Integrating Elephant Conservation with Protected Area Management in Sri Lanka

Natarajan Ishwaran
Programme Specialist in Natural Heritage,
World Heritage Centre, UNESCO,
7, place de Fontenoy,
75352 Paris, France

ABSTRACT *Gray Haynes (1991) has correctly noted that "it is no longer possible to describe the optimal or ideal preferred habitats of wild elephants, because, virtually all surviving populations inhabit special protected lands such as national parks which are restricted ecosystems". In Sri Lanka, a large part of what was once the elephant's home range in the dry and intermediate zones has been converted to agriculture. Even where the cores of their home ranges overlap with the boundaries of Sri Lanka's protected areas, elephants move outside of those boundaries and come into conflict with subsistence and plantation agriculture. Despite the limitations of national parks and equivalent reserves of Sri Lanka as elephant habitats, it is inevitable that future management of wild elephant populations would have to be planned in and around clusters of such protected areas. Management planning for* in-situ *conservation of elephant populations cannot be solely dependent on defensive, agriculture-friendly prescriptions, i.e. removal of troublesome individuals, translocation of elephant herds pocketed-in by surrounding agricultural lands to nearby protected areas, capture of elephants for protection in captive herds such as those at Pinnawela orphanage etc. (Ishwaran, 1993). It must necessarily include attempts to regularly monitor the composition and "health" of wild elephant populations, and interventions to manage habitats and land-use in and outside of protected areas so as to improve range conditions, and the elephant's access to parts of its range which were lost to agriculture and other land-uses in the past. This paper provides an overview of the ecology and population structure of the Asian elephant, and the interactions between humans and elephants in Sri Lanka. A framework for designing a pilot project, that could build on a cluster of Sri Lanka's protected areas for elaborating a management regime to improve habitat and range conditions for* in-situ *conservation of the elephant is outlined.*

Ecology and population structure of the Asian elephant in Sri Lanka-an overview

Parker & Graham, in their two-part analysis (1989a,b) of the downward trends in African elephant distribution and numbers note that: "Humans and elephants are complete competitors. Biological theory maintains that such species cannot co-exist on the same range and that increase in one will exclude the other. Measurements of human increase, elephant decline and ivory production are in keeping with this hypothesis".

Competition between humans and elephants is particularly intense in agrarian societies. In Asia, most elephant range countries have large rural populations which seek land for agriculture. Governments have sought to use the pride and the sense of security which people associate with owning a plot of arable land to launch massive river valley development projects where agricultural land is parcelled out to settlers. More often, settlers in such schemes are not necessarily indigenous to the area where the project is executed. Many of the settlers are drawn from rural, suburban and urban populations sympathetic to ruling powers and are attracted to new settlements through the offer of economic and other incentives. The preferential settlement of river valleys and similarly high-yielding habitats for crop production has been a policy that has denied the elephant its most favoured habitats. That policy has been in vogue among Asian rulers, both

native and colonial, for millennia. The following quote from Sukumar (1989) clearly illustrates the antiquity of this policy and its attendant practices. "Kautilya's *Arthasastra* (c 300BC to 300 AD), a manual of statecraft, advises that elephants were to be eliminated from river valleys under settlement but preserved in the outer hill forests"

One of the latest sagas in river valley development schemes displacing elephants from preferred parts of their home ranges occurred in Sri Lanka, under the Accelerated Mahaweli Development Programme (AMDP), which changed the water-flow of the Mahaweli River, the longest of Sri Lanka's rivers, and has perhaps already led to long-term changes in the ecology of the villus.

The Mahaweli villus, which were abundant on both sides of that river's course northeastward from Mannampitiya, were a unique grassland habitat. Prior to the late 20th century renaissance of irrigated agriculture in the dry zone of Sri Lanka, the Mahaweli river, which drains catchements and river-basins in the wet, intermediate and dry zones before draining into Indian Ocean near Trincomaee, flooded the villus at least twice a year, during the southwest as well as the northeast monsoons. The Mahaweli villus thus ensured a supply of palatable stages of grass for the elephant and other grazing herbivores throughout much of the year.

