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Beach Carrying Capacity Assessment: How important is it?

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ABSTRACT

Beaches are highly valuable tourist resources; therefore determining their carrying capacity is an essential factor for their sensible use and management. The study synthetically presented in this paper is focused on the SW coast of Portugal, during the summer of 1998 and 1999. It explores the concepts of physical carrying capacity (number of individuals a beach can physically accommodate) and social carrying capacity (concentration of individuals above which beach users become uncomfortable – crowding perception).

Two distinct methods of data collection were used. Measurements on georeferenced digitised aerial photography were used for the physical carrying capacity evaluation. For the social carrying capacity, several user counts, video images and more than 200 interviews were conducted at five different beaches, exploring landscape perception, landscape evaluation and behaviour.

The results achieved enable the understanding of fundamental differences between the two carrying capacity types and how to link and integrate them within management plans. The results also illustrate the difficulties in producing a universal carrying capacity formula, which can be applied in any beach indiscriminately. Nevertheless, the limitations encountered do not question the validity of these studies, as they are evidently of great importance for beach management and thus should be used in a flexible way, fully adapted to the existing specific site conditions.

ADDITIONALINDEXWORDS: *Beach zoning, perception, coastal management.*

INTRODUCTION

In the last fourty years, with the increase of time for leisure and recreation, the concept of carrying capacity has been a central research theme for social scientists (GRAEFFE *et al*. 1984, SHELBY 1984, STANKEY and McCOOL 1984). Problems like crowding and recreation satisfaction have been introduced as research issues, a method to measure the experience felt by people, and to define what has been identified as the recreation carrying capacity of places (CLARK, 1996; MANNING, 1999).

These problems became important in coastal areas, where tourism has increased dramatically, with harsh associated impacts such as traffic congestion, crowding, and pollution. Defining the carrying capacity of these places is easier in terms of physical carrying capacity, where the limits are set by the available space for building, the dimensions of the infrastructure (roads, water, electricity, etc.) and not by other kinds of constraints.

In contrast, the evaluation of social carrying capacity limits is much more difficult to achieve (SCHREYER 1984), although it is clearly defined as the maximum level of recreational use, in terms of numbers and activities, above which there is a decline of the recreational experience, from the point of view of the recreation participant (PIGRAM, 1985). But while this kind of correlation is easy to assume, i.e.higher densities – less quality, it is much more difficult to demonstrate it on the field, as people often behave differently from their survey answers.

The carrying capacity of a beach is a good example of these problems. It does not derive strictly from the area of sand available to beach users; other aspects have to be carefully assessed like the distance to a nearby urban centre, beach accessibility, car park availability, beach access condition, existence of life-guards, restaurants, leisure facilities (HECOCK, 1983), children playground and, in particular, peoples behaviour and characteristics (sex, age, socio – economics and cultural background) (MORGAN, 1999).

Studies on the carrying capacity of beaches have been

conducted for almost 40 years (ANDRIC *et al*. 1962; An FORAS FORBATHA 1973, De RUYUCK 1997,YEPES 1998). This case study aims at the development and improvement of beach carrying capacity measurement techniques on several beaches of the Sines Municipality, Portugal.

The method chosen includes the use of aerial digital photographs for the physical carrying capacity evaluation, and both video images and interviews of users of those beaches, in order to understand mechanisms involved in social carrying capacity thresholds. The importance of combining these two methods represents a contribution to beach management studies which is one of major issues discussed in this article.

STUDYAREA

The Sines Municipality is located 150 kms south of Lisbon (Figure 1) on a rugged and windy coast, which can be divided in two different stretches. North of Sines is a scarcely populated sandy coast, generally associated with sand dune systems more than 70Kms long, only interrupted by small lagoons. South of Sines is a rocky coast with small pocket beaches inside a protected area, the Natural Park of SWAlentejano e Costa Vicentina.

