

Recreational use of protected areas in Germany



Evaluation visitors' perception of crowding
in the Wadden Sea National Park

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**Recreational use of protected areas in Germany: Evaluating
visitors' perception of crowding in the Wadden Sea National Park**

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Zusammenfassung

Intakte, naturnahe Landschaften bilden die Grundlage und Kulisse für zahlreiche Erholungsaktivitäten. Naturtourismus und Ausflüge in die deutschen Nationalparks haben in den letzten Jahren kontinuierlich Zulauf erhalten. Dabei kommt es durch die Erschließung der Gebiete für ein breites Publikum zu einer Steigerung der Besucherzahlen und des Störungspotenzials durch den Tourismus. Ausgangspunkt der vorliegenden Arbeit sind zumeist hohe Besucherzahlen in den Sommermonaten in populären Erholungsgebieten wie z.B. an der deutschen Nordseeküste oder im Alpenraum. Innerhalb dieser Destinationen sind bestimmte Landschaftsräume als Nationalparke ausgewiesen, die durch Besucherströme in der Region einem hohen Nutzungsdruck unterliegen und in ihrer Tragfähigkeit begrenzt sind.

Neben Belastung und Störung der ökosystemaren Zusammenhänge durch die Erholungsaktivitäten stellt sich zusätzlich die Frage nach einer sozialen Tragfähigkeit des Gebietes. Während die ökologische Tragfähigkeit in zahlreichen Untersuchungen thematisiert worden ist, sind Untersuchungen zu Belastungsgrenzen aus einer sozialen Perspektive in Deutschland nur vereinzelt zum Einsatz gekommen. Das konzeptionelle und empirische Wissen darüber, wie hohe Besucherzahlen auf die individuelle Besuchsqualität wirken und wie die Besucher auf diese steigende Frequentierung der Gebiete reagieren, ist im Vergleich zur Forschung in Nordamerika sehr begrenzt.

Ziel der vorliegenden Arbeit ist es, die vielschichtigen Beziehungen zwischen absoluten Besucherzahlen, Begegnungen zwischen Besuchern im Gebiet und Wahrnehmung der daraus resultierenden Störungen des individuellen Erholungserlebnisses zu erfassen und zu bewerten. In der kumulativen Dissertation wird in einer Fallstudie auf der Hamburger Hallig im Nationalpark Schleswig-Holsteinisches Wattenmeer die Wahrnehmung von Übernutzungen durch verschiedene Besuchergruppen unter Verwendung einer Vorort-Befragung und etablierter und standardisierter Messverfahren erhoben. Zusätzlich bildet das Datenmaterial, welches in einer parallel durchgeführten Besucherzählung erhoben wird, die Grundlage für eine Simulation der Besucherströme und direkte Kontakte zwischen den Besuchern auf dem Weg zur Hallig während des Befragungszeitraumes. Mit Hilfe dieser Methodenkombination sollen Zusammenhänge zwischen der Anzahl von Begegnungen der Besucher (Reported encounter) und daraus resultierende potentielle Störungen (Perceived crowding) bzw. Präferenzen für bestimmte Nutzungslevels aufgedeckt werden.

Summary

Unspoiled natural environments are the backbone for various recreational activities. In recent years, visits to large scale protected areas continue to increase or at least be maintained at a high level. At the same time these areas provide important, sometimes competing landscape functions such as the protection of natural resources. Starting point of this work is that popular tourist sites in Germany such as the North sea coast and the Alps, attract numerous visitors annually and have to cope with a great demand for outdoor recreation activities.

The high number of people visiting natural areas has generated a number of concerns about the ability of these areas to sustain appropriate levels of social impacts, especially in the summer season. Growing demand for access and participation in outdoor leisure activities can damage the ecological integrity of sensitive environments, and reduce the quality of visitor experiences at the same time. These social aspects are framed in terms of carrying capacity, which characterises the ability of a site or region to absorb recreational use without deterioration. Detailed knowledge of crowding issues in national parks in Europe and especially in Germany is rather limited. While the ecological impacts of tourism in protected areas in Germany are well documented, studies on social impacts in terms of social carrying capacity and how visitors perceive their recreation experience are rare.

Primary purpose of this dissertation is to explore the interrelationships of visitor encounters and related perception of crowding and thus the identification of appropriate social indicators to measure recreation quality. A case study research design with several methodological approaches is applied in a comparative manner to assess the social carrying capacity of recreation use in a popular German coastal recreation area.

The empirical data has been collected in an on-site survey on the Hamburger Hallig located in the Wadden Sea National Park to identify various determinants of visitor's crowding perception. A combination of visitor survey and direct observation data is applied to simulate the visitor use patterns and respondents' reported encounter associated with areas' actual density. This approach was used to analyse the perception of contacts with others (reported encounters), congestion (perceived crowding) and preferences for certain visitor numbers within the study area.

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1 Dissertation concept and themes - PART A

1.1 Clarification of key terms

Carrying capacity is defined as the fundamental concept in natural resources and environmental management with regard to the ultimate limits of growth as constrained by environmental factors [Manning, 1999].

Recreation carrying capacity involve the character or level of use that an area can withstand over a specified time and a certain level without excessive damage to either the physical environment or the experience for the visitor [Wagar, 1964, Lime and Stankey, 1971].

Social carrying capacity comprehend a specific level of acceptable tourism development and use, beyond which further development of the setting can result in socio-cultural deterioration or a decline in the quality of the experience gained by visitors [Saveriades, 2000].

Actual density is measured as an observable, objective number of visitors that represent the relationship between people and space in a given area [Hsu et al., 2007].

Crowding describes a motivational state directed toward the alleviation of perceived restriction and infringement, through the augmentation of one's supply of space, or the adjustment of social and personal variables so as to minimise the inconveniences imposed by spatial limitation [Stokols, 1972a].

Congestion is defined as a type of constraint interaction that occurs when some resource or facility is shared in common by a number of people who affect each other's use and benefits more or less symmetrically [Dorfman, 1984].

Social norms are defined as standards used by individuals to evaluate activities, environments, management strategies, or conditions as good or bad, better or worse [Donnelly et al., 2000].

Encounter norms are describing standards that individuals use when evaluating the acceptability and appropriateness of different levels and types of encounters with other visitors [Vaske and Donnelly, 2002].

Indicator of recreation quality are specific and measurable indicators that reflect areas' resource conditions and help define the quality of visitor experience [Manning et al., 2001].

Standards of quality in outdoor recreation are defining the minimally acceptable condition of the indicator variables [Manning et al., 2001].

Monitoring of visitor activities in a given area represents a systematic and periodic measuring of human activity in a given area including impacts on ecological integrity and recreation experience quality [Lime et al., 2004].

1.2 Demand for protected areas for recreation purposes

Large scale protected areas¹ provide important, sometimes competing landscape functions such as the protection of natural resources, while at the same time providing recreation opportunities. National parks and related areas protect significant natural and cultural resources, preserve scarce wildlife habitat, strengthen local economies, attract new businesses, contribute to the local tax base, increase property values and improve the physical and mental health of the population [Eagles et al., 2002, NRPA, 2011]. At the same time, they constitute popular recreation settings because of their diversity of landscapes, aesthetic attributes and high recreational potential for various leisure activities.

Popular European tourist sites such as the Mediterranean coast and the Alps, attract numerous visitors annually and have to cope with a great demand for outdoor recreation activities and facilities. Growing demand and participation in outdoor leisure activities create an increased pressure on underlying protected areas and their fragile ecosystems. Since the 1950's the spread of automobiles, increased leisure time, improved living standards, and an expansion in population and the growth of urbanisation have all contributed to large streams of recreationists seeking further recreation opportunities² and holiday destinations [Wagar, 1964, Pigram and Jenkins, 1999]. "City dwellers are frequently attracted for recreation purposes to rural situations possessing a wilderness or natural character which contrasts sharply with the largely man-made city environment [Ovington et al., 1974] (p. 35)."

Large-scale tourism in protected areas has both positive and negative effects on the regional economies, local culture, and the development of physical infrastructure [Gormsen, 1997]. However, increased use of recreation areas has generated concerns about their ability to sustain acceptable levels of various negative impacts, especially during high season. As visits to large scale protected areas continue to increase or at least be maintained at a high level, demand for access and use can damage the ecological integrity of sensitive environments, reduce the quality of visitor experiences, and generate conflicts among stakeholders regarding appropriate management responses.

On the one hand, a growth in visitor numbers and tourism infrastructure is desired as a means of rural development, as more visitors have the potential to increase revenue for local communities and commercial businesses [Job, 2008]. On the other hand, there is increasing recognition that high visitor use levels can have adverse ecological and social impacts [Hadwen et al., 2007]. Guidelines issued by the International Union for the Conservation of Nature (IUCN) explicitly stipulate both the protection of the ecological integrity of ecosystems and opportunities for recreation and tourism as primary goals [Dudley, 2008].

¹In the German context, the term large scale protected areas covers national parks, biosphere reserves and nature parks [Revermann and Petermann, 2003].

²"A recreation opportunity can be defined as the opportunity for a person to participate in a particular activity in a specific setting, in order to realise a preferred type of experience and subsequent benefits [Haas, 2002] (p. 14)."

Therefore, in the context of a growing intensity of utilisation of national parks and other large scale protected areas, it is crucial to find a balance between environmental, social and economic aspects of recreational use.

1.3 Ecological integrity of sensitive environments and the quality of visitor experiences

Large scale protected areas such as popular national parks are described in leisure research as “icons under threat” [Hadwen et al., 2007]. Recreational use of natural resources may result in damage to ground cover including crushing of vegetation and soil compaction due to trampling by visitors, water pollution caused by oil and fuel spills from outboard motors in water based recreation activities, discharge of human waste and disturbance of wildlife. The environmental consequences of outdoor recreation activities and their effective management are discussed and well documented in numerous studies in the field of recreation ecology [Liddle, 1997, Leung and Marion, 2000, Monz et al., 2010]. The purpose of these studies is to analyse and measure the degradation of the natural conditions of recreation areas and to explore the relevance of ecological impacts on soil, water, vegetation and wildlife.

While the environmental impacts of recreation have received considerable attention, a rather small amount of research currently focuses on how visitors perceive their recreation experience. This perceived recreation quality is a function of the development of infrastructure (i.e. extent trail network), specific landscape elements, an area’s accessibility and the amount and character of recreational use [Shelby and Heberlein, 1986, Manning, 1999, Elands and van Marwijk, 2008]. In contrast to the ecological impacts of outdoor recreation activities, the mechanism of how on-site social conditions influence the quality of the visitors’ experiences are not well understood.

Leisure research applies different theories and models derived from the fields of psychology and sociology, to measure human behaviour and thus achieve greater insight into this subject. Evaluating various aspects of quality as experienced in outdoor recreation, provides comprehensive information regarding the perception and appropriateness of visitor density. “(...) Quality is not an inherent property, but something that originates from influences such as the expectations and wishes people have concerning their environment [Elands and van Marwijk, 2005] (p. 4).” Over recent years visitor surveys in recreation areas have been conducted in order to gather data on visitor’s perceptions of social conditions within an area and to evaluate the quality of that recreation experience. Research findings suggest that visitors have normative standards regarding appropriate environmental and social conditions in protected areas and that they are measurable by both qualitative and quantitative social survey research instruments [Manning, 1999].

1.4 The recreation-environment balancing act

Visitors to natural recreation areas expect to satisfy various recreation motives and experiences. At the same time, outdoor recreation activities are the cause for inevitable negative impacts as any amount of recreational use in protected areas generates negative consequences [Borrie et al., 1998].

For this reason, planning and management of visitor use is crucial to maintain the protected areas' values in the face of increasing recreation pressure and so constitute a challenge for local authorities. In detail, increasing demands for large scale protected areas and national parks are making it more difficult for managers to fulfil the twofold mission of (a) protecting natural resources for future generations and (b) providing a satisfying environmental recreation experience [Daniel, 2002].

The goals of visitor management in protected areas are to avoid conflicts between competitive users, increase the durability of physical resources, reduce the destructiveness of visitors and provide a high quality experience depending on management objectives, legal requirements and area type [Wagar, 1964, Lime and Stankey, 1971]. The sustainable management of large scale protected areas such as national parks is vital, in order to protect the ecological integrity of natural resources and to maintain visitor satisfaction by the application of various measures. This complex management of visitor activities and flows in protected areas comprises an inherent trade off. For example, when reducing visitor numbers through management measures, resource impacts and encounters among groups decline. Yet this allows fewer people to enjoy a particular area. Therefore, solving such problems by visitor management are controversial and involve tradeoffs between desirable policy, resource conditions, access to the area and management goals.

1.5 Sustainable tourism and the concept of recreation carrying capacity

Local authorities are faced with the challenges of how to regulate and monitor use levels to ensure that negative impacts on natural resources do not occur and that user experiences are not compromised by the effects of congestion and undesirable visitor conflict. Unplanned development of tourism and visitor flows can transform or even destroy the character of a natural resource and decrease the recreation demand [Saveriades, 2000].

In the field of leisure research this management problem is framed in terms of recreation carrying capacity, which characterises the ability of a site or region to absorb recreational use without deterioration while ensuring that visitor numbers in a destination are maintained within acceptable limits.

Lime and Stankey (1971, p. 174) describe the topic in the question: "What is the appropriate level of use for any given recreation area?" The concept addresses the amount of use that a certain area can support while still offering a high quality recreation experience based on social, environmental, and a well-balanced manage-

ment concept. Different definitions of carrying capacity are related to ecological, physical and psychological concerns.

In the context of the sustainable development of tourism, the United Nation World Tourism Organisation (UNWTO) defines tourism carrying capacity as “(...)the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of the visitor satisfaction” (in [Coccossis and Mexa, 2004], p. 38).

Research findings suggest that recreation areas may not possess numerical thresholds where recreation use levels overwhelm the resource capacity [McCool and Lime, 2001]. Graefe et al. (1984, p. 396) highlight “(...) that carrying capacity is not an absolute value waiting to be discovered, but is rather a range of values which must be related to specific management objectives for a given area.” Some social and environmental impacts of recreation are inevitable. The crucial question is not “how much use is too much”, but more importantly “how much impact or change is acceptable or should be allowed” [Manning, 1999, Manning, 2007, McCool and Lime, 2001].

