Asian Elephants and the Concept of Carrying Capacity

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Introduction

A given area can support only a certain number of individuals of a species. This is called the 'carrying capacity' of that area for that species. It is determined by the availability of resources that are required by individuals for their survival. The resources that determine carrying capacity may be food, water, nesting/breeding sites, cover, social interactions, competition etc. The carrying capacity of an area is determined by a limiting resource. That is, if a particular resource is limiting the number, irrespective of how many the non-limiting resources can provide for, the population will remain at the number determined by the limiting resource. Carrying capacity has been likened to a standing water-filled barrel that is made of wooden slats of different lengths. The shortest slat determines the amount of water it can hold (Fig. 1). The resource represented by the shortest slat is the one that determines the carrying capacity of the area.

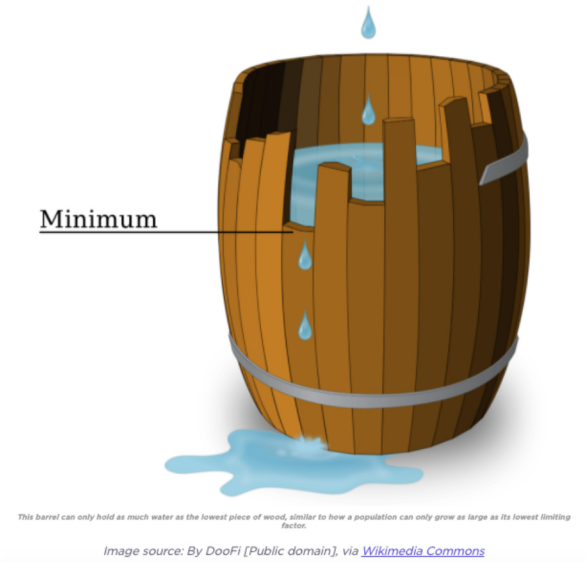

Figure 1. Depiction of carrying capacity

If the shortest slat is replaced by one that is longer, then the next-shortest slat determines the amount of water. Replacing the shortest slat with one that is longer than the next-shortest slat has no impact on the new level of water that the barrel can hold. In relation to animals, in an area with plenty of food and water it may be sites that provide cover that determine the carrying capacity. Or in an area with plenty of

cover and water it may be food. If the resource that is determining the carrying capacity increases, then another resource will become the determinant of the new carrying capacity. For example if there is food enough for 100 and water enough for 500 in an area, the population will not increase beyond 100. If we then provide food for 700 in the same area, water will now become the limiting factor and the population will not increase beyond 500 and so on.

Carrying capacity for elephants

The most important resources that determine the carrying capacity of an area for elephants are food, water, and cover. The determinant in most habitats is food availability, as an elephant needs to feed for 17–19 hours a day, consuming up to 300 kg of food daily to fulfil its requirements. While water is important for elephants, they need to drink water only for a few minutes a day and can walk a few km to get to a water source. We do not know whether Asian elephants need to drink water every day. In the Namib desert in Africa there are elephants that walk through the desert without any water for up to 4 days, to get to water sources (Viljoen 1989). Where water is not a determining factor, increasing the water availability will not increase the carrying capacity.

Where food is the determining factor, the carrying capacity of an area for elephants will vary with time, in accordance with environmental factors such as rainfall, vegetation succession and the abundance of other species that consume the same food. As a long-lived species with a slow reproductive rate, elephants cannot respond to short-term fluctuations of carrying capacity. Therefore, the carrying capacity for elephants is determined by the lowest value of a resource over the long term. For example, if there is a severe drought on average every 10 years that drastically reduces food availability, the carrying capacity will be determined by that and not the amount of food that is present during the 9 years in-between.

Can we determine the carrying capacity?

The carrying capacity is a very important theoretical concept and can help us understand the consequences of trying to limit elephants to particular areas. However, it is not possible to assign an actual number for a given area. This is particularly the case where food is the determining factor. While the amount of green biomass can be measured and even the number of potential food plants counted, not all of it is usable by an elephant. There is no method to determine the actual amount of fodder available to an elephant in a given environment.

As elephants have continuously occupied areas designated as protected areas in Sri Lanka for centuries, all protected areas have to be assumed to be at their long-term carrying capacity, hence cannot accommodate large numbers of additional elephants.

Can we not increase the carrying capacity?

The highest density of elephants in natural habitat is about 3 elephants/km^2 in grassland-savannah-scrub habitat such as in the Udawalawe National Park formerly, whereas in undisturbed/mature forest such as most of Wilpattu and Wasgomuwa National Parks, it is around 0.1 elephants/km^2 (Sukumar 2003; de Silva *et al*. 2011).

