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# Economics of Controlling Trade in Endangered Species: The African Elephant

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# ECONOMICS OF CONTROLLING TRADE IN ENDANGERED SPECIES: THE AFRICAN ELEPHANT

## 1. Introduction

This paper looks at the economics of controlling trade in endangered species. As an example it examines the role of trade in elephant ivory in determining the future of the African elephant.

## 2. Elephants in Decline

The population of elephants in Africa has halved in eight years from 1.2 million to just over 600,000.[1] Kenya's elephant population alone has declined by two thirds from its 1981 population of 65,000 to 16,000 in 1989. During the same period Tanzania has lost over 130,000 elephants and Zambia 128,000- almost three quarters of its 1981 population. Although the data presented in Table 1 indicate that populations have been rising in the central, forested regions of Africa, such as Gabon and Congo, this is due to improved population counts rather than rising population levels. In only a few African countries- South Africa, Botswana, Zimbabwe, Malawi and Namibia - are numbers at least stable. Population projections by the Renewable Resources Assement Group (RRAG) at Imperial College London suggest that, at the rate of decline seen in 1986, elephants could be extinct by 2010.[2]

There are two species of elephant, the bush or savannah elephant, Loxodanta africana, and the forest elephant, L.a. cyclotis. The impact of poaching for ivory on the forest elephant was not thought to be as significant as for the savannah elephant. Instead, human population pressure for land was considered a major population constraint. However, more recent evidence suggests that rate of decline of the forest elephant may be similar to that of the savannah elephant, although this population reduction is more conspicious in the savannah region.

## 3. The Economics of the Decline in Elephant Populations

In terms of the economic theory of renewable resources we can suggest an economic interpretation of the decline in elephant numbers. The theory tells us that if we have a combination of:

(a) a high ratio of the price of ivory to the cost of harvesting (poaching), and
(b) a high discount rate by users relative to the growth rate of the elephant population,

then, from the standpoint of the exploiter, it is actually optimal to run the resource down, even to extinction. These conditions are present with African elephants. Poaching is not

costless but it is cheap relative to the price of ivory. The price is buoyant because of strong final demand in Asian consuming countries for worked and unworked ivory.[3] Condition (a) is thus met.

Condition (b) needs to be modified to allow for changes in the real price of ivory over time. Basically, if the population growth rate is less than the net 'effective discount rate' (actual discount rates less the rate of the real price increase) it will be optimal to the exploiter to run the resource down to extinction. If real prices grow through time, they will therefore slow the rate of exploitation. While it is desirable to compute real prices to obtain the price component of this inequality, it only needs a high discount rate, relative to the growth rate, for condition (b) to be met. As the growth rate of elephant populations is low compared to many other species the likely inequality between discount rates and natural growth rates appears to hold.[4]

Finally, we cannot assume that as the population declines compensatory population adjustments will take place - in fact the reverse may be true. Poaching may lead to stress and this may actually reduce rather than increase population adjustment. For example, studies in Amboseli National Park, Kenya, show that for every adult female killed at least one immature elephant will die.[5] A calf younger than two years old stands no chance of surviving the death of its mother, while a calf orphaned between two and five years old has a 30 per cent chance of survival, and one aged between six and ten years old has a 48 per cent chance of survival. Furthermore, poaching has seriously disrupted breeding patterns in some herds because gunmen pick off elephants with big tusks, typically the older and more sexually active males. In Tanzania's Mikumi reserve, where poachers are very active, the ratio was 99.6 per cent females to 0.4 per cent males. Populations in Queen Elizabeth Park in Uganda and Tsavo in Kenya are similarily skewed. An elephant cow is fertile for only two days during her three-monthly oestrus, and must find a rutting male during this brief period. The chances of mating successfully under these conditions are slim.

It could be argued that if the objectives of the ivory exploiters were the same as some socially determined objective, then the extinction of elephants could be considered optimal. However, there are at least two major reasons for suggesting that what is actually happening to elephant populations at present is not socially desirable. First, an individual's costs of elephant harvesting are reflected in the price of the ivory. However, the wider social costs of elephant harvesting are not reflected in the ivory price. These social costs may include: the loss of sustainable future income from ivory and other elephant products to the relevant populations (the 'user cost' argument); the loss of any ecological and 'tourist' values (the 'external cost'

argument); and the loss of 'existence value' to people who simply want elephants to be conserved. All of these costs may be significant, but they may also be offset somewhat by some savings from mortality - e.g. foregone elephant damage costs, such as crop damages and woodland destruction. However, since the price of ivory does not reflect the full cost of elephant offtake, the level of supply and demand of ivory, and consequently the rate of decline in elephant population levels, is not socially desirable.

Second, the discount rates of ivory consumers, traders and poachers are likely to be above socially determined discount rates. The arguments for supposing this to be the case are many and they are not discussed in detail here.[6]

Finally, there is an additional reason for supposing that the level of elephant harvesting is not optimal. Elephants occupy open-access or common lands. Economic theory tells us that such lands will be used by man up to the point where the total costs of utilising these lands equals the total revenues, i.e. to the point where rents (profits) are totally dissipated. While this situation may be stable, it runs a high risk of over-use resulting in degredation and depletion of the land and the resources within it. Thus the rationale for supposing that the current decline in elephant numbers is economically unwarranted is demonstrated.

