

**RECREATIONAL AND DEVELOPMENTAL
CARRYING CAPACITIES OF COASTAL
ENVIRONMENTS**

**A Review of Relevant Literature
and Research**

Prepared For:

Atria Engineering Hydraulics Inc.

8 Stavebank Road North, Suite 401
Mississauga, Ontario, Canada
L5G 2T4

Prepared By:

Chris Stewart
Coastal Resource Scientist
Christian J. Stewart Consulting
Coastal Resource Specialists and Geographers
22 Glenwood Avenue
Guelph, Ontario, Canada
N1H 4L3

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TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	PURPOSE AND FORMAT OF THIS REPORT	2
2.0	THE CONCEPT OF CARRYING CAPACITY	2
2.1	GENERAL HISTORY	2
2.2	A COMPREHENSIVE DEFINITION OF CARRYING CAPACITY	4
2.2.1	Ecological Carrying Capacity	5
2.2.2	Physical Carrying Capacity	5
2.2.3	Facility Carrying Capacity	5
2.2.4	Economic Carrying Capacity	6
2.2.5	Social Carrying Capacity	6
2.3	CROWDING	6
3.0	APPLICATIONS OF CARRYING CAPACITY RESEARCH	9
3.1	INTRODUCTION	9
3.2	CARRYING CAPACITY RESEARCH IN NATIONAL, STATE, AND PROVINCIAL PARKS AND WILD LAND OR BACKCOUNTRY RECREATION AREAS	9
3.3	CARRYING CAPACITY RESEARCH IN RIVER RECREATION AREAS	9
3.4	CARRYING CAPACITY, LAKE RECREATION AND RECREATIONAL BOATING	10
3.4.1	Lake Recreation	10
3.4.2	Recreational Boating	12
3.5	CARRYING CAPACITY AND TOURISM	13
3.6	CARRYING CAPACITY AND THE COASTAL ZONE	15
3.6.1	Coastal Tourism	15
	Coastal Resorts	16
3.6.2	Coastal Recreation	18
3.6.3	Coastal Management	20
4.0	SUMMARY AND CONCLUSIONS	21
	REFERENCES CITED	22
	RELATED READINGS	45
	APPENDIX A (SUMMARY TABLES A AND B)	50



1.0 INTRODUCTION

1.1 BACKGROUND

Shorelines throughout the world have historically been places favoured for recreational and tourism related activities and often coveted as places to reside on either a permanent or seasonal basis. This is witnessed in such places as the tropical islands of the Caribbean, the Atlantic and Pacific coasts of North America, the east coast of Australia, the Mediterranean coastline of Europe, and the shorelines of the North American Great Lakes to name a few.

Conflicts between people and nature have always existed along these coasts, however the increasing desirability and accessibility of coastlines as places to live, work and play has intensified these conflicts greatly over the past 20 years or so. In the United States for example, the 1990 census shows that 25 of the 30 coastal states have had dramatic population increases since 1980, the largest being in Alaska, Florida and California (Williams et al., 1990). Similarly, almost half of all residential and non-residential construction in the United States between 1970 and 1989 occurred in coastal areas (Culliton et al., 1992). Coastal areas across the United States now have population densities five times the Nation's average. Fifty percent of the Nation lives within 75 kilometres of a coast and it is predicted that this will increase to seventy-five percent by the year 2010 (Williams et al, 1990).

As the coastal population grows, not only in the U.S., but in all areas of the world, so does the need for additional facilities for accommodation, transportation, recreation, water supply and waste disposal. Pollution, already severe near large coastal urban areas, may also increase, which can have severe negative impacts on the environment, as well as on recreation activities and "coast dependant" industries such as commercial fishing. Development along the shoreline increases the amount of damage that could potentially occur during storm or hurricane events, and also increases the potential for loss of life during such events. Influx of permanent and seasonal residents to coastal areas can also create overcrowding, which brings with it a whole series of negative social impacts that need to be considered.

Given these "conflicts", the question arises as to the capability of these coastal areas to support additional development. Does a shoreline possess some "capacity" for development, beyond which severe negative environmental, physical or social impacts begin to occur? If so, can it be easily defined or measured, and subsequently easily incorporated into the planning process for the future development of these areas?



1.2 PURPOSE AND FORMAT OF THIS REPORT

This report is a first step toward answering these questions. Its' purpose is to provide a review of the literature and a summary of research that has been conducted on the topic of "carrying capacity", particularly those studies related to recreational activities and the coastal environment.

The report will have two key sections. Section 2 will provide a thorough discussion of the general history of carrying capacity research along with a number of key definitions of the various "types" of carrying capacity. Section 3 will then highlight carrying capacity investigations that have been undertaken, specifically as related to a number of different areas of application (e.g. national parks, rivers, tourism, etc.). This section will also highlight those studies pertaining directly to the coastal environment. Finally, Section 4 will provide a brief summary of the report. References will include those cited in the report, as well as a list of other related research on the topic.

2.0 THE CONCEPT OF CARRYING CAPACITY

2.1 GENERAL HISTORY

The concept of carrying capacity was initially introduced in biology to define the relationship between the resource base, the assimilative and restorative capacity of the environment and the biotic potential of a species (Lein, 1993). While a more comprehensive definition can be found in Section 2.2, for introduction purposes, carrying capacity, in biological terms, can be thought of as the limit or level a species population size attains, given the environmental resistance indigenous to its location (Lein, 1993). In a planning or environmental management context, carrying capacity has been defined as the ability of a natural or man-made system to absorb population growth without significant degradation (Schneider, 1978), or similarly, the degree of human activity that a region can sustain at an acceptable quality of life in perpetuity (Bishop et al., 1974).

In the field of recreation and leisure research, the issue of carrying capacity is perhaps one of the most frequently studied and has a long history of literature. Stankey (1982) reports that the first reference to recreational resources having limitations to their ability to sustain continuous use can be traced to comments by Lowell Sumner (1936 and 1942), an employee of the U.S. National Park Service, who noted that "park areas cannot hope to accommodate unlimited numbers of people" and that the use of wildland areas must be kept "within the carrying capacity or recreational saturation point." Subsequent early work



on the topic had a strong biological focus - it was directed primarily at maintenance of naturally occurring conditions - and as a result, gave a predictably physical resource orientation to the early studies.

In the early 1960's increasing research attention was being directed at the social aspects of capacity. That is, it was increasingly recognized that growing use levels would alter the nature of the recreational experience offered by a particular place to the point that it was different from that which originally attracted participants. Such research was largely done in wilderness settings where it was hypothesized that increasing levels of contact could produce large reductions in visitor satisfaction (e.g. LaPage, 1963; Wagar, 1964; Lucas, 1964 a and b; Priddle, 1964; Lucas and Priddle, 1964) . Similar work on carrying capacity continued into the early seventies (e.g. Lime, 1970; Morgan, 1970), culminating in three important papers which refined earlier definitions (Stankey and McCool, 1984). In Lime and Stankey (1971), the importance of establishing objectives in the carrying capacity concept was argued and they also stated that identifying the public for which to manage was an important decision in the process. Stankey (1972) addressed this question by using a wilderness purism scale to contrast visitors with differing value systems. Finally, Frissell and Stankey (1972) outlined how important it is in management to examine changes in environmental and social conditions - not just absolute numbers of visitors - and managing for those desired conditions.

Throughout the mid-to late 1970's and early 1980's, research on carrying capacity continued to focus on the relationships between use levels and visitor satisfaction (e.g. Fisher and Krutilla, 1972; Stankey, 1973; Alldredge, 1973; Shelby and Nielsen, 1976; Price, 1977; McConnell, 1977; Schreyer and Roggenbuck, 1978; Shelby, 1980; Shelby and Heberlein, 1980; Brown and Haas, 1980; Absher and Lee, 1981; Shelby and Colvin, 1982), but also began to integrate the ecological and social aspects of the carrying capacity concept (Carothers and Aitchison, 1976; Shelby and Nielsen, 1976; Frissell et al., 1980; Jensen, 1981). Other research advanced the carrying capacity concept in more conceptually sophisticated and theoretically based writings (e.g. Lime, 1976; Schreyer, 1976; McCool, 1977; Brown, 1977; Heberlein, 1977; Schreyer, 1979; Shelby, 1981; Gramann, 1982).

This time period also saw researchers begin to re-think the original concepts of carrying capacity and formulate critical reviews of the work that had been done to date. This was perhaps spearheaded by Wagar (1974) who maintained that the emphasis on carrying capacity may focus so much attention on physical site factors that other equally important factors are overlooked. Clark (1978) argued that while the concepts of carrying capacity were well established, the majority of statements referring to carrying capacity contained in master plans and more detailed management plans were rather vague, and based on assumptions, rather than empirical data concerning the requirements of the user and the limitations of the environment. Stankey (1982) reviewed the key criticisms of the carrying



capacity concept, but in conclusion offered that it represents a useful strategy for reaching a desired end and that the research effort directed at the capacity question was becoming more rigorous, well-funded and applicable to the decisions facing management. Perhaps the most comprehensive and useful review of the carrying capacity concept during this period was conducted by Graefe et al. (1984), who highlighted research being conducted in three key areas of the carrying capacity issue - density, encounters, and satisfaction. This review spawned additional work by Shelby and Heberlein (1984), who provided a conceptual framework for carrying capacity determination, and by Stankey and McCool (1984) who further expanded upon the literature pertaining to the relationships between encounters and satisfaction, and who provided a brief reformulated model of the carrying capacity concept.

Despite criticisms of the concept, carrying capacity continued to be examined and applied to specific recreational and natural resource issues. For example, Heberlein et al. (1986) used social carrying capacity to estimate impacts of marina development. Kuss and Morgan (1986) and Morgan and Kuss (1986) combined the concept of carrying capacity with the Universal Soil Loss Equation to determine the capacity of natural areas for recreational activities. Specific examples of coastal applications (see Section 3.6 for more detail) included a case study of carrying capacity in a South African estuary (Sowman and Fuggle, 1987) and the development of a procedure for assessing carrying capacity of coastal resort areas (Sowman, 1987). Research on crowding in recreational settings continued (e.g. Botkin, 1985; Manning, 1985 and 1986; Graefe et al., 1986; Westover and Collins, 1987; Westover, 1989) and culminated with an important review by Shelby et al. in 1989. Finally, research into the 1990's, although less intense to date, is beginning to combine carrying capacity methods, with advanced technologies such as expert systems analysis and Geographic Information Systems (Lein, 1993) in order to address recreational and natural resource management issues.