The quality and quantity of grass and grazing lands in the Mahaweli villus would have been considerably higher than that even in areas further upstream along the river, in and around what is currently the Wasgomuwa National Park, and in the flood plains of other nearby rivers such as Maduru Oya, During 1981-1982 when the implementation of AMDP was beginning to be 'accelerated', one measure of food-quality, i.e. percentage crude protein of faecal samples of elephants, was significantly higher in the villus and surrounding forests than in the Wasgomuwa National Park and habitats along the Maduru Oya (Ishwaran, 1984)

Grasslands are the preferred feeding habitat of elephants; they do however, need other habitats for movement, resting, shade, breeding and other purposes. Chena lands which have been invaded by 'illuk' *(Imperata cylindrica)* are grazed upon soon after a burn, when fresh growth of grass is abundant. Once illuk matures, particularly after it has past the flowering stage, it does not constitute a significant feed for the elephant. Where there is a range of habitats and a river flow regime which provides access to varying extents of grasslands throughout the year, browse constitutes only a small portion of the diet (Ishwaran, 1984). Most size-classes of browse are used in proportion to their availability (Ishwaran, 1984); earlier findings showing preferences for certain size classes of woody plants (Ishwaran, 1983) are inconclusive since preference indices were calculated as point-estimates, and did not include estimates of variation due to sampling biases.

Results of studies on relationships between elephant densities, and variables related to grassland structure and composition, and densities of other herbivores such as water buffalo and domestic cattle, in mixed, upland grasslands in the AMDP area (Ishwaran, 1984) have important implications for designing management policies for the elephant. In the dry season elephant densities are positively influenced by availability of tall grasses. As McKay (1973) pointed out, elephant grazing in the dry season is negatively impacted by the presence of other herbivores which graze grasses down to ground level, resulting in elephants having to "scarify" grasses with their front legs before collecting them with their trunks for injestion. In the event elephants are forced to spend increasing amounts of time in scarfying grasses before collecting and feeding upon them, there is likely to be a point where the decreasing net energy gain obtained from a mouthful of grass may force the elephant to seek out alternative diets, such as plantation crops and woody plants, even if those alternatives would not be eaten or be avoided under optimal range conditions. Elephant feeding preferences and behaviour are known to change over time to due to changes in its habitat. In the case of elephants in the Rjaji National Park of India, Vinod Rishi, as quoted in Sarka *et al.* (1995), had observed that "as far back as 1969, the changes in the eating

habits of elephants were recognised as spelling impending disaster. But this recognition went unheeded. A famous publication of 1962, ***Camera in Tigerland,*** says that elephants abhor rohini, *Mallotus philippensis* as food, and today we see that elephants in Rajaji are causing destruction by uprooting this plant ..... the source of this problem (is located) in the large scale extraction of bamboo from the region in 1969"

Even during the wet season, elephant densities could be negatively correlated with densities of buffalo and livestock since heavy grazing pressure from the latter could increase patchiness in available grass cover, causing elephants to spend a decreasing amount of time in any given grassland-site. The extent to which densities of buffaloes should be controlled has been a controversial issue in the management of protected areas such as the Yala (= Ruhuna) National Park of Sri Lanka. In Yala where densities of other grazing herbivores, like spotted deer and sambur are quite high, merely reducing buffalo densities may not increase grazing opportunities for the elephant. In the 1980s when the implementation of the AMDP was beginning to gather momentum, hunting of deer, sambur, and even wild buffaloes, though illegal, was widespread and perhaps contributed to keeping the numbers of these ruminant populations under check. Furthermore the availability of tall-grass-grasslands more favorable to intensive feeding by elephants, such as those found in the Mahaweli villus, made wildlands in the AMDP area far better elephant-habitats than areas inside many of Sri Lanka's national parks. The protection afforded to all wildlife in parks and sanctuaries could set in motion ecological and demographic changes that could gradually lead to increases in grazing herbivore densities which over a period of time could negatively impact availability of grazing opportunities for the elephant.

