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CONSERVING ASIAN ELEPHANTS: ECONOMIC ISSUES ILLUSTRATED BY SRI LANKAN CONCERNS

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ABSTRACT

Provides background on the nature and status of the Asian elephant *Elephas maximus* and compares it with the African elephant *Loxodonta africana*. An overview is also provided of the literature that considers economic issues involved in the conservation of elephants and it is found that much more attention is given to the African elephant than the Asian one, even though populations of Asian elephants may be in greater danger. The analysis then focuses on Sri Lanka, as a case study, and outlines the decline in wild elephant populations in this country, and considers reasons for it. It's pointed out that elephants are a mixed economic good, and the total economic value of Asian elephants is discussed. Pitfalls of total economic valuation analysis are noted. These are pertinent to the conservation of elephants because elephants have both positive and negative attributes and human management of their population involves cost. The question is then taken up of whether Sri Lanka's present protected areas have the capacity to ensure the survival of its population of wild elephants. It is found that they do not have this capacity, and that the long-term survival of its wild elephant populations depends on them being able to use protected areas as well as private land. So the long-term conservation of wild elephants calls for integrated policies involving both public and private landholders. This is true for many mobile wild species.

1. INTRODUCTION AND BACKGROUND

Economists have mostly concentrated on economic issues involved in the conservation of the African elephant *Loxodonta africana* rather than the Asian elephant *Elephas maximus*. However, in many respects the survival of the Asian elephant is more precarious than that of the African elephant. Throughout its range, the Asian elephant has declined in recent decades. As a result, IUCN (1996) declared this species of wildlife as one of the most seriously endangered species of large mammals in the world.

The geographical distribution of the Asian elephant in earlier times was a wide one, stretching from the Tigris and Euphrates valleys of present day Syria and Iraq to China (from southern China up to the Yellow River) in the east and Sumatra in Indonesia in the south (Daniel, 1996). At present, its distribution is highly fragmented and occurs only in thirteen countries in Asia such as India, Sri Lanka, Nepal, Bhutan, Bangladesh, Myanmar, China, Thailand, Laos, Cambodia, Vietnam, Malaysia and Indonesia. The entire Asian elephant population in these countries is estimated to be between 34,000 and 54,000 (De Silva, 1998). In comparison, the population size of the African elephant is about 600,000, and African elephants range across thirty-three countries in Africa. Nevertheless, this is only about 60 percent of the elephant population that inhabited Africa about twenty years ago (Hoare, 2000). However, the population decline of the Asian elephant has not been as sudden as that of the African elephant, rather a gradual erosion over the centuries occurred, which accelerated in the second half of the 20th century.

Although the population size of the Asian elephant is considerably lower than that of the African elephant, Asian elephants have experienced a greater degree of habitat loss and fragmentation than their African counterparts. This is largely due to human impacts: (a) the increase in the utilization of the natural habitats of elephants for agricultural development schemes; and (b) the expansion of human settlements into elephant habitat. Continuing loss of habitat is quite difficult to control because of increasing human populations in Asia and demands for higher per capita income (Daniel, 1996). A likely corollary to a decrease in the range available to a species is a decrease in its resource-base, and for such a wide-ranging species as the elephant, this means that the animal has reduced flexibility to buffer the effects of local depletion of resources by moving to other areas (Croze et al., 1998). The example of Sri Lanka is illustrative. The human population of Sri Lanka increased from about 2.5 million at the beginning of the 20th century to over 18 million at its end. Moreover, at present Sri Lanka's population growth is about 1.2 percent per annum, and the size of its population is expected to exceed 25 million by the year 2025 and to reach 35 million by the 2050 (Marshall, 1996). On the other hand, since 1900, the forest cover of the country has declined from 70 percent to about 24 percent (Legg and Jewell, 1995). This situation has confined the majority of the elephant population in Sri Lanka to protected areas in the Dry Zone on the eastern side of Sri Lanka. If the present trend in deforestation and human population

growth continues unchecked, the elephant in Sri Lanka will soon be confined to these protected areas. Whether they will be able to survive in such restricted areas in the long term is uncertain. This situation, as pointed out by Laws (1981) in the case of African elephant, has developed in Sri Lanka from one where "human islands existed in a sea of elephants, to a sea of people with elephant islands".

As in many other Asian countries, the elephant population in Sri Lanka underwent a marked reduction starting from the mid-nineteenth century. About 12,000 elephants are thought to have inhabited the island in the mid-nineteenth century. Although the exact size of the present day elephant population is unknown, most estimates place it between 3,000-5,000 elephants (Silva and Attapattu, 1997; Silva, 1998; Weerakoon, 1999). About 90 percent of this population is located in the protected area network of the country and altogether this area amounts to 8,220 km^2. This is equal to about 12 percent of total land area of Sri Lanka. However, most of the protected areas involved are small in size and they have been established on an *ad hoc* basis. As a result they are not large enough to support a viable population of elephants on their own (Desai, 1998). A recently conducted survey confirmed that while some elephants range completely within some parks while a fraction of the herd ranges outside the boundary of parks (Weerakoon, 1999). Habitat fragmentation and the subsequent loss of feeding grounds has been recognised as one of the major reasons for this latter phenomena (Santiapillai and Jackson, 1990; Silva, 1998; Weerakoon, 1998).

Habitat fragmentation generally leads to smaller and more isolated animal populations. Smaller populations are then more vulnerable to local extinction, due to stochastic events, and they are more susceptible to the negative effects of inbreeding depression (Shaffer, 1981). On the other hand, such isolated elephant populations more frequently confront humans in the vicinity of natural habitats of elephants such as national parks or protected areas (Sukumar, 1989). Desai (1998) explained this point further by arguing that the level of conflict and the extent of crop and property damage vary with the extent of habitat loss of the individual elephant ranges. However, taking into account the small size of the country, its already larger commitment to conservation, the economic aspirations of its growing human population, and its socio-economic conditions, it may be impossible in the future to increase the size of its protected areas to any substantial degree.