2.2 A COMPREHENSIVE DEFINITION OF CARRYING CAPACITY

Perhaps one of the earliest formal definitions of carrying capacity was that put forward by James and Ripley (1963) who simply defined it as the biological and physical limitations of the land to support recreational use (cited in Pratt, 1976). However, an examination of several other author's works have revealed various other dimensions to the carrying capacity concept. A degree of impact on the user was noted in a definition by LaPage (1963) who maintained that there are two essential components to be considered: 1) the aesthetic recreational carrying capacity, which is defined as that level of development and use beyond which measurable decreases in satisfaction occur as a direct result of gross numbers of recreationists; and 2) biotic carrying capacity, which might be defined as that level of development and use beyond which the site's capacity to provide a sustained high level of satisfaction becomes impaired due to severe damage to the natural site.



Lime and Stankey (1971) have defined this concept more concisely, as the character of use that can be supported over a specified period of time by an area developed at a certain level without causing excessive damage to either the physical environment, or the experience for the visitor. Clark (1978) agrees, but further recognized that management objectives for recreation also need to be considered and defined carrying capacity as the level, type and/or character of recreation use that can be supported over a specific time, by a specific area which maximizes user satisfaction *within administrative and resource constraints*.

While similar definitions have been put forth by others (e.g. Wagar, 1964; Pfister and Frenkel, 1974; Butler and Knudson, 1977; Stynes, 1977), perhaps the most comprehensive definitions of carrying capacity have been put forth by Pigram (1983) and Shelby and Heberlein (1984). The latter authors propose a generic definition and describe carrying capacity as the level of use beyond which impacts exceed acceptable levels specified by evaluative standards. They further maintain that there are four types of carrying capacity - ecological, physical, facility and social. Pigram (1983) agrees, but instead of facility capacity, describes what he calls economic carrying capacity. Each of these types is defined further below.

2.2.1 Ecological Carrying Capacity

Ecological capacity is concerned with impacts on the ecosystem. That is, how does use level affect plants, animals, soil, water and air quality and so on? It can be formally defined as the maximum level of recreational use, in terms of numbers and activities, that can be accommodated by an area or an ecosystem before an unacceptable, or irreversible decline in ecological values occurs (Pigram, 1983). "Ecological values", or ecosystem "parameters" (Shelby and Heberlein, 1978), that might be examined include percent of viable ground cover, ratios of various plant species, number of animals observed, or coliform counts.

2.2.2 Physical Carrying Capacity

Physical capacity is concerned with the amount of space in undeveloped natural areas (Shelby and Heberlein, 1984), or alternatively, as the maximum number of "use units" (people, vehicles, boats) which can be physically accommodated in an area (Pigram, 1983). In many ways, it can be considered as a design concept, and impacts can be thought of as "space parameters." Calculation of physical carrying capacity is often complicated, as assessment of space requirements for different types of activities often have to be made. As the amount of space in natural areas is fixed, the only opportunity to increase physical capacity will lie in the development of management parameters aimed



at more complete or efficient utilization (Shelby and Heberlein, 1984). Thus, calculation of physical carrying capacity should serve as a starting point from which the assessment of overall recreational carrying capacity can proceed.

2.2.3 Facility Carrying Capacity

Shelby and Heberlein (1984) describe *facility capacity* as those man-made improvements intended to handle visitor needs, including such things as parking lots, boat ramps, developed campgrounds and rest rooms. Administrative personnel are also included in this category because they also "facilitate" use. Facility capacity can almost always be increased by spending money. It is possible for example, to expand campgrounds, build additional launch facilities, or add more personnel. Impacts associated with facility capacity can be referred to as "development parameters."

2.2.4 Economic Carrying Capacity

Pigram (1983) defines *economic capacity* as relating to situations where a resource is simultaneously utilized for outdoor recreation and economic activity, such as a domestic water-supply reservoir. Here, the concern is to establish acceptable recreation-use levels that do not unduly interfere with the non-recreational activity so as to reduce the economic viability of the resource. In such situations, it is often necessary to undertake an ecological study in order to determine the economic tolerance level of the system to different levels of recreational use.

2.2.5 Social Carrying Capacity

Social Capacity (also referred to as perceptual, psychological, or behavioral capacity) is concerned with the visitor's perception of the presence (or absence) of others simultaneously utilizing the resources of an area. This concept is concerned with the effect of crowding on the enjoyment and appreciation of the recreation site or experience. Pigram (1983) defines social carrying capacity as the maximum level of recreational use, in terms of numbers and activities, above which there is a decline in the quality of the recreation experience from the point of view of the recreation participant. Shelby and Heberlein (1984) relate it to "experience parameters" and define social capacity as that level of use beyond which experience parameters exceed acceptable levels specified by evaluative standards. Experience parameters focus on the number, type, and location of encounters with other human groups and on the way these encounters affect the recreation experience. This is the least tangible of the capacity concepts, since the level



of crowding tolerated would not only vary between individuals, but could also vary for the same person in different situations.

2.3 CROWDING

The issue of crowding, or perceived crowding, in social carrying capacity research, has been one of the most frequently studied aspects of outdoor recreation (Cicchetti and Smith, 1973; Stankey, 1973; Altman, 1975; Heberlein, 1977; Heberlein and Vaske, 1977; Manning and Ciali, 1979; Shelby, 1980; Absher and Lee, 1981; Gramann, 1982; Hammitt, 1983; Graefe et al., 1984; Manning, 1985; Shelby and Heberlein, 1986; Harrington, 1987; Kuss et al., 1989; Shelby et al., 1989; Westover, 1989). Crowding has been defined simply as a negative evaluation of a certain density or numbers of encounters (Desor, 1972; Stokols, 1972a; Altman, 1975; Schmidt and Keating, 1979). Most theorists recognize a difference between density and crowding (Stokols, 1972b; Lawrence, 1974; Altman, 1975; Rappoport, 1975; Stockdale, 1978; Gramann, 1982), but even scientists (e.g. Galle et al., 1972; Langer and Saegert, 1977) sometimes use the word *crowding* inappropriately when referring to high density. *Density* is a descriptive term that refers to the number of people per unit area. It is measured by counting the number of people and measuring the space they occupy, and it can be determined objectively. Crowding, on the other hand, is a negative evaluation of density; it involves a value judgement that the specified number is too many (Shelby et al., 1989).

Most of the research on crowding in outdoor recreation has focused on a single population or setting, and the analysis has focused on the relationships between visitor numbers and recreationist attitudes and perceptions. Individual, social and psychological characteristics are usually seen as mediating the relationship between visitor numbers and perceived crowding (Graefe et al., 1984; Manning, 1985). This work has led to a good understanding of the psychological factors such as motivations, expectations, and preferences (Schreyer and Roggenbuck, 1978; Absher and Lee, 1981; Ditton et al., 1983; Shelby et al., 1983); the role of encounters with various groups (Heberlein and Vaske, 1977; Titre and Mills, 1982; Hammitt et al., 1984); the types of people who are most sensitive to crowding (Vaske et al., 1980; Graefe et al., 1986); the role of standards in evaluating a situation as being crowded (Heberlein, 1977; Shelby, 1981; Vaske et al., 1986; Whittaker and Shelby, 1988); and the influence of environmental quality on crowding (Bultena et al., 1981; Vaske et al., 1982).

Shelby (1980) provides a review of the various models used by recreation researchers while investigating crowding. The most common model examined in many studies (e.g. Shelby, 1976; Heberlein and Vaske, 1977) identifies relationships between actual visitor density, number of encounters with others, perceived crowding, and satisfaction with the experience. More recent studies suggest that visitor perceptions of crowding are affected by many variables that interact with perceptions of the number of people at recreation



settings. Shelby (1976), Schreyer and Roggenbuck (1978), and Heberlein et al. (1979) have found that the standards people use to evaluate a setting are influenced by their expectations for that experience. Lawler (1973) suggests that these differences in expectations are learned from the social setting in which the experience occurs. Other studies have shown direct effects of expectations for the number of visitors encountered (e.g. Heberlein et al., 1979) and the type of experience sought (e.g. Schreyer and Roggenbuck, 1978; Absher and Lee, 1981). A person's prior experience with the setting may also affect evaluations of the setting (Nielsen et al., 1977; Heberlein, 1977). Vaske et al. (1980) found different perceptions of crowding between experienced and first-time visitors, thus providing additional support for the importance of expectations. Research conducted in non-recreation settings also suggests that the feeling of crowdedness is influenced by a variety of types of variables (Altman, 1978; Loo, 1973; Baum et al., 1975).

The location of contacts with others has also been related to perceived crowding. Stankey (1973) found that encounters along the periphery of the wilderness differed in their impact on users from those occurring in the interior. Likewise, visitors show greater tolerance for encounters near the trailhead than near their destination and for encounters along the trail rather than at the campsite (Badger, 1975).

Crowding is also known to vary with individual preference and situational definitions (Proshansky et al., 1970; Stokols, 1972a; Stokols et al., 1973). Gramann (1982) also maintains that behavioral crowding effects are often more important than reactions to simple density in contributing to crowding experiences. For example, Gramann and Burdge (1981b) reported a major source of crowding evaluations among reservoir recreationists to be exposure to certain types of objectionable boating-related behaviour by others, including reckless boating. Similarly, a study of backcountry hikers (Bultena et al., 1981) found hiker's encounters with objectionable traces of human behaviour, such as litter, to be positively associated with crowding reports. Womble and Studebaker (1981) reported that "rude" behaviour on the part of other campers contributed significantly to feelings of crowding in a backcountry campground. Titre and Mills (1981) similarly reported that disruptive behaviour on the part of others was a more sensitive predictor of crowding than the frequency of encounters with others on the Guadalupe River in Texas.