## 4. Factors Determining the Decline in the Elephant Population

Three major factors affecting elephant populations levels are: competition for land; the dissipation of rent and lack of rent capture; and, most significantly, the international trade in elephant ivory.

### a. Competition for Land

The 'competing land' argument embraces Hardin's notion of the survival of the fittest, where the demands of two sympathetic species are sufficiently similar that competition between them leads to the extinction of one.[7] In this case the species are man and elephant who compete for essential resources of food and habitat. Man's plant foods demands are similar to those of the elephant, and they also indirectly compete for the use of the same resources for their domestic stock. This competition is likely to be significant given that the African population doubling time is now merely eighteen years, and has brought about rapid forest conversion for agricultural and pastoral activity.

### b. Rent Dissipation and Capture

The decision whether to maintain the stock of elephants or convert this population to an alternative form of asset - in this case ivory - is affected by the dissipation and capture of rents

derived from elephants.[8] Here 'rents' are taken to be the difference between the value of the sale of ivory and the cost of harvesting the ivory, and are expected to rise with increasing scarcity. In this case, rents from the sale of elephant ivory are dissipated amongst a wide range of individuals - including poachers, local traders, local chieftans, domestic officials, foreign traders and so on. The individual who actually makes the harvesting decision receives a relatively insignifficant proportion of the total revenue and thus receives relatively low returns from the resource, compared to the actual returns accruing to the resource, upon which to base his consumption/investment decision. This distortion, combined with great uncertainty and risk involved in abstaining from current conversion in order to generate a flow of revenue from the resource in the future, creates an incentive to harvest the resource as quickly as possible. The following figures give some indication of the sums that accrue to harvesters in Africa compared to the value of raw ivory in Japan.

Revenues Flowing to Harvesters in Africa
and Comparison with Raw Ivory Value in Japan (1985)[9]

| Chad | CAR | Cameroon | Zaire | Zimbabwe | Japan |
|---|---|---|---|---|---|
| $7/kg | $6-8/kg | $15/kg | $7/kg | $63-76/kg | $85-99/k |

What is more, the vast diversity of the rent receivers, with the majority of them typically being foriegn traders, makes it virtually impossible for them to come together to manage the resource effectively. The governments of those countries with elephants have generally failed to capture sufficient rent from the ivory trade to make adequate elephant management proposals worthwhile, including monitoring, protection and harvesting controls. This is reflected in the relatively insignificant investment in elephant protection - only 1.5% of the elephants' total range of 5.9 million km² lies within strictly warded and adequately protected areas and these areas have shrunk by 20% from 7.3 million km² during the past decade.[10]

c. International Trade in Elephant Ivory

Unsustainable elephant harvesting can be attributed primarily to the international demand for elephant ivory. The main cash value of the elephant is its tusks, although the hide is also demanded both internationally and locally, and the meat often consumed locally. Studies of the scale and direction of world trade of elephant ivory have enabled a better understanding of the role of trade in influencing the demise of the African elephant.[11] As shown in Figure 1 the price of ivory has been increasing dramatically - between 1979 and 1985 the current price of one kilogram of ivory was around $50, in 1987 it reached over $120 and in 1989 it is nearing $300 per kilogram.

It is important to consider all available data sources to arrive at an estimate of the total volume of ivory entering into international trade from various centres in Africa. Simply looking at the export figures in the exporting counties' customs statistics, where they exist, does not give a reliable estimate of the total volume of ivory entering into international trade from various countries within Africa. Because of the illegal nature of the ivory trade as it leaves Africa, much of the ivory only appears in the official trade statistics after it has passed through one or more intermediate countries. At this stage it may pick up official documentation from the Convention on the International Trade in Endangered Species (CITES). However, CITES have only accounted for around 20% of the recorded trade in recent years. Using these data, but primarily looking at importing country trade statistics, where there is less of an incentive to mislead and data figures are more realistic, export totals have been reconstructed.

Total exports of unworked ivory leaving Africa have risen from between 200 to 400 tonnes per annum (tn/yr) in the 1950's to a peak of 900tn in 1979. Since then the volume of unworked ivory exports has fallen to 600tn in 1986 and 300tn in 1987. The sum total of ivory exported between 1979 and 1987 amounts to 6,828tn, see Table 2. As a very approximate guide it can be taken that an average pair of tusks weighs 9 to 10 kg (although this is a dangerous assumption as average tusk weights have changed over time) and from this it can be estimated that during this period between 680,000 and 760,000 elephants were exploited for their ivory.

The decline in tonnage looks encouraging, but the statistics hide the real impact of the ivory trade on the elephant population. In 1979 a tonne of ivory represented approximately 54 dead elephants. These were mainly the bull elephants, valued for their bigger tusks, with an average tusk weight per elephant of 9.3 kg. By 1987 most of the mature bull elephants had been shot, leaving cows and calves to support the demand for ivory. They have a much lower average tusk size of 4.7 kg, such that one tonne of ivory now directly represents about 113 dead elephants. There is a further disturbing indirect effect that needs to be considered. The high female ratio of the harvested population leads to the death of a further 55 calves with no ivory who are orphaned or die of starvation. As a consequence, almost the same number of elephants were harvested in 1987 as in 1979 to support the demand for ivory, but from a much reduced and more fragile population.