The establishment of national parks around artificial reservoirs such as Gal Oya, Maduru Oya, Ulhitiya Oya, Uda Walawe etc., is probably one of the best options available for conserving elephants in a country like Sri Lanka, where irrigation, hydro-power and flood control benefits due to those reservoirs provide economic justification for their construction. Fluctuating water levels in such reservoirs mimic floodplains of rivers in exposing varying extent of grasslands throughout the year. However, allowing a large number of domestic livestock to graze inside parks such as the Gal Oya National Park could in the long run lead to changes in the structure and composition of grasslands along the shores of the waters of the Senanayake Samudra that could be detrimental to the use of those grasslands by elephants (McKay, 1973; Ishwaran, 1979). Furthermore, the extents of grassland that are exposed by receding waters in reservoirs located within protected areas like the Gal Oya National Park is a function of the withdrawal of water for agricultural and power generation purposes. Considerations for managing the extents of grasslands for elephants have never entered the equation that determines schedules of water withdrawals from reservoirs located inside national parks.

In the Gal Oya National Park, the northeast monsoonal rains during 1975-1976 was exceptionally heavy. Throughout 1975, due to regular rainfall conditions, elephants were observed to graze in the grasslands along the shores of the Senanayake Samudra even during the normally dry months of July and August (Iswaran, 1981). Earlier studies at the same site (McKay, 1973) had indicated that elephants left the park during the dry season, but grazed in the grasslands along the shores of the reservoir only during the rainy season. During the 1975-1976 rainy season, there was a period of about 15 days in January 1976 when the reservoir had filled to such an extent that the water level extended up to the forest border and there was hardly any grassland exposed for elephants to feed upon. Elephants were known to move outside the park during those high rainfall months when the reservoir had filled up. (Iswaran, 1979).

It is probable that the use of grasslands by elephants, in reservoir-centred national parks such as Gal Oya, apart from being determined by factors such as grassland composition, densities of water buffalo and domestic cattle etc., would also depend on other factors, *i.e.* the distance of grazing locations from the forest

border; and proximity of grazing locations to drinking sites. Grasslands in a natural floodplain, like the Mahaweli villus, provide grazing locations which are in close proximity to both forest cover and drinking sites. In an artificial reservoir like that in Gal Oya or Maduru Oya National Park, grazing locations along the shores of the reservoir could become unattractive to the elephant, particularly during the height of the dry season, when the distance between the forest border and the high-water mark increases. Human demands for water from these reservoirs are also highest during the dry season.

Considerations for managing grasslands along the reservoir to favour elephants is likely to run contrary to the requirements of human needs. In the wet season when more and more grasslands are inundated, it will be useful to release water from the reservoir in order to keep a minimum extent of grasslands "open" for grazing although the demand for water for agricultural activities is likely to be minimal. In the dry season, the situation reverses itself; more and more grasslands are opened up by water withdrawal for irrigatiobn but the grasslands which are exposed, both from a point of view of access and quality may not provide optimal grazing conditions for the elephant. The ecology of these grasslands could be further impacted if domestic cattle, sometimes brought into the park by herders from distant provinces and municipalities, and large numbers of water buffalo continue to graze these grasslands during the dry season (Ishwaran, 1979;1981)

The favourable habitat conditions for the elephant in ranges which occurred along the Mahaweli river prior to the completion of the AMDP may have also influenced the age class structure of elephant populations. In Table 1, age-class distributions with respect to infants, juveniles, sub-adults and adults for elephants using the villus and forests in Trikkonamadu, and the Wasgomuwa National Park areas during 1981-1982 are provided. Observations provided are for selected days when the total number of individuals observed was 30 or more and could therefore have comprised at least 10% of the population of elephants using the respective areas (see Ishwaran, 1993 more details).