By controlling environmental and social conditions, management influences the quality of experience to a substantial degree [Cole and Hall, 2009]. Contemporary planning and management frameworks such as Limits of Acceptable Change (LAC), Visitor Experience and Resource Protection (VERP), and Visitor Impact Management (VIM) are in use to address this question of acceptable impacts. All frameworks have in common quantitative measuring of selected social and resource indicators at specific sites to reveal standards of quality at which these indicator conditions become unacceptable [Needham et al., 2004].

These standards are expressed in a quantitative manner such as visitor numbers or number of encounters with others. The indicators of quality are explicit, specific and measurable variables influencing the quality of the recreation experience. For example, an indicator for the appropriateness of social conditions might be the number of encounters with other visitors per hour. The relating standard based on management decision might be an average of no more than three encounters with other visitors per day.

1.6 Scope of the study

The first application of social carrying capacity to park and outdoor recreation areas took place in the 1960s, when large numbers of motorised visitors began to explore the wilderness areas in the United States. Since then, several recreation studies in North America have documented visitor conflicts and crowding effects [Shelby et al., 1989, Manning, 2007, Vaske and Shelby, 2008]. Over the past 40 years, various empirical studies have been developed and implemented in different recreational settings in the U.S. and Canada to evaluate social carrying capacity [Manning,

2007]. These studies' findings suggest that social impacts can be measured by gathering the actual visitor numbers within the area, evaluating the number of other people that visitors encounter during their recreational experience and measuring the degree to which they feel crowded during their visit [Vaske and Donnelly, 2002]. For example, the number of visitors one would expect to encounter in a wilderness setting differ from those expected at a popular urban recreation area [Westover, 1989]. For some visitors seeking a nature-based recreational experience, the issue of crowding effects can have a significant negative impact on the valuation of their trip.

Most North American research into social carrying capacity is primarily concerned with wilderness or backcountry recreation areas. In this context, designated wilderness is the highest level of conservation protection of federal land in the United States. The Wilderness Act, enacted in 1964, prohibits permanent roads and infrastructure and any commercial enterprise to preserve wild, undeveloped parts of national parks. These backcountry zones provide solitude and a rather primitive type of recreation [Wagar, 1964, Runte, 2010].

Based on a history of implementing legislation within parks in North America (i.e. NPS Organic Act 1916 and Wilderness Act 1964), the local National Park authorities have a comprehensive body of experience in managing visitor use in protected area. A high public appraisal of National Parks in North America also results in a stronger support for unpopular management decisions, i.e. limitation of visitor numbers. As mentioned before, the concept of social carrying capacity is successfully applied in North American recreation area management. The National Park Service (NPS) directly manages opportunities for outdoor and wilderness recreation including solitude and wilderness experiences. Growing numbers of visitors have led to the need for management to reduce the biophysical impacts of recreation, and have highlighted concerns about interactions between different user types. The concept of social carrying capacity and measurement of crowding perception have been used to evaluate management performance within legislation boundaries. Understanding patterns of recreational use of national parks in North America has long been an important aspect of managing the National Park system (i.e. Visitor Use and Impact Monitoring Program of NPS). Providing a high-quality visitor experience in front country settings and solitude in wilderness areas has been a core component of park management. As a result, focus is placed on the social-psychological components of resources management, including the visitor experience of congestion.

The basic conditions of national parks in Europe differ remarkably with regard to history (young parks) and administration (small-sized authorities). Wilderness only exist in Scandinavia and in some remote regions at the eastern border of the continent. Most natural landscapes in Europe are more or less a product of traditional agricultural, hydrological and forest management regimes and intensive land-use changes. These areas can be described as multi-purpose landscapes with competing public uses. In Central Europe, the majority of recreational use occurs in high-use areas such as recreation sites close to metropolitan regions, which are

used by locals for everyday leisure activities [Arnberger and Brandenburg, 2007]. One of the fundamental problems with tourism is its concentration on specific periods of the year, which is related both to climate and the cultural and socio-economic rhythm of everyday life. This overcrowding results “(...) in temporary saturation of the communication infrastructure, tourist facilities, and the carrying capacity of destinations, which gives rise to reduced quality [EC, 2003] (p. 5).”

So far, the social aspects of tourism and recreation in Europe have received little attention. Arnberger and Mann (2008) identify only 16 European crowding studies since the 1980s primarily undertaken in North and Central Europe in rural and urban forest settings. Those exceptions are studies in Scandinavia [Fredman and Hörnsten, 2004], Austria [Arnberger et al., 2004, Sterl et al., 2004] and Germany [Grossmann and Klaphake, 2004, Mann, 2006, Kalisch and Klaphake, 2007]. An aggregation of these studies undertaken in the European context seems to be impossible due to the application of different measurement approaches, scale types and differences in question wording [Arnberger and Mann, 2008]. Also the very different situational settings, for example in a Swedish versus a German National Park in terms of received visitor numbers and accessibility, complicate a detailed comparison of survey results.

Even though limited in Europe, congestion research to date shows that perceived crowding, interpersonal conflicts, inadequate visitor behaviour and high visitor numbers occur in European national parks. Against this background, it seems to be highly desirable to enlarge research into congestion within large scale protected areas within Germany. National park authorities recognise a growing conflict between the goals of area management and visitor use level during the high tourist season. In Germany, the coverage of natural recreation landscapes is rather limited and an adequate visitor flow management is needed to achieve a sustainable recreation development [Mann and Absher, 2007]. In recent years, data has begun to be gathered on how visitors respond when encountering high use levels during their stay. This empirical research data can be used to inform visitor management in national parks and advance the effectiveness of different management options.

The scope of this particular study is to examine the consequences of recreation resource use in a coastal national park in the north of Germany from a social capacity perspective, to evaluate if the effects of crowding are measurable with established approaches derived from North American recreation research and to determine how visitors rate their recreational experience.

1.7 Outline of thesis

This thesis is structured into three main sections. Section A outlines the theoretical background and scope of the study. Section B is based on four manuscripts that have been submitted to peer-reviewed journals or are pending submission. All papers have a methodological focus and present results from the evaluation of

congestion effects and a comparison of visitor attitudes towards the quality of the recreation experience. The first manuscript discusses the potential and applicability of the established nine-point crowding scale in a German recreation context. In the second paper the usefulness of a conjoined measurement approach to study visitors' preference for hypothetical recreation scenarios on the trail to Hamburger Hallig is analysed. The third paper explores respondents' perceptions of setting density and levels of congestion, based on different measurement approaches applied in the thesis. The fourth manuscript comprises a simulation of visitor interactions on the Hallig trail, which allows to compare visitors' perception of congestion and actual user density. In section C, the findings of the study are summarised, management recommendations are discussed and needs for further research are highlighted.

1 Dissertation concept and themes - PART A

2 Outdoor recreation in national parks in Germany

“All park planning and management decisions in parks are ultimately based on values [Eagles, 2010] (p. 189).”

2.1 Outdoor recreation and the society

2.1.1 The restorative quality of nature and get away from everyday life

Frissell and Stankey (1972) describe the value of protected areas as being a source of certain human experiences, including solitude and interaction with the natural environment. Thereby, the use value of the landscape is related to the opportunities the environment offers for various recreation activities [Elands and van Marwijk, 2008]. Outdoor recreation has a long-standing history, beginning with the demands of social elites for hunting reserves, through to the development of the urban middle classes who visited coastal and mountainous areas for recreation purposes which has evolved into modern mass tourism [Eagles et al., 2002, Bell et al., 2007].

Outdoor recreation in general can be defined as an “(...) activity that people undertake out of doors in places where they can assess nature or green areas, mainly as part of their daily or weekend routine [Bell et al., 2007] (p. 6).” Nature tourism covers activities that people enjoy while on holiday and which focus on engagement with nature. The opportunities for nature-based tourism are highly dependent upon the destination attributes of the natural environment [Eagles, 2001].

Unspoiled natural environment is the backbone for various recreational activities in everyday life or while on holiday, including nature sport activities, bird watching, hiking, biking, cycling, and canoeing [Bell et al., 2007]. Media and local tourist boards spread an idyllic image of recreation areas that often conflict with the reality involved in visiting outdoor recreation settings. Traffic jams, long queues for attractions or facilities, rude visitors, and congestion are just some of the annoyances that visitors experience during high season [Miller and McCool, 2003].

Why do people visit areas of nature? Research revealed that there is a wide range of experiences visitors are seeking in natural areas [Kaplan and Kaplan, 1989, Elands and van Marwijk, 2008]. In particular, individual hedonistic and idealistic values have been shown to be central to leisure research [Petermann, 1998]. Based on sociological consideration, these can include having fun and pleasure (amusement), escaping from everyday reality (change), fascination with nature and landscapes (interest), experiencing the self (rapture), and merging with the other unexplored world (dedication) [Elands and van Marwijk, 2008].

“The ability to view natural and man-made scenes that are pleasing - or at least interesting - is an important part of the tourism experience and is probably the principal motivation for many visitors [Healy, 1994] (p. 597).” Being in nature areas is believed to be beneficial and to contribute peoples’ well-being and vitality. Especially in densely populated countries of Central Europe, nature-based tourism and recreation are often motivated by the need to escape from everyday routine in urban environments. Peoples’ desire to visit unplanned and unspoiled natural areas stem from a need to get away from planned, well-regulated modern environments [Kupper, 2009]. In areas that are subject to high visitor numbers and inadequate management measures to guide visitor use levels, opportunities for people seeking more specialised recreational experiences involving a nature-based experience can decrease [Manning, 1999].

Natural recreation areas offer a broad variety of outdoor activities, which range from the passive (i.e. enjoying a view) to more active (i.e. mountain biking) and from consumptive (i.e. fishing) to non-consumptive (i.e. hiking). These activities are related to different visitor motivations. The main motives for visiting nature are solitude, stress relief, nature sport activities, escape from everyday life and education [Petermann, 1998, Hall, 2001, Kyle et al., 2006, Legare and Haider, 2008].

2.2 National Park tourism in Germany

2.2.1 Relevance and extent of national park tourism in Germany

National parks and other large scale protected areas can be defined as human political constructs and coupled social-ecological systems [Buckley, 2009]. Recreational use of parks and protected areas is one of the fundamental components of society’s reason for the creation of such areas. National parks are natural and cultural resources of great importance to nations and the international community [Eagles, 2001, Dudley, 2008].

Large scale protected areas in Germany such as national parks are limited in extent and are generally open to the public without any limits. This management problem can be framed according to the tragedy of the commons, as increasing exploitation of resources will lead to unacceptable environmental and social degradation [Hardin, 1968]. “The National Parks present another instance of the working out of the tragedy of the commons. At present, they are open to all, without limit. The parks themselves are limited in extent - there is only one Yosemite Valley - whereas population seems to grow without limit. The values that visitors seek in the parks are steadily eroded. Plainly, we must soon cease to treat the parks as commons or they will be of no value to anyone [Hardin, 1968] (p. 1244).” In summary, the primary goal of national parks is the protection of natural biodiversity along with its underlying ecological structure and supporting environmental processes and to promote education and recreation [Dudley, 2008].

Currently we find more than 300 national parks on the European continent [UNEP, 2008]. The IUCN Category II area “National Park” is defined as following: “Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities [Dudley, 2008] (p. 16).”

Given that the first National Park in Germany was opened in 1970, the country has a very young population of parks when compared to other countries. The area of the 14 German parks range from 3,000 up to nearly 450,000 hectares. The distribution of the strictly protected core zone varies greatly between 10.7 and 91.5 percent. All areas are classified as IUCN category II [Job, 2008]. Legislation implements laws and regulations for both the interests of nature conservation and tourism. The regulatory frameworks such as the German Federal Nature Conservation Act¹ define the main purpose of national parks as a means to protecting endemic species, undisturbed natural processes, biodiversity and the ecological integrity within areas of pristine character. National parks are also open for scientific research, environmental education and to allow the general public to experience nature first hand.

In recent years, national park tourism in Germany has become a popular trend and an essential competition factor for the surrounding regions [Job, 2008, Mayer et al., 2010]. Pristine nature is the basis for most recreational activities and also the main motive for visiting national parks. Visitors from urban agglomerations seek authentic natural experiences in unspoiled landscapes [Hannemann and Job, 2003]. The promotion of ecotourism and recreation in national park areas has become an important component of many governmental policies and regional tourism boards for example the marketing campaign of The German National Tourist Board² “Lust auf Natur - Natur erleben in Deutschland” in 2002 and the German Railways³ campaign “Fahrtziel Natur”.

For example, the Wadden Sea National Park in Germany attracts more than 14 Million day visitor per year. Against this background, national park authorities have to decide carefully which strategies and measures are useful and feasible to balance the conservation of the protected areas with recreational use. All in all, the assessment of suitable measures should be based on monitoring data and produce appropriate and comprehensible management actions.

¹Bundesnaturschutzgesetz - BNatSchG

²Deutsche Zentrale für Tourismus e.V. (DZT)

³Deutsche Bahn

2.2.2 Monitoring of visitor activities in protected areas

“Understanding how people perceive a recreation/tourist experience requires an initial understanding of recreation participation and motivation [Graefe and J., 1987] (p. 391).” The basis for any effective management and for research into social and ecological impacts of outdoor recreation involves gathering reliable information about visitors. In detail, data is needed to ensure a high quality recreation experience, sustainable tourism development, and the promotion of public health and well-being [Kajala, 2007].

Visitor monitoring in national parks includes a systematic and periodic measuring of human activities to expose violations of natural resources or social conditions [Cessford and Muhar, 2003]. Data sampling should also have a repeated and replicable character to enable comparison over certain intervals of time [Lime et al., 2004]. The collected data is used for an effective recreation and visitor management, prognoses for the future development and needs of tourism marketing. Several methods for visitor monitoring in recreation areas have recently been put into operation. These methods vary from the quantitative such as video observation and counting devices, to more qualitative approaches, namely visitor surveys [Muhar et al., 2002].

Three categories of visitor use data can be distinguished [Cope et al., 2000]:

- Visitor counting (quantitative data about the total usage and temporal and spatial distribution)
- Visitor profiling (demographic and socio-economic data)
- Visitor opinions (information about attitudes, preferences, satisfaction and motivations of visitors)

In most of the protected areas in Europe, accurate counting and monitoring of visitor numbers and nation-wide monitoring programs with standardised methods are scarce [Muhar et al., 2002]. A survey of national park authorities in Austria, Germany and Switzerland revealed that most of the authorities (81%) simply estimate their recreational use levels. In general, it appears that they simply count participants in organised national park activities (i.e. guided walks) or visitors to main park attractions and roughly estimate overall visitor numbers. Also knowledge on the temporal and spatial distribution of visitors within the area is scarce [Kalisch and Klaphake, 2008].