The home ranges of the Asian elephant vary between 47.5 km^2 to 183.6 km^2 (Fernando, 1997). Weerakoon (1999) has reconfirmed these figures, and he distinguishes the difference between the home ranges of male and female elephants. According to his estimates, the home ranges of male elephants range between 47.5 km^2 and 157.9 km^2 while the home ranges of female elephants range between 53.6 km^2 to 183.6 km^2. These estimates demonstrate that the land area required to support a minimum viable population of Asian elephants is large, larger than any single protected area currently existing in Sri Lanka or likely to exist in the future. Therefore, the crux of Sri Lanka's problem in conserving elephants is that confinement of elephants to Sri Lanka's protected areas is incompatible with the long-term survival of its wild elephant population. Furthermore, such confinement may be an uneconomic strategy or an unworkable one. Thus, it seems that the survival of Sri Lanka's elephants depends on their being able to utilise private lands as well as protected areas. This inevitably results in conflicts with farmers because elephants can be quite destructive of crops and farm property.

The survival of wild elephants in Sri Lanka, and in Asia generally, depends to a large extent on successful public policies for managing such conflict. This article briefly outlines the nature of the current and changing status of the Asian elephant, makes some comparisons with the African elephant and provides some details on the status of *Elephas maxima* in Sri Lanka. In this analysis, the Asian elephant is considered as a mixed economic good possessing use and non-use values. Moreover this article also examines the sufficiency or otherwise of Sri Lanka's protected areas for the survival of its wild elephant population as well as the mobility of such animals. This provides the necessary background for assessing Sri Lanka's policies for conserving wild elephants. The issues raised are pertinent to other Asian countries, as well as to situations of other species of roaming wildlife which cannot be or are not confined to protected areas, and to those species which need to use extra land in addition to protected areas in order to survive.

2. AN OVERVIEW OF THE MAIN ECONOMIC ISSUES INVOLVING THE CONSERVATION OF ELEPHANTS

Economic issues involving elephant conservation attracted considerable attention in the economic literature after the implementation of the decision made under Convention on

International Trade in Endangered Species (CITES) in 1989 to restrict international trade in elephant products (Simmons and Kreuter, 1995; Tisdell and Xiang, 1996; Mendelsson, 1999). Most of this literature has focused on three important economic aspects of elephant conservation. One has been the likely impact of the ban in trade in ivory and elephant derived products on the conservation of elephants (Dublin and Jachmann, 1992; Bulte and Kooten 1999; Khanna and Harford, 1996; Barbier et al., 1990; Barnes, 1996; Bulte, 1996). Dublin and Jachmann (1992), examine the impact of the ivory ban on illegal hunting in six elephant ranges in Africa. Sugg and Kreuter (1994) outline the effects of the ivory ban on the elephant population in Africa. Khanna and Harford (1996) and Bulte (1996) provide a detailed account of the economic efficiency of the ivory trade ban in preventing illegal trade. Simmons and Kreuter (1995) used a political economy framework to examine economic issues involved in the ivory trade ban. In this analysis, they tried to analyse who owns the elephant in Africa under the CITES recommendations. The work of Bulte and Kooten (1999) examines the opposing and supporting arguments for the trade ban using empirical results from Kenya.

The second economic issue considered in the elephant-conservation literature is the extent to which provisions of some communal property rights to elephants can support their conservation and reduce poaching (Balakrishnan and Ndhlovu, 1992; Kiss, 1990; Kreuter and Simmon, 1995; Treves and Sanderson, 1995; Skonhoft, 1998; Dickson, 1999; McPherson and Nieswiadomy, 2000). The works of Kiss (1990), and Kreuter and Simmon (1994), provide detailed accounts of the economic viability of community-based conservation programs in Africa. Skonhoft (1998) examines the conflict between wildlife conservation and the cost and benefit obtained from it in east Africa assuming that local communities share in the profits from utilisation of elephants in protected areas. He finds that such sharing arrangements do not necessarily result in a net economic benefit for the local people. Dickson (1999) analysed the argument favoring the assignment of property rights in wildlife to local communities in the context of Communal Areas Management Program for Indigenous Resources (CAMFIRE) in Zimbabwe. In this analysis, in order to examine the success of the integrated conservation and development program, he used two related assumptions based on a participatory approach to wildlife. McPherson and Nieswiadomy (2000) outlined the

merits and demerits of the community-based wildlife conservation program using a political economy framework.

The third issue canvassed in the economic literature on elephant conservation is the assessment of the total economic value (TEV) of elephants. The works of Brown and Henry (1989), Giest (1994), Barnes (1996) and Gowdy (1997) provide a detailed analytical framework that can be used for the estimation of the economic value of elephants. Barnes (1998) investigated the direct economic use value of the elephant population in Botswana, in terms of the present value of fifteen years of gross output and national income discounted at 6 percent. Elephants used for viewing were the *status quo*. Uses examined included elephant viewing, possible introduction of safari hunting tourism, licensed hunting by Botswana citizens, elephant cropping (culling) for ivory, hides and meat, and combinations of these. Mendelssohn (1999) assesses whether the rigorous application of economic valuation techniques to land-use decisions and to policy and project analysis could result in an increased and more targeted level of investment in elephant conservation in Africa. In this analysis, he also highlights the practical problems associated with the application of cost-benefit analysis and market analysis.