Other research addressing behavioral crowding effects has dealt with the type of people encountered, rather than with any rude or objectionable behaviour per se. Stankey (1973) and others (Cicchetti and Smith, 1973; Heberlein and Vaske, 1977) have found that the type of recreational activity engaged in by others (e.g. horseback riding, motorboating, canoeing, etc.) often affects how encounters are evaluated. Some activities may be regarded more negatively than others, contributing to greater feelings of crowding or dissatisfaction when participants in them are encountered (Gramann, 1982). One reason for this is suggested by research on conflict between recreational groups, which indicate that activities often differ in the kinds of psychological goals important to participants, and



that behaviour in pursuit of one set of activity goals may hinder the ability of participants in other activities to fully realize their own goals (Driver and Bassett, 1975; Gramann and Burdge, 1981a; Heberlein and Vaske, 1977). For example, a fisherman encountering a group of inner-tube floaters may feel crowded, because the social goals and behaviour of the floaters interfere with the fisherman's greater desire for solitude.

Research on physical crowding, although limited, describes similar results. People engaging in recreational activities need a minimum amount of physical space in order to pursue their activity in an unconstrained manner. Interference with these functional needs for space due to excessive density will cause physical crowding to be experienced (Choi et al., 1976; Stokols, 1976). For example, Womble and Studebaker (1981) showed that one fourth of campers in their study felt crowded because of insufficient picnic tables, lean-to shelters, fireplaces and latrines in a backcountry campground. This caused congestion and forced the sharing of some facilities with other camping parties. Titre and Mills (1981) reported a strong positive association between river floater's crowding perceptions and the frequency of physical contacts between river craft passing through the rapids, as well as the amount of time craft speed had to be altered in order to avoid collisions with other floaters. Heberlein (1977) refers to these conditions as representing the "facilities carrying capacity", which when exceeded, places pressure on people to modify physically their normal behaviour in order to accommodate the presence of others. This places constraints on usual behaviour patterns, producing the experience of physical crowding.

3.0 APPLICATIONS OF CARRYING CAPACITY RESEARCH

3.1 INTRODUCTION

The above section has provided a comprehensive review of the history, and definitions involved, in carrying capacity research, including discussion of the social aspect of crowding. This section will serve to highlight carrying capacity investigations that have been carried out in specific "areas" (e.g. national parks, rivers) or for specific recreational activities (e.g. recreational boating, tourism). This section will also highlight carrying capacity and related research pertaining to coastal areas of the world.

3.2 CARRYING CAPACITY RESEARCH IN NATIONAL, STATE, AND PROVINCIAL PARKS AND WILD LAND OR BACKCOUNTRY RECREATION AREAS

Due to their attractiveness for a variety of recreational activities (e.g. camping, canoeing, hiking), along with a need for management guidelines to govern such activities, publicly owned parkland and reserves, along with other backcountry recreation areas, have often



been the focus of studies into recreational carrying capacities and related issues. Many of the references cited in previous sections of this report (e.g. Cicchetti and Smith, 1973; Badger, 1975; Frissell et al., 1980; Brown and Haas, 1980; Bultena et al., 1981; Womble and Studebaker, 1981; Botkin, 1985), along with studies by Greist (1976), Cole (1982, 1983a and b), Cole and Dalle-Molle (1982) and Lucas (1980) are examples of such research conducted in many of these areas in the United States. Ovington et al. (1974) and Sinden (1976) describe and discuss procedures adopted to determine the carrying capacity of Ayers Rock-Mt. Olga National Park in Australia at different levels of management input and to resolve a number of conflicting issues. Clark (1978) discusses the concept of carrying capacity and its use in the development of management plans for Killarney, Algonquin and Quetico Provincial Parks in Ontario. Other Canadian examples include work by Lucas and Priddle (1964) and an examination of wilderness perception of the Algonquin Provincial Park interior by Priddle (1964).

3.3 CARRYING CAPACITY RESEARCH IN RIVER RECREATION AREAS

For many of the same reasons as described above, carrying capacity research also takes place in river recreation areas. Again, many of the previously cited references refer to work of this type. For example, in a study of river runners in the Grand Canyon, Shelby (1976) utilized observers to record all encounters occurring on the river, at attraction sites, and at campsites. Heberlein and Vaske (1977) utilized a one-page questionnaire to record encounters among canoeists, fishermen, and tubers on the Bois Brule River in Wisconsin. McCool et al. (1977) and Schreyer and Roggenbuck (1978) used trip diaries and questionnaires respectively to examine encounters and other capacity issues on the Green and Yampa Rivers in Dinosaur National Monument, on the border of Utah and Colorado. Aside from his work on the Colorado River, Shelby, along with Colvin (1982) explored the relationships between encounter measures for the Rouge and Illinois Rivers in Oregon. Manning and Ciali (1979) studied the relationship between density and satisfaction by collecting data from recreationists using the White, Mad, Winooski, and Battenkill Rivers in Vermont. Ditton et al. (1983) used data from a survey of Buffalo National River floaters in Arkansas, to help develop measures of crowding. Other examples include work on the Colorado River (Carothers and Aitchison, 1976), the Ausable River in Michigan (Driver and Bassett, 1975), the Boundary Waters Canoe Area of Minnesota (Lucas, 1964a; Lime, 1970; Morgan, 1970), and the Kromme River Estuary in South Africa (Sowman and Fuggle, 1987).



3.4 CARRYING CAPACITY, LAKE RECREATION AND RECREATIONAL BOATING

3.4.1 Lake Recreation

On lakes and reservoirs used for recreation, the question of carrying capacity becomes particularly acute. Shoreline facilities and the recreation activities which they generate must be in balance with the ability of a waterbody to withstand the impact of water based recreation. In other words, do lakes, where water-based recreation takes place, have an ability to accommodate increasingly greater amounts of activity, or do they exhibit a limit beyond which no more activity could, or should, be tolerated (Jaakson, 1970; Jaakson et al., 1976)?

For the purpose of lake recreation planning, carrying capacity may be defined in three ways: first, a physical carrying capacity: the attributes of a physical environment and the amount of use it can withstand; secondly, a human activity carrying capacity: the number of people engaged in an activity at a density that is efficient and safe for the users; thirdly, a physiological carrying capacity: the acceptable density of people engaged in an activity, as perceived by the users themselves (Jaakson et al., 1976).

Much of the early work in lake recreation planning, including carrying capacity, was pioneered by the Wisconsin Conservation Department. Threinen (1961 and 1964) developed certain guidelines for shoreline ecological zoning and water-surface recreation activity segregation. Others have discussed zoning as a method to both calculate and to manipulate carrying capacity (United States Department of the Interior, 1964; Wilson, 1964). Schneberger and Threinen (1964) postulated that for various water-oriented recreation activities, a minimum water-surface acreage is required. Ten acres of water-surface per boat, as an aggregate of various activities, was recommended. Earlier, the State of New Hampshire (New Hampshire State Planning Project, 1949) had theorized that a linear relationship exists between recreation water-surface activities and lake size. Water-surface zoning has been proposed by McCarty (1959) and Jaakson (1972). Jaakson (1972) also provides an outline of some general principles of lake recreation planning.

In Ontario, provincial government departments in charge of the disposition of public land for cottage and other development have long been plagued by the question of how much development to allow on a given lake. Jaakson (1968 and 1970) followed the lead of Threinen (1964) and developed what is known as the "boat limit" system to estimate the recreation carrying capacity of a lake. In 1970 there was a major extension to the boat limit system in Ontario, when the LAKEALERT lake recreation planning methodology was introduced (Ontario Ministry of Natural Resources, 1970). The Canadian Parks Service has also conducted a number of waterway and boating capacity studies, primarily for the Rideau and Trent-Severn Waterways (see for example Canadian Parks Service, 1978;



Michalski and Usher, 1987; Michalski et al., 1990; and Geomatics International, 1991).

Substantial research has also been carried out to base lake recreation carrying capacity on physical environmental variables, especially water quality since water is one of the more sensitive elements in a lake ecosystem. Water quality and other ecological indices do not measure capacity as such, but they reflect the quality of the environment which itself is closely related to the intensity of use. Water quality carrying capacity measures use a series of indicators which allow the quality of a lake environment to be measured on a composite scale. Ryder's (1965) work on the morphoedaphic index, frequently used to predict fish production, provided early direction for carrying capacity studies based on water quality and lake ecology. The Ontario Department of Municipal Affairs (1971) developed a predictive model of water quality and other environmental features in order to determine recreational and development capacities for the shorelines of inland lakes.

Other systems that have been developed base carrying capacity predictions on the average of a number of parameters, including physical and chemical variables, and involve the weighting of the importance of these by a panel of experts, using the Delphi technique (Brown, 1972). Dillon (1974) has established an excellent system of lake recreation carrying capacity measurement based on water quality criteria; phosphorous has been identified as one of the key indices of capacity loading. Seppänen's (1972) work has provided one of the few attempts which combine carrying capacity measurements of the intensity of development, aesthetics, and the biological capacity of a lake to absorb wastes. Jaakson et al. (1976) combined a comprehensive inventory of activities and natural resources of the study area, along with a model of carrying capacity, to help resolve planning issues for three lakes in Saskatchewan. Similarly, Usher et al. (1987) investigated beach use in Ontario and its relationship to environmental quality parameters in order to develop a computational procedure for forecasting the consequences of pollution abatement and environmental protection programs in terms of changes in beach use and enjoyment.

3.4.2 Recreational Boating

Although boating has been a recurring theme in recreation research, most studies have focused on the perceptions of boaters and not on their on-water activities, or interactivity conflicts. The literature on recreation boating can be divided into four broad themes (Jaakson, 1989). The first is a psychological theme. The focus here has been attitudes, opinions and perceptions of boaters. For example, Lentnek et al. (1969) surveyed the willingness of boaters to travel to boating destinations and Murphy (1975) and Perdue (1986) examined boater's awareness of different boating destinations. Nielsen and Shelby (1977) looked at how various boaters perceive the attraction of a water area for boating. Gramann and Burdge (1984) surveyed conflicts between water-skiers and fishermen and how perception of conflict affects the achievement of goals. Taylor (1985) investigated



boater's attitudes and perceptions of opportunities on the Trent-Severn Waterway in Ontario.