Such data is highly relevant given the varying seasonal visitation patterns in many protected areas and selective hot spots within the area, with high impact levels during peak periods and low impact levels in off-season periods. Information on the spatial distribution of visitors is also important because visitor allocation within the site is never homogeneous [Hammit and Cole, 1998]. In recent years, national park authorities in Germany have started to adopt periodical visitor monitoring to gather data on visitor numbers and characteristics and changing recreation trends.

Generally however, there remain significant differences in the quality and extent of monitoring programs.

For instance, the national park authority in the Wadden Sea National Park has implemented a comprehensive strategy for communication, information, visitor guidance (Visitor Information System⁴) and monitoring (Socio-economic Monitoring System⁵) to achieve nature conservation goals and provide opportunities for experiencing nature [Gätje et al., 2002]. Thus, this program strengthens the acceptability and traceability of implemented measures. Visitors are informed about the ecological value of the landscape and the necessity of imposing certain restrictions and constraints (see Table 2.1).

1. VIS - Visitor Information System

An extensive information system has been established to guide tourists in the national park and reduce the disturbance caused by recreation activities. A network of visitor information centres and public information boards offer educational information and improved communication with the public. National park rangers are employed to inform visitors about the environment and regulations within the area.

2. SEM - Socio-economic Monitoring System

The National Park authority launched a socio-economic monitoring program in 1999 to assess the spatial and seasonal distribution of visitor groups and to produce additional information on their behaviour, attitudes and expectations. In detail, the monitoring concept provides data, which highlights the importance of the national park for economic development, satisfaction of visitors and acceptance of the protected area by locals and visitors [Gätje et al., 2002]. On-site visitor surveys and counting of individuals are regularly conducted at tourist hot spots along the coastline and on the islands. The data is used to improve public relations, develop knowledge on visitors and inform the management teams of the protected areas [Gätje, 2004].

Table 2.1: Visitor monitoring and management in the Wadden Sea National Park

⁴BIS - Besucherinformationssystem

⁵SÖM - Sozio-ökonomisches Monitoring

2 Outdoor recreation in national parks in Germany

3 A theoretical overview of social carrying capacity

“Carrying capacity in tourism is conceived as a maximum number of visitors that can be tolerated without irreversible or unacceptable deterioration of the physical environment and without considerably diminishing user satisfaction [Seidl and Tisdell, 1999] (p. 401).”

3.1 Evolution of the concept of carrying capacity

The concept of carrying capacity has its origin in the field of resource and wildlife management and is based on the assumption that an organism can survive only within a limited range of physical conditions [McCool and Lime, 2001]. In this ecological context, the term is defined as the largest population of flora or fauna a unit of habitat can support and refers to the ultimate limits to growth as constrained by the relevant environmental factors. “The term carrying capacity was presumably coined by range managers, who were concerned with the use of land for grazing livestock [Price, 1999] (p. 6).” In terminology of wildlife management, carrying capacity can be described as the number of animals that are maintained in a given habitat before excessive biological or ecological impacts occur [Manning, 1999].

The model of carrying capacity involves a logistic growth dynamic based on the Malthusian growth model, where an exponential population growth is slowed down by an upper limit related to environmental factors [Seidl and Tisdell, 1999]. “The capacity issue is driven by recognition that there are limits on the ability of environments to support human use and that ignoring those limits can have many impacts, ultimately decreasing the quality of life [Whittaker et al., 2010] (p. 1).” The concept of carrying capacity implies an optimum level of utilisation of natural resources based on complex and interacting physical, ecological and social factors [Carey, 1993].

Within the context of outdoor recreation, carrying capacity involves a vast number of definitions [Saveriades, 2000]. Until now, carrying capacity has focused on the relationship between the extent of recreation use and natural resource conditions (soil, water quality, flora and fauna), physical factors (capacity of infrastructure), social conditions (visitor behaviour, congestion, recreation conflicts), and management regulations (measures, restrictions) [Manning, 1999, Coccossis and Mexa, 2004]. The concept is multi-dimensional and consists of two main effects of recreational use in protected areas: (a) impacts on the quality of the environmental conditions (biophysical component) and (b) impacts on the quality of the recreation experience (sociological component). Recently, separate fields of thought which deal with the concept of carrying capacity have emerged:

3 *A theoretical overview of social carrying capacity*

- Ecological carrying capacity
- Physical carrying capacity
- Social carrying capacity

Ecological carrying capacity is related to the integrity of the natural resource implying some tolerance level after which further use may impose negative impacts on the natural ecosystem. It is defined as the maximum level of recreational use that can be accommodated by an area before an irreversible decline in ecological resources occur [Sowman, 1987].

The physical carrying capacity is the threshold limit of space as defined by the dimension of infrastructure and area size. For example, a car park has a finite physical capacity and the extent of a lake allows only a certain amount of boating activities. The concept describes the maximum number of people or equipment that can be accommodated comfortably and safely by a site [Sowman, 1987].

Social carrying capacity “(...) can be defined as the maximum level of use (in terms of numbers and activities) that can be absorbed by an area without an unacceptable decline in the quality of experience of visitors and without an unacceptable adverse impact on the society of the area [Saveriades, 2000] (p. 149).” As a consequence, the social carrying capacity can be handled from two perspectives: (a) the capacity of the host population to tolerate the presence of tourists [Saveriades, 2000] and (b) the level of visitor use at which visitor experience parameters exceed acceptable levels specified by evaluative standards and management objectives [Graefe et al., 1984]. For example, when a recreation area has a low capacity, it is designed to provide opportunities for solitude in a pristine natural environment and alternatively a high capacity, if the objective is to provide opportunities for the general public. The social carrying capacity is reached when there is a decline in the quality of recreational experience from the visitor individual perspective.

An overuse in outdoor recreation areas in terms of high visitor numbers create a situation where a “(...) collective effect of individual decisions to maximise personal benefits in a public commons results in a negative effect with a depleted common resource that has diminished collective and individual value [Bullock and Lawson, 2008] (p. 71).”

Applied to the management of recreation areas, the concept is used in North America as a basis for landscape planning and resource management [Ovington et al., 1974, Sinden, 1976]. The first application of carrying capacity to outdoor recreation in the United States emerges in the early 1960s with the conceptual monograph of Wagar (1964).

Wagar (1964: 3) defined recreation carrying capacity as the “(...) level of recreation use an area can withstand while providing a sustained quality of recreation.” Furthermore, Wagar (1964, p. 6) stated that “(...) carrying capacity ultimately depends on the value judgement of people.”

3.1 *Evolution of the concept of carrying capacity*

The major contribution of Wagar's and his colleague's analysis is the enhancements of carrying capacity from its prevalent emphasis on environmental impacts to a dual focus that also includes socio-psychological considerations. His main contribution is that when more people visit a recreation area both the environmental resources and quality of the recreation experience are affected. Therefore any attempt to determine carrying capacity requires the consideration of human values [Lime and Stankey, 1971]. Lime and Stankey (1971, p.175) described carrying capacity more detailed as "(...) the character of use that can be supported over a specified time by an area developed at a certain level without causing excessive damage to either the physical environment or the experience for the visitor."

Criticism and limitations of the concept of the recreation carrying capacity model is widely discussed in leisure literature [McCool and Lime, 2001]. Simply focusing on use levels in terms of visitor numbers may be misleading and offer a simplistic view of the complex nature of recreation patterns. Current carrying capacity literature suggests that there is not a single clear benchmark or threshold ("magic number") for visitor use in recreational settings [McCool and Lime, 2001]. Hence, the carrying capacity of an area is not an absolute value, but rather a function of social values than an immanent element of the area [Lime and Stankey, 1971, McCool and Clark, 2007]. In fact, it is based on the needs and values of visitors and can only be defined in relation to management judgements that are typically related to adequate resource conditions.

The idea that there might be some level of visitor use beyond which the recreation experience quality diminishes is the backbone of the concept of social carrying capacity [Manning et al., 2002]. However, the question of how much visitor use and change is acceptable or desirable comprises a social judgement, which is informed by science¹, but finally decided by a political discourse [McCool and Lime, 2001].

¹"Ultimately science is the process for building understanding, particularly from knowledge gained through empiricism, rationality and logic, quantification, reductionism and specialisation [Cole, 2004] (p. 10)."

3.2 Congestion in natural recreation areas

“How many can enter an area before it becomes crowded, reducing the quality of individual experience [Shelby, 1980] (p. 43)?”

3.2.1 Roots and definition of congestion and crowding

Beginning in the late 1960s and early 1970s, the concept of social carrying capacity has been applied to express environmental thresholds induced by various human activities [Seidl and Tisdell, 1999]. The level of congestion in terms of user density and related perception of crowding have been found to be an essential component in the concept of social carrying capacity [Manning, 2007].

Crowding is a psychological concept that includes a personal, subjective evaluation of the amount of a given space supply [Gramann, 1982]. A distinction is drawn between crowding and the term density that has a strict physical quality and is directly measured as person per unit of space [Stokols, 1972a, Altman, 1975]. “Crowding can be viewed as distinctly separate from the notion of congestion, which is more concerned with the density and physical interference of one user versus another. Thus, a setting may be congested but not crowded [McCool and Clark, 2007] (p. 81).” Altman (1975) developed a model of crowding, in which people are expected to have some desired level of privacy derived from personal characteristics (personality), interpersonal characteristics (group cohesion), and situational factors (physical features). If the achieved privacy is less than the desired privacy, the effect of overcrowding occurs based on an “(...) interpretation of the adequacy of the surrounding physical environment in terms of personal needs for space [Gramann, 1982] (p. 113).” All in all, crowding can be defined as a negative value judgement of a particular density, which will vary between individuals according to social and psychological factors [Shelby, 1980, Manning, 1999].

In Figure 3.1 (p. 31) the hypothetical relationship between actual density within the area and social impacts in terms of perceived crowding is illustrated. The graph represents the association between the level of visitor use ($X_{1,2}$) and visitors' perception of crowding ($Y_{1,2}$). In this simplified illustration an increasing amount of visitors leads to an increase of perceived crowding. It also shows that some negative impact on the recreation quality is inevitable when the area is open for public use. The challenge in carrying capacity determination lies in deciding which of the points along the y-axis represent the maximum amount of perceived crowding which is acceptable [Manning, 2002].

Congestion and visitors perception of crowding comprise a persistent issue in the field of outdoor recreation research and leisure literature starting in the 1960s by estimating space requirements in wilderness areas by NPS [Wagar, 1964]. The majority of research on crowding focus on backcountry wilderness areas, because these areas are required by law to provide opportunities for solitude based on the Wilderness Act [Manning, 1999].

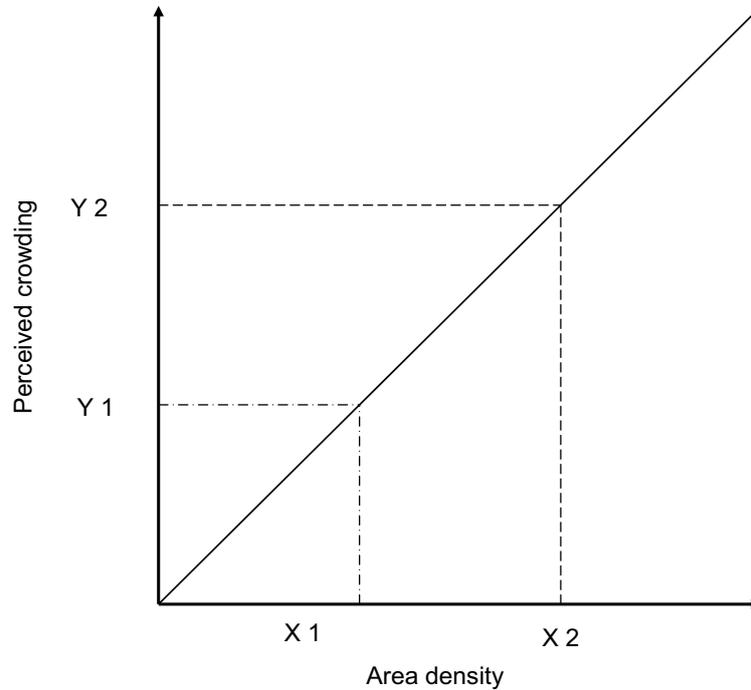


Figure 3.1: Hypothetical relationship between a definite actual density and visitor's perception of crowding perception (Adapted from [Manning, 2002])

The law explicitly highlighted the outstanding opportunities for solitude and primitive type of recreation in wilderness areas. Issues of overuse and overcrowding in outdoor recreation literature have been found to negatively influence the quality of recreation experience quality and substantively reduce the public benefit [Cicchetti and Smith, 1973, Shelby, 1980]. Gramann (1982) found that visitors experience crowding because they are exposed to a higher level of social interaction or density than they prefer.

The beginning of crowding research is characterised by examining the hypothetical relationship between increasing visitor numbers, the perception of crowding and overall enjoyment with the recreation experience [Shelby, 1980]. The explored relationship is based on the economic concept of marginal utility.

It describes the effect of an addition of any successive visitor to a recreation setting may lead to a progressively decline of the marginal enjoyment of each individual visitor, but overall or aggregated enjoyment within the area will increase [Manning, 1999]. The so-called satisfaction model examined the effect of use level on

3 A theoretical overview of social carrying capacity

social welfare. Early research in estimations of recreation benefits under congested conditions indicated that an overuse of recreation areas results in individual's dissatisfaction [Wagar, 1964, Becker, 1978, Cicchetti and Smith, 1973, Stevens and Allen, 1980, Schomaker and Knopf, 1982].

In one of the first empirical tests to construct a satisfaction curve that depicts the relationship between satisfaction and the number of parties encountered by Stankey (1973), visitors were asked how they felt about increasing numbers of other visitors on a five-point scale ranging from "very pleasant" to "very unpleasant". Results showed that high actual density leads to a high level of perceived crowding and visitors are likely to experience dissatisfaction [Stankey, 1973]. Later on, several weaknesses in the model were identified: 1.) participation in recreation activities is largely self-selected and voluntary according to their normative idea of adequate recreation experience (additionally they have made a substantial investment of money and leisure time) and therefore visitors tend to show high satisfaction levels, 2.) dissatisfied visitors may move on to less crowded areas and are replaced by more crowding resistant visitors and 3.) overall satisfaction is related to several other factors including expectations, etc. [Shelby, 1980, Graefe et al., 1984, Manning, 1999]. Especially the existence of multiple goals and satisfaction levels of individuals makes the relationship between density and overall satisfaction extremely complex [Gramann, 1982].

