo is the baseline for African elephants in Africa. Scoring the characteristics of the DR Congo market results in a score of 33. Dividing the baseline value for the rate of turnover, which is 166 kg, by 33 gives a per unit baseline value of 5.0303. This figure is used to score other African countries for which the rate of consumption is unknown. For example, Senegal's market score is 22, so by multiplying 22 by 5.0303 we establish a maximum rate of turnover of 111 kg for Senegal.

As stated, determining the maximum rate of turnover is dependent on extrapolating from data that contain several real weaknesses. The difficulty of obtaining accurate estimates of the number of carvers and rates of ivory consumption has already been mentioned. While the scoring system addresses to some extent these concerns, we acknowledge that some of the criteria used in scoring either have little actual data or the data for a given market are highly variable (such as degree of commercial export, extent of stockpiling, use of alternatives, market trend). Thus it is important to reduce the assumed rate of consumption to a level where the influence of the uncertain variables is minimized. To ensure a conservative estimate we have used a 60% reduction of the maximum rate of turnover to determine the minimum rate of consumption. The choice of 60% was based on the one check that was possible against Indian mortality figures (see section below).

Table 4 therefore provides a score for each of the nine criteria used for comparatively assessing the domestic ivory markets in the 25 countries under consideration. These features are described in the source reports or are known to the authors of the reports from personal visits and knowledge. In some cases objective information, such as distance from elephant range (for instance, Egypt compared with Mozambique) or ETIS data on semi-worked and worked ivory seizures, has been taken into account. As described, the resulting scores together with the data on ivory carvers in table 1 have been used to allocate a minimum and maximum estimate of kilograms of ivory each carver uses per year. We emphasize that estimates of the rate of turnover remain the weakest point in the data available. Thus as mentioned, we have taken a cautious approach to reduce the risk of exaggeration.

Based on the above approach, columns 5 and 6 of table 2 estimate the possible range in the volume of ivory that is required for domestic ivory production in each country. To assess the effect of current poaching, countries such as South Africa, Zimbabwe and Japan, where the greater part of their carving industry comes from government-owned or -regulated legal stocks, have been removed from the totals where appropriate.

Results

How many elephants are potentially poached per annum?

When we compare the estimated volume of ivory for Africa with that for Asia, it comes as a surprise that Africa appears to require more ivory to sustain its domestic ivory markets than Asia; 13 countries in Africa need 32–81 tonnes of raw ivory per annum compared with 12 countries in Asia requiring 13–34 tonnes. To focus on the possible impact of unregulated markets, the ivory requirements of South Africa, Zimbabwe and Japan can be excluded. Africa still requires some 26–65 tonnes of raw ivory compared with only 7–18 tonnes for Asia. In sum, African countries require between 2 and possibly up to 11 times as much raw ivory to support domestic ivory carvers as is the case for Asia—a finding contrary to conventional notions about contemporary ivory trade dynamics.

This raises the question of who is purchasing this worked ivory from Africa. Martin and Stiles (2000), Stiles and Martin (2001) and Courouble et al. (2003) all report that buyers include European and Asian diplomats, French military, Asian businessmen, United Nations staff, West African traders, expatriates, and tourists from Europe, America and Asia. These reports indicate that such trade is not just individual demand for personal effects but that significant quantities of carved ivory are being purchased for selling commercially else-