3. THE NATURE AND STATUS OF THE ASIAN AND AFRICAN ELEPHANTS: A COMPARISON

The elephant is the largest living land animal. There are two broad species elephants in the world: the Asian elephant *Elephas maximus* and the African elephant *Loxodonta africana*. A summary of the physiological differences between Asian and African elephants is presented in Table 1. The Asian elephant is divided into three sub-species. The Sri Lankan subspecies *maximus* has the darkest skin, the Asian mainland species *indicus* has medium darkness of skin, and the Sumatran species *sumatranus* has the lightest skin colour and least depigmentation (patches on the skin). The Asian elephant inhabits a variety of habitats, mainly forest, but also grasslands, marshes, lake shores and transitional zones between forest and open habitats. They prefer grasses. However they also consume bark, roots, leaves, and stems of trees, vines, and shrubs. Most of an adult's activities involve searching for and eating food. They eat in the morning, evening and at night, but rest during the hottest part of the day. On average, this species of wildlife consumes about 150 kg of vegetation and drinks about 140 litres of water a day

but only about 44 percent of what is consumed is actually digested. Moreover, they rarely forage in one area for more than a few days in a row.

Table 1: The physiological differences between Asian and African elephants

Attribute	Asian Elephant	African Elephant
Weight	300-500kg	4,000-7,000 kg
Height at shoulder	2-3.5 metres	3-4 metres
Skin	Smooth	More wrinkled
Highest Point	Top of head	Top of shoulder
Size of ears	Smaller	Larger
Number of ribs	Up to 20	Up to 21
Shape of back	Convex	Concave
Shape of head	Dorsal bulges	No bulges and dish
Tusks	Males only	Both sexes have tusks
Trunk	Fewer rings and more rigid	More rings and less rigid
Tip of trunk	One finger	Two fingers
Hair	More hair	Less body hair
Heaviest recorded tusk	39.0 kg	102.7 kg

Source: Based on Sukumar (1989) and Whyte (1996).

The Asian elephant is slightly smaller in size than the African elephant. It can grow to be 2-3.5 metres in height and 4-6 metres in length. It is tallest at the arch of the back. It weighs between 3,000-5,000 kg. Only the males have tusks and these are smaller than those of the African elephant, and are not present in all males. The ears are small and do not cover the shoulders. The forehead has two humps and the trunk has a single lobe at its tip. The front feet have five toes while the back feet have four. Asian elephants can reach speeds of 40 km/h while running and 6.4 km/h while walking. They are an oddity among mammals because they grow until they die, which is usually around the age of sixty.

Asian elephants have a long history of association with humans. This species of wildlife still has a particular place in human society, and its history, culture, folklore and mythology in most Asian countries. Especially in the past, thousands of elephants were domesticated for use in transportation and logging in most areas of India, Burma, Thailand and Sri Lanka. At present, about 10,000 or fewer elephants are used as working animals in these countries.

During the last half of the 20th century the wild Asian elephant population has declined to an estimated 34,000–54,000 individuals (Santiapillai and Jackson, 1990). As a result, since 1976 this species of wildlife has been listed as endangered in Appendix I of CITES. The main reason for this reduction in numbers is the increase in human population and human demands on natural resources that destroy the habitat of the elephants (Daniel, 1996). Competition with humans for basic resources has had a dramatic effect on the distribution and migration habits of Asian elephants, which are prepared to travel great distances in search of water and adequate vegetation.

There are two subspecies of the African elephant: the Forest elephant *Loxodonta africana cyclotis* and the Savannah elephant *Loxodonta africana africana*. The African Forest elephant is smaller than the Savannah elephant, and lives in the equatorial forests of central and western Africa. The Savannah elephant is found throughout the grassy plains and bush lands of the continent. The African elephant is the world's largest living terrestrial mammal (shoulder height to 3-4 metres; weight to 4,000-7,000 kg) and it has a social structure organised around females and calves. In the Savannah subspecies, each family unit usually contains about ten individuals, although several family units may join together to form a 'clan' consisting of six to seventy members led by a large female. Forest elephants live in much smaller family units. Small, temporary associations of males also exist; the members of such groups join and leave at will. Adult bulls are often seen with cow-calf groups. Sexual maturity is reached at about 10 years in males and females, although males become sexually active much later. Usually, a single calf is born after a gestation period of 22 months. Females can remain fertile until 55-60 years old. Both the male and female African elephant can live up to an age of 60 to 70 years and have the lowest metabolic rate of any placental mammal on earth. Home ranges vary in size between 14 and 3,120 km^2, depending on the availability of food and water resources. A fully-grown African elephant eats up to 200 kg of grass, leaves, roots fruits and bark every day. Unlike the Asian elephant, both sexes carry tusks. The ivory tusks and prehensile trunk are distinguishing features of the African elephant. The longest recorded tusk of an African elephant was 3.8 metres long and 94.5 kilograms weight. The large, columnar feet on the African elephant allow it to move surprisingly quickly over rough ground, reaching speeds of 25 mph in short bursts.

Although it is difficult to assess population numbers accurately, it is believed that there may have existed 3-5 million African elephants between 1930 and 1940. During the 1970s and 1980s, the population is estimated to have declined significantly. Probably fewer than 600,000 animals remain today. Most of this decline is believed to be the direct result of unsustainable off-take by illegal ivory trade, coupled with habitat loss due to human population pressure. Historically, the illegal ivory trade was possibly the greatest threat to African elephant populations and still remains a potential threat today. Most elephant ranges in Africa extend outside protected areas, and human-elephant conflicts occur when farming activities take place within the elephant range. Often elephants raid fields and destroy crops. It is predicted, that as human populations continue to grow, habitat loss and degradation through activities such as logging and agriculture will become the major threats to the survival of the African elephant. WWF (1997) has identified five issues that need to be addressed in order to conserve African elephants. They are: (i) slowing the loss of natural habitat; (ii) strengthening activities against poachers and the illegal ivory trade; (iii) reducing conflict between human and elephant populations; (iv) determining the status of elephant populations through improved surveys; and (v) enhancing the capacity of local wildlife authorities to conserve and manage elephants.