Table 1 Age Class data for Trikkonamadu and Wasgomuwa National Park Areas based on elephants observed on separate days during the specified time periods (% estimated in parentheses)

Trikkonamadu area:

[1981 (August-November) and 1982 (April-June)]

	I	J	SA	A	Total
a.	2(6.1)	13(39.4)	10(30.3)	8(24.2)	33
b.	14(15.4)	41(45.1)	23(25.3)	13(14.3)	91
c.	3(6.7)	27(53.3)	9(20.0)	6(13.3)	45
d.	3(2.8)	21(58.3)	9(25.0)	3(8.3)	36
e.	5(8.5)	21(35.6)	20(33.9)	13(22.0)	59
f.	10(10.8)	42(45.2)	24(25.8)	17(18.3)	93
g.	4(9.5)	13(31.0)	15(35.7)	10(23.8)	42
h.	10(14.5)	22(31.9)	20(29.0)	17(24.6)	69
avg %	9.3	42.5	28.1	18.6	

Wasgomuwa area: (1981 May-November)

a.	4(10.0)	17(42.5)	11(27.5)	8(20.0)	40
b.	4(12.5)	16(50.0)	6(18.6)	6(18.8)	32
c.	3(7.3)	21(51.2)	15(36.6)	2(4.9)	41
d.	7(14.2)	19(38.8)	17(34.7)	6(12.3)	49
e.	7(10.0)	26(37.1)	23(32.9)	14(20.0)	70
f.	7(8.0)	30(34.1)	33(37.5)	18(20.5)	88
g.	8(9.2)	28(32.2)	31(35.6)	20(23.0)	87
h.	3(8.8)	14(41.2)	12(35.3)	5(14.7)	34
i.	2(4.8)	21(50.0)	13(30.9)	6(14.3)	42
Avg %	9.4	41.9	32.2	16.5	

I- Infants; J-Juveniles; SA-Sub Adults; and A-Adult as per McKay (1973). Parts of these data published in Ishwaran (1984) and (1993)

In Table 2, age-class distributions are provided for elephant populations that were observed in a number of protected areas of Sri Lanka during the 1960s and the 1970s as reported in McKay (1973) and Kurt (1974). Unpublished data from my own studies in Gal Oya National Park and Ampara Sanctuary during 1975-1977 have also been included. These age-class distributions have been derived from (a) the total number of animals observed during a month (McKay, 1973),

(b) the total number of individually identifiable animals (Kurt, 1974), and (c) the minimum total number of recognisable individuals for months when the largest number of observations were made (Ishwaran, unpublished). Despite these differences in the methods used for the estimation of age-class distributions which make direct comparisons between the different sets of data impossible, they may have value as background information for designing future research studies.

Both Wasgomuwa and Trikkonamadu populations (Table 1), at the time of observations in the early 1980s, had less restricted home ranges than the other populations in the protected areas indicated in Table 2. Hence, the fact that the two populations described in Table 1 had relatively higher percentages of juveniles and lower percentages of adults compared to those populations described in Table 2 provides room for speculations that may lead to the postulation of hypotheses that could be tested by future research.

Table 2 Age class data for other elephant populations of Sri Lanka from published and unpublished data of various authors from 1967-1976.

I	J	SA	A	Total
Yala National Park				
7(8.0)	26(29.9)	23(26.4)	31(35.6)	87[ai]
13(14.6)	21(23.6)	19(23.9)	36(40.5)	89[b]
Gal Oya National Park (Hatpatha area)				
8(12.0)	7(11.1)	26(41.3)	22(34.9)	63[a2]
5(12.2)	7(17.1)	11(26.8)	18(43.8)	41[a3]
9(15.0)	14(23.3)	21(35.0)	16(26.4)	60[ci]
Ampara Sanctuary				
9(14.5)	16(25.8)	15(24.2)	22(35.5)	62[a4]
7(14.5)	17(35.4)	13(27.0)	11(22.9)	48[c2]
Lahugala				
8(10.6)	23(30.7)	26(34.7)	18(24.0)	75[a5]
21(16.9)	29(23.4)	41(33.1)	33(26.7)	124[a6]

I - Infants; J-Juveniles: SA- Sub Adults and A-Adults as per McKay (1973). McKay (1973) reporting observations made in August 1967 [a1], June 68[a2], January 69[a3] December 68[a4], November 67[a5] and November 68[ab]; Kurt (1974) reporting observations during 1968-69[bi] and Ishwaran's (unpublished) observations made in September 1975[cl] and May 1976[c2]

[See text of the paper for differencees in the methods used by the different authors in the estimation of number of individuals (percentages in parentheses) per size clas category].