Table 2 lists the main African ivory exporters. The exporters are not necessarily the elephant producing countries, however. Several African countries have acted as entrepots for neighbouring countries. These include Sudan, Burundi, the Central African Republic (CAR), and Congo, each of which exported

more than 900tn of ivory between 1979 and 1987. For many years, Burundi, located between Zaire and Tanzania, had just one elephant. In 1986 this elephant apparently produced 23,000tn of ivory, all carefully documented as originating in the country! In South Africa elephants were virtually wiped out at the turn of the century, but strictly enforced conservation measures have allowed the population to expand to a controlled 8,200 today. At maximum reproductive rates the elephants could produce no more than 885 tusks per year. However South Africa set export quotas in recent years at 8,000, 10,000 and 12,000 tusks.

One of the characteristics of the illegal trade (here illegal trade is taken to be the same as non-CITES trade) is its remarkable fluidity. Whenever one channel through which ivory is passing has been blocked, another has opened up almost immediately. Over recent years ivory has often passed through a number of staging points, such as Dubai, Singapore, Macao and Taiwan, each of which was chosen for the convenience of some legislative loophole. For example, in 1987 the legal loopholes of the import restrictions on ivory entering Hong Kong were exploited by a trader. That is, until August 1988 Hong Kong had no restrictions on imports of worked ivory. The trader sent 67 carvers and 150 labourers from Hong Kong to Dubai, United Arab Emirates (UAE) to set up two carving factories. After pressure these factories were closed, but were soon set up again in Ajmer, UAE. By buying poached ivory in UAE at $60/kg from established ivory traders and then carving the ivory sufficiently to pass as 'worked' ivory, the trader was then able to import the ivory legally into Hong Kong and sell it at $200/kg.

Table 3 shows that the major demand for raw ivory has long been in East Asia, and especially in Japan, and in recent years Singapore. In Japan the ivory is particuarly prized for making 'hankos', personal seals traditionally used by some Japanese in place of a signature. An economic analysis of demand for raw ivory in Japan firmly indicated that in Japan raw ivory is considered a luxury good, that is it responds more than proportionately to a change in real income.[12] Technically, it has an income elasticity greater than one.[13] This implies that as Japan gets richer, its demand for ivory increases more than proportionately. Since Japan continues to be a highly successful economy, future demand for ivory in Japan is likely to carry on increasing at a faster rate than that of income growth. Responsiveness to price, the price elasticity, is fairly low, indicating that Japanes demand will not be heavily influenced by increases in the price of ivory. The analysis also showed that an 'asset demand' may be present, i.e., that expectations of rising real prices of ivory do influence the demand to hold ivory as an asset comparable to other interest-earning assets. However the evidence for this is less compelling.

Hong Kong is a major importer of raw ivory. However, unlike Japan, Hong Kong is less of a final source of end-use demand than a major 'entrepot' in the world ivory trade. A significant proportion of its imports are re-exported to other countries, principally to Japan, the USA and Europe as worked ivory. The newly industrialised Asian countries, such as Singapore, are also playing an increasingly important role in the demand for ivory. Econometric analysis for Hong Kong indicates a high income elasticity for gross exports (1.5), but a low elasticity for net exports (0.5). This can be interpreted as reflecting comparitively less interest in Hong Kong for ivory to be retained there as artifacts compared to the trade motive wherby the ivory is demanded primarily for its value as export worked ivory commodities. That is, 'high value' ivory is exported compared to the lower value ivory which is retained in Hong Kong. Price elasticity analysis for Hong Kong yields counteractive results until a lag of one year is introduced. This means that demand responds to last year's price rather than this one. Results are then broadly constitent with those of Japan: demand is generally not very responsive to price. Interest rates and exchange rates play arole in determining demand, as one would expect with an importing nation that essentially treats ivory as a raw material for its export trade. However these variables are not as open to policy influence by any authority seeking to regulate the ivory trade.

## 5. Economic Incentives for Conservation

The economic incentives for conservation are determined by the values that we place on the direct use, the indirect use and the non-use/preservation of the African elephant and the extent to which these values are translated into direct financial incentives.[14]

### a. Direct Use Value

The direct use value is derived from economic use of the resource and its services, such as for ivory or tourism. One argument for conservation is that it would permit a sustainable offtake of revenue from harvesting the resource (ivory, hide and meat) and from its non-consumptive economic value (tourism). This would benefit the immediate and long run balance of payments of Africa. The alternative, to 'mine' the elephant population, as is currently happening, permits short term financial gain at the expense of sustainable income over long periods.

Intuitively, the sustainable management approach should appeal to exporting nations more than the mining approach. In practice, there appears to be a preference for the short-term mining approach. At a purely financial level, mining makes sense if it yields a current revenue higher than the value that would be obtained by managing the resource sustainably. How sensible it

is to mine elephants on this very narrow criterion will then depend, as discussed in section 3, upon discount rates, expected interest rates and expected future values of ivory. It has not been feasible to engage in such an analysis, but it is possible to say how much Africa receives by way of revenue from ivory exports.