Thus, theoretically, converting one km^2 of undisturbed/mature forest to grassland-savannah-scrub can increase the carrying capacity for elephants from 0.1 to 3. Such habitat management could theoretically provide food for elephants driven into protected areas. However, this requires the conversion of approximately 80 acres of undisturbed/mature forest to grassland-savannah-scrub per elephant.

At an estimated cost of Rs. 30,000 to cut and burn one acre, it would cost approximately Rs. 2.4 million per year to increase the carrying capacity of a protected area by one elephant. If there are around 6,000 elephants in Sri Lanka (DWC 2013) since 70% of elephant range is in areas with resident people (Fernando *et al*. in press) at least 4,000 elephants would be in areas with people. Habitat management for 4,000 elephants would entail a cost of around Rs. 9,600 million. Increasing carrying capacity by managing habitats other than undisturbed/mature forest, would require the conversion of greater extents per elephant, as the increase in carrying capacity would be less in such habitats. For example, conversion of scrub forest to grassland would only increase the carrying capacity from about 2–2.5 to 3 elephants/km^2. Therefore to increase the carrying capacity by one elephant, 1–2 km^2 of scrub would need to be converted to grassland, which would cost approximately Rs. 7–14 million per year per elephant.

If the carrying capacity of an area is increased by habitat management, the area has to be actively maintained in the new state forever, incurring annual expenditure. For example, if forest habitat is converted to savannah-grassland, effort has to be expended annually to maintain it in that state. This is because savannah-grassland is not a climax vegetation state and will naturally revert back to the climax state of mature forest, through a process termed 'ecological succession'.

Such change can be seen to occur in the Udawalawe National Park. Prior to the 1960s the area of today's Udawalawe National Park was covered in mature forest. With implementation of the Udawalawe Development Project, large-scale logging and chena cultivation converted it to grassland-savannah habitat by the 1970s (Molegoda 1984). Over the years it has been slowly reverting back to forest and currently is in an intermediate state of scrub and secondary forest (Fig. 2). As a result, the carrying capacity of elephants has been continuously decreasing over the past few decades and elephants are starving to death inside the park (Fernando 2015). Many attempts at habitat management by the DWC to convert it back into grassland-savannah by removal of invasive plants, scrub and planting grass, have failed.

Figure 2. Typical vegetation in Udawalawe National Park in 2010 (left) and 2015 (right)

What about cultivating crops for elephants?

Cultivating nutritious food such as crops, as food for elephants inside protected areas is not practical, as food scarcity applies mainly in the dry season when nothing can be grown. If crops are grown inside protected areas with irrigation, other animals such as peacocks, hare, porcupines, monkeys, wild boar, deer, buffaloes and cattle will consume most of it and their numbers will explode, creating further human-wildlife conflict problems. Also, all these species, including elephants, will not wait for the crops to mature but will start consuming it from initiation of cultivation, which will result in extremely low yields.

Impacts on biodiversity

Habitat management for 4,000 elephants requires the clearing of a minimum of 1,300 km^2 of undisturbed/mature forest. Given the scale of habitat management that is required, in addition to being unaffordable and impractical, it will cause a massive loss of forest cover and biodiversity as many other species depend on the forest. With Sri Lanka being committed to conserve its biodiversity and being a signatory to the International Convention of Biological Diversity, such a strategy would also be untenable in terms of long standing national and international priorities and obligations.

Conclusion

Driving large numbers of elephants that are outside into protected areas and confining them there causes exceeding of the carrying capacity and the elephants' death by starvation. This has already been observed to happen when elephants were driven into the Lunugamvehera and Yala National Parks and fenced in (see Annex III Elephant Drives). So far these are the only two occasions when elephants driven and confined to a protected area were monitored. However, it is the likely result of any such drive.

References

de Silva S, Ranjeewa DG & Weerakoon D (2011) Demography of Asian elephants (*Elephas maximu*s) at Uda Walawe National Park based on identified individuals. *Biological Conservation* **144:** 1742-1757.

DWC (2013) *The First Island Wide National Survey of Elephants in Sri Lanka 2011*. Department of Wildlife Conservation. Battaramulla, Sri Lanka.

Fernando P (2015) The starving elephants of Udawalwe. *Sanctuary Asia* **35(5)**.

Fernando P, De Silva MKCR, Jayasinghe LKA, Janaka HK & Pastorini J (in press) First country-wide survey of the endangered Asian elephant: Towards better conservation and management in Sri Lanka. *Oryx*.

Molegoda S (1984) *Ecology of Uda Walawe National Park*. MSc thesis, University of Colombo, Sri Lanka.

Sukumar R (2003) *The Living Elephants*. Oxford University Press, New York.

Viljoen PJ (1989) Spatial distribution and movements of elephants (*Loxodonta africana*) in the northern Namib Desert region of the Kaokoveld, South West Africa/Namibia. *Journal of Zoology* **219:** 1-19.