Sukumar (1989) provides a discussion on scenarios that could arise from different kinds of relationships between age distribution and population growth rates. As he has pointed out, populations could grow due to an increase in fertility, decline in mortality or a combination of the two. Given the long life spans of elephants a population could still be growing even when the percentage of calves in a population is falling. While, it would be impossible to make any statements as to whether or not any of the populations referred to in Tables 1 and 2 are growing, declining or stable, the following conjenctures may be used to derive hypotheses that could be tested in the future:

as elephant range and habitats change from an "open-ended" situation as in Trikkonamadu and Wasgomuwa of the early 1980s to the Parks and Sanctuaries referred to in Table 2, population structures may be becoming more dominated by adult classes; this may well be due to a combination of low mortality of adults, and increased recruitment of juveniles into sub-adult and adult classes.

despite the fact that all protected area centred populations in Table 2 have higher percentages of calve in comparison to the two populations referred to in Table 1, all of them have lower percentages of juveniles; this may be due to a lower recruitment from infant to juvenile classes that may be related to nutritional and habitat factors influencing infant mortality rates.

sex-ratios of sub-adult and adult classes are skewed in favour of females, and in all cases except in Wasgomuwa the ratios of females to males were higher among sub-adults than adults; adult and sub-adult sex ratios approaching unity may be an indicator of decreasing opportunities for sub-adult and adult males to disperse from their maternal herds and home ranges. Such opportunities may be reducing in protected areas, as surrounding lands become gradually converted to year-round agricul-

ture, and habitat fragments suitable for elephant feeding and movement outside of the protected area become less accessible to elephants.

Protected areas - management principles, priorities and practice

Principles of managing protected areas, *i.e.* national parks, strict nature reserves, wildlife sanctuaries etc., have changed, particularly since the late 1960s and the early 1970s. The concept of the "human environment" introduced during and after the Stockholm Conference in 1970 has challenged the assumption that protected areas could be managed as enclaves with minimum or no regard to the needs of people resident in the immediate vicinity of parks and equivalent reserves. The notion that conservation and development are two sides of the same coin has gained ground and peaked at the UN Conference on Environment and Development, held in Brzil in 1992. The outcome of the growing recognition of conceptual linkages between conservation and development has had both advantages and disadvantages for protected areas. It is no longer necessary to belabour the point about the indispensable role protected areas play in national economic development. But at the same time, protected areas may have lost their privilege of being isolated enclaves in rural and marginal lands catering to the aesthetic and recreational pursuits of the urban and well-to-do folks. Protected area managers are more and more complied to give due consideration to the social and economic well being of the poorer sectors of rural societies resident in the immediate vicinity of parks and reserves.

Integrated Conservation and Development Projects, or ICDPs, implemented in and around protected areas have become increasingly attractive to donor agencies because they make an explicit commitment to bringing benefits to rural poor and/or tribal and indigenous communties. Some others have, however, cautioned against the tendency in many ICDPs to de-emphasise the biodiversity protection objectives of national parks and equivalent reserves. Sanderson & Redford (1997) point out that "conservation has become use" and go on to add that the "concerns that fostered the original concept of biodiversity have been surrendered - even forgotten - in the struggle for common ground, to the detriment of science and conservation". Similarly, others have questioned whether there has been "too much emphasis on the "lose or use" argument for conserving species and on economic justifications of conservation areas" (MacKinnon, 1979). The mix of activities implemented by ICDPs sometimes tilt heavily towards "development" rather than supporting "conservation". In an ICDP being implemented with financial assistance from the Global Environment Facility (GEF) in and around the Kerinci-Seblat National Park in Sumatra, Indonesia, 40% of the development activities undertaken consisted of bridge and road construction projects; as pointed out by MacKinnon (1997) it was not clear whether those roads and bridges "will draw populations away from the park or actually open the hinterland to more developments that further threaten the park's integrity". MacKinnon (1997) also agreed with the observation made earlier by Wells & Brandon (1992) that too many ICDPs turned out to be rural development projects with no obvious linkages to conservation.

