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## Cross references

Coastal Climate  
Coral Reefs  
Mangroves, Coastal Ecology  
Mangroves, Coastal Geomorphology  
Meteorologic Effects on Coasts  
Mining of Coastal Materials  
Small Islands  
Tourism and Coastal Development  
Tourism, Criteria for Coastal Sites

## CARRYING CAPACITY IN COASTAL AREAS

The concept of capacity has received considerable attention as a result of increasing anthropogenic pressure in certain natural environments. Much consideration has recently been given to increases in coastal populations, with the implication that the carrying capacity of the world's coast is finite and such considerations form part of several coastal management initiatives (UNEP, 1996).

Johnson and Thomas (1996) argue that present interest in tourism capacity is due to growth in tourism combined with increasing awareness of environmental issues. The concept is particularly important in the coastal zone which is undergoing rapid change as a result of demographic changes and industrialization (see Kay and Alder, 1999, p. 21) in the context of global climate and sea-level change. In its broadest sense, carrying capacity refers to the ability of a system to support an activity or feature at a given level. In the coastal zone, these systems can vary greatly in both scale and type, and range from small salt marshes through large beach resorts to entire continental coasts. The activities or features that they support are also varied and include, for example, beach recreation or species abundance. The term "carrying capacity" does not therefore have a single precise definition. Rather, it is a broad term that covers a range of different concepts. These concepts are related by the idea that systems such as beaches have certain limits or thresholds. For example, a maximum number of animals can be grazed on any given dune system. Attempting to determine the actual limits is often problematic and raises some fundamental questions. In the case of dune grazing, various criteria could be used to define the carrying capacity. This could involve assessing the effects of grazing on, for example, the physical integrity of the site, its ecological status, or its recreational value. In practice, these features may be interrelated.

The situation is further complicated by the subjective nature of certain limits. For example, the point at which the aesthetic impact of grazing becomes unacceptable is difficult to define and may vary from one location or cultural setting to another. In recognition of the diverse nature of carrying capacity as a concept, a variety of types of carrying capacity have been identified. Most of these fall into the following categories: physical, ecological, social, and economic.

*Physical carrying capacity:* This is a measure of the spatial limitations of an area and is often expressed as the number of units that an area can physically accommodate, for example, the number of berths in a marina. Determining the physical capacity for certain activities can, however, become problematic when subjective elements are introduced. For example, the maximum number of people that can safely swim in a bay depends on human perceptions and tolerance of risk.

*Ecological carrying capacity:* At its simplest, this is a measure of the population that an ecosystem can sustain, defined by the population density beyond which the mortality rate for the species becomes greater than the birth rate. The approach is widely adopted in fisheries science (e.g., Busby *et al.*, 1996). In practice, species interactions are complex and the birth and mortality rates can balance over a range of population densities. In a recreational context, ecological carrying capacity can also be defined as the stress that an ecosystem can withstand, in terms of changing visitor numbers or activities, before its ecological value is

unacceptably affected. This approach raises the difficult question of defining ecological value and what constitutes an unacceptable change in it.

*Social carrying capacity:* This is essentially a measure of crowding tolerance. It has been defined as "... the maximum visitor density at which recreationists still feel comfortable and uncrowded" (De Ruyck *et al.*, 1997, p. 822). In the absence of additional changes, beyond this density visitor numbers start to decline. The social carrying capacity can, however, be influenced by factors such as the recreational infrastructure, visitor attitudes, and sociocultural norms.

*Economic carrying capacity:* This seeks to define the extent to which an area can be altered before the economic activities that occur in the area are affected adversely. It therefore attempts to measure changes in economic terms (Rees, 1992). Examples from the coastal zone might include examining the effect of increased numbers of trailer parks on agricultural activity in dune systems.

In addition to these single discipline assessments, there are a number of composite measures such as recreational and tourist carrying capacity. These attempt to define the threshold of an area for tourism or recreation by combining a range of indicators (Sowman, 1987). The actual carrying capacity of a coastal area assessed according to any of the above approaches depends largely on the nature of the area. Carter (1989, p. 357) noted that "Coastal environments vary considerably in their ability to absorb anthropogenic pressure. The carrying capacity of dune grassland is many orders of magnitude below that of rock cliffs." While this may be true, at least in some views of carrying capacity, it should be borne in mind that capacities are not necessarily fixed in time. They can often be altered by management practices for example, the provision of recreational facilities can increase the social carrying capacity of an area. They can also alter in response to wider environmental changes, whereby a change in mean sea temperature could affect the ecological carrying capacity of an area for a range of species, or a shift in social attitudes could alter what was considered acceptable degradation. As Arrow *et al.* (1995, p. 520) have noted: "Carrying capacities in nature are not fixed, static or simple relations. They are contingent on technology, preferences, and the structure of production and consumption. They are also contingent on the ever-changing state of interactions between the physical and biotic environment."

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## Cross-references

Coastal Zone Management  
Economic Value of Beaches  
Environmental Quality  
Human Impact on Coasts  
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