Table 4. Scoring of 25 domestic markets, based on a scale of 1–5

Market	1. Trend in no. carvers	2. Method of carving	3. Degree of export	4. Use of alternatives	5. Extent of stockpiling	6. Access to illicit sources	7. Market trend	8. Legality of ivory supply	9. Degree of regulation	Total
African baseline										
DR Congo	2	3	4	4	1	5	4	5	5	33
West Africa										
Cote d'Ivoire	2	3	1	2	2	4	1	5	4	24
Nigeria	3	3	1	3	3	5	3	5	5	31
Senegal	1	3	0	2	1	3	2	5	5	22
Central Africa										
Cameroon	1	3	4	3	2	5	3	5	5	31
Central Afr. Rep.	1	3	2	2	1	4	1	5	5	24
Gabon	1	3	1	1	2	4	1	5	2	20
North Africa										
Egypt	2	3	0	2	2	3	2	5	3	22
Eastern Africa										
Ethiopia	1	3	0	2	2	4	2	5	4	23
Sudan	1	3	0	2	1	3	2	5	3	20
Southern Africa										
Mozambique	2	1	0	2	2	4	2	5	5	23
South Africa	1	5	1	2	2	1	1	1	2	16
Zimbabwe	1	4	0	5	2	3	1	1	2	19
Asian baseline for Asian elephant ivory										
Cambodia	1	1	0	2	1	3	1	5	3	17
Lao PDR	1	1	0	2	1	2	1	5	3	16
Myanmar	3	1	0	4	2	3	3	3	4	23
Nepal	1	1	0	2	1	2	1	5	3	16
Sri Lanka	1	1	0	1	1	2	1	5	2	14
Vietnam	1	2	0	2	1	1	1	5	3	16
South Asia										
India	2	1	1	1	2	3	1	3	1	15
Asian baseline for African elephant ivory										
Japan	2	4	0	4	5	1	2	1	2	21
Thailand	3	3	0	4	2	3	3	5	3	26
East Asia										
China	2	4	3	3	3	3	3	5	3	29
Hong Kong	2	2	2	1	5	1	1	3	2	19
Taiwan	1	4	1	1	1	2	1	5	2	18

where in the world. Evidence of commercial trade has been documented, with worked and semi-worked products being shipped to markets in Asia and Europe from West Africa (Courouble et al. 2003). There is also evidence that ivory is being sold by dealers through markets in Europe, particularly in London, Brussels and Paris, and through Internet auction sites such as eBay under the pretext that it is antique or pre-1989 ivory (IFAW 2004). The role of these markets and the number of buyers of worked ivory in Europe and North America need more attention, an issue also raised by Martin and Stiles (D. Stiles, pers. comm. 2004).

Given this estimate of annual ivory turnover, the question remains of how many elephants must be poached to supply these unregulated markets. A basic assumption is the belief that almost all of the ivory used in the carving industries of West and central Africa comes from elephants that have been illegally killed. Tusks from natural mortality are rarely found in forest habitats (R. Barnes, pers. comm. 2004). They are more easily found in savannahs, so it is possible that small quantities of ivory from natural mortality are reaching these markets. Nonetheless, such ivory is still illegal if it has moved across international borders without CITES permits. Likewise, some supply of ivory is believed to 'leak' from various government-owned stockpiles in Africa, and a portion of these stocks certainly find their way into carving markets in Africa. Finally, elephants are killed for a variety of reasons, especially for meat for human consumption or in defence of human life or property. In such cases, killing for ivory is not the primary motive, but the ivory is often taken and subsequently goes into trade as an important by-product.

As derived from conversion variables used in the TRAFFIC analysis of more than 7800 ivory seizure records, average tusk weight is 3.68 kg (Milliken et al. 2000c). Assuming that each elephant yields 1.88 tusks (Parker and Martin 1982), we establish an estimate of 6.9 kg of ivory per African elephant. For Asian elephants, where only males have tusks, we assume an estimate of 8 kg per animal (this figure is based on measurements taken by E. Martin from tusks in storage in southern India and is used in the absence of any reliable published figure). Using these conversion figures, we estimate that the ivory from between 4862 to 12,249 African elephants and between 123 to 349 Asian elephants is required annually (see columns 7 and 8 in table 2) for the unregulated markets examined in this report.

For India, we can compare the number of elephants derived in table 2 and the Indian mortality database (currently of the countries listed in table 2, only India and Sri Lanka have such a database). According to data from 1991 to 2003, the annual number of Indian tuskers poached for ivory ranges between 40 and 80. Because reporting dead elephants is widely acted on and is very much part of Indian culture and tradition, it is believed that few dead elephants are missed. Indeed, the encounter rate of carcasses could be as high as, or better than, 90% (S.S. Bist, pers. comm. 2004). It is reassuring to note that the minimum figure for the number of elephants required for India's ivory trade in table 2 is consistent with the numbers reported in India's mortality data. The difference at the maximum level is probably due to two factors: 1) some portion of India's ivory-carving industry derives from ivory sources that have been stockpiled in the country for over a decade, and 2) the data and extrapolation methods used in this analysis have certain inherent weaknesses. Regardless, the Indian data serve to support the conservative approach in applying a 60% reduction to the maximum consumption value.

Where are the poached elephants coming from?