By taking the best estimates of ivory exports and multiplying them by representative implicit prices per kg of ivory, ivory export values can be determined. Current annual ivory exports are thus between $50-60 million for Africa as a whole. This figure only represents the value of raw ivory exports, and does not include ivory used in the domestic carving industry, or any revenue from hides and meat. The values obtained are based on c.i.f. prices and probably overstae the actual export gate receipts by 10-15%. Other problems exist, such as determining how the resulting value is distributed between the state, traders, poachers and so on.

This ivory export revenue of $50-60 million is a tiny fraction of African exports and suggests that Africa, as a whole, would suffer little loss from sacrificing current revenues from ivory for sustainable management of the elephant population. However the revenue is significant for a few individual countries. For example, in the Central African Republic (CAR) ivory exports are of fairly continuous significance with export values in the range of $10 - 25 per annum. Those countries which dominate the export of ivory are also those where non-consumptive use values such as tourism have the lowest prospect, namely Congo, Sudan, Uganda and Zaire. These individual countries may thus have a substantial financial incentive to trade in elephant ivory. Countries with tourist trade, including Kenya, Zambia and Zimbabwe, tend to have low ivory export values. Zimbabwe's comparatively low export values for raw ivory are consistent with its use of indigenous culling to support a domestic carving industry. The overriding conclusion is that harvested ivory is not of great value as an export to most African nations, with the exception of CAR, and that there may be a significant potential for revenue earned from non-consumptive use of the African elephant.

Brown has attempted to estimate part of the non-consumptive value of elephants.[15] Based on survey responses from questionaires filled in by safari tourists and tour operaters in Kenya, Brown applied travel cost and contingent valuation techniques to estimate the viewing value of elephants. The results of the two techniques are quite comparable, and suggest the value of viewing elephants in Kenya to be $25 million per year. This may be as much as ten times the value of its poached ivory exports. This suggests that there is a powerful financial case for keeping elephants alive for their non-consumptive value rather than harvesting them for their ivory.

b. Indirect Use Value

Indirect use value is derived from the natural ecological functions of the elephant, such as their ability to diversify savanna and forest ecosystems, act as seed dispersers and reduce bushlands, expand grasslands and reduce the incidence of the tsetse fly. Elephants have an essential ecological role in the African savannas and forests. Western reports how elephants, acting as 'keystone species', open up areas - to make them accessible to other herbivores, including domestic stock, by feeding and trampling down tall sedges and promoting the growth of higher quality grasses.[16]

The ecological benefits of elephants are dependant on their density being neither too high nor too low. At each of these two extremes habitat impoverishment results, for example in protected areas where elephants crowd in, or areas of non-protected lands that are abandoned. In Amboseli National Park, Kenya, there are extremely high densities of elephants in the centre of the national park falling away to neglible levels beyond the park boundaries. The elephant density gradient is reflected in the damage to the dominant woodland tree, the yellow-barked acacia, Acacia xanthopholoea. During the period 1950 to 1989 there was little change in the tree densities in the early decades, but in the late 1980's, following the compression in elephants in the park, the woodlands have disappeared in the park vicinity and increased in areas where elephant activity is negligible.

Both the number of plant species and their relative abundance have been similarily affected. Relatively few plants, dominated by one or two species, are located in areas of little elephant disturbance. This species richness increases in terms of species abundance and distribution in areas of the park where elephants are in moderate density. However, in the central park, where elephant densitites are exceptionally high, richness is low and dominance is high. There also tends to be a significant increase in grazer biomass (zebra, wildebeest, Thomson's gazelle and buffalo) and decrease in browser and mixed feeder biomass (giraffe, impala, grant's gazelle) where elephant densities are high. The reverse is true in areas where elephant densities are high. The most equitable mix of grazers and browsers is found in the mosaic of woodlands and grasslands associated with moderate elephant densities straddling the park boundaries.

The local community may also derive other benefits indirectly from the elephants, such as employment from the tourist trade, a market for handicrafts and so on which could be significant. However, these indirect benefits may be offset any detrimental crop or other damage caused by the elephant.

c. Non-Use and Preservation Value

Finally, non-use values (no direct/indirect benefit from services or components) and preservation values (values in addition to direct/indirect current use) need to be considered. These embrace existence values, bequest values and option values. Existence value is where people derive satisfaction from just knowing that elephants will be preserved. The bequest value arises when an individual has no intention of 'using' the elephant, but values the opportunity of future generations to use them. The option value occurs when an individual is risk averse, and effectively insures against the risk today of irreversibly losing the elephants which may be valuable in the future. Although it is very difficult to measure and assess these values, this does not make them any less important than other financially measurable values. Indeed, these values may be highly significant. The total economic value of the elephant is the sum of the direct, indirect and non-use/preservation values.

6. Current Situation

At a conference of the Parties to CITES in Lausanne, Switzerland, October 9-20, the African elephant was transferred from Appendix II (which allows some trade, with permits, in elephant ivory and skin) to Appendix I, as from January 18, 1990 by majority vote of 76 out of 91. This is an indefinate ban of all trade in elephant products. In future individual countries with healthy elephant populations, an effective elephant conservation and management programme and effective ivory trade controls will be able to apply to a 'techincal committee' (yet to be established) to be transferred back to Appendix II listing.