The second theme is carrying capacity. The focus here has been how many boats a defined water environment can accommodate. Boating capacity estimates have typically been based on spatial variables, such as water area (Jaakson, 1984), or on water quality (Dillon, 1974, Seppänen, 1972). In more recent studies, Heberlein et al. (1986) asked boaters themselves to evaluate different estimates of the capacity of an area to accommodate additional boats. Hepner and Wales (1986) and Wales et al. (1987) conducted similar studies to determine spatial patterns of recreational boat use and provide berthing supply projections for the Mississippi Gulf Coast. Management of lake development has also been based on boating capacity estimates (Ontario Ministry of Natural Resources, 1968 and 1970; Hough, Stansbury and Associates, 1969). Boating capacity studies also form a subset of the broader theme of activity density and the perception of crowding (Absher and Lee, 1981; Becker et al., 1984; Burch, 1981 and 1984; Gramann and Burdge, 1984; Heberlein, 1977; Schreyer and Roggenbuck, 1978).

The third theme is landscape assessment. The focus here has been the evaluation of the scenic value or recreation activity potential of water environments. Leopold's (1962, 1969a and 1969b) and Leopold and Marchand's (1968) river landscape aesthetic assessment methods, which have been critiqued by Hamill (1974, 1975 and 1977), are examples of scenic value studies. A method to assess white-water canoeing capability (Egarr et al, 1979), which was applied to all major rivers in New Zealand, illustrates the activity potential focus. Management has also been based on landscape assessment research. Jaakson (1988) based the decision of whether or not to proceed with the construction of a proposed new marina on data of how a river configuration influences boat traffic. McGill (1982) described how a river was artificially shaped to form a white-water canoeing competition course.

The fourth theme is activity analysis. In one such study, Jaakson (1984) analyses motorboat, sailcraft and canoe activities in order to provide recommendations on water surface zoning and time scheduling of activity on a busy lake. Similar work examined the activity patterns of recreational boating on an urban lake (Jaakson, 1989).

3.5 CARRYING CAPACITY AND TOURISM

Hovinen (1982) defines *tourist carrying capacity* as the maximum number of visitors that can be accommodated without causing excessive environmental deterioration and without leading to a decline in visitor satisfaction. O'Reilly (1986), on the other hand, describes two schools of thought concerning tourist carrying capacity. In one, carrying capacity is considered to be the capacity of the destination to absorb tourism before negative impacts



are felt by the host population. Capacity is dictated by how many tourists are wanted rather than by how many can be attracted. The second school of thought contends that tourism carrying capacity is the level beyond which tourist flows will decline because certain capacities, as perceived by the tourists themselves, have been exceeded and therefore the destination area ceases to satisfy and attract them.

Mathieson and Wall (1982) say carrying capacity is the maximum number of people who can use a site without an unacceptable alteration in the physical environment and without an unacceptable decline in the quality of experience gained by visitors. O'Reilly (1986) contends that this definition only takes into consideration the physical impact of tourism on the destination from an environmental and experiential point of view. He claims that carrying capacities can be established, not only from a physical perspective, but also for the social, cultural and economic subsystems of the destination. Economic carrying capacity, as described by Mathieson and Wall (1982), is the ability to absorb tourist functions without squeezing out desirable local activities. They define social carrying capacity as the level at which the host population of an area becomes intolerant of the presence of tourists. Lindsay (1986), in discussing tourism carrying capacity for national parks, defines it as the physical, biological, social and psychological capacity of the park environment to support tourist activity without diminishing environmental quality or visitor satisfaction.

Martin and Uysal (1990) borrow from all of these definitions and describe tourist carrying capacity as the number of visitors that an area can accommodate before negative impacts occur, either to the physical environment, the psychological attitude of the tourists, or the social acceptance level of the hosts. Physical carrying capacity involves two areas. These are the actual physical limitations of the area - the point at which not one more person can be accommodated. It also includes any physical deterioration of the environment which is caused by tourism. Psychological carrying capacity has been exceeded when tourists are no longer comfortable in the destination area, for reasons that can include perceived negative attitudes of the locals, crowding of the area, or deterioration in the physical environment. Social carrying capacity is reached when the local residents of an area no longer want tourists because they are destroying the environment, damaging the local culture, or crowding them out of local activities. Such changes in the attitudes of locals toward tourists have been documented by Doxey (1976) by an index of irritation which shows feelings that range from euphoria to regret that tourism ever came to the area.

Interest in the capacity to absorb tourism has grown concomitantly with two major research trends (Getz, 1983). The first of these has been an increasing concern for the negative impacts of tourism. Authors such as Young (1973), Turner and Ash (1975), Bosselman (1978) and Rosenow and Pulsipher (1979) have popularized discussion of tourism impacts and the possibility of controlling negative effects. Young discusses tourism capacity explicitly by arguing that emphasis should be placed on how many tourists are wanted and



can be absorbed, rather than on how many visitors want to or can be persuaded to come to an area. Basic texts on tourism also generally include discussions of impacts, planning and controls (e.g. Lundberg, 1980; McIntosh and Gupta, 1980). Environmental impacts of tourism are also well documented. Studies by Inskeep (1987), Fagence (1990), Farrell and Runyan (1991) and May (1991) are just a few that highlight the importance of the environmental and ecological aspects of tourism planning and development.

The second research trend which has generated interest in capacity has been associated with a realization that destination areas and resorts display cycles of popularity and decline (Christaller, 1963; Plog, 1974; Stansfield, 1978; Crompton and Hensarling, 1978; Butler, 1980; Meyer-Arendt, 1985; Haywood, 1986; Cooper and Jackson, 1989; Martin and Uysal, 1990; Debbage, 1990; Getz, 1992). As expressed by Butler (1980), it is contended that the number of visitors to a destination will decline as certain capacities are exceeded or as overcommercialization occurs. Consequently, argued Butler, developments should be kept within predetermined capacity limits.

Despite a high degree of interest in the application of capacity to absorb tourism, there are only a few examples of actual applications in the tourism management and planning field. The landmark study in this field was a demonstration project in Ireland (An Foras Forbartha, 1966), in which the aim was to devise a methodology and ongoing planning process so that objectives for development and environmental protection could both be attained. Hall (1974) determined tourist carrying capacity in Yugoslavia by determining the physical limits of beaches and the available supply of water. The Scottish Tourism and Recreation Planning Studies (STARPS, no date) also considered capacity in its planning guidelines, although the only specific advice provided pertained to the physical capacity of facilities. Getz (1982) conducted a comprehensive analysis of tourism impacts and a subsequent identification of capacity thresholds for the Spey Valley in Scotland. In Ontario, the provincial government (Balmer, Crapo and Associates, 1976) established an approach in which development strategies would be undertaken for specific zones possessing a high potential for the development of tourism. One of the first of these strategies has been completed for part of the Georgian Bay region (Marshall, Macklin, Monaghan, Thorn, Stevenson and Kellog, 1980). More recent examples include studies conducted in coastal resort and tourist areas, which will be discussed in the next section.

3.6 CARRYING CAPACITY AND THE COASTAL ZONE

The various concepts of carrying capacity as discussed in the previous sections have, surprisingly, been applied in many different coastal applications. While much of this literature is framed in a coastal management and development context, and while most of the studies do not address carrying capacity directly, there are three general themes that emerge from the literature and are discussed below: 1) coastal tourism - which includes



discussion of beach resort planning and evolution; 2) coastal recreation - which includes capacity studies, but also examinations of the impacts of recreation on the coastal environment; and 3) coastal management - which includes those studies related to the development and planning of the shore zone.

3.6.1 Coastal Tourism

Coastal tourism can be defined as tourism brought to bear on the coastal environment and its natural and cultural resources. Most coastal tourism takes place along the shorelands and in the water immediately adjacent to the shoreline; it occurs outdoors and indoors, as recreation, sport and play, and as leisure and business. The fundamental tourism activity is the passive observation of the environmental and social scene. The most frequently enjoyed active recreational pursuits are undoubtedly the various swimming, boating and watersport related activities (Miller and Ditton, 1986). In the context of conservation and sustainable development of the coastal zone, key management issues of coastal environments become one of managing the amenity interactions of the range of these uses (Kenchington, 1993). These activities will all have some type of impact, to the point that management is needed to prevent or minimize damage. Many of the past research on coastal tourism has focused on such impacts. For example, Edwards (1987) described the nature and extent of ecological impacts on coasts in England and Wales, and provided a discussion of management techniques in light of projected increases in tourism activities. Rosier et al. (1986), Kozlowski et al. (1988) and Walker (1991) described environmental limitations of a small island in the Great Barrier Reef in Australia and devised a methodology for identifying areas, development levels and time periods to which various forms of tourism activities should be confined, so as not to exceed these limitations. Miossec (1988) describes physical consequences of tourist development -erosion in front of embankments, destruction of dunes, siltation of marinas - along the Atlantic coast of France. Similarly, Cabanne (1992), also in France, discusses the pressure that tourism development puts on space and the natural environment and also on traditional local trades, such as fishing.

Social systems can also be disrupted when tourism gives evidence of, for example, increased crime, dislocation, racism, and stratification in coastal communities (Miller and Ditton, 1986). This may also involve changes in the quality of life for local populations (see for example Smith, 1977; Bosselman, 1978; de Kadt, 1979; Gunn, 1979; Gee et al., 1984). Coastal tourism is both a cause and a consequence of congestion and contributes to multiple use conflicts (e.g. resort development vs. retention of residential housing; or retail/restaurant trade vs. traditional water-dependent commerce) and allocation conflicts (e.g. commercial vs. recreational vs. subsistence fishing interests) (Miller and Ditton, 1986).

A majority of the literature on coastal tourism has focused on the development of



management plans, policies and strategies for both attracting and governing tourism in the coastal zone. Clarke (1981) and Klemm (1992), for example, discuss the administrative, planning and implementation goals of tourism development for the Languedoc-Roussillon shoreline of France and evaluate its success in terms of a number of social and economic criteria. Nicholls (1982) discusses a major state-funded tourism development project in Brazil, while Romeril (1983) outlines a similar development plan for the shoreline of Les Mielles, Jersey. Miller (1987) highlights the underutilization of the Washington coastal zone as a tourism and recreation destination and outlines a number of cooperative coastal tourism planning recommendations that would help promote tourism, while at the same time protecting both natural and cultural/social features. Kenchington (1989) describes a series of policies that will help in developing a viable tourism strategy for the Galápagos Islands - one which reflects the environmental sensitivity, the social and economic setting, and the current and realistically predictable levels of visitor arrivals. The incorporation of tourism into multiple-use planning programs has been discussed by Agardy (1991), and examples of areas where it has been successfully integrated include Quinta Roo, Mexico (Ogden and Ziemann, 1977; Agardy, 1988; Emory, 1989), the Galapagos Islands (Agardy and Epler, 1986; Broadus and Gaines, 1987), the Great Barrier Reef of Australia (Kenchington, 1991), and the Lesser Antilles (Van't Hof, 1985). Finally, management programs and policies that attempt to incorporate public attitudes and perceptions regarding coastal tourism are discussed by Hickman and Cocklin (1992) in New Zealand, and by Dowling (1993) for the west coast of Australia.