In summary, recreational research identified descriptive and evaluative elements of social carrying capacity. The descriptive component focuses on objective characteristics of recreation use and their relationships to indicators of quality (i.e. types and amount of use, site factors). The evaluative component focuses on determining the amount of change or social impact in the recreation experience that is acceptable.

The evaluation incorporates a value judgement of the visitors about:

- Actual density: number of people per unit (measured by visitor counting during the survey)
- Reported encounters: number of other people in a recreation setting that visitors recall to see
- Perceived crowding: negative evaluation of the number of people the individual remembers seeing

Individual's value judgement combines descriptive information (encounter level experienced by individual) with evaluative information, namely individual's negative evaluation of density within the area [Vaske and Donnelly, 2002].

Actual density describes the number of visitors per space unit [Stokols, 1972a, Stokols, 1972b, Stokols, 1976]. The physical conditions in terms of spatial parameters, i.e. number of people per unit gathered by visitor counting and can be measured objectively. The second component is described by reported encounter, measured

by the number of other people in a recreation setting that a visitor remembers seeing during a trip or at a given location. The evaluative component is based on an encounter measurement describing the number of other visitors an individual remembers seeing during a trip or a given location. Visitor's perception of crowding is the negative evaluation of those encounters [Vaske and Donnelly, 2002].

The issue of perceived crowding is considered as a value judgment about a certain visitor use level or level of congestion and is highly dependent on a number of factors and circumstances. These dependent factors have been broadly grouped into three categories [Schreyer and Roggenbuck, 1978, Shelby, 1980, Manning, 1999]:

1. Personal characteristics of visitors including (a) motivation for outdoor recreation (respondents who felt crowded reported higher ratings on motivations involving solitude and experience of nature), (b) preferences and expectations for encounter rates (high correlations were found between perceived crowding and preference and expectations of encounter), (c) level of experience (more experienced visitors tend to be more sensitive to higher use level) and (d) attitudes (respondents with strong wilderness purism attitudes reported a higher degree of crowding at each encounter level tested)
2. Characteristics of those encounters including type (mode of travel) and size of group and their behaviour. "When others are encountered who are viewed as inappropriate or different in unfavourable ways, crowding is perceived at relatively low levels of use [Manning, 1999] (p. 110)."
3. Situational variables including type of area in terms of topography and location of encounter within the area (i.e. trail head or interior zone)

The comprehensive crowding model developed by Shelby (1980) described the function between encounters and density and its relation to the perception of crowding. He assumed individual's preferences and expectations to have a greater effect on perceived crowding than actual density and encounters. The expanded crowding model developed by Manning (1999) assumes that area's actual density causes encounters between different visitors that depend on the type of area, geographical variables and trip characteristics. The encounter rate has been found to effect the perception of crowding. Recreation experience quality may be affected by the perception of crowding, but is not expected to be the only variable. All in all, within recreation research there is no definite method to measure these contacts and some researchers have rated the variable as a "hard to measure indicator" [Lawson, 2006].

3.2.2 Social psychological perspectives on crowding

Even if a recreation area is used intensively, it is not necessarily the case that visitors feel crowded. In some recreational settings the presence of many other people is expected or even sought [Altman, 1975]. There is an inherent distinction between density, as a physical condition involving the limitation of space, and crowding, as an experiential state, in which the restrictive aspects of limited space are perceived by the individuals exposed to them [Stokols, 1976]. “People engaging in recreation 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 [Gramann, 1982] (p.120).” The normative theory relates the concept of use level as a physical concept (countable visitor numbers per unit of space) and perceived crowding² as psychological concept (negative and subjective evaluation of an experienced use level).

Social norms³ in outdoor recreation are visitor-based standards that individuals and groups use to evaluate social and environmental conditions. Graefe et al. (1984) describe social norms as a shared behavioural expectation or prescription of what people think “should” happen in a given context. Most of recreational crowding research is based on social-psychological paradigms. The perception of crowding results from social interaction processes and can be analysed by using theories of social psychology [Owens, 1985].

In detail, these social-psychological paradigms are:

- Expectancy theory: People engage in recreation activities with the expectation that their activities will lead to a certain outcome and satisfy single or multiple expectations [Schreyer and Roggenbuck, 1978]
- Discrepancy theory: Visitors compare the perceived outcomes they receive from an experience with the reward they expected to receive [Schreyer and Roggenbuck, 1978]
- Stimulus overload models: Crowding perception, as a potential source of inconvenience, is greatest when the level of social stimulation exceeds the desired amount and the individual is unable to reduce that stimulation through adaptive strategies [Stokols, 1976, Gramann, 1982]
- Social interference model: Crowding perception occurs, when the number or behaviour of other persons in a recreational setting is incompatible with an important goal and interferes with its attainment [Gramann, 1982]

²The term “perceived crowding” is used to emphasise the subjective nature of the value judgement about acceptable visitor numbers within the area [Vaske and Shelby, 2008].

³Traditionally applied in sociology and social psychology, norms guide individual behaviour through social obligations and are shared by social groups [Manning et al., 1999].

3.3 Encounter-norm-crowding relationship

“Normative theory makes an important distinction between use level and crowding, outlines variables that influence crowding judgements, and suggests that visitors to parks and outdoor recreation areas may have normative standards regarding appropriate use levels of such areas [Manning et al., 2000] (p. 57).”

Social norms for encounters with other visitors and the perception of crowding in recreation settings have been an important field in outdoor recreation research. Transferred from sociology and social psychology, the normative theory was integrated into recreation research to measure individual crowding norms of each visitor [Kuentzel and Heberlein, 2003, Krymkowski et al., 2009]. Norms are generally defined as standards that individuals use for evaluating behavioural, social and environmental conditions in recreational settings [Manning et al., 1999].

The encounter norm is defined as a standard for the number of contacts with other people that an individual will tolerate over the course of a day or trip [Donnelly et al., 2000]. “Crowding involves a value judgement that the number of people encountered is too many [Vaske and Donnelly, 2002] (p.256).” When undertaking outdoor recreation activities visitors are expected to have certain preferences, expectations or other standards by which they judge a setting as crowded or not.

Encounter norms are standards that individuals use for evaluating contacts with others as acceptable or unacceptable [Manning, 2007]. Visitors compare the experienced conditions (observed social impacts) with their attitude of what is acceptable (normative standards framework).

The social norm curve based on Jackson’s “return-potential curve” is used to aggregate individual encounter norms to a social norm curve, for a given setting [Kuentzel et al., 2008]. Figure 3.2 (p. 36) shows the change of individual’s acceptability ratings when the number of encountered visitors increases along the horizontal axis.

The vertical axis shows the evaluative responses of visitors based on the applied rating scale (in this example a nine-point scale from 4 = very acceptable to -4 = very unacceptable). In North American outdoor recreation research the majority of studies have used acceptability as the evaluative dimension (see [Manning et al., 1999] for a comprehensive overview). The social norm curve can be analyzed for structural characteristics such as the minimum acceptable condition⁴, norm intensity⁵ or strength, and degree of consensus about the norm (norm crystallisation).

The normative approach has been applied as a feasible way to conceptualise, collect, and organise empirical data representing value judgments about resource management issues [Vaske et al., 1993]. “The relevance of expectations and norms to social carrying capacity lies in their ability to explain visitor evaluations of quality recreation experiences [Graefe et al., 1984] (p. 398).”

⁴Minimum acceptable conditions are reached when the norm curve crosses the neutral line.

⁵Norm intensity indicates the importance of the indicator to respondents and is measured by the relative distance from the neutral line at each point on the curve.

3 A theoretical overview of social carrying capacity

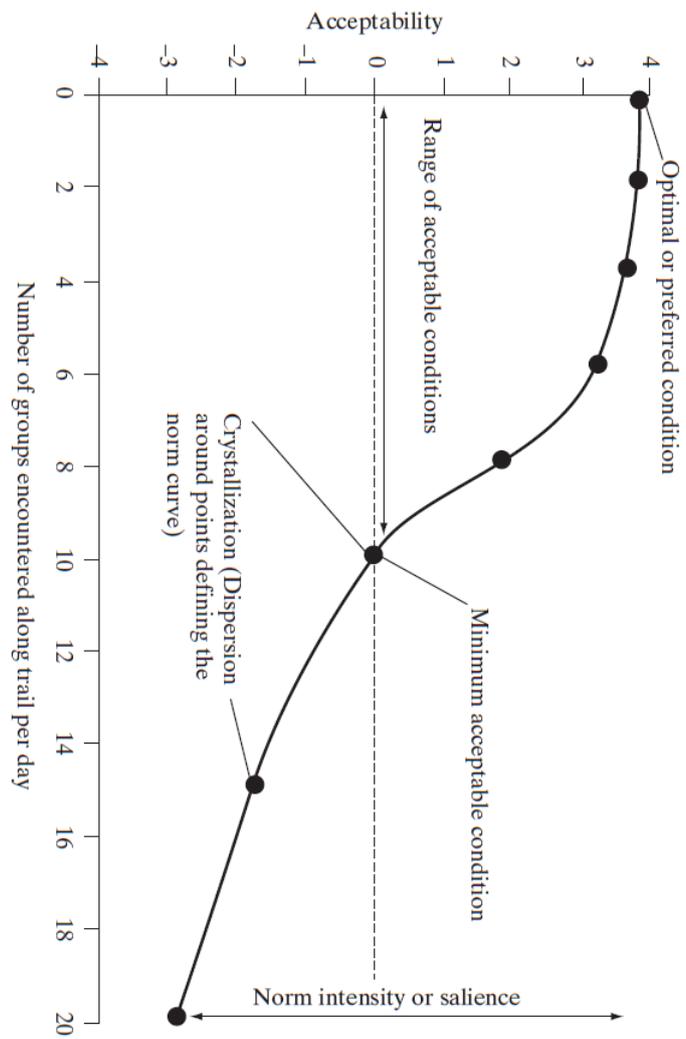


Figure 3.2: Hypothetical social norm curve [Manning et al., 1999] (p. 99)

Visitors have been found to have normative standards regarding how many trail encounters are acceptable before the quality of the visitor experience declines to an unacceptable degree.

3.4 Influencing factors on crowding perception

Over the last decades, visitor's perception of crowding is a definite issue in outdoor recreation [Shelby et al., 1989], but findings have also discovered a lack of information on the various individual-level factors that are related to social norms and different types of settings. In addition, recent research reveals that the perception of crowding is a result of a multidimensional and dynamic process influenced by different factors, including visitor characteristics, subjective feelings, expectations, motivations, image of the site [Manning, 1999]. The influence of high visitor numbers and associated unwanted visitor behaviour that can both diminish a recreational experience, have been detected in several studies in North American crowding research.

As previously stated, the first scientific approach to apply the concept of carrying capacity within the field of recreation research was undertaken by Wagar (1964) in North America. Pioneering studies in recreational crowding were undertaken primarily in wilderness or other relatively underdeveloped recreation settings. Since the 1960s numerous studies in North American recreation research have focused on situational and cognitive influences on visitors' perception of crowding in natural settings [Altman, 1975, Schreyer and Roggenbuck, 1978, Gramann, 1982], including the concept of normative standards about appropriate area conditions [Donnelly et al., 2000, Vaske and Donnelly, 2002, Krymkowski et al., 2009], and how it could be measured [Manning et al., 1996, Manning, 1999, Hall and Roggenbuck, 2002, Manning et al., 2002, Manning and Freimund, 2004]. Other studies focussed on the relationship between the perception of crowding and motivations for recreation behaviour [Schreyer and Roggenbuck, 1978, Gramann and Burdge, 1984] and the effects of unwanted behaviour of other visitors [Womble and Studebaker, 1981]. These studies revealed that visitors have preferences for the number of other visitors they would like to encounter and the level of crowding during different recreation activities such as camping [Womble and Studebaker, 1981], hiking [Carothers et al., 2001], hunting and fishing [Shelby and Vaske, 2007] and recreational boating [Shelby, 1980, Ditton et al., 1983, Boteler, 1984, Herrick and McDonald, 1992, Tarrant and English, 1996, Tseng et al., 2009]. The evaluation of appropriate or acceptable resource conditions are affected by a visitor's experience (when people first time visit a recreation site, they have little knowledge or vague expectations about appropriate use levels), types of resource (visitors of frontcountry settings have more ambivalence regarding appropriate conditions and are willing to tolerate more encounters than they prefer) and activity type [Kuentzel et al., 2008].

3 *A theoretical overview of social carrying capacity*

Manning (1999) compared 54 wilderness area studies that examine the (a) density/satisfaction, (b) density/crowding and (c) crowding/satisfaction relationship conducted in North America in 1970s to 1990s. These detailed study findings showed that the strength of relationship between density and satisfaction are low to moderate in particular cases, but weak or nonexistent in most of the study results (also supported by [Graefe et al., 1984]).

A moderately strong relationship between density and the perception of crowding were found in about half the areas where these variables were measured (weak or none for the other half). The relationship between crowding and satisfaction were generally weak or nonexistent.

In addition, Graefe et al. (1984) examined the relationship between density and perceived crowding in 13 studies. Ten of these reported a positive effect, as visitors were more likely to evaluate the recreation experience as crowded when use level/actual density increases.

Crowding perception varies greatly across recreation settings and visitor characteristics [Shelby et al., 1989, Manning et al., 2000]. Aggregate analyses of survey data shows different factors which determine encounter rates and crowding perception [Graefe et al., 1984, Shelby et al., 1989, Vaske and Donnelly, 2002, Vaske and Shelby, 2008]:

1. Time or season of use
2. Resource abundance or availability
3. Resource accessibility or convenience
4. Type and intensity of use
5. Diversity of recreation activities
6. Imposed management strategies

In general, visitor use differs with specific dates and seasons of use. Several studies identify uneven distribution of recreation use over time, with peak levels on weekends or public holidays like Easter or Whitsun [Manning and Powers, 1984]. In addition, participation in activities such as canoeing or cross-country skiing is concentrated in defined seasons [Shelby et al., 1989]. These peak seasons are characterised by high visitor numbers and congestion is more likely as encounter rates increase. Also the availability of a resource, which is often related to certain season (i.e. optimal water level for white-water rafting, snow conditions, etc.) can increase or decrease recreational use. Recreation areas, which are located next to metropolitan areas and more easily accessible attract more visitors, which can also lead to overcrowding. Differences in crowding perception were found between experienced and first-time visitors. For example, first-time visitors tend to tolerate higher numbers of other visitors when compared with visitors who are familiar with the area.