The entire area has several characteristics that make it an interesting case study. Until the 1960's Sines was only known as a fishing harbour, but by the end of the 60's this situation changed dramatically, as the Portuguese government decided to develop there a major industrial site.

Huge investments were made to build a deep-water port, capable of receiving large oil tankers to supply a refinery and a petrochemical complex, but for several reasons the project failed, although the deep – water port and the industrial complex were actually built and produced severe impacts on the previously unspoiled landscape.

A power station and the chimneys of the industrial complex became the most important new landmarks in the landscape; as a result tourism was expected to be in jeopardy. However, the natural landscape was preserved, with the area south of Sines being very popular for coastal tourism due to the natural conditions of the coast.

In the mid 1980's tourist pressure reached a peak, resulting in the development of plans to build tourist resorts able to accommodate more then 100 000 people in the area. Consequently, the authorities decided to create a protected area and to produce urgent legislation, in order to manage the territory in a sustainable manner.

Presently that area is under a Regional Plan (PROTALI), a Management Plan for the Coastal Area (POOC Sines-Burgau), a Management Plan of the Natural Park (Plano de Ordenamento do Parque Natural do Sudoeste Alentejano e Costa Vicentina) and Local plans for each County Council. Probably due to the existence of several plans, the tourist development of the area has been severely controlled, and no major resorts have been developed.

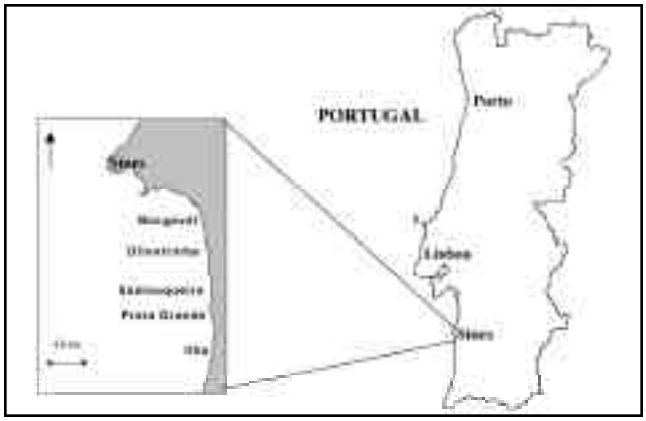

Figure 1. Location of the Study Area

The predominant forms of tourist accommodation are rented apartments, hostels, small hotels and, in particular, camping parks. This type of accommodation, without major

Table 1. Main characteristics of the beaches

Beaches	Characteristics
Morgavél	Associated with sand dunes Besides a municipal road Irregular car parking Two restaurants associated and life guards
Oliveirinha	Associated with sand dunes Irregular car parking on sand dunes Problems of erosion One restaurant associated, no life guards
Samouqueira	Pocket beach, associated with cliffs Irregular Car park at the top of the cliffs No life guards Walking distance from the tourist village of Porto Covo
Praia Grande	Associated with cliffs Organized car park One restaurant associated, lifeguards and facilities available.
Ilha	Associated with sand dunes Problems of erosion as result irregular car parking One restaurant associated, lifeguards, facilities available.

resorts, has been one of the key complaints from the population and local authorities, arguing that all these plans and restrictions impede local and regional development.

The beaches studied in this article are located south of Sines and inside the Natural Park, as they are among the most popular for coastal tourism and have a very high demand during the month of August. Although the study area is relatively small, no more than 20 kms long, it is possible to find a diversity of situations that differentiate the existing beaches significantly (Table 1).

In general, these beaches are poorly served by public transport and have problems like irregular car parking (outside organized and managed parking lots) and informal access to the beaches, both of which are responsible for severe vegetation degradation and erosion problems. Restaurants are present at almost all beaches. They partially contribute to the popularity of the beaches and amplify the demand for recreational facilities.