Coastal Resorts

One of the primary destinations for tourists in the coastal zone is a beach resort, which can be defined as geographic areas offering a variety of facilities, services and activities which are oriented toward seaside recreation for the accommodation, use and enjoyment of visitors (adapted by Smith (1991) from Metelka (1990)). The evolution of beach resorts has merited considerable attention in the literature. (Smith, 1991 and 1992a) observed that while beach resort development begins well, as the resort matures, resort ambience deteriorates, pollution levels climb, negative social impacts increase, and questions of the distribution of economic benefits arise. This observation closely parallels concepts of tourist carrying capacities and tourism life-cycles discussed previously (e.g. Butler, 1980).

Smith (1991) further maintains that an understanding of how resorts grow and change over time is imperative if the benefits of beach resorts are to be realized and their negative aspects anticipated and mitigated. This observation has led a number of researchers to describe beach resort development in various ways. McGoodwin (1986), for example, has recorded the growth of tourism and changes in social structures at a small, Mexican fishing village, after an all-weather road was constructed linking the village to the mainland. One frequently cited model of beach resort development was devised by Barrett (1958), who described the physical form of beach resorts in England and Wales and produced a model



of their morphology that defines their generalized spatial organization. Stansfield and Rickert (1970), in a refinement of this model, have undertaken an empirical study of the commercial functions of three resort towns: two in New Jersey, where the seafront is the recreational focus; and Niagara Falls, where the view is the major focus. Another study which applies both the Barrett (1958) and Stansfield and Rickert (1970) models to an evaluation of the evolution of beach resort development is by Pigram (1973), in which the twin-town developments at the north and south extremities of the City of Gold Coast beach resort in Australia are studied. Other researchers (e.g. Lavery, 1974; Funnell, 1975; Baker, 1983; Bollerey, 1986; Rudney, 1986) have also reported on the morphology of coastal resorts. Other work on the evolution of beach resorts includes that by Hudson (1987), who reports on the transformation of natural and man-made resources, Gonen (1981), who considers demographic change as a result of coastal tourism, and Smith (1991, 1992a and 1992b) who describes the development of various beach resorts in the Asia-Pacific region and proposes a general model for resort development evolution.

Various environmental factors have to be considered in developing the coast for tourism (Jolliffe and Patman, 1986). In a beach resort, these are manifested as part of the site which also has an influence on the resort's morphology. Of the various site problems, the prevalence of beach erosion is probably the most common for many resorts (Wong, 1990). In some cases, poor understanding of the coastal environment has led to the use of elaborate and expensive structures (Bird, 1985). Miossec and Paskoff (1979) found that hotel development on the beaches along the north-eastern coast of Jerba Island (Tunisia) aggravated beach erosion. Jackson (1986) attributed the beach erosion problem of some beach hotels in the Caribbean islands to the failure to establish setback from the beach, and to the extraction of beach sand for construction. More specifically, Baines (1977) cited various issues related to beach resort sites in Fiji: the need for a "setback line" in accordance with the coastal type; developers' unawareness of catastrophic events of low and unpredictable frequency, e.g., storms; and the disposal of sewage effluent. On the east coast of Malaysia, one particular resort has been seriously threatened by coastal erosion (Jamaluddin, 1982) and a few more face the same problem. The lack of an appreciation of coastal geomorphology seems to underline these examples, and more often than not, the site for a beach resort is based on non-geomorphological factors, such as availability of land and accessibility (Wong, 1990). In an attempt to rectify this, Wong (1990) provides a geomorphic typology of beaches which can be used as a guide for future resort development.

One last issue pertaining to coastal resorts has to do with the concept of carrying capacity. Sowman (1987) argues that in coastal areas which have been identified as suitable for resort development, it is important to ascertain the appropriate level of use that can be sustained by the environmental resources of the area, yet he also point out that relatively little progress has been made towards practical application of this kind. To rectify this, he



describes a systematic and structured procedure for evaluating the suitability of applications for extending resort towns and expanding recreational facilities in the coastal zone. This procedure was successfully employed in a study of the Kromme River Estuary in South Africa (Sowman and Fuggle, 1987) and it was possible to make predictions about future boating pressure associated with expanding recreational facilities and thus indicate whether the carrying capacity of the estuary would be exceeded.

3.6.2 Coastal Recreation

Recreation in the coastal zone is something more than a simple variant on the theme of outdoor recreation. Certainly the basic elements of traditional outdoor recreation are also found in the coastal zone, but coastal recreation differs in a number of ways (Ditton and Miller, 1986). First, coastal recreation is decidedly influenced by the private sector. In the U.S., since most of the nation's shorelands are in private ownership, the private sector is the main provider of leisure experiences in the coastal zone. Second, coastal recreation is dramatically urban in character, as many coastal recreation resources (in the U.S.) are located adjacent to, and used extensively by, urban populations. Third, coastal recreation policies determine not only how recreation resources are divided among diverse leisure-based interest groups, but how these resources are guaranteed for leisure rather than alternative uses (Ditton and Miller, 1986).

A growing body of literature regarding coastal recreation is beginning to emerge. In the U.S. for example, the U.S. National Park Service (1954) issued a report entitled *Our Vanishing Shoreline* which dealt with the issue of availability of coastal recreation resources. In 1955, the U.S. Bureau of Sport Fisheries and Wildlife published the results of its first *National Survey of Fishing and Hunting*. This recreation data collection has been conducted every five years since then and provides a continuing source of comparable information on salt water fishermen and their participation patterns. In 1962, the U.S. Outdoor Recreation Resources Review Commission issued a report that spoke to present and future coastal recreation needs, and national policies and programs to encourage acquisition efforts. Much of the literature has emerged from conferences and workshops on coastal recreation, such as a 1975 National Conference on Marine Recreation (Anderson, 1976), the First Annual Marine Recreational Fisheries Symposium, held in 1976, and the Second National Outdoor Recreation Trends Symposium held in 1985 (Ditton and Miller, 1986).

A considerable body of literature in coastal recreation focuses on conflicts between different user groups of the coastal zone, impacts to the environment caused by coastal recreation, and the management policies that address these conflicts and impacts. This includes the effects of overuse and trampling on sand dune environments (e.g. Chappell et al., 1971; Brockman and Merriam, 1973; Kusler, 1975; Foin et al., 1977; Vogt, 1979),



and the effect of off-road vehicles in dune areas (e.g. Hope, 1972; Vogt, 1979; Noe et al., 1982). Noe et al. (1982), expanding upon studies by Wellman and Buhyoff (1979), further examined the social and physical conflicts between pedestrians and off-road vehicles at Cape Hatteras National Seashore and attempted to resolve the problems through the application of a "norm-activation" model. Barrett (1986) examined the pressures and conflicts affecting decisions on marine recreation in the Solent area of the U.K. and provided a critique of the adequacy of current policies to address such conflicts. Moreira (1988) describes a series of environmental and land use conflicts that arise along the coast of the Madeira Islands, as a result of the inappropriate development of limited coastal recreation areas. Becker et al. (1986) have identified a series of "threats" - both natural and man made - to coastal National Parks in the U.S. and have devised a technique to help establish priorities for managing these threats. Similar work has also been conducted in areas of sensitive coral-reef reserves (Salm, 1984; White and Palaganas, 1991).

Carrying capacity research in the area of coastal recreation is somewhat limited and is confined mainly to those coastal resort and tourism studies reported earlier. Other examples that have been located include the examination of the planning capacity of recreational beaches in the Netherlands (Van Lier, 1973 and 1980; Van Lier and Bijkerk, 1980; Beckers, 1980), an examination of the carrying capacity for recreational activities of a forested sand dune at Wasaga Beach, Ontario (Yurick, 1977) and an examination of congestion and use limitations in recreational park and beach areas (Goldin, 1971). Other research related closely to carrying capacity includes a number of studies on crowding (Darling and Eichhorn, 1967; Lee, 1968; Ritchie and Mather, 1971; Forster, 1973; Fogg, 1975), all of which found the presence of crowds on a beach to be a positive factor, as well as a study of unregulated California beaches which found that litter did not deter beach users, as long as the attractions of the area were thought to be great (Bechtol and Williams, 1977). Other examples were related to studies of human behaviour and examined the distribution of recreationists in relation to one another along a number of beaches in southern Ontario (Brougham, 1982), the patterns and distribution of beach users relative to the physical conditions existing at various sites (Hecock, 1966 and 19??) and the patterns and intensities of non-exploitative recreational shore utilization on sandy beaches in South Africa (Van Herwerden and Bally, 1989; Van Herwerden et al., 1989).

Other examples of research carried out on coastal recreation include: a comprehensive land use survey of the Canadian Lake Erie shoreline and an evaluation of land use in relation to the recreational and tourist potential of the area (Jackson, 1966); a description of planning issues that face British planners in planning for the recreational use of coastlines (Cosgrove and Jackson, 1972); a discussion of the recreational aspects of shorezone development in Canada (Harrison, 1977a); a summary of design principles for recreation on urban waterfronts (Hough, 1989); and an outline of the problems and prospects for leisure and recreation on urban waterfronts in Canada and the United States



(Wilkinson, 1989).

3.6.3 Coastal Management

The term "coastal management" is applied in a general sense here, as it can easily be argued that all of the previously cited references in Section 3.6 fall into the coastal management category. This section will thus serve to highlight a number of additional studies related to management and development of the coastal zone that did not fall clearly into any of the above categories. While none of these studies address the issue of carrying capacity directly, they all - through the use of such terms as "acceptable development" and "development pressure"- imply that there is a limited capacity for recreational, commercial, social or industrial activities in the coastal zone. A first example relates to development controls and public access to the shoreline. Crandall (1974) outlines a series of guidelines for bluff-top development - which delineate certain environmental and aesthetic parameters within which development can take place - that have been adopted by the San Diego Coast Regional Commission and assure retention of scenic vistas and provision of public access, while permitting landowners "reasonable use" of their property. Moore (1975) describes a series of land use pressures facing the coastal area of Southern Queensland in Australia and emphasizes the importance of environmental impact studies to ensure that these pressures are adequately managed. In a study of the Puget Sound area of Washington state, Harrison (1975), McCrea (1976), and Harrison (1977b) analyzes the region in terms of population growth, rate of urbanization, changing occupational structures, and changing income patterns, to suggest spatial differences in the pressure for coastal development. Yapp (1986) describes residential and recreational pressures in the coastal zone of Australia, and describes coastal management "arrangements" that have been adopted to address them.