It was also agreed that the international trade ban should apply to all existing ivory stocks, with no special exemptions for the large ivory stockpiles - in particular in Hong Kong and Burundi. Given the threat that there may be an attempt to move ivory stockpiles to consumer countries before the 18 January deadline, the UK recommended that Parties should apply Appendix I listing immediately. This was accepted by the EEC, the USA are likely to maintain their existing import bans, and from November 1 Japan imposed an ivory trade ban. Elephant trophy hunting is a very important source of income and one of the mainstays of local wildlife utilization schemes to countries such as Zimbabwe. However, under a strange twist of US law, and following an unexpected intervention from Botswana, elephant trophy imports into the US from countries taking a reservation will be prohibited. The overall decisions received support from the majority of the African nations and consuming countries. Some southern African nations voiced disatisfaction at the proposal- Zimbabwe has already entered a reservation, Botswana, Malawi and Mozambique have said they intend to, which must be submitted before January 18, 1990.

Table 1
Elephant Numbers: Regions and Selected Countries

| | 1981[a] | 1989[b] |
|---|---|---|
| Zaire | 376,000 | 112,000 |
| CAR | 31,000 | 23,000 |
| Chad | NA | 2,100 |
| Congo | 10,800 | 42,000 |
| Equatorial Guinea | NA | 500 |
| Gabon | 13,400 | 74,000 |
| **Central Africa Total** | **436,200** | **277,000** |
| Kenya | 65,000 | 16,000 |
| Tanzania | 203,900 | 61,000 |
| Sudan | 133,000 | 22,000 |
| Ethopia | NA | 8,000 |
| Rwanda | 150 | 50 |
| Somalia | 24,300 | 2,000 |
| Uganda | 2,300 | 1,600 |
| **East Africa Total** | **429,500** | **110,000** |
| Botswana | 20,000 | 68,000 |
| South Africa | 8,000 | 7,800 |
| Zambia | 160,000 | 32,000 |
| Zimbabwe | 47,000 | 52,000 |
| Angola | 12,400 | 18,000 |
| Malawi | 4,500 | 2,800 |
| Mozambique | 54,800 | 17,000 |
| Nambia | 2,300 | 32,000 |
| **Southern Africa Total** | **309,000** | **204,000** |
| Benin | 1,250 | 2,100 |
| Burkina Fasa | NA | 4,500 |
| Ghana | 970 | 2,800 |
| Guineau | 800 | 560 |
| Guineau Bissau | NA | 40 |
| Ivory Coast | 4,800 | 3,600 |
| Liberia | 2,000 | 1,300 |
| Mali | 780 | 840 |
| Mauritania | 40 | 100 |
| Niger | 800 | 440 |
| Nigeria | 1,820 | 1,300 |
| Senegal | 200 | 140 |
| Sierra Leone | 500 | 380 |
| Togo | 150 | 380 |
| **West Africa Total** | 17,600 | 15,700 |
| **Africa Total** | 1,192,300 | 622,700 |

Note : NA - not available

a. UNEP/IUCN/WWF (1982). Elephants and Rhinos in Africa - A Time for Decision. Based on findings and recommendations of the African Elephant and Rhino Specialist Group.

b. Recent estimates (October 1989) from Ian Douglas Hamilton of the African Elephant and Rhino Specialist Group.

