Biophysical Carrying Capacity

Description

The concept of carrying capacity is fundamental to many facets of resource management. It is the maximum level of use a specific bounded area can sustain, as determined by natural factors such as food, shelter and water. Beyond this limit, no sustained increases in population or use can occur. The concept originated in America during the 1960s as a tool for rangeland and grazing management and has gained worldwide. The rangeland carrying capacity has been extended in recent years to recreation management a a response to increased levels of use of wilderness and outdoor areas.

Managers wished to determine a human visitor carrying capacity, above which the natural area could not be sustained. An early development of this application was to widen it to include social as well as ecological capacity, i.e. the impact of visitors on the visitor experience. Carrying capacity also became a tool for crowding management. In recent years it has been extended to identify the capacity of regions, countries and the entire world to sustain human populations based on their resources (i.e. related concepts of social carrying capacity and 'ecological footprint').

How and when the tool is used

Since the 1960s, the carrying capacity concept has been used widely around the world, including in New Zealand. This summary considers the biophysical aspects rather than the social aspects. Development of biophysical carrying capacity needs to be based on biophysical *impacts*. In New Zealand a number of reviews have been undertaken, the most comprehensive review for natural areas was completed for the Department of Conservation (DOC) by Ward and Beanland in 1996. DOC's Visitor Strategy requires natural and historic resources to be protected by minimising the impact of visitor activities and of related facilities and services. A key action is to develop and implement a process for identifying and overcoming unacceptable visitor impacts. This will include developing a range of environmental indicators, monitoring visitor impacts and educating visitors through environmental messages. Before this can begin it is necessary to know the nature and extent of the impacts. Ward and Beanland divide biophysical impacts into three groups:

- *Terrestrial impacts:* including vegetation and habitat degradation, soil erosion and compaction, and damage to natural features.
- *Wildlife impacts:* including wildlife disturbance affecting behaviour and breeding success, and habitat alteration.
- *Visitor impacts on environmental quality:* including degraded water quality, contaminated soil, air pollution, noise pollution, and decrease in amenity values. Note that this group includes effects that may be regarded as social rather than biophysical.

Practical implementation of biophysical carrying capacity concepts in New Zealand has been mainly through the protection of fragile vegetation and soils, wildlife (especially marine mammals) and a few fragile natural features, especially in caves. Considerable work on biophysical carrying capacity in relation to soils and vegetation in the vicinity of tracks has been carried out for DOC. Some thresholds for the number of walkers before damage occurs have been suggested, but these vary widely even within the same type of environment. Impacts on fragile soils and vegetation in the vicinity of tracks can often be mitigated by various methods of track improvement (see visitor impact management). Such methods increase the biophysical carrying capacity, but do not address social carrying capacity issues.

Impacts on wildlife have been studied for a number of sensitive and/or threatened iconic species which receive visitor attention, e.g. studies of whale and dolphin behaviour at Kaikoura and the Bay of Islands. In a study of dusky dolphin behaviour at Kaikoura, researchers undertook detailed observation of behaviour in the presence and absence of viewing and other boats, and recognised some significant changes in dolphin behaviour, thought to disrupt normal resting behaviour. Based on these observations the researchers were able to recognise likely thresholds of biophysical carrying capacity for dolphin viewing.

Application - strengths and weaknesses

As stated above, development of biophysical carrying capacity needs to be based on an understanding of the biophysical impacts, and this can only be accomplished by monitoring. Usually such monitoring is based on selected indicators. Researchers from Lincoln University and Landcare Research have developed guidelines for the measurement, management and mitigation of tourism effects. These are now available on the Ministry of Tourism's Tourism Planning Toolkit. The Performance Index Toolbox within the toolkit uses potential indicators to assess performance in relation to tourism objectives.

These assessments and associated modelling confirm that the biophysical carrying capacity of different sites varies greatly. For many less sensitive sites, off-site factors (e.g., waste disposal at accommodation centres) or on-site social factors (e.g., perception of overcrowding) may limit the use of these assets long before any on-site biophysical effect becomes significant. At other more sensitive sites, the carrying capacity of the asset is much lower and on-site biophysical impacts would rapidly limit sustainable use.

The concept of biophysical carrying capacity and absolute thresholds of use is very appealing to many decision makers. Once established, thresholds can be linked to a number of planning tools (e.g. zoning, rules in Resource Management Act framework plans etc to implement). However, a number of fundamental problems with implementation of biophysical carrying capacity concepts have emerged both internationally and in New Zealand. These problems include:

- Different recreation/tourism experiences have different carrying capacities.
- Impacts on biological and physical resources do not help establish carrying capacity.
- A strong cause-and-effect relationship between amount of use and impacts does not exist.
- Carrying capacity is a product of value judgement and is not purely a product of natural resource base and therefore not determinable through careful observation and research.
- Carrying capacity does not help determine the balance between protecting the pristine qualities of a natural area and allowing visitor use.

These judgements may be unfairly harsh when applied to some fragile environments or species, where almost any visitor interaction would result in significant adverse effects, e.g. fragile cave formations, threatened species with low tolerance of disturbance, physically fragile rare vegetation formations. In such situations, where the biophysical carrying capacity is obviously very low, it may be possible to set limits of use at very low levels and be confident that these levels help to protect the species or natural resource. Even here, biophysical carrying capacity is likely to be subject to fluctuations and variability in the natural environment and to seasonal variation. Elsewhere, in the majority of natural area tourism settings, tourism impacts are more about human perceptions of impacts (i.e., about social carrying capacity) rather than about absolute biophysical carrying capacity. In all such situations, questions about impacts are relative, such as "what impact is acceptable" or "how much change is acceptable?", rather than "how much impact is too much?". This is the basis for the Limits of Acceptable Change (LAC) methodology or other types of crowding or visitor management.

Overall evaluation

The concept of carrying capacity is attractive. Biophysical aspects have been widely studied and may be usefully implemented in limited, mainly wilderness situations or where very low levels of use can have significant adverse impacts on fragile natural resources. Elsewhere, carrying capacity is more closely related to human perception and the concept of social carrying capacity is more relevant.