3.4 Influencing factors on crowding perception

In addition, recreational crowding studies identify individuals' experience levels, attitudes and motivations for recreation as significant predictors of perceived crowding [Westover, 1989, Manning, 1999]. Motivations for participation in certain activities affect their sensitivity for congestion, as nature seekers are generally less tolerant than urbanists [Schreyer and Roggenbuck, 1978]. Imposed management strategies, or a lack of adequate measures, influence visitor density and use levels, which in turn influences the occurrence of congestion.

Encounters with others during the recreation experience can affect the individual's perception of crowding. For example, when encounters are rated as inappropriate (i.e. type and size of groups, behaviour of others, etc.) and conflict with individual preferences, crowding is already perceived at a relatively low level of use.

The perceptions of encounters and visitor numbers are also strongly related to situational variables. Type of recreation area, location within an area and perceived environmental quality all can influence the evaluation of visitors.

What is crucial is the fact that most of crowding research in North America is undertaken in remote wilderness areas with rather low visitor numbers. The experience of solitude and pristine natural landscape together with freedom of management constraints play an important role in the North American wilderness recreation ideal. Research also demonstrates that visitors would be willing to tolerate management restrictions such as limits on usage, to protect the wilderness character of natural areas and keep visitor use within an acceptable level [Lawson and Manning, 2002].

In summary, the perception of crowding in outdoor recreation is evaluated in several studies and has generated extensive literature on the social impacts of visitor use in North America. A review of research conducted by Graefe et al. (1984) started with Wagar (1964) and identified 13 studies which report the relationship between actual density and crowding perception. They found that "(...) there are several types of impacts that can result from increasing use level and that these impacts are interrelated and influenced by a variety of factors [Graefe et al., 1984] (p. 423)." They also recommend the integration of other variables and factors such as expectations, preferences, and prior experience to study crowding perception. Five years later, Shelby et al. (1989) compared aggregated data from 35 studies in 59 different settings and activities. Their main findings are that crowding varies (a) across settings, (b) by time or season (when comparing peak use periods with non peak periods), (c) by resource availability and accessibility or convenience and (d) management strategies. When compiling findings from 35 crowding studies, Shelby et al. (1989) found a great diversity in crowding judgements with the percentage of respondents who report some degree of crowding (3-9 on crowding scale) ranging from 12 to 100%.

In 2008, Vaske and Shelby expanded this database by examining 181 studies in 615 different setting and activities. They revealed that crowding varied (a) by the year the study was conducted (perceived crowding has declined from 1975-2005), (b) within different regions of the United States; (c) by country (45% felt some degree of crowding in the United States, 37% in Canada and 58% in New Zealand);

3 A theoretical overview of social carrying capacity

(d) at specific locations within a resource (lowest at starting and ending locations of the trip) and (e) by specific type of activity (including hunting, angling, camping, floating, rafting, kayaking, canoeing, boating, biking and hiking). All in all, 40% of respondents reported suppressed crowding (0-35% of respondents feel crowded) and 9% evaluated area conditions as greatly overcapacity (81-100% of respondents feel crowded).

Empirical research has often found that visitor satisfaction may remain relatively high, even when use levels of a park or related area increase [Manning, 1999]. Some visitors may adopt so called “coping mechanisms” in response to perceived crowding. For example, some visitors cope with crowding and conflict through the process of displacement⁶. Increasing use level may result in dissatisfaction due to visitor’s perception of crowding. Individuals change their recreation activity use patterns and are displaced by visitors more tolerant of high use levels [Manning and Valliere, 2001]. Spatial displacement arises from a shift of visitors’ recreation activities to other locations within the same area (intra-spatial) or to another area (inter-spatial). Visitors who are not as sensitive to increased use levels may not visit certain areas again and relocate their activities to areas that are more remote and less likely to be crowded. The effects of use displacement have been recognised and examined in several studies and different types of areas [Manning, 1999, Arnberger and Haider, 2007b, Arnberger et al., 2010].

3.5 Measurement approaches issues

“If recreation visitors have normative standards concerning relevant aspects of recreation experiences, then such norms can be measured and used as a basis for formulating standards of quality [Manning et al., 2002] (p. 339).”

Congestion in outdoor recreation areas is a prevalent phenomenon in recent leisure research, with a wide range of applied behavioural research techniques and response formats over the past 30 years [Haider, 2002]. “Normative research in outdoor recreation is conventionally conducted using quantitative methods that generate numerical estimates of respondent norms or evaluative standards of quality for park and outdoor recreation conditions [Manning et al., 2005] (p. 205).” For example, visitors to recreation areas are asked to evaluate the acceptability of a range of related impacts including encounters with other visitors or level of congestion. The main method of research has involved ex-post evaluations of the recreation experience. These approaches have mainly used post-experience questionnaires (i.e. on-site or mail-back surveys), with questions relating to reported encounters, such as “how many encounters with other groups did you have”, perceived crowding

⁶“Displacement is a behavioural coping mechanism in that it involves spatial or temporal changes in use patterns [Manning, 1999] (p. 95).”

such as “did you perceive crowding” and visitor’s evaluation of overall satisfaction. Survey respondents are asked to rate the acceptability of a wide range of social conditions in order to measure visitor’s perception of crowding and personal norms of visitors. Therefore, the selection of measurement approaches depends on a variety of contexts including area characteristics, use level, length of survey and budget restraints.

In recent years, alternative crowding and encounter-norm measurement approaches were developed to identify social carrying capacity, namely verbal (i.e. respondents are asked to evaluate a range of encounters with other groups per day along trails) and visual approaches (i.e. respondents are asked to evaluate a series of photographs with different use levels), long and short question formats, and evaluative dimensions. Computer-edited photographs are often used as a visual representation of particular scenarios as an alternative to the written or narrative descriptions.

Manning et al. (1996) successfully applied this visual approach and highly recommended the use of visual presentation especially in areas with high use levels. Contacts between visitors are measured by (a) actual contacts recorded by a participant observer, (b) reported encounters by respondent after their trip (respondents were asked to indicate the number of other visitors they remembered seeing) and (c) diary methods [Shelby, 1980].

The diversity of approaches reflects the complex relationship between various variables influencing the perception of crowding. Thus, measurement approaches have to be adjusted to the specific area’s setting attributes, activity types and use intensity.

3.5.1 Actual and global crowding measurement

Two different types of crowding measures dominate the recreation literature 1.) actual measures and 2.) global measures of perceived crowding [Arnberger and Haider, 2007a]. The actual measurement approach is documented in several empirical studies investigating the relationship between actual density and associated perception of crowding [Shelby et al., 1989, Vaske and Shelby, 2008]. The measure combines descriptive information about the current use level within the area with evaluative information gathered by on-site interviews (i.e. “How crowded do you perceive the area now?”). In contrast, the global measure is an aggregation of crowding perceptions over a larger spatial and /or temporal unit perceived by individuals [Stewart and Cole, 1999]. Visitors are asked to combine past experiences within the area to one single overall evaluation (i.e. “How crowded do you perceive the area usually on workdays/on weekends?”). Arnberger and Haider (2007a) examined intra-individual differences between global and actual measures of crowding in an urban forest in Austria. This study’s findings showed that global evaluations of perceived crowding are consistently higher compared to actual measurements independent of the survey day.

3.5.2 Verbal and visual approaches

Most of the studies apply a univariate approach instead of treating the recreation experience as a multi-attribute good [Arnberger and Haider, 2007b]. Visual approaches are used to overcome this constraint by using digitally manipulated images to investigate crowding. These have been widely used over the past few years [Manning et al., 1996, Manning et al., 1999, Manning et al., 2000, Needham et al., 2004, Sterl et al., 2004, Laven et al., 2005, Arnberger and Haider, 2007b].

Image capture technology is applied to create hypothetical illustrations of recreational use within the area and show respondents an illustration of use condition. The visual representations of landscape and related social and managerial settings provide a realistic and accurate depiction of potential settings and future conditions with computer aided design. Manning et al. (1999) especially recommends the adoption of visual approaches in settings of high use levels. As each measurement approach has advantages and disadvantages, their application should be adjusted to the context. For example, a traditional study design might be appropriate in wilderness areas. In contrast, visual research methods are more adequate in complex high-use urban settings with diverse visitor groups where social conditions are difficult to describe in narrative formats [Arnberger and Haider, 2007b, Manning, 2007].

As the content of images is identical across all respondents variations in individual's minds are avoided, in contrast to designs where recreation scenarios are presented verbally [Behan et al., 2001]. In detail, the advantages of visual research methods are (a) a provision of additional pertinent information to respondents including a presentation of potentially important characteristics of those encountered, (b) an overcoming of the limitation of verbal descriptions to capture the complexity of recreation experiences in high density situations, (c) in high-use areas it might be unrealistic to expect respondents to accurately judge the maximum acceptable number of visitors or groups of visitors and (d) a direct and exclusive focus on the variable under study [Hall and Roggenbuck, 2002, Manning et al., 1996, Manning, 2007].

There are also limitations to visual research methods, in that (a) visualisations are not capable of displaying all relevant characteristics of visitor use, (b) they are only static presentations of the setting, (c) they are more time consuming to evaluate during a survey and (d) may overburden respondents [Manning et al., 1996, Manning, 2007]. When constructing visualisations it is essential to consider the landscape perspective of photographs.

Also "starting point bias", namely impacts that the order of the questions or the timing of the survey have on the responses given, and also the placement of visitors within an image (individuals in the foreground of study photographs have been found to influence acceptability ratings to a greater degree than individuals in the

background) are subject of this methodological discussion [Manning et al., 2001]. Different evaluative response scales are used, such as acceptance, preference or absolute tolerance. The results of these acceptability ratings are generally plotted on a social norm curve to determine standards of recreational quality.

3.5.3 Multivariate measurement approaches

In recreation research, attribute-based methods have been applied to study visitors' preferences and choice behaviour concerning a wide range of issues. "Conventional survey techniques often fall short of uncovering the multivariate nature of visitor preferences for wilderness experiences and can therefore, be of limited value when facing complex management decisions [McCormick et al., 2004] (p. 13)." Nevertheless, stated preferences and choice methods receive less attention in recreation research and visitor management compared with other research approaches. The strength of choice models is their predictive ability. They provide researchers and managers with foresights about how the public is likely to respond to various policy alternatives [Lawson et al., 2006].

Respondents are asked to make a series of discrete choices between competing configurations of multi-attribute scenarios, for example respondents may be asked to choose between alternative recreation setting profiles where each profile is described by varying levels of visitor use density.

Aggregation and statistical analyses of respondent's choices are used to estimate preferences for the level of the presented attributes and the relative importance of each attribute [Bullock and Lawson, 2008]. "Recent research has used stated preference techniques, such as stated choice and conjoint analysis, to develop quantitative estimates of the relative importance visitors place on selected attributes of the wilderness setting and the extent to which they support alternative management practices designed to optimise tradeoffs related to wilderness management [Lawson et al., 2006] (p. 575)."

Multivariate measurement approaches, often apply digitally, manipulated images to portray realistic descriptions of the setting including visitors' management preferences for protected area management scenarios [Newman et al., 2005], social carrying capacity of an urban park in Vienna [Arnberger et al., 2004, Arnberger, 2005, Arnberger and Haider, 2007b], visitors' preferences for managing visitor use of a national park icon site [Bullock and Lawson, 2008] and visitors' preferences for lake management scenarios [Smyth et al., 2009].

3 *A theoretical overview of social carrying capacity*

4 Applying social carrying capacity to outdoor recreation management

“Appropriate planning frameworks can help to avoid unnecessary impacts, duplication, and lost opportunities to ensure optimal benefits flow from public lands [McCool and Clark, 2007] (p. 1).”

4.1 Integrating carrying capacity research into NP management

Since the 1960s, the U.S. National Park Service (NPS) and the U.S. Department of Agriculture (USDA) Forest Service have initiated a series of research projects to identify recreation carrying capacities [McCool and Clark, 2007]. The concept of carrying capacity has been used to develop management frameworks for national parks to deal with increasing numbers of visitors, resource degradation and a decrease of experience quality. The added human component in terms of overcrowding and conflicting uses, has broadened the concept of carrying capacity from a purely biological one to a complex issue with both biological and social components.

Therefore, management frameworks require two major elements: (a) description of the relationship between specific conditions of use and (b) value judgement of the acceptability of various impacts. In order to transfer the theoretical concept to a management framework it is crucial to determine how much impact is excessive and which decline or change is acceptable or appropriate, before management interventions are necessary.

In the early days of empirical recreation research, carrying capacity was interpreted in terms of finding a definite number of users, which an area could support. As a consequence, exceeding this number would result in unacceptable impacts. For example, in 1972 the authority of Grand Canyon National Park established a threshold for water rafting on the Colorado River, without evaluating the relationship between visitor use and its impacts. Schreyer and Roggenbuck (1978) concluded that such use-limits tend to be based on educated guesses rather than upon hard data and firm criteria.

Contemporary research shows that the absolute number of visitors is not the only indicator. Establishing a “magic number” will even fail to control, reduce or mitigate impacts. Factors such as season of use, party size, length of stay, mode of travel and visitor behaviour were often more important in explaining impacts than the amount of use alone [McCool and Lime, 2001].

4.2 Application of carrying capacity frameworks in the U.S. National Park system

Originating from collaboration between researchers, NPS staff and national non-governmental organisations, carrying capacity has been embodied in recent park planning and management frameworks in the United States. Since the 1970s, a large body of management frameworks has been developed, addressing issues such as recreation carrying capacity, visitor use that causes stress on natural resources, methods to determine appropriate levels and conditions of recreation use, etc. (see Nilsen and Taylor (1997) for a comprehensive review of development history). Several “management by objectives” programs, including the most commonly applied Recreation Opportunity Spectrum (ROS), Limits of Acceptable Change (LAC) and the Visitor Experience and Resource Protection (VERP) have been used in North America (see Table 4.1, p. 47).