## Table 2

## Volume of Raw Ivory Exports (kg) 1979-88

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | 0 | 0 | 5 | 0 | 50 | 10 | 0 | 0 | 0 | 0 | 65 |
| Benin | 0 | 0 | 0 | 195 | 0 | 0 | 10 | 0 | 0 | 0 | 205 |
| Botswana | 12699 | 5529 | 5716 | 4019 | 5580 | 2333 | 16487 | 360 | 388 | 755 | 53866 |
| Burkina | 0 | 0 | 35 | 26 | 0 | 0 | 30 | 0 | 0 | 0 | 81 |
| Burundi | 138680 | 147333 | 61399 | 46488 | 132124 | 183904 | 215218 | 247000 | 92000 | 8339 | 1272765 |
| Cameroon | 13036 | 7870 | 2195 | 2794 | 869 | 1896 | 1591 | 805 | 3132 | 2518 | 36726 |
| CAR | 197204 | 167274 | 105764 | 205796 | 197901 | 88608 | 116624 | 16928 | 1308 | 413 | 1097909 |
| Chad | 31321 | 3203 | 10551 | 29325 | 33750 | 4383 | 30 | 0 | 1606 | 0 | 114169 |
| Congo | 189876 | 175499 | 234013 | 117232 | 40425 | 86875 | 67868 | 13383 | 84297 | 19287 | 954747 |
| Djibouti | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 10901 | 10904 |
| Ethiopia | 0 | 0 | 0 | 0 | 0 | 172 | 6193 | 4600 | 1764 | 2160 | 14889 |
| Gabon | 3746 | 1482 | 1107 | 239 | 1121 | 223 | 372 | 415 | 4244 | 14238 | 27187 |
| Ghana | 500 | 28 | 80 | 112 | 15 | 30 | 0 | 70 | 75 | 0 | 910 |
| Guinea | 0 | 10 | 0 | 0 | 15 | 0 | 5 | 0 | 0 | 0 | 30 |
| Kenya | 46461 | 30198 | 5642 | 12399 | 4012 | 12883 | 18733 | 383 | 146 | 0 | 130857 |
| Liberia | 90 | 105 | 0 | 10 | 17 | 4 | 25 | 21 | 26 | 0 | 298 |
| Malawi | 560 | 2 | 735 | 263 | 1191 | 329 | 830 | 79 | 958 | 762 | 5709 |
| Mali | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 3 | 0 | 8 |
| Mozambique | 5949 | 714 | 10 | 870 | 16 | 960 | 850 | 2597 | 6336 | 7802 | 26114 |
| Namibia | 22005 | 1754 | 152 | 5683 | 1642 | 3040 | 1840 | 988 | 1 | 0 | 37105 |
| Niger | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 18 |
| Nigeria | 210 | 640 | 522 | 420 | 273 | 162 | 232 | 92 | 0 | 6000 | 8551 |
| Rwanda | 0 | 170 | 80 | 0 | 0 | 0 | 4485 | 3224 | 0 | 0 | 7959 |
| S Africa | 37900 | 35193 | 33540 | 28372 | 45175 | 34929 | 39696 | 40460 | 17668 | 9554 | 322492 |
| Senegal | 0 | 273 | 89 | 0 | 1 | 6 | 55 | 0 | 30 | 0 | 454 |
| Sierra Leone | 0 | 48 | 29 | 10 | 5 | 0 | 10 | 0 | 0 | 0 | 102 |
| Somalia | 0 | 108 | 18240 | 7468 | 852 | 7247 | 4508 | 64413 | 158 | 0 | 102994 |
| Sudan | 124438 | 205626 | 272588 | 272778 | 327836 | 52270 | 18705 | 74130 | 63934 | 0 | 1412305 |
| Swaziland | 0 | 0 | 0 | 0 | 0 | 0 | 276 | 0 | 0 | 0 | 276 |
| Tanzania | 33110 | 43755 | 23068 | 17639 | 14601 | 43955 | 54676 | 72922 | 55692 | 42561 | 401999 |
| Togo | 0 | 200 | 20 | 0 | 50 | 160 | 170 | 90 | 135 | 0 | 825 |
| Uganda | 25147 | 19292 | 45125 | 10403 | 12702 | 99547 | 122982 | 3081 | 4 | 281 | 338564 |
| Zaire | 157779 | 96202 | 45256 | 79837 | 159121 | 66395 | 21144 | 35851 | 24037 | 19314 | 704936 |
| Zambia | 15551 | 22452 | 28033 | 34352 | 18308 | 1659 | 12645 | 10983 | 4325 | 1621 | 149929 |
| Zimbabwe | 3030 | 1650 | 1303 | 14147 | 14075 | 18256 | 22759 | 7481 | 7929 | 6983 | 97613 |
| Total (MIN) | 979492 | 986615 | 895300 | 890877 | 1017807 | 710316 | 749041 | 600361 | 370214 | 153529 | 7333552 |
| MAXIMUM | | | | | | | | | | | |
| Burundi | 144880 | 192517 | 61399 | 46488 | 133798 | 183989 | 215218 | 247000 | 92000 | 8339 | 1325628 |
| Sudan | 124438 | 354112 | 273588 | 282778 | 327836 | 52270 | 18705 | 74130 | 63934 | 0 | 1571791 |
| Tanzania | 33110 | 43755 | 23068 | 17639 | 14601 | 43955 | 116726 | 296460 | 55692 | 42581 | 687587 |
| Uganda | 25147 | 19292 | 45125 | 10403 | 12702 | 99547 | 205045 | 3081 | 4 | 281 | 420627 |
| Total (MAX) | 985492 | 1160285 | 896300 | 900877 | 1019481 | 710321 | 893154 | 823899 | 370214 | 153529 | 7913552 |

Note: These are the 'best estimates' of African exports, disaggregated by country of export, using import and export data from customs sources, and CITES data. They were compilled by Richard Luxmore from the Wildlife Trade Monitoring Unit for 'The Ivory Trade and the Future of the African Elephant', Interim Report of the Ivory Trade Review Group, prepared for the second meeting of the CITES African Elephant Working Group, Gabarone, Botswana, July 1989.