METHODS AND TECHNIQUES

In order to study the physical carrying capacity of a beach, it is crucial to accurately measure the available area for recreational purposes on each beach. Aerial digital photographs were utilised for this purpose, relying on their high resolution to produce very good quality images, as required for measurement procedures. Photos were acquired during a flight that took place on the 29th of September 1999, at 12.15 A.M., with a low tide situation, at an approximate altitude of 3079 feet and 90 knots speed. Infrared digital photographs were taken using a digital camera, with a spatial resolution of 30 cms and a 10 % along track overlap. Finally, the measurements for each beach were performed using specific software: Image Analyst for MicroStation.

Car parking outside adequate facilities is recognized as being one of the major problems in this area. It is clearly regarded as the main agent responsible for erosion both on sand dunes and top of cliffs. Therefore, the digital photographs were also used to measure parking areas normally used during peak season at those beaches. These parking areas are adjacent to the beaches but have no clear limits or marks and exhibit a chaotic parking pattern. They are clearly inadequate for parking, although they are invariably used for that purpose. The analysis of the parking areas was also performed on equivalent 1979 orthophotomaps, in order to compare and understand the evolution of those areas in terms of shape, size and location.

During the first week of August 1998 and 1999, for the same beaches, more than 12 hours of images were acquired with a video camera, to study the spatial distribution of beach users. This data is essential to measure the exact number of people on the beach at a certain time, to understand how the different areas of the beach are used, and to evaluate the intensity of that use.

For the spatial distribution analysis the beaches were divided into 10 – meter wide strips, parallel to the sea, with the help of markers placed on the beach prior to image acquisition. The markers were placed at the end of each line, outside the utilisable sand area itself, so as to avoid any disturbance that could condition the occupation of the beach, and consisted of small poles identifiable on the frames of the footage.

For the acquisition of the video images two observation points were selected, one from the north of the beach and one from the south, having perfect visibility of the whole beach. Imagery was acquired twice a day. In the morning between 11.00 – 12.00 h, and in the afternoon between 16.00 – 17.00 h, because these hours match the time period when beaches were more crowded.

Weather conditions changed considerably during the survey, which is a very important factor for beach use, consequently, only eight different sets of images were chosen for each beach, corresponding to eight different days, including a weekend. All the images chosen had comparable weather conditions: maximum temperatures above 28º C, a clear sky and no wind. The images were quantitatively analysed, the distribution of beach users was measured for each beach, using the 10-meter strips to evaluate spatial distribution.

The assessment of beach perception, at the five different beaches, was carried out through 216 interviews to beach users, in the first two weeks of August 1998. The questionnaire was designed using a combination of opened and closed questions to understand how the beach was viewed by users, to determine the likes and dislikes of users regarding the beach as well as their expectations for the future of the beaches.

The assessment of beach perception is based on the analysis of two questions in the survey: the first question was about the number of people present at the beach at the time of the survey (crowding perception); with the answer ranging from -1 (overcrowded) to 1 (the beach could accommodate more people), with zero meaning that the users felt comfortable with the number of people on the beach. The second question was about the assessment made by the beach users about four different aspects of the beach: Safety, Parking, Cleaning and Facilities. The answers ranged between –2 (very poor) and 2 (very good). The quality of the results was assessed using a significance test, one – way analysis of variance (ANOVA), to check for any relevant differences between beaches.

The users strongly welcomed the survey, only 3% refused to answer and the average duration of each interview was approximately 16 minutes, which gives a clear indication about the desire for public participation in coastal management in Portugal.

RESULTS AND DISCUSSION

The measurement of beach areas (Table 2), for physical carrying capacity evaluation, was performed after the pre-processing of the aerial digital photographs, that consisted of geometric rectification, georeferencing, and mosaicking using Image Analyst for Microstation. For measurement purposes, beach area was defined as: the whole homogeneous stretch of sand, without significant topographic variations, that is limited by the low tide mark (maritime margin) and the bottom of the cliffs or the first sand dunes colonized by vegetation (continental margin).