These programs help to define the amount of changes within the setting to be allowed by means of standards or limits and are accompanied by long-term monitoring programs to ensure a minimum acceptable resource condition [Manning, 2004]. Despite distinctions in matters of terminology and sequencing, the frameworks share the same basic logic and common procedure (see Figure 4.1, p. 48). At the very beginning of the implementation process, it is essential to formulate management objectives and desired future resource conditions. In this management context, objectives are broad, narrative statements, which define the degree of resource protection and the type of visitor experience to be provided [Manning et al., 2001]. Associated indicators relating to physical, ecological and social impacts must be carefully selected and underlying standards have to be specified and established. These indicators of experience and resource conditions must be measurable, manageable variables that reflect the essence or meaning of management objectives. For example, indicators can be quantifiable measures of minimum acceptable visitor use conditions related to established management objectives.

Adequate monitoring techniques are used to supervise the indicator variables and determine, if management measures have to be implemented in order to keep conditions within standards. An effective framework is generally applied to (a) identify tradeoffs between the provision of a high recreation experience and protection of natural values, (b) address the complexity of recreation use within the area and (c) accommodate the stakeholder’s interest in the specific area or issue [McCool and Clark, 2007]. Concepts and frameworks for the management of multi-purpose open access resources in North America provide a rational, structured process for supporting decisions. All frameworks use the carrying capacity model by examining the level and type of recreational use that can be accommodated in a park or related area, without violating standards for relevant social and ecological indicator variables [NPS, 1997]. These frameworks follow the steps of standard rational planning, terms of reference, database development, situation analysis, synthesis, objectives, alternatives, final plan, and implementation, which are typical in the

<p>1. Recreation Opportunity Spectrum (ROS) The ROS was developed by researchers working for the USDA Forest Service to deal with the growing recreational use of scarce resources, and legislative directives that stipulated for an integrated and comprehensive approach to natural resource planning [Manning and Lime, 2000, McCool and Clark, 2007]. The opportunity spectrum includes recreation qualities such as nature attributes, activity options within the area and measures and regulations created by management. The variation of attributes and their parameters offer different recreation settings in which visitors can derive various recreation experiences [Clark and Stankey, 1979]. The main objective is to define the range of opportunities for expected experiences within the area (“primitive to urban”) and provide guidelines for the local management [Nilsen and Tayler, 1997].</p> <p>2. Limits of Acceptable Change (LAC) This process focuses on adequate management of inevitable recreational impacts. The procedure requires managers to define limits of acceptable changes by means of most appropriate and acceptable resource use level and social conditions. If necessary, area management implements proper measures to protect and maintain appropriate conditions [Frissell and Stankey, 1972, Stankey et al., 1985].</p> <p>3. Visitor Experience and Resource Protection (VERP) This framework is an adaptation of LAC by the NPS, focussing on visitor use, their impact on the quality of the experience and on natural resources. It is characterised by a stronger consideration of social aspects such as visitor behaviour, number of visitors and spatial and temporal distribution of recreation use [NPS, 1997, Manning, 2007].</p>
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Table 4.1: Overview of most commonly used frameworks in North American national parks

U.S. planning context. In each approach a hierarchy of decisions that need to be made is recognised. They range from inventory and analysis to the development of a management concept (strategic decisions), and subsequently, implementation and operations (tactical decisions) [Nilsen and Tayler, 1997].

Surprisingly only a few applications of the described frameworks can be found in the European context. Exceptions include the development of a research-based management plan for tourism and recreation based on ROS for Svalbard/Spitsbergen in Norway [Kaltenborn and Emmelin, 1993], an implementation of VERP as part of its visitor management plan the Austrian Gesäuse National Park [Zechner, 2007] and an application of ROS for planning and zoning for Blekinge Archipelago Biosphere Reserve in Sweden [Ankre, 2009].

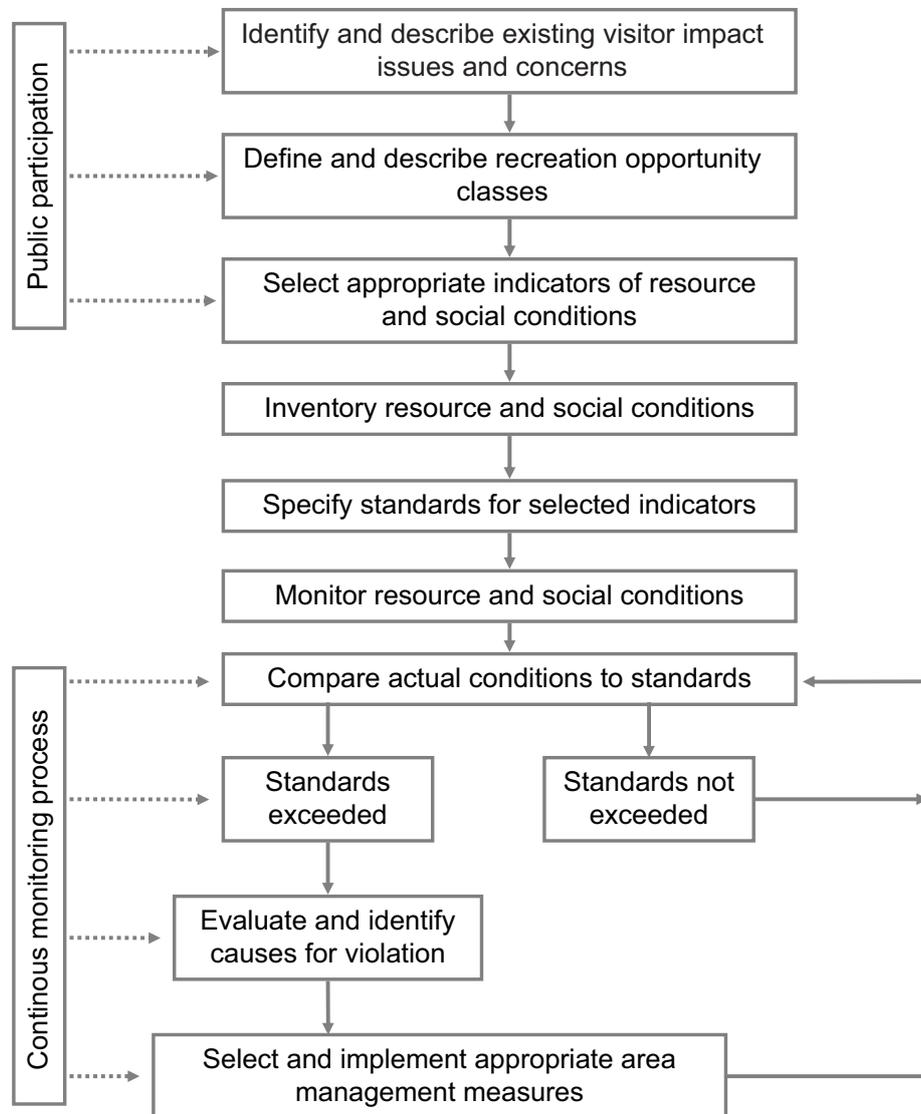


Figure 4.1: Procedure of planning and management frameworks (Adapted from [Marion, 1991, Farrell and Marion, 2002])

5 Congestion in European National Parks

Studies into recreational crowding undertaken in European national parks are based on experiences of North American research on crowding effects [Arnberger and Brandenburg, 2007]. When comparing these studies, it is important to emphasise differences in visitor management of national parks and the definition of the term national park' on both continents. The U.S. national parks have more than 100-years of history, including the idea of wilderness and the solitude experience. In comparison, the situation in Central Europe is different. Small national parks are located close to metropolitan areas and are generally open to the public who are invariably faced with various kinds of recreational activities and high visitor numbers [Haider, 2006, Arnberger and Mann, 2008]. In contrast, most studies in North America have been conducted in remote and lightly used national parks and wilderness areas.

In recent years, a small quantity of research has been carried out in Europe and only a few studies which utilise crowding measurements can be found. The research focus has been more strongly placed on ecological impacts of recreational use rather than on social impacts. In Scandinavian countries, such as Finland and Sweden, recreational use of protected areas is monitored on a regular basis and questions concerning crowding perceptions of visitors are included [Fredman and Hörnsten, 2004]. In Austria, the research in urban forest recreation is well developed [Arnberger and Haider, 2007b].

As large wilderness areas are non-existent in the European context, most studies have been undertaken in rural, suburban and urban areas. Arnberger and Mann (2008) in their review of recent research of crowding in European forests examined 16 studies. The research was generally carried out in North and Central Europe while issues of crowding were not outlined in Southern or Eastern European recreation research. Studies on beach carrying capacity in Portugal and Spain are exceptions [da Silva, 2002, Jurado et al., 2009].

Based on literature review, nine studies were identified in the context of European national parks. Table 5.1 (p. 50) summarises research location, methods, surveyed user groups and season of the crowding studies. Two studies were conducted in Scandinavia (Finland and Sweden), six in Central Europe, namely Austria, Germany and Switzerland and one study in Western Europe (UK). With the exception of the Scandinavian protected areas the eight other parks are located in the vicinity of metropolitan areas and can be reached within a day trip. In comparison to North America, national parks in Europe where crowding studies were conducted are relative young. Two areas were established in the 1980s, three in the 1990s and the remainder after 2000.

5 Congestion in European National Parks

Location	Country	Established	User	N	Author
Urho Kekkonen	Finland	1983	Backpacker	311	Saarinen (1998)
Norfolk Broads	UK	1988	Boater	209	Brouwer (1999)
Fulufjället	Sweden	2002	All visitors	1271	Fredman & Hörnsten (2004)
Müritz	Germany	1990	Canoeist	285	Grossmann et al. (2004)
Danube Floodplain	Austria	1996	Canoeist	139	Sterl et al. (2004)
Wadden Sea*	Germany	1985	All visitors**	260	Kalisch & Klaphake (2007)
Gesäuse	Austria	2002	All visitors	527	Arnberger et al. (2009)
Jungfrau- Aletsch*	Switzer- land	2001	All visitors	415	Kernen et al. (2010)

*UNESCO World Heritage Site

**Survey was undertaken on the island of Hallig Hooge

Table 5.1: Studies in recreational crowding in European national parks

What these parks hold in common is that recreational activities have had a long tradition in these areas. For example, the development of tourism infrastructure at the German North Sea coast already began on the Wadden Sea islands in the 19th century. When comparing user groups, three of the studies focused on congestion in boating areas [Brouwer, 1999, Grossmann and Klaphake, 2004, Sterl et al., 2004], while the others surveyed all relevant user groups within the area. In contrast to the North American situation, carrying capacity research in Europe did not come into play until the 1990s. Two identified studies were conducted in 1990s, the majority in the last ten years during the summer season between spring and autumn. Data on visitor use and perception were gathered by using on-site surveys within seven areas (see Table 5.2, p. 53). Only two surveys used a mail-back enquiry. Whereas issues of overuse and visitors' encounter perception were the central research objectives of almost all studies, differences existed in the application of the scale type. Crowding scales range from four-point to traditional nine-point scales measuring actual crowding perception at the time of the visit. Arnberger and Brandenburg (2007) also included the relevance of past experience and a global perception of crowding, as their study area was located near Vienna and used by many local visitors.

Three studies used an alternative approach to analyse the acceptance for different encounter levels by integrating a visual approach. Respondents were asked to rate the acceptability of hypothetical use level scenarios, depicting different number of canoeists on the Danube river [Sterl et al., 2004], visitors on a North Sea island trail [Kalisch and Klaphake, 2007] and visitors of a trail in the Aletsch forest [Kernen et al., 2010].

70% of respondents in the Danube Floodplains NP evaluated the scenario depicting three canoes as the least pleasant and overcrowded situation. On the North Sea Island and the Aletsch forest, between 6 to 10 visitors in a scenario depicting a 100 m section of the trail were found to be acceptable to the majority of respondents. In general, the study findings highlighted the relationships between the perception of crowding and number of encounters [Fredman and Hörnsten, 2004, Grossmann and Klaphake, 2004, Arnberger et al., 2009], group size [Saarinen, 1998, Sterl et al., 2004], location within the area [Grossmann and Klaphake, 2004], type of visitor [Kalisch and Klaphake, 2007], past on-site experiences of visitors [Arnberger and Brandenburg, 2007] and visitors' expectations for encountering other visitors [Arnberger et al., 2009].

When summarising the findings of the nine studies, a break point in visitors' preference for use level in the Swedish national park can be observed, where 60% of the respondents felt crowded at 50 perceived encounters [Fredman and Hörnsten, 2004]. In addition, Grossmann et al. (2004) found that the probability that a person perceives the effects of congestion negatively is significant higher with higher boat density levels. The results of visitors' encounter preferences showed that the response to encounters with other users was dependent on group size, as encountering large groups were less pleasant [Saarinen, 1998, Sterl et al., 2004]. More than the half of all respondents considered the encounter of other boat users in the Norfolk Broads as a problem. 8% even thought that the number of boats was a very serious problem [Brouwer, 1999]. The location within the canoeing area at Müritzer NP had an influence on the perception of crowding, as 55% of the respondents perceived a problem with the number of canoes encountered during paddling and only 30% perceived a problem with overcrowded resting and portaging sites [Grossmann and Klaphake, 2004].

The relationship between the perception of crowding and different visitor types was documented in the study of Hallig Hooge where independent visitors were found to be more sensitive to high visitor numbers when compared to organised visitors. In comparison 15% of organised trips and 31% of independent visitors experienced disturbance due to the number of other visitors [Kalisch and Klaphake, 2007]. The past on-site experiences of park visitors have been found to be an influencing factor, as respondents with more on-site experience (generally people who live in the vicinity of the area) expressed a greater impression of congestion [Arnberger and Brandenburg, 2007]. When asked about their expectations for encountering other visitors, Arnberger et al. (2009) observed that more than one third of respondents expected fewer visitors during the trip and 18% expected to encounter more visitors.

5 Congestion in European National Parks

Overall, in the European studies the percentage of respondents who reported some degree of crowding range from 20 to 70. Results are not comparable because of the utilisation of diverse crowding measurement approaches, heterogeneous user groups and different types of locations.