4. THE PRESENT STATUS AND HISTORICAL OVERVIEW OF THE DECREASE IN ELEPHANT POPULATION IN SRI LANKA

Although, recent estimates indicate that the size of the current elephant population in Sri Lanka is placed between 3,000 and 5,000 elephants, scientific evidence to ascertain the exact number is inadequate (De Silva, 1998). Despite some conflicting earlier evidence (Norris, 1959; McKay, 1973; Schultz, 1984), Desai (1998) argues that the size of Sri Lanka's population of elephants has been decreasing since the early 1800s. Moreover in his analysis, he also argues that this decreasing size of the elephant population has had a significant impact on the distribution of the elephant population in the country today. This distribution is shown in Figure 1.

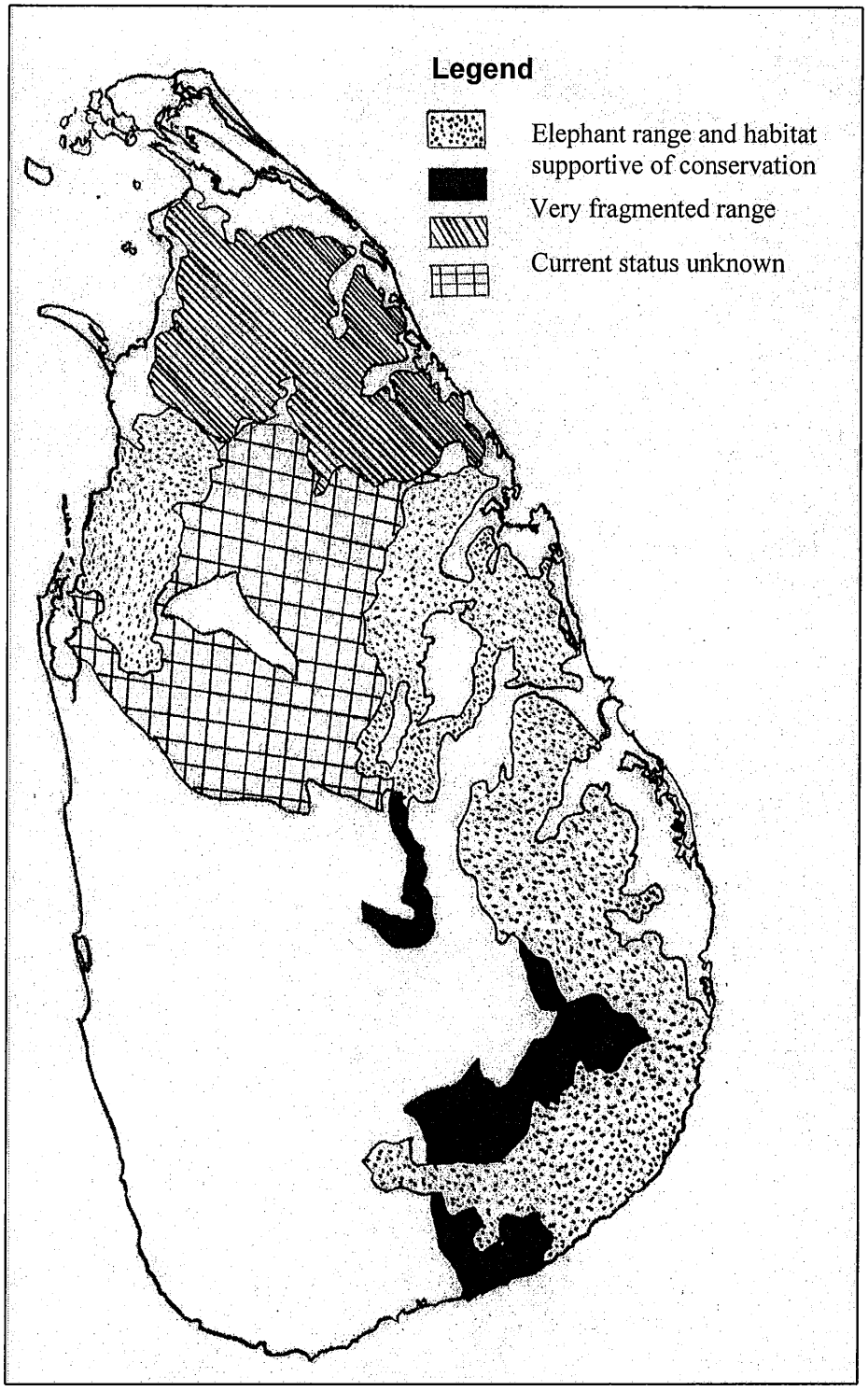

Figure. 1 Generalised elephant distribution in Sri Lanka in 2000 as suggested by the GEF Project, Department of Wildlife Conservation, Sri Lanka

Desai (1998) establishes three phases of the decrease in the elephant population of Sri Lanka by reviewing the literature on the economic history of Sri Lanka under the British. The first phase was the domestication of the elephant as an export commodity in the early to third quarter of the 1800s. During this period, elephants were regarded as a

harvestable resource to be exploited and thousands of wild elephants were captured and exported (Marshall, 1996). This export trade flourished until the third quarter of the 1800s. According to Deraniyagala (1955), between 1853 and 1872, approximately 2,500 elephants were exported. However, the actual number of elephants removed from the wild for domestication during this period would be much higher if elephant mortality during the process of capture, training and transport is taken into account.

The second phase of the decrease in Sri Lanka's elephant population occurred with the expansion of the plantation industry in Sri Lanka between the 1870s and 1940s. During this period elephants were still regarded as resources and exports continued. However, with the expansion of the plantation industry, elephants were considered to be a pest and a bounty was paid for their destruction with a large number of elephants being shot throughout their range, especially in the Central Province. Both sport and bounty hunting accounted for the removal of thousands of elephants during this period. For instance, in the Northern Province bounties were paid for the killing of 3,500 elephants in mid-1887 and in Hambanthota, bounties were paid for the killing of 2,000 elephants between 1878–1882 (Olivier, 1978). This trend continued until Sri Lanka's political independence in 1948.