The spatial distribution of beach users was analysed on video images. The results showed that on each beach the occupation density is not homogeneous, nevertheless, the distribution of people by sector on all the beaches is similar. The main findings are summarised below:

1. Most of the people are located less than 50 metres away from the sea and less than 250 metres away from formal accesses to the beach;
2. The stretch of beach between the low tide mark and the high tide mark has an average occupation density of one third of that on the upper sector of the beach;
3. Occupation is low or absent more than 50 metres depth from the high tide mark;
4. Areas more than 250 metres away from the formal access points to the beach contain on average about 10 % of the total users on the beach;
5. The maximum distance that most of the users are apparently willing to walk until they find a suitable location on the beach is 250 metres. This was also the distance considered for the calculation of beach carrying capacity in the management plan of this coastal area (CONSULMAR – RISCO PLANEAMENTO, 1998).

These observations enabled a zoning of the beaches, according to the different densities recorded and measured, defined in the following manner:

B 1 – Sand stretch starting at the low tide mark, with a maximum width of 50 metres from the hide tide mark towards the continental margin, located less than 250 metres from a formal access point to the beach: this sector has the highest occupation densities on all the beaches and all the beach facilities are concentrated in this sector;

B 2 – Sand stretch located more than 250 metres away from a formal access point to the beach, with a maximum depth of 50 metres from the high tide mark towards the continental margin;

Table 2. Beach Areas.

Beach	Beach Area m^2
Morgavél	50252.7
Oliveirinha	53007.3
Samouqueira	26351.7
Praia Grande	29130.6
Ilha	72484.8
TOTAL	231227.0

B 3 – Sand stretch between the low tide and the high tide mark, utilisable only for recreational purposes during low tide, with an average occupation density of one third of the other areas;

B 4 - Sand stretch beyond 50 metres from the high tide mark towards the continental margin, which always had a low or non – existent occupation.

Table 3 shows the division of the five beaches into three different zones and the mean results of the eight counts of beach users. These results do not include the area defined as B4, because as previously stated, the measured occupation density is residual or non – existent. The other reason for excluding this area is because, on pocket beaches, location near the base of the cliffs is dangerous due to potential rock fall. Another relevant fact is related to the actual size of three analysed beaches. At Morgavél, Samouqueira and Praia Grande the entire beach is less than 250 metres away from the formal access point and therefore the B 2 sector is absent.

The analysis of Table 3 also shows that Praia Grande is clearly the beach with most demand, the occupation values are the highest, with an average available area by user of only 17 m2/person at B1; possibly because this beach is in close proximity to the main tourist centre of the area, Porto Covo. Although the average values for Morgável, Samouqueira and Oliveirinha are not that low and denote a slightly less dense occupation, they require a detailed attention. At the other extreme, Praia da Ilha has the highest available area occupation density, which may reflect its eccentric position in relation to Sines and its dimensions (it is largest of the analysed beaches).

The analysis of Table 3 also shows that, in determining the physical carrying capacity, the size of B1 is more important than the total area available, because it was where the highest concentration of beach users were measured. Some authors (AN FORAS FORBATHA, 1973; PEARCE 1986, Yepes 1998) consider the maximum tolerable carrying capacity (overcrowding) to be around 3 – 5 m2/ per person, and although the values measured in this case study are under this threshold, they must be taken into particular

Table 3. Mean values of beach users and mean available area per person.