Method	Objectives	Crowding scale	Results	Author
On-site	Preference for encounter Effect of different user groups in encounter situations	Five-point (prefer to contact to prefer not to contact other visitor)	80% prefer contacts with others Encountering large groups was less pleasant	Saarinen (1998)
On-site	Perception of boater density	Five-point (number boats not a problem at all to very serious problem)	More than 50% considered the number of boats somewhat of a problem	Brouwer (1999)
Mail- back	Measurement of crowding perception Preferences for encounters while hiking	Nine-point (not at all to extremely crowded)	25% reported some degree of perceived crowding (3-9 on scale) If the number of encount- ers exceed 50, perceived crowding increases	Fredman & Hörnsten (2004)
On-site	Perception of boater density	Four-point (too many boats - agreement)	Negative perception of boat density by visitors ranges from 30 to 70%	Grossmann et al. (2004)
On-site	Measurement of crowding perception Acceptance of maximum numbers of encounters (visual)	Five-point (encounter very few to very many visitors)	40% indicated that the number of canoeists seen during the trip was neither very many nor very few Six encounters per trip determined to be acceptable	Sterl et al. (2004)

Table 5.2: Objectives and results of crowding studies in European National Parks (PART I)

Method	Objectives	Crowding scale	Results	Author
On-site	Measurement of crowding perception	Four-point (global measurement from not at all crowded to crowded overall)	36% felt the park to be generally crowded or crowded at specific times or places More than 50% of local, regular visitors rated the park as crowded (per date and location)	Arnberger & Brandenburg (2007)
On-site	Relevance of past experience			
On-site	Perception of visitor density	Five-point (experienced to not experienced crowding)	20% of all respondents did feel disturbed by the number of other visitors Between 6 to 10 visitors	Kalisch & Klaphake (2007)
	Evaluation of the acceptability of different use level scenarios (visual)		(number of people depicted on trail section) seem to be acceptable	
Mail-back	Perception of visitor density	Seven-point (empty to very crowded)	23% reported some to high degree of crowding during weekends	Arnberger et al. (2009)
	Expectation for use level		36% expected fewer visitors during their trip	
On-site	Pleasantness of maximum numbers of encounters (visual)	Seven-point pleasantness measurement	Between 6 to 9 visitors on trail section seem to be acceptable	Kernen & et al. (2010)

Table 5.3: Objectives and results of crowding studies in European National Parks (Part II)

6 Development of dissertation research approach

6.1 Research objectives

To date research in social carrying capacity and congestion has been mostly undertaken in remote and lesser used national parks and wilderness areas in North America. Detailed knowledge of visitor use and related crowding issues in national parks in Europe and especially in Germany is rather limited [Arnberger and Mann, 2008]. This deficit is remarkable, because most large protected areas are located in the vicinity of metropolitan areas and accessible as a day trip destination for millions of day visitors. Especially in the densely populated centre of Europe the occurrence of overcrowding caused by large streams of visitors is highly likely. The research approach for a coastal national park setting in Germany is based on findings from both North American and European research. These results are adjusted and developed to the specific recreation setting.

In particular, study objectives focusing on key elements of the social carrying capacity framework are:

1. Assess visitor use levels and potential crowding effects at a tourist hotspot in a German national park setting
2. Measure, determine and analyse the relevance of congestion in Wadden Sea National Park in Germany namely at Hamburger Hallig by applying established social science methods
3. Analysing the relationship between visitors' perception of crowding, reported encounters and actual density on the trail to the Hallig
4. Provide management recommendations and social impact mitigation strategies for Hamburger Hallig

6.2 Methodology

6.2.1 Study area

The Wadden Sea between Esbjerg (Denmark) and Den Helder (The Netherlands) is a large temperate coastal wetland system containing an extensive system of tidal flats. There are various habitats with tidal channels, sandy shoals, sea-grass meadows, mussel beds, sandbars, mudflats, salt marshes, estuaries, beaches and dunes. The area provides habitats for about 2,700 marine species in the tidal zones

and at least 5,000 terrestrial species in salt marshes and dunes. All in all, in the Wadden Sea area over 2,300 species of flora and at least 4,200 species of fauna can be found [IUCN, 2009].

The German North Sea coast is one of the major tourist areas in Germany. The National Park “Schleswig-Holsteinisches Wattenmeer” (IUCN category II) was established in 1985 by state law, which was supplemented in October 1999. In addition, the coastal region together with the National Park “Niedersächsisches Wattenmeer” and the Dutch Wadden Sea was added to the UNESCO World Heritage List in 2009. The National Park is bordered on the mainland and along the coasts of the islands and Halligen by a line, which runs at a distance of 150 m seaward of the dikes and dunes. Offshore, the National Park is bordered by the 3 sea-mile line, including a whale protection area off the islands of Sylt and Amrum bordering the 12 sea-mile line. The National Park area covers 4,410 km². The islands and some of the Halligen are not included in the National Park area. Since 2004 the five inhabited Halligen of Gröde, Hooge, Langeness, Nordstrandischmoor and Oland belong to a development zone of the “Biosphärenreservat Schleswig-Holsteinisches Wattenmeer und Halligen”.

The most important economic factor for local residents of the National Park area is tourism. It contributes to 37% of people’s income on the Schleswig-Holstein North Sea coast (even more on the islands). Within the region the two main destinations in terms of number of tourists and tourism infrastructure are (a) the Nordfriesische Inseln und Halligen (see Figure 6.1, p. 57), which attract most of the tourists, primarily because of the beaches, landscape, the opportunities in the field of health tourism and the cultural features and (b) mainland locations in the administrative districts “Nordfriesland” and “Dithmarschen”. These regions have turned into tourist centres due to ferry connections to the islands, accommodation facilities and their scenic coastal landscape.

The National Park and the coastal region receive almost 2 million overnight stays and 14 million day visitors per year. “The exact amount of visitors to the park is, and will remain, unknown due to above the mentioned geographical situation with lacks a central point of entry [Gätje et al., 2002] (p. 70).” The visitor structure throughout the busy tourist season (April to October) is dominated by North Sea holiday makers (75%), followed by day trippers from outside the region (13%). Locals and other visitors account for another 12% [Gätje et al., 2002].

One of the tourist hot spots are the Northfriesian Halligen. During the summer months some of them are faced with high visitor numbers. For example, on Hallig Hooge, just 5.7 km² in size, the numbers of daytrips can reach 150,000 per year.

In this dissertation, empirical data has been collected on the Hamburger Hallig, located within national park territory. The Hallig is approximately 50 ha in area and is connected with the mainland by a 3.5 km causeway, which is open for car traffic. The dam is surrounded by 500 ha of salt marsh, which is regularly flooded in winter and occasionally in summer months. The access road is closed for traffic between November and March.

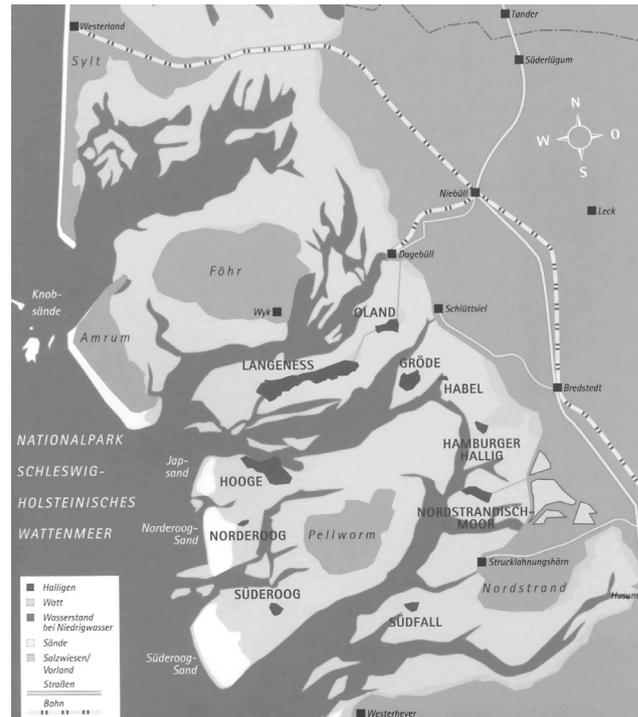


Figure 6.1: Nordfriesian Islands and Halligen [NPA, 2000]

The whole area is part of Zone 1 (“Wild area with no public access”) of the National Park and an important breeding area and resting ground for seabirds. The island can be reached easily from the mainland and constitute an important destination for day trips. The visitors are not allowed to leave the designated trails and enter sensitive areas of the Hallig and salt marshes [Gätje et al., 2002]. The main tourist activities during the season are hiking, cycling, bathing and bird-watching. Facilities for visitors are located on the mainland including an information centre (Amsinck Haus), which provides bikes for rent and on the Hallig namely a National Park Station (Wattwerkstatt) and restaurant.

6.2.2 Methods and data

The primary purpose of this study is to assess social carrying capacity and thus the identification of appropriate social indicators to measure recreation quality on Hamburger Hallig. A case study research design is used to identify various determinants of recreational participants’ crowding perception and potential conflicts between recreation groups. Primary data for the investigation was collected at an on-site survey and an accompanying visitor count. Methods for data collection and analysis included four main components:

6 *Development of dissertation research approach*

- Estimation of visitor use on the trail to Hamburger Hallig by visitor counting (direct observations)
- Design and implementation of an on-site questionnaire put to public trail users at the Hamburger Hallig trailhead (face-to-face interviews) which is based on previous research results
- Data analysis of participants' responses to variables to determine crowding effects
- Discussion of management strategies and recommendations for the Hamburger Hallig

The questionnaire was developed to obtain quantitative data about the sample population's characteristics and attitudes towards social conditions on the trail to Hamburger Hallig. The on-site questionnaire consists of three main parts: (a) general respondent profile, (b) visitors motives and experience and (c) perception of crowding effects. Part I (respondent profile) was designed to gather information about gender, age, origin of visitors, group size, mode of travel, and recreational activities. In part II (motives and experiences) respondents were asked about motives for their visit and about their experiences. Part III (crowding perception) contains a verbal and a visual approach to measure visitors crowding perception during their stay and impressions from prior visits. Reported encounters and perceived crowding were measured using an established narrative nine-point crowding scale which has been used in many previous studies [Shelby et al., 1989, Manning, 1999, Vaske and Shelby, 2008]. Respondents were asked to indicate on this scale how many visitors they encountered during their visit to the Hallig trail. In a visual survey, respondents were asked to rate eight different scenarios. The eight computer-edited photographs included four different factors. The questionnaire was limited to 3 pages, which on average took respondents no longer than 20 minutes to complete. Data was obtained from surveys administered on-site at Hamburg Hallig in spring and summer of 2009. The spring survey also included the Whitsunday weekend and working days. The summer date was chosen due to the holiday period that fell in many nearby federal states. Both dates were selected due to their expected high-use visitation. Workdays were also included to gather data also during expected low visitation periods.

During one week in May and June 2009 (May 28th to June 3rd) and one week in August 2009 (August 7th to 13th), visitors to the Hallig were approached at the National Park border, and asked to participate. Surveys were carried out according to weather conditions for each day of the week 11:00 am to 6:00 pm. All trail users returning from the Hallig were asked if they were at least 18 years of age, and if they were willing to participate in the survey. Visitors were informed that their responses would remain anonymous. The visitor survey resulted in N= 509 completed questionnaires.

7 Journal manuscripts - PART B

7.1 Manuscript 1

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“Relevance of crowding effects in a coastal national park in Germany: Results from a case study on Hamburger Hallig”

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Abstract: Coastal environments are popular sites for tourism and faced with an increasing recreational demand. Most of European coastal areas attract numerous visitors annually. In recreation research this management problem can be described in terms of carrying capacity which expresses the ability of a site or region to absorb recreational use without deterioration of natural resources and the quality of the visitor experience. As social aspects of recreation in Europe still have received little attention, the purpose of this study is to examine the applicability of the concept of social carrying capacity in a German coastal national park. The article addresses if the relationship between perceived visitor encounters, crowding perception and visitor characteristics is applicable by using data from an on-site survey (N=509) of visitors conducted on Hamburger Hallig, Germany. It examines whether effects of overcrowding are measurable on a popular day trip destination with established approaches. Results demonstrate that visitors to Hamburger Hallig are characterised by a heterogeneous visitor composition of local residents and domestic tourists with different motivations and who mainly visited the area for hiking or cycling. Study findings show that valuation for reported encounters and perceived crowding differed substantially among origin of visitors and sampling dates. All in all, respondents report a high level of encounter with others and in contrast a very low level of perceived crowding.

Keywords: *Social carrying capacity, crowding effects, reported encounter, Wadden Sea National Park, on-site survey*

1. Introduction

Worldwide, coastal recreation areas are encountering a growing number of visitors. These areas are very popular recreation settings because of the diversity of landscape, aesthetic attributes and their high potential for various leisure activities. Growing demand and participation in outdoor recreation activities creates an increased pressure on sensitive coastal and marine ecosystems [Sowman, 1987]. An increase in environmental pressures due to social and ecological impacts may lead to a degradation of natural resources. Increasing use has generated concerns about the ability of these areas to sustain acceptable levels of ecological and social impacts during high season.

Due to the increase in recreational activities during the 1950s, management responsible for protected areas had to begin to consider the physical impacts of recreation on the environment and to react to interactions between different recreation users. The sustainable management of coastal resources is an important policy goal, as coastal recreational areas are, in most cases, protected areas of national and international importance. The quality of visitors' experiences is dependent on the conditions or settings within the area. Thereby, the local management influences the quality of experience to a substantial degree, by controlling environmental and social conditions [Cole and Hall, 2009]. Social and ecological impacts are making it more difficult for the responsible authorities to fulfil their dual mission; to provide resources for the enjoyment of visitors while protecting natural resources for future generations. Recreational use induces different impacts on nature, the regional economy and the overall experience of the visitors. While the ecological impacts of tourism in protected areas around Europe and the economic effects of tourism on local communities are well documented, studies on social impacts in terms of social carrying capacity are rare.

High visitor numbers and the perception of crowding can decrease a recreational experience and reduce the public benefit of outdoor recreational participation. The appropriateness of certain use levels within the areas varies between different visitors. One visitor may seek encounters with nature in pristine landscapes without other visitors and the same individual may accept the presence of other visitors at another location. Crowding perception is defined as a negative evaluation of certain density or number of encounters with other visitors in a recreation area [Shelby et al., 1989]. The concept of social carrying capacity refers to the amount and type of visitor use that can be appropriately accommodated within a national park or recreation area. Pigram and Jenkins (1999) defined social carrying capacity as maximum level of recreational use above which there is a decline in the quality of recreational experience from the visitor individual perspective.