As stated in the introduction, evidence on where elephants are being poached will continue to improve, with programmes such as MIKE being put in place. But currently, Courouble et al. (2003), as did Martin and Stiles (2000), state that their investigations reveal that the ivory supplying West African carvers is coming from central Africa. Preliminary evidence from MIKE supports the view that West African elephants are not a major source of ivory, probably because most populations in the region are already small and fragmented, thus providing an inadequate supply and making any offtake relatively uneconomical.

Similarly, preliminary MIKE evidence suggests that while elephant poaching certainly exists in eastern and southern Africa, levels of illegal killing appear to be comparatively low and stable. For southern Africa, it is assumed that what is required by Mozambican ivory carvers is largely derived from elephants poached in Mozambique or stolen from existing stockpiles within the southern African region. Ivory poached in eastern Africa probably contributes to the Ethiopian market and to a lesser extent to the Sudanese and Egyptian markets. Even if we take these

assumptions into consideration, an estimated annual supply of 26–65 tonnes of ivory, representing between 3700 and 9500 elephants, remains unaccounted for. If the Asian demand for African elephant ivory is included, the number of elephants unaccounted for rises to between 4800 and 12,250 per year.

This places the spotlight on central Africa. Information provided to the IUCN/SSC African Elephant Specialist Group meeting in December 2003 by the Institut Congolaise pour la Conservation de Nature (ICCN) in collaboration with the Wildlife Conservation Society highlighted the significant state of recent elephant poaching in eastern DR Congo, a region consumed by civil strife. This information is supported by carcass data from that area provided to MIKE for 2003.

Further evidence suggests that this is not the only part of the Congo Basin forest that is under worrying levels of poaching pressure. Elephant research work is signalling disappearance of elephants from an area under survey in one park located in the tri-national area of south-eastern Cameroon, south-western Central African Republic and northern Congo (Brazzaville) (A. Turkalo, pers. comm. 2004). The MIKE programme is currently undertaking a number of forest elephant surveys in that region, and although a careful and objective analysis of the data is still pending, there are worrying signs that carcass encounter rates are higher than what would normally be expected in some of the sites. There is also concern that encounter rates of elephant dung are low in those same sites. This raises the spectre that elephant poaching may have been going on relatively unknown to outsiders for some time.

Discussion and conclusion

The supposition that central African forest elephants are under real poaching pressure is not yet backed by hard scientific evidence, but the body of circumstantial evidence is certainly growing. The principal purpose of this article is to fly an early warning flag and raise serious concerns that central African elephants are facing poaching pressures that are stronger than any of the current signals coming from the other three African subregions or Asia. The likelihood of central Africa being the main source of poached ivory, when linked to the elephant population data for that region provided by the *African elephant status report 2002* (Blanc et al. 2003) suggests that the illegal killing for ivory carving examined in this study may be occurring at the rate of between 2.5% and 6.3% of the elephant population per annum of that region (see table 5). In making this observation, it is important to keep in mind that central Africa's elephant population estimates rely largely on the *Possible* and *Speculative* categories as defined by Blanc et al. (2003). Still, if the percentage of illegal off-take for ivory to service African and Asian carvers proves true, it is certainly worrying, keeping in mind that no consideration whatsoever has been made in this study regarding other forms of mortality—illegal, legal and natural. Such occurrences clearly push elephant mortality up further. If the assumption is valid that elephant killing is concentrated in the forest areas of central Africa, the sustainability of current rates of off-take becomes even more precarious.

While the analysis represented in table 2 is not

Table 5. Estimated annual offtake of elephants, based on a central Africa scenario as the main source of ivory required for unregulated markets

	Elephant numbers (Blanc et al. 2003)			
	West Africa	Central Africa	Southern Africa	Eastern Africa
Definite (*w*)	5,458	16,450	246,592	117,716
Probable (*x*)	1,188	32,263	23,722	17,702
Possible (*y*)	3,039	64,477	26,098	22,511
Speculative (*z*)	3,498	82,563	7,508	5,738
w + *x* + *y* + *z*	13,183	195,753	303,920	163,667

Scenario 1. Ivory for West, central, eastern, northern Africa, China and Thailand coming from central Africa