The third phase covers the current post-independence period. During this period, the largely undeveloped Dry Zone area in the east of Sri Lanka was targeted for development. The Dry Zone contained the last large tract of elephant habitat in Sri Lanka containing a major elephant population (De Silva, 1998). The main development scheme in this zone was the accelerated Mahaweli Development Program, the objective of which was to develop 260,000 ha of new land for agriculture using irrigation facilities. Land-use changes on this scale resulted in tremendous fragmentation of the habitat of elephants in this area and enhanced the conflict between humans and elephants. The present human-elephant conflict in the Mahaweli and North West region is a direct consequence of such drastic and large-scale land-use change over a very short period of time. As the elephant was a protected species during this period, elephants in areas designated for development were simply driven off agricultural land into adjacent patches of habitat. Jayewardene (1994) has given a concise and clear picture of the development of the Mahaweli river basin (including the North West region), its impact on elephants and the actions adopted for controlling elephants. Santiapillai (1994)

estimates elephant mortality in Sri Lanka for the period between 1951 and 1970. According to his estimates, during this period a total of 1,163 elephants perished in the wild, of which 639 (or 55 percent) were killed by farmers in defence of their crops. More recently, De Silva (1998) updated the estimate of elephant mortality in Sri Lanka and reveals that on average about sixty elephants perished annually in the period between 1970 and 1998. Primarily elephants were killed during this period because of their interference with agriculture and with other human activities. Ivory poaching was simply a by-product.

While elephant habitat was reduced and fragmented to a fraction of its original size, what remained of the elephant population was left largely intact. Displacement, shrinking habitats, lack of adequate natural resources and increased overlap in land-use between man and elephants, all contributed to the increasingly severe conflict between humans and elephants. This conflict is a symptom of a deeper problem, namely that of habitat loss and the resulting displacement of elephants. This problem was further compounded by habitat fragmentation, which created a mosaic of elephant habitats and agricultural areas where patches of environments were widely interspersed within agricultural areas. This is typical of many elephant ranges in the region. It indicates that legislation to protect a species, though well intended, does not achieve much in the absence of effective habitat protection. Effective habitat protection in turn depends upon far-sighted land-use plans prepared and implemented well ahead of large-scale development interventions. This has hardly happened anywhere and often even 'committed' (promised) safeguards have been overlooked. It is the ecosystem, the species and their habitat that need to be protected if conservation is to succeed. As elephants have neither the space nor the resources they require, they resort to crop raiding and often involuntarily kill humans and destroy property.

5. THE ASIAN ELEPHANT AS A MIXED GOOD WITH POSITIVE AND NEGATIVE ATTRIBUTES

Compared to African elephants, little attention has been given to estimating the economic value Asian elephants (Barnes, 1998). However, the range of economic values of the Asian elephant appear to be wider than those of the African elephant. A close association between Asians and elephants dates back for more than 2,000 years (Jayewardene, 1994) and there are strong traditional cultural ties between Asians and

the elephant. The elephant enjoys a quasi-religious status in the long-established Buddhist and Hindu traditions of these societies (Rudran et al., 1995). The widespread emotional attachment of Asians to the elephant (and its plight) is indicated by its press coverage. Because of the deep and widespread cultural and emotional attachment of the people to the elephants, it is regarded as a 'flagship species' for conservation in most countries in Asia (De Silva, 1998). De Silva (1998) and others believe that the elephant can be used as a 'flagship species', to pave the way for not just elephant conservation but also to support biodiversity conservation in general in this region.

The Asian elephant is a mixed economic good because some attributes are marketable whereas others are not. Furthermore, it has both positive and negative (pest) attributes. Changes in the relative values of these components have a considerable impact on social decision-making about the conservation of elephants.

The concept of total economic valuation (*TEV*) provides a framework to capture the positive aspects of the economic value of elephants (Barnes, 1996). In the *TEV* framework, economic value of any give environmental amenity is categorised into two major components, namely; use value (*UV*) and non-use value (*NUV*). The *UV* may be broken into two major sub groups such as direct use value (*DUV*) and indirect use value (*IUV*). In addition, *NUV* may be divided into two components: option value (*OP*) and existence value (*EV*). Therefore, the estimation of the *TEV* of elephants:

$$TEV = UV + NUV, \text{ or}$$
$$TEV = DUV + IVU + OV + EV$$

However, it is evident that these values are not easily aggregated in a straightforward fashion. For example, conservation of elephants in their natural state involves direct costs of preservation for setting up a protected area, and this may include paying guards and rangers to protect and maintain the area and may perhaps involve the cost of establishing a 'buffer zone' for surrounding local communities. In this process, the direct use options of elephants are sacrificed, if non-use value options are chosen. Therefore the opportunity cost of non-use value options are the benefit that would have been made if use value options were chosen. Such costs are easily identifiable as they often comprise marketable outputs and income sacrificed. It is not surprising therefore, that governments and donors usually concentrate on these costs – the direct costs plus the foregone benefits of conservation when choosing to retain the elephant in its natural

or a managed state. However, many of the values of natural or managed environmental resource are not bought and sold on markets, and thus are generally ignored in private and public development decisions. For example, the market value of environmental resources converted to some commercial use usually does not reflect the lost environmental benefits. Likewise, conservation decisions of any wildlife are therefore often biased in favour of those uses that do have market outputs. Thus, the failure to account fully for the economic costs of conversion or degradation of environmental resources is sometimes a major factor resulting in inappropriate conservation policies.

The total economic valuation framework, as applied to the positive attributes of Asian elephants, is summarised in Table 2. Positive use values of elephants are classified according to whether they are direct or indirect. The former includes the productive or consumptive values of elephants as resources for such commodities as ivory, hide, other elephant products, recreation and tourism. Basically these are all private goods in principle because they can be marketed. However, they may not all be marketed fully e.g., viewing of elephants. Marketable uses may be important in both domestic and international markets. In general, the value of marketable goods and services is easier to measure than the value of non-marketable direct uses. Often policy-makers only take account of marketable uses of species such as elephants. Indirect use values of elephants are usually not marketed. Thus, indirect use values are difficult to quantify and are often ignored in elephant conservation and management decisions. For instance, conservation of elephants in their natural state helps the conservation of several other species that are directly or indirectly benefited by habitat association with elephants.