Coastal use "conflicts" are also a theme in a number of studies. Losada et al. (1988), for example, examine "conflicts" caused by the construction of protection and navigation works at Hondarribia Inlet, Spain. Similarly, Charlier (1989) discusses conflicts between the different types of coastal area activities and suggests possible lines of action to solve the main conflict between development and maintenance of environmental quality.

Some final examples of coastal management research relate to the evaluation of proposed coastal developments. First, Fenton and Smye (1989) assessed a number of respondents knowledge of the metropolitan coast in Perth, Australia, particularly as to their feelings toward the acceptability of industrial, commercial, high-rise and marina developments, and for community perceptions of the important planning criteria for coastal development. They subsequently found that the community's perception of a development proposal is an important planning consideration and should be taken into account when examining coastal development proposals. Second, Sowman (1990) outlines a systematic procedure



for evaluating the environmental suitability and social desirability of development proposals in coastal areas, with particular reference to coastal developments in South Africa.

4.0 SUMMARY AND CONCLUSIONS

This report has provided a comprehensive review of the literature and a summary of research that has been conducted on the topic of "carrying capacity" in recreational environments, with specific discussion of those studies related to recreational and developmental activities carried out in the coastal environment. Summary "look-up" tables for all references cited in the report are provided in Appendix A for ease of reference. These tables also include those references not cited, but listed in the Related Readings section.

This review has shown that while the literature is rich with information on recreational carrying capacity, there are very few *direct* applications of this concept in the coastal zone and instead, related studies are framed in a coastal tourism, or coastal management context. In addition, a number of studies focus on *impacts* or *conflicts* in the coastal zone and address management guidelines for addressing these problems.

Clearly, there is room for additional research directly related to the capacity of shoreline areas to support both recreational and developmental activities. This applies not only to existing resort or coastal recreation areas, but also to currently undeveloped coastal areas, since it is these areas that will face increasing pressure in the future, as more and more people seek to live, work and play in the coastal zones of the world.



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APPENDIX A
SUMMARY TABLES A AND B

SUMMARY TABLES A AND B

The following tables are designed to provide convenient "look-up" tables for all of the references listed in both the "cited references" and "related readings" lists above. The tables are organized according to "Setting or Activity" (rows) and "Type of Carrying Capacity or Impacts Examined" (columns). "Crowding" and a catch-all category entitled "Management and Development" are also provided as column headings. Due to the large number of references, the table had to be split into two parts - A and B. Settings and Activities are identical in both tables.

Where a particular reference provides a good description of the methodology involved in determining the specific type of carrying capacity, or in determining the types of impacts caused by specific activities, it is highlighted with an asterisk (*).

In many cases, references will be cross-referenced and fall in more than one cell of the table. For example, a paper examining boating capacity on a lake, will fall under the "Physical Capacity" column for both the "Lake" (setting) and "Boating" (activity) row headings. Similarly, a paper that looks at the ecological impacts of tourism in relation to the planning and management of a national park, may fall under the "Ecological" and "Management and Development" columns for both the "Wildlands" and "Tourism" row headings.

Summary Table A

	Type of Carrying Capacity or Impacts Examined				
	Recreational	Ecological	Social	Economic	Physical
Wildlands^A	<ul style="list-style-type: none"> -Brockman and Merriam (1973) -Brown and Haas (1980) -Clark (1978) -Frissell et al. (1980)* -Kuss and Morgan (1986) -Lucas and Priddle (1964) -Morgan and Kuss (1986) -Schneider (1978) -Schreyer (1976, 1979) -Stankey (1981) -Sumner (1936, 1942) -Wagar (1964, 1974) 	<ul style="list-style-type: none"> -Burton (1973) -Chappell et al. (1971) -Cole and Dalle-Molle (1982) -Cole (1982, 1983a, 1983b) -Foin et al. (1977) -Frissell and Stankey (1972) -Hamill (1974, 1975, 1977) -Jensen (1981) -Kuss and Morgan (1986) -Lein (1993)* -Morgan and Kuss (1986) 	<ul style="list-style-type: none"> -Brown and Haas (1980) -Burch (1984) -Burton (1973) -Cicchetti and Smith (1973) -Frissell and Stankey (1972) -Greist (1976)* -Hamill (1974, 1975, 1977) -Jensen (1981) -Kuss et al. (1989) -LaPage (1963) -Lucas (1980) -Lucas and Priddle (1964) -Priddle (1964) -Shelby (1980) -Stankey (1972, 1973) -Titre and Mills (1981, 1982) -Vaske et al. (1980, 1982, 1986) 		<ul style="list-style-type: none"> -Bultena et al. (1981) -Burch (1981) -Cicchetti and Smith (1973) -Cole (1982, 1983a, 1983b) -Kuss and Morgan (1986) -Lucas (1980) -Morgan and Kuss (1986)
Rivers	<ul style="list-style-type: none"> -Leopold and Marchand (1968) -Leopold (1962, 1969a, 1969b) -Lime (1970) -Lucas (1964a, 1964b) -McCool (1977) -McCool et al. (1977) -Pfister and Frenkel (1974) -Sowman and Fuggle (1987)* 	<ul style="list-style-type: none"> -Carothers and Aitchison (1976) -Egarr et al. (1979) -Jaakson (1988) -Jensen (1981) -Leopold (1962, 1969a, 1969b) -Leopold and Marchand (1968) -Shelby and Nielsen (1976) 	<ul style="list-style-type: none"> -Brown (1977) -Ditton et al. (1983)* -Driver and Bassett (1975) -Egarr et al. (1979) -Gramann and Burdge (1981a, 1981b, 1984) -Heberlein et al. (1979) -Heberlein and Vaske (1977) -Heberlein (1977) -Jensen (1981) -Leopold and Marchand (1968) -Leopold (1962, 1969a, 1969b) -Lucas (1964a, 1964b) -Manning and Ciali (1979)* -McCool et al. (1977) -McCool (1977) -Morgan (1970) -Nielsen and Shelby (1977) -Nielsen et al (1977) -Priddle (1964) -Schreyer and Roggenbuck (1978)* -Shelby and Nielsen (1976) -Shelby (1976, 1981) -Shelby and Colvin (1982)* -Titre and Mills (1981, 1982) 		<ul style="list-style-type: none"> -Gramann and Burdge (1981a, 1981b, 1984) -Jaakson (1988) -Lime (1970) -Morgan (1970) -Nielsen and Shelby (1977)

A-Wildlands include places such as National, State, or Provincial Parks, National Forests, National Wilderness Areas, etc.

B-Coastal Recreation includes such activities as sunbathing, swimming, off-road vehicles, and other general activities that may take place on a beach.

*Indicates that a good description of the methodology utilized for carrying capacity or impact determination is provided in paper.

	Type of Carrying Capacity or Impacts Examined				
	Recreational	Ecological	Social	Economic	Physical
Lakes	<ul style="list-style-type: none"> -Canadian Parks Service (1978) -Geomatics International (1991) -Hough, Stansbury and Assc (1969) -Jaackson et al. (1976)* -Jaakson (1968, 1970, 1972, 1984, 1989*) -McCarty (1959) -Michalski et al. (1990)* -Michalski and Usher (1987) -New Hampshire State Planning Project (1949) -Ontario Ministry of Natural Resources (1968, 1970) -Ontario Department of Municipal Affairs (1971) -Schneberger and Threinen (1964) -Smith (1979)* -Threinen (1961, 1964) -Wilson (1964) 	<ul style="list-style-type: none"> -Brown (1972) -Dillon (1974) -Jackson (1966) -Ontario Department of Municipal Affairs (1971) -Ryder (1965) -Seppanen (1972) -Smith (1979)* -Threinen (1961, 1964) -Usher et al. (1987) 	<ul style="list-style-type: none"> -Gramann and Burdge (1981a, 1981b, 1984) -Jackson (1966) -Seppanen (1972) -Smith (1979)* -Taylor (1985) -Usher et al. (1987) 		<ul style="list-style-type: none"> -Baker (1983) -Canadian Parks Service (1978) -Dillon (1974) -Geomatics International (1991) -Gramann and Burdge (1981a, 1981b, 1984) -Hough, Stansbury and Assc (1969) -Jaakson (1968, 1970, 1972, 1984, 1989*) -Jackson (1966) -McCarty (1959) -Michalski and Usher (1987) -Michalski et al. (1990)* -New Hampshire State Planning Project (1949) -Ontario Ministry of Natural Resources (1968, 1970) -Schneberger and Threinen (1964) -Seppanen (1972) -Threinen (1961, 1964) -U.S. Dept. of Interior (1964) -Usher et al. (1987) -Wilson (1964)
Coasts (General)	<ul style="list-style-type: none"> -Bollery (1986) -Hawaii Env. Sim. Lab. (1975) -Sowman (1987)* -U.S. National Park Service (1954) 	<ul style="list-style-type: none"> -Rosier et al. (1986)* -Salm (1984)* -Walker (1991) 	<ul style="list-style-type: none"> -Gopalakrishnan and Davidson (1988) 	<ul style="list-style-type: none"> -Charlier (1989) 	<ul style="list-style-type: none"> -Bollery (1986) -U.S. National Park Service (1954)
Beaches	<ul style="list-style-type: none"> -Vogt (1979) -Yurick (1977) 	<ul style="list-style-type: none"> -Bechtol and Williams (1977) -Kusler (1975) -Usher et al. (1987) -Yurick (1977) 	<ul style="list-style-type: none"> -Bechtol and Williams (1977) -McConnell (1977) -Usher et al. (1987) 	<ul style="list-style-type: none"> -Duran et al. (1987)* -Newsome-Brighton (1984) -Smith and Piggot (1989)* 	<ul style="list-style-type: none"> -Beckers (1980) -Brougham (1982) -Duran et al. (1987)* -Goldin (1971)* -Hall (1974) -Hecock (19??*, 1966) -McConnell (1977) -Smith and Piggot (1989)* -Usher et al. (1987) -Van Herwerden et al. (1989)* -Van Herwerden and Bally (1989)* -Van Lier (1973*, 1980*) -Van Lier and Bijkerk (1980)* -Vogt (1979)
Marinas		<ul style="list-style-type: none"> -Jaakson (1988) -Miossec (1988) 	<ul style="list-style-type: none"> -Heberlein et al. (1986)* 		<ul style="list-style-type: none"> -Heberlein, McKinnel and Ervin (1986) -Hepner and Wales (1986)* -Jaakson (1988) -Rhode Island Sea Grant (1992) -Wales et al. (1987)*

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B-Coastal Recreation includes such activities as sunbathing, swimming, off-road vehicles, and other general activities that may take place on a beach.