Table 3

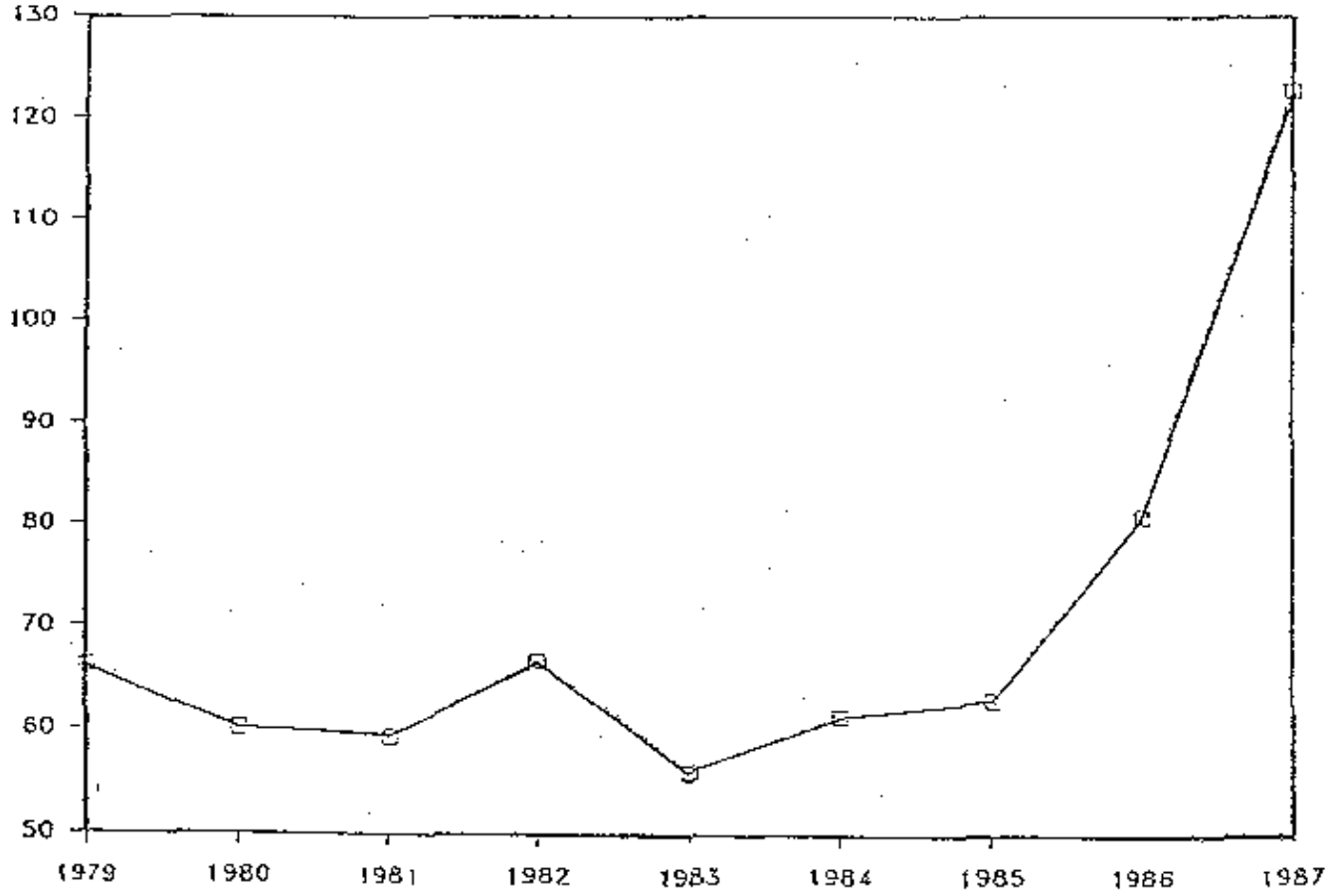
Net Imports of Raw Ivory to Major Consumers (in tonnes)

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|
| USA | 6 | 23 | 11 | 7 | 20 | 55 | 24 | 17 | 21 | 9 |
| FR Germany | 74 | 181 | 32 | 35 | 43 | -7 | 16 | 7 | 2 | 1 |
| UK | -5 | -26 | 0 | -3 | 2 | 3 | 28 | -1 | 7 | 3 |
| Hong Kong | 366 | 376 | 427 | 318 | 428 | 267 | 85 | 127 | 145 | 133 |
| India | 17 | 19 | 19 | 24 | 23 | 30 | 21 | 8 | 6 | 4 |
| France | 89 | 22 | 7 | 4 | 11 | 21 | 5 | 5 | 4 | -2 |
| China | 7 | 10 | 10 | 54 | 20 | 7 | 7 | 19 | 39 | 50 |
| Japan | 270 | 240 | 256 | 205 | 174 | 179 | 113 | 25 | 85 | 75 |
| Thailand | 1 | 1 | 2 | 4 | -5 | -12 | -2 | 1 | 0 | -3 |
| Belgium | 16 | -90 | -248 | -123 | -105 | -116 | 0 | 0 | -10 | 12 |
| Singapore | -7 | -4 | 3 | 7 | 0 | 120 | 60 | 324 | -148 | -129 |
| Macau | | 0 | 0 | 5 | 16 | 38 | 82 | 57 | 8 | 11 |
| Taiwan | 11 | 18 | 17 | 18 | 28 | 34 | 21 | 18 | 80 | 5 |
| Total Net Imports Only | 857 | 890 | 785 | 680 | 765 | 742 | 461 | 606 | 397 | 303 |

Note: These 'best estimates' of final demand for raw ivory by the main consuming countries are based on customs trade statistics and CITES documentaion, and were compilled by Richard Lukmore of the Wildlife Trade Monitoring Unit for 'The Ivory Trade and the Future of the African Elephant', Interim Report of the Ivory Trade Review Group, prepared for the second meeting of the CITES African Elephant Working Group, Botswana, July 1989.