The need for linking conservation and development has been accepted by most governments and conservation groups. Yet, land and resource use activities which can co-exist with, and in the long-run benefit conservation are not always easy to identify and execute. Where rural poor are resident near protected areas there appears to be a tendency to promote crop cultivation as the optimal land use for helping people and conservation. In lands within or adjacent to protected areas, which are home ranges of elephants, raising crops, particularly those belonging to the family Garminae, such as rice and sugar cane, will most likely result in human-elephant conflicts. It is perhaps necessary to identify other income generating activities, e.g. animal husbandry, community based tourism, small scale rural and/ or artisanal industries, and construction, operation and management of service sector installations like schools, research stations and hospitals etc., whose goals and objectives are more compatible with those of management of habitats for elephants. Furthermore, the abrupt spatial transition from an elephant habitat inside a protected area to paddy and/or sugar cane lands immediately outside the protected area is not a suitable design for a landscape

architecture which aims to minimise human-elephant conflicts.

The following "idealized" categories of protected areas (IUCN, 1997) allow for a broader range of resource use areas to be juxtaposed with elephant habitats in and around protected areas of Sri Lanka, than those solely devoted crop production, either on a subsistence or industrial scale:

CATEGORY I a : Strict Nature Reserve
A protected area managed mainly for science

Definition: An area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

CATEGORY I b: Wilderness Area
A protected area managed mainly for wilderness protection

Definition: A large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

CATEGORY II : National Park
Protected area managed mainly for ecosystem protection and recreation

Definition : A natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

CATEGORY III : Natural Monument
A protected area managed mainly for conservation of specific natural features

Definition: An area containing one, or more, specific natural or natural/cultural features which are of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

CATEGORY IV : Habitat/Species Management Area
A protected area managed mainly for conservation through management intervention

Definition : An area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

CATEGORY V : Protected Landscape/Seascape
A protected area managed mainly for landscape/seascape conservation and recreation

Definition: An area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

CATEGORY VI : Managed Resource Protected Area
A protected area managed mainly for the sustainable use of natural ecosystems

Definition: An area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Of the six categories of protected areas mentioned above , only Ia and I b would contradict with interventionist management strategies. In all other cases interventions to manipulate habitats and resource use in order to favour targeted species conservation objectives could be justifiable. Zoning approaches to protected area management can also facilitate habitat

manipulations and other interventionist management regimes to favour elephants in all protected areas. In the Sri Lankan scenario, it is not difficult to foresee an elephant range to comprise one or more national parks (category II) linked to a wildlife sanctuary (category IV) with additional areas which may be forest reserves (category VI) and jungle corridors (category IV, V or VI depending on the specifics of the legislation used to protect the area).

Building a protected area centred *in-situ* conservation and management regime for elephants in Sri Lanka would require that conservationists, resource managers and planners and scientists accept the philosophy behind interventionist management regimes, i.e. that fragments of natural areas legally protected as parks and equivalent reserves require :

(i) explicit definition of their management objectives,

(ii) agreement among different land and resource use agencies regarding strategies and actions prescribed for attaining those objectives, and

(iii) effective monitoring and evaluation mechanisms for assessing the performance of the management with regard to outcome of the implementation of prescribed actions and activities.

This would apply even in cases where the management decides to "leave nature as it is"; in such cases maintaining fragments of a natural ecosystem in as "natural" a state as possible would require a series of prescriptions with regard to:

(i) an appropriate and effective legislative framework to ensure protection,

(ii) staff and other resources to regularly patrol the areas and to prevent illegal encroachments and other violations, and

(iii) education of people resident in the vicinity of the area in order to seek their compliance with protection objectives of the management.

Outline of a Protected area centred management plan for *in-situ* elephant conservation in Sri Lanka

In Sri Lanka, specific protected area clusters have been identified in the past with a view to developing tools such as management plans (see Kotagma *et. al.*, 1990). These clusters may still be valid for designing a plan for elephant conservation. However, current knowledge on elephant movement patterns outside protected areas, and the potential for maintaining the most contiguous elephant ranges must be reviewed and assessed in order to select one protected area cluster which can serve as a pilot project site to test and demonstrate the feasibility for linking protected area management and *in-situ* conservation of elephant populations. In selecting such a pilot project site, factors such as difficulties in access to parts of a cluster where security conditions may have deterioration since the early 1990s must be given due consideration.