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	Type of Carrying Capacity or Impacts Examined				
	Recreational	Ecological	Social	Economic	Physical
Coastal Resorts	-Bollery (1986) -Sowman (1987)*	-Jamaluddin (1982) -Jolliffe and Patman (1986) -Miossec and Paskoff (1979) -Sowman (1990)*	-Gopalakrishnan and Davidson (1988) -Sowman (1990)*		-Baker (1983) -Bollery (1986) -Funnell (1975) -Gonen (1981) -Hudson (1987) -Husbands (1986) -Lavery (1974) -Pigram (1973) -Stansfield and Rickert (1970) -Stansfield (1978)
Activity					
Coastal Recreation^B	-Ontario Department of Municipal Affairs (1971) -U.S. National Park Service (1954) -Yurick (1977)	-Bechtol and Williams (1977) -Edwards (1987)* -Hope (1972) -Jackson (1966) -Moreira (1988) -Ontario Department of Municipal Affairs (1971) -Rosier et al. (1986)* -Yurick (1977)	-Bechtol and Williams (1977) -Hickman and Cocklin (1992) -Jackson (1966) -Wellman and Buhyoff (1979)		-Goldin (1971)* -Jackson (1966) -Moreira (1988) -Noe et al. (1982)* -Ratcliffe (1992) -U.S. National Park Service (1954) -U.S. Outdoor Rec. Res. Rev. Comm. (1962) -Wellman and Buhyoff (1979)
Coastal Tourism	-Bollery (1986)	-Agardy (1988) -Agardy and Epler (1986) -Baines (1977) -Broadus and Gaines (1987)* -Dowling (1993)* -Edwards (1987)* -Emory (1989) -Farrell (1986) -Jackson (1986) -Jolliffe and Patman (1986) -Kenchington (1989, 1991*) -Kozlowski et al. (1988)* -Miossec (1988) -Miossec and Paskoff (1979) -Ogden and Ziemann (1977) -Rosier et al. (1986)* -Walker (1991)	-Farrell (1986) -Hickman and Cocklin (1992)	-Cabanne (1992) -Kenchington (1989)	-Bollery (1986) -Cabanne (1992) -Hall (1974) -Hudson (1987) -Husbands (1986) -McGoodwin (1986) -Stansfield and Rickert (1970) -Stansfield (1978)
Tourism (General)		-Fagence (1990)* -Farrell and Runyan (1991) -Gartner (1987)* -Inskip (1987)* -Kienholz (1986) -May (1991) -Ovington et al. (1974)*	-Doxey (1976) -Gee et al. (1984) -Gunn (1979) -Mathieson and Wall (1982) -Plog (1974)	-Mathieson and Wall (1982)	-Doxey (1976) -Mathieson and Wall (1982) -Roehl and Fesenmaier (1987)* -Rosenow and Pulsipher (1979) -STARPS (19??)

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	Type of Carrying Capacity or Impacts Examined				
	Recreational	Ecological	Social	Economic	Physical
Boating	-Canadian Parks Service (1978) -Geomatics International (1991) -Hough, Stansbury and Assc (1969) -Jaakson et al. (1976)* -Jaakson (1968, 1970, 1972, 1984, 1989*) -McCarty (1959) -Michalski and Usher (1987) -Michalski et al. (1990)* -New Hampshire State Planning Project (1949) -Sowman and Fuggle (1987)* -Ontario Ministry of Natural Resources (1968, 1970) -Schneberger and Threinen (1964)	-Hamill (1974, 1975, 1977) -Jaakson (1988)	-Gramann and Burdge (1981a, 1981b, 1984) -Hamill (1974, 1975, 1977) -Lentnek et al. (1969) -Murphy (1975) -Nielsen and Shelby (1977) -Perdue (1986) -Taylor (1985)	-Stoll et al. (1988)	-Canadian Parks Service (1978) -Geomatics International (1991) -Gramann and Burdge (1981a, 1981b, 1984) -Heberlein, McKinnel and Ervin (1986) -Hepner and Wales (1986)* -Holland et al. (1992) -Hough, Stansbury and Assc (1969) -Jaakson et al. (1976)* -Jaakson (1968, 1970, 1972, 1984, 1988, 1989*) -Lentnek et al. (1969) -McCarty (1959) -Michalski et al. (1990)* -Michalski and Usher (1987) -New Hampshire State Planning Project (1949) -Nielsen and Shelby (1977) -Ontario Ministry of Natural Resources (1968, 1970) -Rhode Island Sea Grant (1992) -Schneberger and Threinen (1964) -Wales et al. (1987)*
Camping		-Cole (1982, 1983a, 1983b) -Cole and Dalle-Molle (1982)	-Badger (1975) -Cicchetti and Smith (1973) -Heberlein and Dunwiddie (1979)*		-Bultena et al. (1981) -Cicchetti and Smith (1973) -Cole (1982, 1983a, 1983b)
Hiking			-Heberlein and Dunwiddie (1979)*		-Bultena et al. (1981)
Canoeing	-Lime (1970) -Lucas (1964a, 1964b)		-Egarr et al. (1979) -Lucas (1964a, 1964b) -Morgan (1970)	-Egarr et al. (1979)	-Lime (1970) -Morgan (1970)
Rafting or Tubing		-Carothers and Aitchison (1976) -Shelby and Nielsen (1976)	-Brown (1977) -Ditton et al. (1983)* -Driver and Bassett (1975) -Heberlein (1977) -Heberlein and Vaske (1977) -Heberlein et al. (1979) -Nielsen and Shelby (1977) -Schreyer and Roggenbuck (1978)* -Shelby and Nielsen (1976) -Shelby and Colvin (1982)* -Shelby (1976, 1981) -Titre and Mills (1981, 1982)		-Nielsen and Shelby (1977)
Fishing		-White and Palaganas (1991)	-Gramann and Burdge (1981a, 1981b, 1984)	-White and Palaganas (1991)	-Gramann and Burdge (1981a, 1981b, 1984) -U.S. Bur. Sport Fish. and Wildlife (1955)

A-Wildlands include places such as National, State, or Provincial Parks, National Forests, National Wilderness Areas, etc.

B-Coastal Recreation includes such activities as sunbathing, swimming, off-road vehicles, and other general activities that may take place on a beach.

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	Type of Carrying Capacity or Impacts Examined				
	Recreational	Ecological	Social	Economic	Physical
Recreation (General)	<ul style="list-style-type: none"> -Ashworth (1984) -Barkham (1973) -Brockman and Merriam (1973) -Butler and Knudson (1977) -Geomatix International (1991) -James and Ripley (1963) -Knudson (1980) -Lime and Stankey (1971) -Lime (1976) -Oigram (1983) -Pratt (1976) -Schneberger and Threinen (1964) -Schreyer (1976, 1979) -Shelby and Heberlein (1984) -Stankey and McCool (1984) -Stankey (1982) -Street (1969) -Street (1969) -Stynes (1977) -Wall (1989) 	<ul style="list-style-type: none"> -Burton (1973) -Chubb and Ashton (1969) -Foss (1973) -James and Ripley (1963) 	<ul style="list-style-type: none"> -Altman (1975, 1978) -Becker et al. (1984) -Burch (1984) -Burton (1973) -Fisher and Krutilla (1972) -Graefe et al. (1984) -Gramann and Burdge (1981a, 1981b, 1984) -Heberlein (1977) -Heberlein and Vaske (1977) -Heberlein et al. (1979) -Kariel (1990) -Kuss et al. (1989) -Lawler (1973) -Lawrence (1974) -Nielsen et al (1977) -Price (1977) -Shelby and Heberlein (1980, 1986) -Shelby et al. (1983) -Stankey and McCool (1984) -Vaske et al. (1980, 1982, 1986) 		<ul style="list-style-type: none"> -Bishop et al. (1974) -Fisher and Krutilla (1972) -Geomatix International (1991) -Gramann and Burdge (1981a, 1981b, 1984) -James and Ripley (1963) -Ross and Driscoll (1980) -Schneberger and Threinen (1964) -Tourism and Outdoor Rec. Plan. Study Comm. (1975) -U.S. Bur. Sport Fish. and Wildlife (1955)

A-Wildlands include places such as National, State, or Provincial Parks, National Forests, National Wilderness Areas, etc.

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Summary Table B

	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Wildlands^A		-Lindsay (1986) -Ovington et al. (1974)* -Sinden (1976)	-Absher and Lee (1981) -Alldredge (1973) -Badger (1975) -Botkin (1985) -Cicchetti and Smith (1973) -Fogg (1975) -Forster (1973) -Graefe et al. (1986) -Hammitt et al. (1984) -Kuss et al. (1989) -Manning (1985, 1986) -Priddle (1964) -Proshansky et al. (1970) -Shelby (1980) -Stankey (1973) -Titre and Mills (1981, 1982) -Vaske et al. (1980, 1982, 1986) -Womble and Studebaker (1981)	-Badger (1975) -Darling and Eichorn (1977) -Fogg (1975) -Foin et al. (1977) -Forster (1973) -Frissell et al. (1980)* -Lindsay (1986) -Stankey (1981) -Stankey (1972)
Rivers	-Jaakson (1988)		-Ditton et al. (1983)* -Driver and Bassett (1975) -Gramann and Burdge (1981a, 1981b, 1984) -Heberlein et al. (1979) -Heberlein and Vaske (1977) -Heberlein (1977) -Manning and Ciali (1979)* -Priddle (1964) -Schreyer and Roggenbuck (1978)* -Shelby and Nielsen (1976) -Shelby (1976, 1981) -Shelby and Colvin (1982)* -Titre and Mills (1981, 1982)	-Carothers and Aitchison (1976) -Egarr et al. (1979) -McCool (1977) -McCool et al. (1977) -McGill (1982) -Sowman and Fuggle (1987)*
Lakes	-Canadian Parks Service (1978)	-Baker (1983)	-Gramann and Burdge (1981a, 1981b, 1984)	-Canadian Parks Service (1978) -Dillon (1974) -Geomatics International (1991) -Jaakson et al. (1976)* -Jaakson (1968, 1970, 1972, 1984, 1989*) -Michalski et al. (1990)* -Michalski and Usher (1987) -Schneberger and Threinen (1964) -Smith (1979)*

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B-Coastal Recreation includes such activities as sunbathing, swimming, off-road vehicles, and other general activities that may take place on a beach.