Figure 1

Implicit Current Ivory Prices, 1979-87
(unweighted average)




Source: The London Environmental Economics Centre

## NOTES

1. Recent estimates from Ian Douglas-Hamilton of IUCN's African Elephant and Rhino Specialist Group, October 1989. Previous estimates from IUCN/WWF/UNEP, (1982). Elephants and Rhinos in Africa - A Time for Decision, based on findings and recommendations of the African Elephant asnd Rhino Specalist Group.

2. J. Beddington, R. Mace, M. Basson and E-J Gulland, (1989). 'The Impact of the Ivory Trade on the African Elephant Population'. A report to the Ivory Trade Review Group by the Renewable Resources Assement Group, London.

3. This is examined in more detail in two papers prepared by E.B. Barbier, 'The Demand for Unworked Ivory: A Case Study of Japan', Economics Working Paper ITRG/EG 89-01, February 1989, and 'The Demand for Unworked Ivory: A Case Study of Hong Kong', Economics Working Paper ITRG/EG 89-09, April 1989. Both papers were prepared as part of the LEEC contribution to the Ivory Trade Review Group report, (1989). A Statistical and Economic Analysis of the Ivory Trade. The analysis is published in E.B. Barbier and J.C. Burgess, (1989). Analysing the Demand for Raw Ivory: Case Studies of Japan and Hong Kong, LEEC Discussion Paper 89-05, London, UK.

4. Elephants are 'K-selected' - see James Wilen, 'Bioeconomics of Renewable Resource Use', in Allen Kneese and James Sweeney, Handbook of Natural Resources and Energy Economics, Volume 1, North Holland, Amsterdam, 1985.

5. J.H. Poole, (1989). 'The Effects of Poaching on the Age Structures and Social and Reproductive Patterns of Selected East African Elephant Populations'. Final report to the African Wildlife Foundation, printed in the Interim Report of the Ivory Trade Review Group, 'The Ivory Trade and the Future of the African Elephant'.

6. There are two compelling arguments. The first is that the welfare of future generations is a public good to the present generation and that, therefore, the present generation underinvests in future welfare, which is formally equivalent to saying that the discount rate is too high. The second argument is that the social treatment of uncertainty should be different to the private treatment of uncertainty. Society can pool risks across a large number of projects so that discount rate because of risk is less for society than for a private investor who cannot pool risks by 'portfolio spreading'. Additionally, society can pool risks across many different people (or at least

the number of taxpayers) so that the risk premium to be attached to the underlying discount rate tends to zero. For further discussion of these arguments see D.W. Pearce, A. Markandya, E.B. Barbier, (1989). Blueprint for a Green Economy. Earthscan Publications Ltd, London.

7. See G. Hardin, (1960). The Competitive Exclusion Principle, Science 131, 1291-1297, and I.S.C. Parker and A.D. Graham (1988). 'Elephant Decline: An Hypothesis' and 'Men, Elephants and Competition'. Draft documents, Nairobi, Kenya.

8. T.M. Swanson, (1989). International Regulation of the Ivory Trade, LEEC Discussion Paper, 89-04, London UK.

9. Ibid.

10. I. Douglas-Halimton, (1988). 'African Elephant Population Study', Phase 2 of African Elephant Database Project, executed by The World Wide Fund for Nature in cooperation with Global Environment Monitoring System, for the Commission of the European Communities, United Nations Environment Programme.

11. Extensive anaysis of the international trade in elephant ivory was undertaken by the London Environmental Economics Centre and the Wildlife Trade Monitoring Unit. A summary of the findings is printed in 'The Ivory Trade and the Future of the Africam Elephant', Interim Report of the Ivory Trade Review Group.

12. Barbier and Burgess, op.cit.

13. The income elasticity indicates the responsiveness of quantity demanded to changes in income, i.e., the ratio of the percentage change in quantity demanded to percentage change in income. If this ratio is significantly less than one, then the demand is said to be income inealstic. Simarly, if it is greater than one it is said to be income elastic.

14. E.B. Barbier, (1989). The Economic Value of Ecosystems: 1- Tropical Wetlands. LEEC Gatekeeper 89-02, London Ecnironmental Economics Centre, UK.

15. G. Brown with W. Henry, (1989). 'The Viewing Value of Elephants', revised draft of a project supported by The Ivory Trade Review Group.

16. Western, (1989). 'The Ecological Value of Elephants: A Keystone Role in African Ecosystems'. A report prepared for the Interim Report of the Ivory Trade Review Group, 'The Ivory Trade and the Future of the African Elephant'.

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David W Pearce, Edward B Barbier and Anil Markandya, Sustainable Development: Economics and Environment in the Third World, Edward Elgar Publishing Limited, London 1989 [in press].

The authors attempt to give some structure to the concept of sustainable development and to illustrate ways in which environmental economics can be applied to the developing world. Beginning with an overview of the sustainable development concept, the authors indicate its implications for discounting and economic appraisal. Core studies on natural resource management are drawn from Indonesia, Sudan, Botswana, Nepal and the Amazon.

David W Pearce, Anil Markandya and Edward B Barbier, Blueprint for a Green Economy, Earthscan, September 1989, £6.95

This book by the London Environmental Economics Centre was prepared as a report for the Department of Environment, as a follow up to the UK government's response to the Brundtland Report. Here it stated that: '...the UK fully intends to continue building on this approach (environmental improvement) and further to develop policies consistent with the concept of sustainable development.'
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