In the early 1980s, the Wasgomuwa-Maduru Oya - Gal Oya cluster of reserves was considered to be the most important from the point of view of conservation and management of elephants in Sri Lanka (see Ishwaran & Punchi Banda, 1982). Although this cluster, together with Wasgomuwa's links to the Mahaweli floodplains, is still likely to be the home of the largest concentration of elephants in Sri Lanka, its choice as a pilot site for testing and demonstrating *in-situ* elephant conservation may have been adversely affected by the following:

deterioration of security conditions which prevent access to the more northeastern parts of the Mahaweli floodplains and eastern parts of the Gal Oya National Park

the rejection of the proposal made by the Wildlife Department for a corridor linking Wasgomuwa and Maduru Oya National Parks because the establishment of such a corridor was considered economically unjustifiable ((TAMS 1980), and

the extent to which elephants, particularly female herds, use the Nilgala corridor linking the Maduru Oya and Gal Oya National Parks.

Reasons of easy access and the ability to monitor habitat use by elephants in all parts of the protected area cluster, including areas which may be outside the boundaries of protected areas, could lead to the choice of the cluster of reserves extending westwards from Yala National Park to Uda Walawe National Park as the best option for a pilot project. Access and security conditions also play an important role in considering the following in the design and planning of the pilot project:

feasibility to propose alternative resource and land use schemes to agriculture in areas immediately juxtaposed to protected areas, e.g. animal husbandry; community based tourism development, establishment of facilities for research, education and/or health that can cater to the needs of nearby resident communities, environment-friendly rural industries, and setting up locations for captive herds of elephants, such as the orphanage in Pinnawela etc.,

habitat manipulations in selected parts of protected areas where natural habitats have already been modified, and in areas outside protected areas where elephant intrusions and crop damage are frequent enough to provide social and economic justifications for changing land use to alternatives which are less conflicting with elephants

Proposals for re-visiting the dogma that agriculture is the only land use option in areas immediately adjacent protected areas which serve as cores of elephant habitats are likely to be dismissed as utopian. But the social and economic hardships of villagers living under continuous threat from elephants to their property and crops may lead them to opt for other livelihood options which are less stressful and have a better revenue generating potential. Land distribution in most river valley development schemes of Sri Lanka are based on egalitarian principles, i.e. each settler is given the same area of land. The area of land per settler family in some of the more recent river valley development projects, such as the AMDP, was as low as 1-1.5 ha., including the area for constructing a house and establishing home gardens and cultivating paddy. The extent to which such a small area of land could provide a sustainable livelihood option and revenues for many settler families is questionable. In all river valley development schemes in Sri Lanka, cases where settlers have been known to either lease or sell their lands to other farmers or even outsiders are not difficult to come across. Hence, the feasibility of a Government Department repurchasing the land from a settler or giving the settler incentives to use it for alternative purposes other than agriculture merits serious consideration and should not be dismissed as unrealistic.

Even where agriculture is practised in lands adjacent to protected areas which are elephant home ranges, limiting cultivation to the wet season with the intention of opening fallow agricultural lands for dry season grazing by elephants must be investigated. In agricultural areas southeast of the Wasgomuwa National Park, elephants were observed feeding in fallow lands during the dry season (Ishwaran, 1993); similar observations have been reported for the African elephant too (Lewis, 1986).

Despite the fact that indisputable scientific evidence is lacking for the negative impacts which competition from water buffalo and domestic cattle may be having on elephant populations, it will be desirable to minimise grazing by domestic cattle in wildlands and keep wild water buffalo populations under check where they share grazing areas with elephants. A combination of prescribed burning and grazing techniques may also improve the value of *Imperata* and other upland, tall-grass grasslands as elephant habitats (see Ishwaran & Punchi Banda, 1982).

Interventions to construct water-holes for the elephants should be assessed with considerable caution; it would appear that the creation of water-holes or "mini-reservoirs" will be justifiable only when they are of sufficient size and are subject to a river-flow regime whose fluctuations can create adequate areas of grass-

lands along the edge of the water. Management interventions to create and improve grazing opportunities for elephants should also receive priority consideration over "habitat enrichment" programmes planting preferred browse species of the elephant. Increasing grazing opportunities is likely to provide better results in containing elephant herds and individuals within predetermined limits of their home ranges and minimising crop damage in nearby agricultural lands.