Beach m²	Areas m²	Mean number of users observed n.°	Mean number of users observed (m²/person)	Maximum number of users observed n.°	Maximum number of users observed (m²/person)	Minimum number of users observed n.°	Minimum number of users observed (m²/person)
Morgavél 50252.7	B1 11942.2 B2 0 B3 33612.0	382 * 127	31.2 - 264.6	814 * 245	14.6 - 137.1	115 * 39	103.8 - 861.8
Oliveirinha 53007.3	B1 13849.7 B2 1178.1 B3 37979.4	343 39 107	40.4 30.2 354.9	576 64 193	24.0 18.4 196.7	228 24 77	60.7 49.1 493.2
Samouqueira 26351.7	B1 7993.4 B2 0 B3 17952.4	326 * 108	24.5 - 166.2	486 * 160	16.4 - 112.2	210 * 72	38.1 - 249.3
Praia Grande 29592.6	B1 15896.1 B20 B3 6224.0	884 * 258	17.4 - 24.1	1136 * 380	13.5 - 16.4	603 * 203	25.6 - 30.7
Ilha 72484.8	B1 25352.5 B2 11292.7 B3 22329.4	456 51 148	55.6 221.4 150.9	583 65 190	43.5 173.7 117.5	227 25 77	111.7 451.7 290.0

* The total area of the beach is in a range of 250 meters from the main access point.

account because these beaches are all inside a Natural Park, where excessive occupation levels may cause disruption.

Until now the analysis has concentrated exclusively on the direct use of the beach, however another essential factor has to be taken into account: the parking areas adjacent to the beaches. In the beaches analysed, this is one of the major environmental problems, as a result of the limited capacity and the impact generated, especially in sensitive areas, where erosion is promoted and various endemic species are endangered.

The use of digital aerial photographs, paired with the fieldwork carried out in August 1998 and 1999, enabled a rigorous measurement of the parking areas utilized by the beach users. After identifying these areas on the 1979 orthophotomaps, and comparing them with the 1999 images, the measured expansion in parking areas on the five beaches was more than 50% in these 20 years (Table 4). This increase means that an extra 14.000 m² were being used for parking between 1979 and 1999, which also reveals the degree of tourist demand for these beaches. The growth recorded in parking areas, beach by beach between 1979 and 1999 was greatest at Praia Grande (+ 225%), Samouqueira (+116%) and Ilha (+117%).

The only exception is Morgavél, because in 1979 the Municipal road parallel to the sea ended exactly at that beach, and acted as an enormous parking area. When the road was extended, in the beginning of the 90's, the situation changed dramatically, Morgavél evolved from being the end of the road to become a passing place.

As shown in Table 5, irregular car parking (outside organized and managed parking lots) is a critical problem in these beaches, representing almost 60% of the overall parking area available near the beaches. The high proportion of chaotic parking can be observed especially at Ilha (64%), Samouqueira (63%) and Morgavél (62%). The

Table 4. Evolution of the car park areas between 1979 and 1999

Praia	1979 m^2	1999 m^2	%
Morgavél	9161	4195	-45.8
Oliveirinha	4570	7038.5	54
Samouqueira	3586.5	7772.5	116.7
Praia Grande	2950.7	9590	225
Ilha	4840	10539	117.7
TOTAL	25108.2	39135	55.9

Table 6. Number of people on the beach at the time of the survey.

Beach	Too many %	Well like this %	Accept more %
Morgavél	18.5	57.4	24.1
Oliveirinha	0.0	51.4	28.6
Samouqueira	45.2	45.2	9.5
Praia Grande	32.3	61.3	6.5
Ilha	19.5	50.0	30.0

only reason why this critical situation is not more severe is because beach users park in the restaurant parks that were originally intended strictly for customers.

If the physical conditions around the beaches prohibit an increase of organized and managed parking areas, they exert a strong influence on carrying capacity. As this study clearly shows, within an area where beaches are poorly served by public transport, parking is probably one the most important factors determining the carrying capacity of those beaches.

If understanding the spatial distribution of users on the beaches is very important, then, understanding how the users perceive this distribution is also essential. When questioned about how they evaluated the number of people on the beach at the moment the survey was taking (Table 6), the majority stated that the number was adequate, with the exception of Samouqueira.