Table 2. List of positive use and non-use economic values for Asian elephants

Use Values		Non-use Values	
Direct Use Values	Indirect Use Values	Option and Quasi-Option Values	Existence Values
Ivory and ivory carving Elephant safaris and tourism Hides and hire Sale of elephant calves	Markets generated for local agricultural products and other services by tourism Ecological role as a flagship species (?) Habitat impacts favourable to conservation of other wildlife	Future possible demands for an elephant product and services such as educational and scientific Expected value of the information derived from delaying exploitation and of the elephant	Intrinsic or pure existence value Biological diversity Social, historical, cultural and religious value Bequest value

The non-use value of elephants (these are non-marketable goods) can be categorised into two broader categories: option and existence values, including bequest value. Option value arises because individuals may be uncertain about their future demands for elephant products and services/or their availability in the future. In most cases, the preferred approach for incorporating option values into the analysis is through determining the difference between ex-ante and ex-post valuation. This can be done by developing well-specified models of individual choice, through reasoning about how marginal utility of income differs in the various contingency states. If an individual is uncertain about the future value of the elephant product and services, but believes it may be high or that current exploitation and conversion may be irreversible, then there may be quasi-option value derived from delaying the development activities. Quasi-option value is simply the expected value (if the situation is not so uncertain as to prevent the assignment of probabilities to future outcomes, as it may well be) of the information derived from delaying exploitation and conversion of the elephant today. Some economists believe that quasi-option value is not a separate component of benefit but involves the analyst in properly accounting for the implications of gaining additional information. Quasi-option value can be calculated with an analysis of the

conditional value of information in the decision problem. In contrast, however, there are individuals who do not currently make use of any values of elephant but nevertheless wish to see them preserved 'in their own right'. Such an 'intrinsic' value is often referred to as existence value. It is a form of non-use value that is extremely difficult to measure, as existence values involve subjective valuations by individuals unrelated to either their own or (arguably) others' use, whether current or future. It may reflect the view that humankind has a stewardship role in relation to nature or involve 'deep ecology' concerns. An important subset of existence values is bequest value, which results from individuals placing a high value on the conservation of elephants for future generations of humans.

However, Table 2 does not contain all the characteristics of elephants that influence their total economic value, and it might also be noted that some deep ecologists would object to attempts to value elephants in monetary terms. Table 2 does not allow for negative economic attributes of elephants. These include the economic costs of damage to agricultural crops, to fences, and sometimes farm building as well as occasionally human injury or death. These negative economic values must be offset against the positive economic values of elephants to obtain Net Total Economic Value (NTEV), as previously pointed out by Tisdell and Zhu (1998), see also Tisdell (1979).

Suppose that the NTEV of elephants is solely a fraction of the size of their total population, X, even though this is unlikely to be solely so in practice. It is assumed for the purpose of showing the maximum of NTEV is not likely to correspond to the social economic optimum, using the Kaldor-Hicks criterion. This is because the economic cost of varying the elephant population must be taken into account in determining the social economic optimum.

Let

$$\text{NTEV} = f(\text{X}) \qquad (1)$$

and imagine that in the absence of control $X = X_0$. The total cost of varying the population of elephants, X, may depend on whether the size of the population is to be increased or decreased. Represent it by

$$\text{C} = \text{C}(\text{X}) \text{ for } \text{X} \geq \text{X}_0 \qquad (2)$$

for an increase and by

$$\text{R} = \text{R}(\text{X}_0 - \text{X}) \text{ for } \text{X} \leq \text{X}_0 \qquad (3)$$

for a decrease.

Consider the case when NTEV reaches a maximum for $X \geq X_0$, say at X_2. Then social economic welfare derived from the elephant population *might* be raised by outlays to increase the population of elephants. An increase is desirable in the case illustrated in Figure 2. In Figure 2, the net social economic welfare, W, from the population of elephants,

$$W = NTEV - C(X) \quad (4)$$

$$= f(X) - C(X) \quad (5)$$

reaches a maximum for $X = X_1$. This occurs when the marginal NTEV from increasing the population of elephants equals the marginal cost of doing so. In the case shown in Figure 2, this is so for $X = X_1$. X_1 involves a smaller population of elephants than that which maximises NTEV, which in turn could be expected to be lower than the population of elephants that maximises TEV.