Community based tourism development options, as an alternative to agricultural crop production, in lands adjacent to elephant home ranges must be given serious consideration. This may be combined with the creation of "captive herd populations" similar to that in the Pinnawela orphanage immediately adjacent to the home ranges of wild elephants. The best option for success in captive breeding of elephants is to allow females to feed in areas frequented by wild male elephants. This technique is practised in several parks in India, Myanmar and Nepal (see Lair, 1997), where captive elephants, maintained near protected areas which provide home ranges for wild elephants, also carry visitors and tourists into the protected area, thereby minimising the need for road construction inside protected areas.

A pilot project which aims to experiment with using a protected area cluster for elephant conservation must be designed on the basis of the best available scientific date for the particular areas and elephant populations under consideration. Preliminary studies for rapid assessments of elephant movement patterns and population structure and for vegetation and land use mapping as well as socio-economic and villager attitude surveys are likely to be essential. Furthermore, management interventions that are to be tested out must be phrased as hypotheses, i.e. their predicted outcome should be stated explicitly and the time frame for monitoring and evaluating the outcome of management interventions must be defined (Peterson, 1996). The results and outcome of the pilot project must be objectively and rigorously analysed before any decision to repeat the project in other elephant ranges is entertained.

Table 3 Sex ratios (female/male) among observed numbers of sub-adult and adult elephants described in Table 1

	Sub-adult			*adult*		
	M	F	F/M	M	F	F/M
Trikkonamadu Area:						
a.	5	5	1.0	2	6	3.0
b.	4	19	4.75	5	8	1.6
c.	3	6	4.75	3	3	1.0
d.	2	7	3.5	1	2	2.0
e.	6.	14	2.33	5	8	1.6
f.	2	22	11.0	9	8	0.9
g.	5	10	2.0	2	8	4.0
h.	5	15	3.0	5	12	2.4
Avg F/M			3.7			2.1
Wasgomuwa area						
a.	4	7	1.75	1	7	7.0
b.	1	5	5.0	2	4	2.0
c.	3	12	4.0	-	2	--
d.	-	17	-	2	4	2.0
e.	8	15	1.88	5	9	1.8
f.	11	22	1.88	5	9	1.8
g.	10	21	2.1	5	15	3.0
h.	6	6	1.0	1	4	4.0
i.	4	9	2.25	2	4	2.0
Avg. F/M			2.5			3.1

Table 4 Sex ratios (female/male) among observed numbers of sub-adult and adult elephants described in table 2

	Sub-adult			*adult*		
	M	F	F/M	M	F	F/M
Yala NP						
	8	15	1.88	10	21	2.1
	6	13	2.2	7	19	2.7
Gal Oya NP						
	6	20	3.33	10	12	1.2
	5	6	1.2	11	7	0.64
	6	15	2.5	5	11	2.2
Ampara						
	6	9	1.5	11	11	1.0
	6	7	1.16	4	7	1.75
Lahugala						
	4	22	5.5	8	10	1.25
	7	34	4.9	12	21	1.75

Conclusions

Elephant conservation in Sri Lanka may be nearing a turning point where research and management may have to consider taking new directions. The future of *in-situ* elephant conservation would have to rely on clusters of protected areas and adjacent lands and their management to improve habitat conditions and expand home ranges. Land use options for villagers resident within and adjacent to elephant ranges must diversify beyond agriculture and consider animal husbandry, community based tourism development, rural and artisanal industries, and the establishment of educational and health installations. Areas adjacent to wild elephant ranges could also provide locations for managing captive elephant populations and thereby benefit island wide elephant conservation programmes and community based tourism operations. The design and implementation of a pilot project for the protected area cluster between Yala and Udawalawe National Parks, based on the best scientific information available, management interventions posed as scientific hypotheses and systematic monitoring and evaluation of results against predicted outcome, could mark a new beginning for linking *in-situ* elephant conservation and protected area management in Sri Lanka.

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