These results show that even if, on 4 of the 5 beaches, the majority considered the number of beach users adequate, there are still differences between beaches, as perception was different during the weekends and from beach to beach. This is demonstrated using ANOVA, which shows that answers were influenced by the day of the survey (ANOVA F=3.615, df=10 and p=0) and by the place where the survey was taking place (ANOVA F=4, df=4.505 and p=0.002).

At the place where the number of people present was judged most negatively, Praia da Samouqueira, 45% of respondents stated that the number of beach users was clearly excessive. This could be the result of a combination of both the physical characteristics of the beach, a small pocket beach not very deep and surrounded by high cliffs, and the high number of beach users, as can be observed in Table 3.

In Ilha and Oliveirinha more people considered that those beaches could accommodate more users. This situation can be associated with these beaches being bigger, surrounded by dunes, more opened and providing an impression of more space availability than those enclosed by cliffs.

In the case of Praia Grande it is interesting to note that, even if this beach had the highest user number, more than 60% of the respondents were comfortable with the number of people, revealing that this type of analysis has to be carried out cautiously and requires complementary information.

The last analysis refers to how four distinct aspects of each beach were evaluated by the people surveyed, and how they might play a role in choosing a beach to visit. According to the ANOVA analysis (Table 7), for three of the analysed aspects (Safety, Parking and Beach Facilities), there are significant differences in the way these aspects were evaluated on each beach.

Table 5. Parking Areas, 1999.

Beaches	Organized m2	%	Irregular m2	%	Area Total m2	%
Morgavél	1588	37.9	2607	62.1	4195	100
Oliveirinha	3547	50.4	3491	49.6	7038	100
Samouqueira	2876	37.0	4896	63.0	7773	100
Praia Grande	4370	45.6	5220	54.4	9590	100
Ilha	3762	35.6	6777	64.4	10539	100
Total	16143	41.2	22991	58.8	39135	100

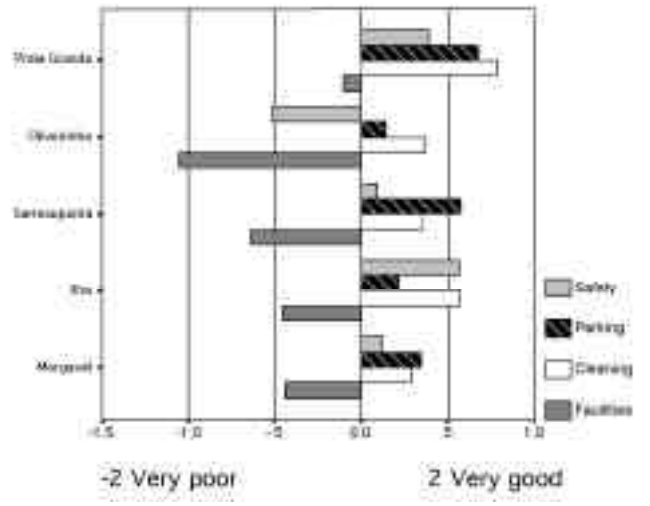

Figure 2. Evaluation of four different beach issues at the beaches studied

As Figure 2 shows, safety is evaluated negatively at Oliveirinha, the only beach studied that does not have lifeguards. The other aspect with negative results is Beach Facilities, as in almost all the beaches there is a complete absence of any kind of facilities (canoe rental, beach games, children playgrounds, etc.) apart from restaurants.

In terms of parking evaluation all the beaches had positive results, contrary to what could was expected as a result of the existing anarchic situation. In reality this result is worrying, because it reveals an almost absolute lack of knowledge on the impact this type of parking promotes.