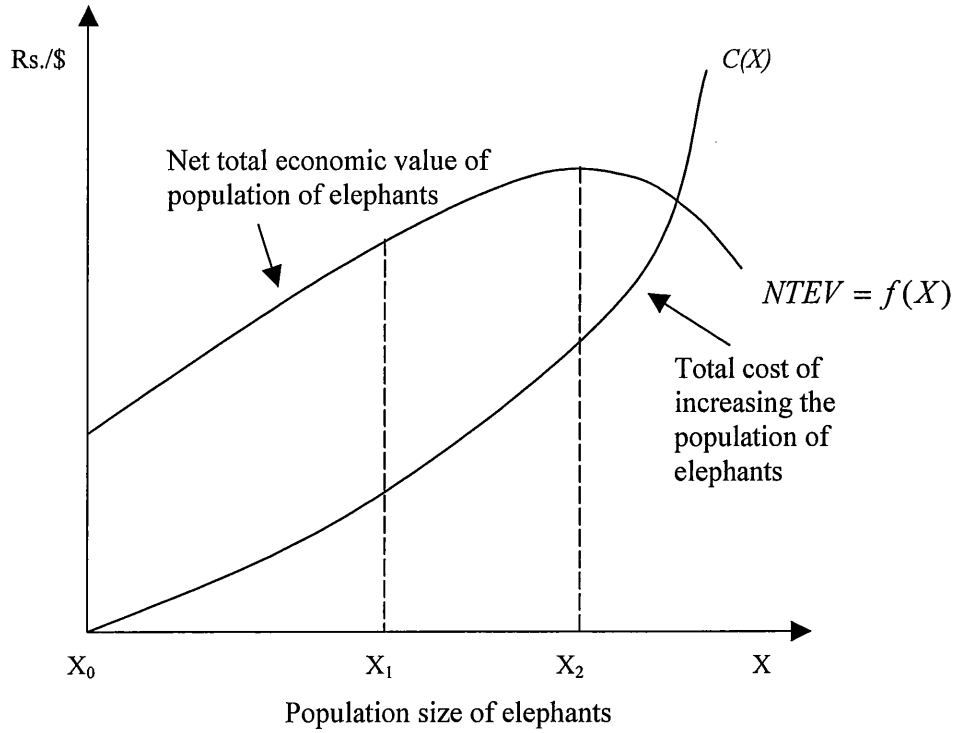

Figure 2. A situation in which Kaldor-Hicks optimum is achieved by increasing the number of wild elephants in a country

Note that in some cases where the maximum of NTEV occurs for an increase in the population of wild elephants, a Kaldor-Hicks social welfare optimum may be achieved by non-intervention to alter the current level of population of elephants because the extra cost of increasing the population exceeds the extra benefits. In this case the optimum remains at X_0, and corner-type solution exists.

Observe also that if the maximum of NTEV occurs for $X \leq X_0$, it is possible that W could be increased by reducing the population of elephants. Once again, this will depend on the costs involved. This case can be illustrated using a similar figure to Figure 2. However, in this case the reduction in the level of the elephant population is treated as the independent or controlled variable and is the variable on the abscissa.

This analysis can be adapted to consider other types of wildlife that have positive as well as negative (pest) economic values. Clearly unbalanced economic analysis results if only the positive attributes of a species (that also has some negative consequences) are considered, and if the costs of managing a species are ignored. In such cases, one cannot rely for policy advice on TEV narrowly conceived. Nevertheless, at the same time, it has to be recognised that the extended analysis itself is an abstraction both from the viewpoint of its welfare or value assumptions and its portrayal of ecological relationships.

Given that one wants to maintain or increase the population of elephants in a country, it is necessary to consider how this can be achieved. Is it possible for example to maintain the current population of elephants of Sri Lanka by confirming them to the existing protected areas for Sri Lanka? If the 'answer' is yes then that would raise the further issue (not discussed here) of how can it be done and would the cost exceed the benefit. But if protected areas are insufficient on their own from an ecological point of view to ensure the survival of wild elephants, their enclosure in protected areas is not an option for conserving elephants in the wild. Consider this matter for Sri Lanka.

6. LIMITED CAPACITY OF SRI LANKA'S PROTECTED AREAS TO ENSURE THE SURVIVAL OF ELEPHANTS AND ISSUES RAISED BY MOBILITY OF ELEPHANTS

The protected area network in Sri Lanka, as in most countries in the world, has been established on an *ad hoc* basis. Many protected areas were previously hunting reserves. The ecological requirements of elephants were often not met when defining the boundaries of these reserves. As a result, its protected areas (PAs) have insufficient carrying capacity to support sustainably their current elephant population. At present about 12 percent of land area in Sri Lanka is designated as PAs for the conservation of elephants and this is little over 8,000 km^2. However, there are only three PAs larger than 500 km^2 and about 49 percent of the PAs are less than 100 km^2. Adding to the small size of the PAs is the fact that they need to support elephant populations whose ecological requirements are relatively large. Even though the PAs were small in the past, there was extensive forest cover outside the PAs. Moreover, this forest cover provided corridors between the PAs for elephants. This in turn ensured that elephants had suitable habitat and were therefore not in serious conflict with the human population (Fernando, 1993). At present, most of the forested areas outside the PAs have already been lost or are being lost rapidly and what remains is fragmented and degraded (Jayawardena, 1996). Therefore, the connectivity between the PAs has been lost to a large extent. As a result, the elephant population in Sri Lanka is scattered and isolated in disjointed ranges. Possibly all PAs in Sri Lanka have insufficient carrying capacity to support and maintain a viable long-term population of elephants merely on their own and the survival of elephants depends on their being able to use land areas outside PAs as well as in PAs. Furthermore, considering the large land area already committed for conservation in Sri Lanka, it may not be possible to create larger and new PAs in the future.

Nevertheless, many believe that even under such limited circumstances, it is possible to implement successful elephant conservation programs. It has been suggested that any such endeavour requires maintaining a minimum genetically viable population and an incomparable individual home range that directly relates to the size of the habitat (Skimmer, 1989). An effective breeding population (N_e) of 50 animals is required for short-term conservation of elephants. Based on age and sex ratios in the population this would translate into a total population of 200 elephants. A recent radio telemetry study of elephant ranging behavior in Sri Lanka has shown that in order to achieve this target, an individual home range as large as 160 km^2 is required (Weerakoon, 1999). Assuming that at least ten non-overlapping home ranges are included in the conservation effort,

one would have to allow at least another 25 percent more area as the home ranges cannot be squeezed in and a larger area would be required depending on the shape of the home ranges. This would work out to an area of 2,000 km^2 and would certainly support a viable population in the short term. However, the largest national park in Sri Lanka is Wilpattu which is 1,316 km^2 in size followed by Ruhuna (978 km^2), Madura Oya (558 km^2) Victoria – Randenigala (420 km^2) and Somawathiya (377 km^2). These are all less than 2,000 km^2. This even the largest national park in Sri Lanka is of insufficient size to ensure a viable population of elephants on its own in the biological short-term. For this purpose, it is essential that elephants in Sri Lanka be able to use areas outside of PAs as well as within them if elephant populations are to remain naturally viable. This is even more imperative if effective long-term conservation of wild populations of elephants in Sri Lanka are to survive.