	Estimated no. of elephants poached	Annual % of central African elephants
Minimum	4,862	2.5
Maximum	12,249	6.3

based on precise data, it nonetheless does not preclude concluding that the unregulated ivory markets in Africa, let alone Asia, are a significant drain on African elephant populations, especially those in central Africa. This supports the conclusions of the ETIS analysis at CoP12 and the subsequent conclusion by the CITES Parties that the illicit trade in ivory is most directly linked to the existence of unregulated domestic ivory markets around the world. The CITES Parties agreed to subject selected ivory markets that had been highlighted in the ETIS analysis to an intersessional oversight process to ensure that such markets comply with CITES requirements for internal trade control or risk punitive sanctions. More recently, the CITES Standing Committee has broadened the scope of this initiative to include all unregulated ivory markets in Africa. Decisions at the 50th meeting of the CITES Standing Committee have put a timetable and a process in motion for shutting down these markets, if they are not properly regulated.

Even though table 2 is not based on precise data, we recommend that future work on analysing ivory markets use it as a template for getting better data. This paper should be regarded as a work in progress; suggestions for improving the methods and data are most welcome as a basis for building MIKE and ETIS links.

Acknowledgements

Special thanks are due to Holly Dublin and Daniel Stiles, who were generous with their time in reading drafts and providing valuable comments and suggestions. The article is much better for their inputs and contributions, but responsibility for the methods used and results obtained belong entirely to the three authors. Ken Burnham provided a useful critique of the final draft and we are grateful to him for his help. Jim Armstrong of the CITES Secretariat also deserves thanks for encouraging us to publish this article as another step forward in developing MIKE and ETIS.

References

Anon. 2003. *An assessment of the domestic ivory carving industry and trade controls in India.* TRAFFIC International, Cambridge.

Blanc, J.J., Thouless, C.R., Hart, J.A., Dublin, H.T., Douglas-Hamilton, I., Craig, C.R., and Barnes, R.F.W. 2003. *African elephant status report 2002: an update from the African elephant database.* IUCN/SSC African Elephant Specialist Group, IUCN, Gland, Switzerland, and Cambridge.

Courouble, M., Hurst, F., and Milliken, T. 2003. *More ivory than elephants: domestic ivory markets in three West African countries.* TRAFFIC International, Cambridge.

Dublin, H.T., Milliken, T., and Barnes, R.F.W. 1995. *Four years after the CITES ban: illegal killing of elephants, ivory trade and stockpiles.* IUCN/SSC African Elephant Specialist Group. IUCN, Gland, Switzerland, and Cambridge.

[IFAW] International Fund for Animal Welfare. 2004. *Elephants on the High Street: an investigation into ivory trade in the UK.* IFAW, London.

Martin, E.B. 1998. New buyers of ivory in the Sudan threaten elephants. *Oryx* 32(3):166–169.

Martin, E.B. 2000. The present day Egyptian ivory trade. *Oryx* 34(2):101–108.

Martin, E.B., and Stiles, D. 2000. *The ivory markets of Africa.* Save the Elephants, Nairobi and London.

Martin, E.B., and Stiles, D. 2002. *The South and South East Asian ivory markets.* Save the Elephants, Nairobi, and London.

Martin, E.B., and Stiles, D. 2003. *The ivory markets of East Asia.* Save the Elephants, Nairobi and London.

Milliken, T., Burn, R.W., and Sangalakula, L. 2002a. A report on the status of the Elephant Trade Information System (ETIS) to the 12th meeting of the Conference of the Parties. CoP12 Doc 34.1, Annex 1. CITES Secretariat, Geneva.

Milliken, T., Burn, R.W., and Sangalakula, L. 2002b. An analysis of the spatial aspects of the elephant product seizure data in ETIS; a report to the 12th meeting of the Conference of the Parties. CoP12 Doc. 34.1, Annex 2. CITES Secretariat, Geneva.

Milliken, T., Burn, R.W., and Sangalakula, L. 2002c. An analysis of the trends of elephant product seizure data in ETIS; a report to the 12th meeting of the Conference of the Parties. CoP12 Doc. 34.1, Annex 3. CITES Secretariat, Geneva.

Parker, I.S.C., and Martin, E.B. 1982. How many elephants are killed for the ivory trade. *Oryx* 16(3):235–239.

Stiles, D., and Martin, E.B. 2001. Status and trends of the ivory trade in Africa, 1989–1999. *Pachyderm* 30:24–36.