Table 7. Evaluation of beaches where the survey took place

Morgavél	Mean	.12	.35	.28	-.45
	N	52	54	54	53
	Std. Deviation	1.04	.95	.76	1.74
Oliveirinha	Mean	-.51	.14	.37	-1.06
	N	35	35	35	35
	Std. Deviation	1.09	.85	.77	.73
Samouqueira	Mean	0.95	.57	.36	-.64
	N	42	42	42	42
	Std. Deviation	1.03	.77	.82	1.01
Praia Grande	Mean	.45	.71	.77	-.06
	N	29	31	31	29
	Std. Deviation	1.09	.64	.56	.70
Ilha	Mean	.55	.18	.56	-.41
	N	49	51	52	49
	Std. Deviation	.84	.89	.94	.76
ANOVA	F=6.366	F=3.153	F=3.237	F=3.431	
	df=4	df=4	df=4	df=4	
	p=0	p=.01	p=.053	p=.01	

CONCLUSIONS

Defining the carrying capacity of a beach is undoubtedly a complex issue, where consensus is hard to achieve. This simple case study aimed at identifying some of the aspects that condition this evaluation, more than defining the carrying capacity of the beach per se. Taking into consideration, factors such as beach topography, location of access points, parking availability or the perception by users, could actually be more important than the total sand area utilisable for recreational purposes. Because the distribution is not homogeneous all over the beach, the use of a standard density application is not appropriate.

In the beaches studied, located inside a Natural Park and where the ecological carrying capacity also has to be taken into account, it became clear that the limiting factor for the carrying capacity seems to be the size of the available parking area, more than the dimensions of the beach, since the occupation densities measured and perceived are at tolerable values.

The carrying capacity of a beach cannot be expressed as a fixed and rigid value; on the contrary, as defined by other authors (De RUYK *et al.*, 1997), it should oscillate between two tolerable thresholds, allowing the management of the concept in an integrated, flexible and sustained way.

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LITERATURE CITED

ANDRIC, N., 1962. Aspects regionaux de la planification touristique. *Tourist Review*, (17)3, pp230-236.

An Foras Forbatha, 1973. *Brittas Bay: a planning and conservation study*. An Foras Forbatha, Dublin, Ireland.

CLARK, J.R., 1996. *Coastal Zone Management Handbook.* Florida. CRC Press. 696 p.

CONSULMAR-RISCO/PLANEAMENTO, 1998. *Plano de Ordenamento da Orla Costeira entre Sines e Burgau*. Instituto da Conservação da Natureza, Lisboa, Portugal.

DE RUYCK, M.C. ; SOARES, A.G. and McLACHLAN, A., 1997. Social Carrying Capacity as a Management Tool for Sandy Beaches. *Journal of Coastal Research*, (13)3, 822-830.

GRAFE, A. R.; VASKE, J.J., and KUSS, F.R., 1984. Social Carrying Capacity: An Integration and Synthesis of Twenty Years of Research. *Leisure Sciences*, (6)4, 395-431.

HECOCK, R.D., 1983. Recreation Behaviour Patterns as Related to Site Characteristics of Beaches, *Journal of Leisure Research*, 15 , 37-250.

MANNING, R.E., 1999, *Studies in Outdoor Recreation. Oregon.* 2nd edition Oregon State University Press. 374p.

MORGAN, R., 1999. Preferences and Priorities of Recreational Beach Users in Wales, UK. *Journal of Coastal Research* 15 (3), 653-667.

PEARCE, D.G. and KIRK, R.M., 1986. Carrying Capacity for Coastal Tourism., *Industry and Environment* (9)1 ,3-7 United Nations Environment Programme.

PIQUERAS, V.Y. 1988. *Planification y Gestión Turística de Playas. Curso sobre Gestion Integral de la Costa*. (Madrid, Spain, CEDEX)

SHELBY, B. and HEBERLEIN, T.A., 1984. A Conceptual Framework for Carrying Capacity Determination. *Leisure Sciences*, (6)4, 433-451.

SCHREYER, R., 1984, Social Dimensions of Carrying Capacity: An Overview. *Leisure Sciences*, (6)4, 387-393.

STANKEY, G.H. and McCOOL, S., 1984 Carrying Capacity in Recreational Settings: Evolution, Appraisal, and Application, *Leisure Sciences*, (6)4, 453-473.