For long-term conservation without management intervention an effective breeding population (N_e) of 500 is suggested (Sukumar, 1989). This in turn would translate into a population of 2,000 elephants. There is only one such population known in Asia and that is in the Nilgiri Biosphere Reserve in south India (Desai, 1998). The reserve covers an area of 5,520 km^2 (total contiguous forest is over 10,000 km^2) and supports a population of over 3,000 elephants. Given the size of the PAs and the elephant population, a conservation program of this scale is unlikely to be possible for a country like Sri Lanka. It may be more practical in Sri Lanka to target conserving several smaller populations and manage these as a single meta-population. In order to achieve such an objective, integrated policies for the management of elephant populations are needed. It is clear that the continued survival of Sri Lanka's wild elephant populations depends upon them being able to use land other than protected areas, including private agricultural land for their survival. Effective elephant conservation must be based upon this reality, and this situation is likely to require the payment of adequate compensation to farmers to tolerate damage from elephants.

7. TOWARDS INTEGRATED ECONOMIC POLICIES FOR THE CONSERVATION OF ASIAN ELEPHANTS

Most policy actions taken in Sri Lanka to conserve elephants and alleviate human-elephant conflict are transient measures and have been taken largely to tie over a particularly critical time on an *ad hoc* basis. De Silva (1998) summarised the important

actions that have been taken by the Sri Lankan Department of Wildlife Conservation and other government and non-government organisations during this period. However, there are inadequate overall management strategies for elephant conservation in Sri Lanka as has been highlighted by several researchers (Thouless, 1994; Fauna International, 1995; Desai, 1998). Therefore, it is necessary to develop a specific overall policy for elephant conservation. There is no doubt that such a policy must ensure the survival of elephants as well as take into account the welfare of the people in the vicinity of elephant ranges. In achieving these objectives, it is necessary to take into account ecological consequences of agricultural development decisions as well as a number of environmental consequences previously ignored by policy-makers. On the other hand, it is also important to consider adequate incentive programs such as farmer insurance schemes and subsidies to farmers to tolerate the presence of elephants in non-protected areas such as agricultural fields in the vicinity of protected areas.

In the past, most elephant conservation programs and attempts to mitigate human-elephant conflict in Sri Lanka have failed to accomplish the combined objectives of ensuring elephant survival as well as maintaining human welfare simultaneously. For instance, the policy of protection has favoured the establishment of national parks and nature reserves, supported by legislation that prohibits or restricts the local communities from their usual access into these areas (Shan, 1995; Tacconi and Bennett, 1997). Access has traditionally belonged to these local communities. In addition to their not obtaining any significant part of the revenue from the commercial park activities, the acquisition of land for establishing these parks in many countries has often directly displaced many rural communities (Barbier, 1992; Skonhoft and Solstad, 1996). Villagers are often prevented from eliminating 'problem' animals in order to protect their crops and livestock by the existing anti-poaching laws and other enforcement (Barbier, 1990). As a consequence, local communities have been alienated to a large extent from the wildlife. Furthermore, since they bear the real cost of conservation without obtaining any significant benefit from it, it is easy to understand why a rather negative attitude to wildlife preservation has emerged among the rural communities. Combined with a dense and fast growing population and scarcity of arable land, this frequently translates into direct involvement in illegal encroachment of local communities into the national parks and other restricted areas (Skonhoft and Solstad, 1998).

Economic benefits from wildlife conservation rarely trickle down to farmers and landowners in the vicinity of protected areas. Rural people believe that the authorities ignore their elephant-related losses while denying them the right to kill raiding elephants and gain some compensation by utilising elephants to supplement farm incomes. They view the apparent lapse in control of problem animals by authorities as avoidance and as part of official wildlife-protection policy, rather than as a genuine operational gap traceable to lack of resources. Moreover, their chronic frustration encountered as a result of cumbersome and ineffectual government procedures when claiming compensation for economic damage caused by elephants in Sri Lanka and elsewhere (Tisdell and Zhu, 1998) compounds this conflict. In addition, villagers perceive the government's failure to pay adequate compensation on grounds of management problems as a denial of rights. These perceptions suggest that if the law remains overprotective of wildlife, and if those who benefit from wildlife are unwilling to share losses and costs, wildlife may not be sustained on private land in the long run. Misconceptions about factual matters also contribute to the intensity of the conflict. Therefore, an effective outcome in elephant conservation requires policies that integrate economics and conservation, and private and public land uses, rather than just pursuance of narrowly defined conservation strategies.

8. CONCLUSIONS

Available protected areas are insufficient in size to ensure the survival of many species of large, mobile terrestrial animals requiring extensive territories for their continued survival. Given the extent of human demands to use land for purposes other than nature conservation, these areas are unlikely to be extended in the foreseeable future to sufficient size to ensure a high chance of survival of such species. This seems to be to the survival of the Asian elephant. Protected areas in Sri Lanka are fragmented and none are of sufficient size to provide a reasonable chance of long-term survival of the Asian elephant in a natural state. Thus survival of this species in Sri Lanka requires its use of protected and non-protected areas, and this is true almost without exception throughout Asia. Therefore, public policies for the survival of Asian elephants must provide appropriate economic incentives for the holders of unprotected lands to tolerate the presence of elephants, if the Asian elephant is to have a reasonable chance of long-term survival. Thus, an integrated approach (taking account of elephants on private as well as public land) to public conservation policy is needed. This is so whether one

adopts the goal of maximising the net total economic value of this species after allowing for management costs, or modifies this goal so as to take account of nature as a merit good. Otherwise there may be only one place in Asia where the Asian elephant could survive in the long-term, namely in the Nilgiri Biosphere Reserve in India.

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