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	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Coasts (General)	-Bollery (1986) -Fenton and Smye (1989)*	-Agardy (1991) -Cabanne (1992) -Dowling (1993)* -Edwards (1987)* -Kenchington (1989, 1991*) -Miossec (1988) -Rosier et al. (1986)* -Smith (1991*, 1992a*, 1992b) -Walker (1991)		-Becker et al. (1986)* -Bird (1985) -Bollery (1986) -Charlier (1989) -Crandall (1974) -Culliton et al. (1992) -Ducsik (1974) -Fenton and Smye (1989)* -Gopalakrishnan and Davidson (1988) -Harrison (1975) -Harrison (1977b) -Hawaii Env. Sim. Lab. (1975) -Losada et al. (1988) -McCrea (1976) -Moore (1975) -Platt (1978) -Salm (1984)* -Williams et al. (1990)
Beaches		-Hall (1974)	-Beckers (1980) -Goldin (1971)* -Hecock (19??*, 1966) -Ogden and Zieman (1977) -Van Herwerden et al. (1989)* -Van Herwerden and Bally (1989)* -Van Lier (1973*, 1980*) -Van Lier and Bijkerk (1980)* -Vogt (1979)	-Kusler (1975) -Newsome-Brighton (1984) -Vogt (1979)
Marinas	-Heberlein, McKinnel and Ervin (1986) -Heberlein et al. (1986)* -Hepner and Wales (1986)* -Jaakson (1988) -Wales et al. (1987)*		-Heberlein, McKinnel and Ervin (1986)	-Hollin (1992) -Jansen (1992)

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	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Coastal Resorts	-Bollery (1986)	-Baker (1983) -Barrett (1958) -Debbage (1990) -Smith (1991*, 1992a*, 1992b)		-Barrett (1958) -Bollery (1986) -Cosgrove and Jackson (1972) -Debbage (1990) -Funnell (1975) -Gopalakrishnan and Davidson (1988) -Hudson (1987) -Jamaluddin (1982) -Jolliffe and Patman (1986) -Lavery (1974) -Metelka (1990) -Miossec and Paskoff (1979) -Pigram (1973) -Rudney (1986) -Smith (1991*, 1992a*, 1992b) -Sowman (1990)* -Stansfield (1978) -Stansfield and Rickert (1970) Wong (1990)*

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B-Coastal Recreation includes such activities as sunbathing, swimming, off-road vehicles, and other general activities that may take place on a beach.

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	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Activity				
Coastal Recreation ^B	-Hough (1989)		-Goldin (1971)* -Lee (1968) -Ritchie and Mather (1971)	-Anderson (1976) -Barrett (1986) -Becker et al. (1986)* -Cosgrove and Jackson (1972) -Ditton and Miller (1986) -Edwards (1987)* -Harrison (1977a) -Hickman and Cocklin (1992) -Hough (1989) -Kenchington (1993) -McCrea (1976) -Mondor and Henwood (1988) -Moreira (1988) -Ratcliffe (1992) -Rosier et al (1986)* -U.S. Outdoor Rec. Res. Rev. Comm.(1962) -Wilkinson (1989) -Yapp (1986)

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	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Coastal Tourism	-Bollery (1986)	-Agardy (1991) -Agardy and Epler (1986) -Broadus and Gaines (1987)* -Cooper and Jackson (1989) -Dowling (1993)* -Edwards (1987)* -Farrell (1986) -Hall (1974) -Jackson (1986) -Kenchington (1989, 1991*) -Kozlowski et al. (1988)* -Meyer-Arendt (1985) -Miossec (1988) -Rosier et al. (1986)* -Walker (1991)		-Agardy and Epler (1986) -Agardy (1988, 1991) -Baines (1977) -Bar-On (1993) -Bollery (1986) -Broadus and Gaines (1987)* -Cabanne (1992) -Clarke (1981)* -Cooper and Jackson (1989) -Dowling (1993)* -Edwards (1987)* -Emory (1989) -Farrell (1986) -Hickman and Cocklin (1992) -Hudson (1987) -Jolliffe and Patman (1986) -Kenchington (1989, 1991*, 1993) -Klemm (1992)* -Kozlowski et al. (1988)* -Marshall, Macklin, Monaghan (1980) -McGoodwin (1986) -Meyer-Arendt (1985) -Miller and Dittton (1986) -Miller (1987) -Miossec and Paskoff (1979) -Nicholls (1982) -Ogden and Zieman (1977) -Peterson and McCarthy (19??) -Romeril (1983) -Rosier et al. (1986)* -Rudney (1986) -Smith (1991*, 1992a*, 1992b) -Stansfield (1978) -Stansfield and Rickert (1970) -Van't Hof (1985) -Walker (1991)

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	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Tourism (General)	-STARPS (19??)	-An Foras Forbartha (1966) -Balmer, Crapo and Associates (1976) -Butler (1980) -Canestrelli and Costa (1991)* -Fagence (1990)* -Getz (1982) -Getz (1983)* -Haywood (1986) -Hovinen (1982) -Inskip (1987)* -Lindsay (1986) -Lundberg (1980) -Martin and Uysal (1990) -May (1991) -McIntosh and Gupta (1980) -Meyer-Arendt (1985) -O'Reilly (1986) -STARPS (19??) -Wall (1983)		-Balmer, Crapo and Associates (1976) -Bosselman (1978) -Butler (1980) -Christaller (1963) -de Kadt (1979) -Dondo-Tardiff and Bronson (1988) -Fagence (1990)* -Gartner (1987)* -Getz (1992)* -Haywood (1986) -Lindsay (1986) -Lundberg (1980) -Marshall, Macklin, Monaghan (1980) -May (1990) -McIntosh and Gupta (1980) -Metelka (1990) -Meyer-Arendt (1985) -Plog (1974) -Roehl and Fesenmaier (1987)* -Rosenow and Pulsipher (1979) -Smith and Godbey (1991) -Spotts (1986) -Turner and Ash (1975) -Young (1973)
Boating	-Canadian Parks Service (1978) -Heberlein et al. (1986)* -Heberlein, McKinnel and Ervin (1986) -Hepner and Wales (1986)* -Jaakson (1988) -Wales et al. (1987)*		-Gramann and Burdge (1981a, 1981b, 1984) -Heberlein, McKinnel and Ervin (1986)	-Barrett (1986) -Canadian Parks Service (1978) -Geomatics International (1991) -Jaakson et al. (1976)* -Jaakson (1968, 1970, 1972, 1984, 1989*) -Michalski and Usher (1987) -Michalski et al. (1990)* -Schneberger and Threinen (1964) -Stoll et al. (1988)
Camping			-Absher and Lee (1981) -Badger (1975) -Cicchetti and Smith (1973) -Heberlein and Dunwiddie (1979)* -Womble and Studebaker (1981)	-Badger (1975)
Hiking			-Absher and Lee (1981) -Botkin (1985) -Heberlein and Dunwiddie (1979)*	
Canoeing				-McGill (1982)

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	Type of Carrying Capacity or Impacts Examined		Other Issues	
	Facility	Tourism	Crowding	Management and Development
Rafting or Tubing			<ul style="list-style-type: none"> -Ditton et al. (1983)* -Driver and Bassett (1975) -Heberlein and Vaske (1977) -Heberlein (1977) -Heberlein et al. (1979) -Schreyer and Roggenbuck (1978)* -Shelby and Nielsen (1976) -Shelby and Colvin (1982)* -Shelby (1976, 1981) -Titre and Mills (1981, 1982) 	<ul style="list-style-type: none"> -Carothers and Aitchison (1976)
Fishing			<ul style="list-style-type: none"> -Gramann and Burdge (1981a, 1981b, 1984) 	<ul style="list-style-type: none"> -U.S. Bur. Sport Fish. and Wildlife (1955) -White and Palaganas (1991)
Recreation (General)			<ul style="list-style-type: none"> -Altman (1975, 1978) -Baum et al. (1975) -Choi et al. (1976) -Desor (1972) -Douglas and Johnson (1992)* -Galle et al. (1972) -Graefe et al. (1986) -Gramann and Burdge (1981a, 1981b, 1984) -Gramann (1982) -Hammitt (1983) -Hammitt et al. (1984) -Harrington (1987) -Heberlein and Vaske (1977) -Heberlein et al. (1979) -Heberlein (1977) -Kuss et al. (1989) -Langer and Saegert (1977) -Lawler (1973) -Lawrence (1974) -Loo (1973) -Price (1977) -Rappoport (1975) -Schmidt and Keating (1979) -Shelby et al. (1983) -Shelby and Heberlein (1980, 1986) -Shelby et al. (1989)* -Stockdale (1978) -Stokols et al. (1973) -Stokols (1972a, 1972b, 1976) -Vaske et al. (1980, 1982, 1986) -Westover (1989)* -Westover and Collins (1987) -Whittaker and Shelby (1988) 	<ul style="list-style-type: none"> -Chubb and Ashton (1969) -Crompton and Hensarling (1978) -Echelberger et al. (1983) -Geomatics International (1991) -Schneberger and Threinen (1964) -Tourism and Outdoor Rec. Plan. Study - Comm. (1975) -U.S. Bur. Sport Fish. and Wildlife (1955) -Van Meter and Irvine (1970) -Van Meter and Irvine (1970)

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