Carrying capacity issues concern not only the number of tourists, visitor flows and spatial patterns of concentration and the functioning of ecosystems, but also the quality of visitors experiences [EU, 2001]. In Central European coastal areas and islands, the tourist season has a rather limited duration, usually no more that a few

months. The increased number of arrivals and of overnight stays during high season may result in significant pressures on the environment resources and the visitor experience. Until now, knowledge of social impacts of recreational use in European coastal settings is limited and only a few studies have been undertaken, such as assessing recreation carrying capacity of coastal resort [Sowman, 1987], recreational use of beaches of the metropolitan region of Barcelona, Spain [Breton et al., 1996], beach carrying capacity in Portugal [da Silva, 2002], perception of crowding on an island in Wadden Sea National Park, Germany [Kalisch and Klaphake, 2007] and measurement of beach carrying capacity in Malaga, Spain [Jurado et al., 2009].

In Germany, the occurrence of crowding effects in coastal recreational settings and their possible implications for recreation quality are not recognised as an issue for research or concepts of visitor management in protected areas. To fill this research gap, this study was undertaken in the German part of the North Sea coast. Each year the National Park “Schleswig-Holsteinische Wattenmeer”, which covers the main proportion of the German Wadden Sea area, attracts millions of visitors. The main holiday destinations are the islands (i.e. Sylt) and small Halligen located a few kilometres off shore. Whereas the islands are popular for overnight stays, the Halligen are primarily day trip destinations. To manage visitor use during high season, the National Park authority has developed concepts for visitor management including guiding visitors and providing visitor information systems.

The study used an on-site survey on Hamburger Hallig to analyse the adaptability of the concept of social carrying capacity and to evaluate recreational use in a German coastal national park. It examines whether effects of overcrowding are measurable on a popular day trip destination with established approaches. A second goal is to evaluate how visitor characteristics such as experience, motive and type of activity differently influence visitors’ attitudes towards ideal recreation conditions within the area. A comparison with results of North American and European research is used to highlight differences in crowding perception. The findings of this research are expected to support the local government of Hamburger Hallig in developing adequate management measures based on reliable data, with the aim of providing a high quality visitor experience. It is also expected to increase awareness of crowding effects that could result from high visitor use level. The study identifies areas of concern and interest that should be communicated to various stakeholders involved with managing the area and also to users of Hamburger Hallig.

The article is made up of four parts. To begin, it reviews the relevant literature on social carrying capacity and crowding effects. The second section is a presentation of the underlying research method and data analysis techniques. This is followed by a discussion of the summary of the study findings. Next, the results are compared with findings from North American and European crowding recreation research. Finally, theoretical and managerial implications are concluded.

2. Conceptual background

2.1. Carrying capacity in outdoor recreation

Since the 1960s the concept of carrying capacity is employed in relation to management of habitats and ecosystems and to management of tourism in protected areas [Seidl and Tisdell, 1999]. Since the 1970s, early studies of outdoor recreation examined carrying capacity in U.S. National Parks [Manning, 2007]. The concept was first applied to national park management when increasing numbers of visitors started to become a concern. A review of North American literature in recreation research suggests that crowding effects or congestion and potential overuse in terms of visitor numbers in national parks are consistent issues.

In the last 30 years this early work on carrying capacity has developed into an extended body of literature on the resource and social impacts of visitor use and the application of social carrying capacity [Graefe et al., 1984, Shelby et al., 1989, Vaske and Shelby, 2008]. As recreational crowding is analysed and studied from different scientific viewpoints its theoretical foundation is based on two paradigms in social psychology: 1.) stimulus overload and 2.) social interference [Gramann, 1982]. The concept of the stimulus overload suggests that the perceptions of crowding effects are greatest when the level of social stimulation is excessive [Stokols, 1978]. In the social interference model, negative perceptions of density are due to perceived interference with visitor's desire (i.e. solitude, stress relief, social interaction) or individuals spatial requirements [Gramann, 1982]. Early recreation research in U.S. national parks supposed that perceived crowding was primarily influenced by the amount of visitors encountered during a visit and that the negative evaluation decreased recreational quality. By contrast, this previously assumed relationship between perceived crowding and visitor satisfaction has been shown to be generally weak or even non existent [Manning, 1999]. Following research broadened these findings and showed that the phenomenon of crowding is much more complex and is affected by specific variables (see Table 7.1, p. 63). Researchers found that the occurrence of crowding effects is influenced by use levels, site characteristics, personal characteristics of visitors, and visitor activities [Manning, 1999, Vaske and Donnelly, 2002]. In addition, these factors influencing the visitor number and social impact relationship are depending on individual variations in tolerance to social impact levels. Visitors vary and differ in their perception and response to increasing recreational use.

For example, visitors motivation for participation in recreation activities may affect their sensitivity to contacts or encounters and people seeking nature or solitude/stress release showed greatest sensitivity to crowding [Schreyer and Roggenbuck, 1978]. Visitors to recreation areas can be distinguished into more homogeneous subgroups. Many studies used a comparison of classified visitor groups (i.e. participants in different recreation activities) which are distinct from a management standpoint, such as day versus overnight users or experienced versus inexperienced visitors [Tseng et al., 2009].

Factors	Variables
Specific site characteristics	Recreation area topology and geographic features (forest versus open landscape) Accessibility of the setting (remote versus urban areas) Type and intensity of use Diversity of area's recreation activities Imposed management strategies
Individual characteristics of visitors	Expectations and preferences for contacts with others Past on-site experience Trip motivations Recreation activity engaged in Attitudes toward management measures
Characteristics of encountered visitors	Encountered activity types (interpersonal conflicts) Size and behaviour of encountered groups (i.e. seeing large parties could reduce the quality of the experience)

Table 7.1: Factors and relating variables influencing the perception of crowding [Shelby et al., 1983, Graefe et al., 1984, Manning, 1999, Vaske and Donnelly, 2002]

The perception of crowding involves a value judgement that the number of people encountered is too many [Vaske and Donnelly, 2002]. The valuation of crowding effects combines descriptive information (number of visitors per unit) with evaluative information (encountered levels experienced by individual and individual's negative evaluation of density within the area). The term reported encounters describes a subjective count of other visitors that an individual remembers observing in a setting. Perceived crowding is a subjective negative evaluation that the number of other visitor observed during the recreational experience exceeded individual preferences (Shelby et al. 1989). "Perceived crowding is a function of density, encounters, preferences and expectations, and situational definition [Shelby, 1980] (p. 45)."

Visitors compare the experienced conditions with their preference for visitor numbers and encounters [Vaske and Donnelly, 2002]. These social norms are defined as standards for a number of contacts with other people an individual will tolerate over the course of a day or trip [Vaske and Donnelly, 2002]. In recreation research three main elements that affect the valuation were identified (see 7.2, p. 64).

Indicator	Character	Definition	Measurement
Actual density	Descriptive	Number of visitors per unit	Measured by direct and indirect observations
Reported encounter	Descriptive	Subjective count of the number of other people that an individual remembers seeing in a setting	Approximation (open ended) or rating on Likert scale (close ended) by verbal or visual approaches
Perceived crowding	Evaluative	Negative evaluation of the number of encounters with others	Rating on Likert scale (i.e. 9-point crowding scale) by verbal and visual approaches

Table 7.2: Indicators of perceived crowding and their measurement [Shelby, 1980, Manning, 1999, Vaske and Donnelly, 2002, Arnberger and Brandenburg, 2007]

The descriptive component of carrying capacity focuses on objective characteristics of recreation use (i.e. types and amount of use, site factors), whereas the evaluative component focuses on determining the amount of impacts in the recreation experience which are acceptable. The evaluation incorporates a value judgement of the visitors. The concepts of reported encounters and perceived crowding have received substantial attention in the recreation literature. It was developed to estimate standards of quality for the recreational experiences and examine the extent to which these standards are being met or exceeded in a particular area [Manning, 1999, Manning, 2007].

Several approaches to measure social impacts in recreation areas are in use. Respondents are asked to evaluate a range of encounters with other groups per day along trails. In this numerical approach maximum numbers of encounters are in the focus of research interest. It measures evaluative standards of visitors (i.e. social norms) by generating social norm curves or impact acceptability curves [Manning et al., 1999]. Current research prefers a visual approach because it provides a realistic and cognitively easy assessment of indicators. Especially when use levels are relatively high, or when visitor impacts are more complex and difficult to explain, visual approaches proved to be useful. It can provide additional information to respondents that would be difficult to communicate through narrative or numerical approaches [Manning, 2007]. For example, respondents are asked to evaluate (choose, rank or rate) a series of photographs with different use levels. Different evaluative dimensions like preference, desirability, pleasantness, ideal, favourableness, acceptability, satisfaction and tolerance are in use.

In North America, several recreation studies have documented visitor conflicts and

crowding effects [Shelby et al., 1989, Vaske and Shelby, 2008]. Over the last 30 years several methods to measure crowding effects have been developed and implemented in different recreational settings in the U.S. and Canada. Research is dominated by a relatively simple measure of perceived crowding that asks visitors to indicate how crowded the area was at the time of their visit using a nine point Likert scale from 1 = not all crowded to 9 = extremely crowded [Shelby et al., 1989, Manning, 2007, Vaske and Shelby, 2008].

In Europe the social aspects of tourism and recreation have received little attention so far. Arnberger and Mann (2008) identify only 16 European crowding studies since the 1980s, primarily undertaken in North and Central Europe within rural and urban forest settings. Those exceptions are studies in Scandinavia [Fredman and Hörnsten, 2004] and Austria [Arnberger et al., 2004]. Most noticeably, in coastal recreation areas which are destinations of mass tourism (i.e. parts of the Mediterranean coast) few studies have focused on crowding effects.

3. Study hypotheses

On the basis of the arguments and previous research results mentioned above the following hypotheses were proposed and tested to evaluate crowding effects on an intensively used island in a German national park. As the study area annually receives high visitor numbers on weekends and holidays more visitors are present during this part of the season. Studies in North America and Europe showed that higher density leads to more encounters between visitors which result in higher crowding levels during peak use periods. While most recreation areas receive high visitor numbers on weekends there is a relatively low use during the week [Shelby et al., 1989, Arnberger and Haider, 2007a]. Consequently, hypothesis 1 tests the existence of variance of crowding perception by time or season of use.

H 1 - There is a significant relationship between season/sample day and perceived encounters and crowding perception. Occurrence of crowding effects varies by date or season of use.

Main activities on the Hallig trail are hiking and cycling. Therefore, it is possible that one activity group is more sensitive to crowding effects than other groups depending on their needs for a particular activity.

Vaske and Shelby (2008) examined if different activity groups perceived more or less crowding and identified substantial differences between certain activity groups when comparing aggregated data from 181 studies. Therefore it is hypothesised:

H 2 - There is a significant relationship between activity of visitor (hiker versus cyclist) and perceived encounters and crowding perception. Visitors perception of crowding effects will vary among both groups.

A pilot study conducted in 2008 showed that Hamburger Hallig is a recreation area with a heterogeneous visitor composition and high seasonal variation in visitor numbers. Arnberger and Brandenburg (2007) findings from a heavily used peri-urban protected area showed differences in crowding perception among different user groups namely local residents and tourists.

H 3 - There is a significant relationship between origin of visitor and perceived encounters and crowding perception. Local visitors are more sensitive against crowding effects than tourists.

Both place of residence and previous experience in the area are important factors when visitors evaluate a particular environmental setting and the recreational experience [Ewert, 1998]. Compared with other user groups, routine visitors of Hamburger Hallig have the highest past experience and the highest crowding evaluations. Consequently, the greater the past experience, the more visitors are likely to report crowding perceptions [Hammit et al., 2004, Arnberger and Brandenburg, 2007].

H 4 - A significant relationship is assumed between visitors' experience and perceived encounters and crowding perception. Visitors with past experience will report greater crowding perception than first-time visitors.

4. Methodology

4.1. Measurement

In this study, different methods of data collection and analysis including on-site interviews and visitor observation were carried out. The following study procedure is applied:

1. Estimation of visitor use on the trail to Hamburger Hallig by visitor counting
2. Design and implementation of an on-site questionnaire administered to public trail users at the Hamburger Hallig trailhead
3. Data analysis of participants' responses to variables to determine crowding effects
4. Discussion of management strategies and recommendations for the Hamburger Hallig

The questionnaire used on the Hamburger Hallig obtained quantitative data to analyse the sample population's observations of the visitor use levels and perceived social conditions. The on-site questionnaire consists of three main parts: a) general respondent profile, b) visitors motives and experience, and c) perception of crowding effects. Part I (respondent profile) was designed to gather information about gender, age, origin of visitors, group size, mode of travel, and recreational activities. In part II (motives and experience) respondents were asked about motives for their visit and experience with the area resulting from former visits. Part III (crowding perception) contains a narrative approach to measure visitors reported encounters and crowding perception during their way on the Hallig trail. Reported encounter and perceived crowding were measured using a nine point crowing scale which has been used in many previous studies. An ex post measurement was used to examine visitors' feelings of congestion during a given trip as an on-site experience. Respondents were asked to indicate on this scale how many visitor they encounter during their visit on the Hallig trail while they were surveyed ranging from 1 = very few other visitors to 9 = a lot of other visitors. Crowding perception was measured on the same 9-point- scale ranging from 1 = I feel not crowded at all to 9 = I feel extremely crowded.

4.2. Study area

The Schleswig-Holstein Wadden Sea has been protected as a National Park since 1985. In 2009 the coastal tidal region together with the National Park "Niedersächsisches Wattenmeer" and the Dutch Wadden Sea was added to the UNESCO World Heritage List (see Figure 7.1, p. 68). The German North Sea coast is one of the major tourist areas in Germany. Its unique coastal landscape of tidal flats, salt marsh, dunes and beaches are inhabited by specialised plants and populated by large numbers of migratory and breeding birds. The most important

economic factor for local residents of the National Park area is tourism. It contributes to 37% of people's income on the Schleswig-Holstein North Sea coast and even more on the islands. The National Park and the coastal region receive almost 2 million overnight stays and 14 million day visitors per year [Gätje et al., 2002]. One of the tourist hot spots are the Northfrisian Islands and Halligen. During the summer months some of them receive high visitor numbers. Recent research in the Wadden Sea National Park showed that crowding effects occur during high season and visitor report some degree of crowding [Riecken, 1982, Kalisch and Klaphake, 2007].

The survey was conducted on Hamburger Hallig in the center of the National Park. The Hallig has a size of approximately 50 ha and is connected with the mainland by a 4.5 km dam. The dam is surrounded by 500 ha salt marsh which is regularly flooded in winter and occasionally in summer months. The access road is closed for traffic between November and March. The whole area is part of Zone 1 ("Wildness area with no public access") of the National Park and an important breeding area and resting ground for seabirds.

Visitors are not allowed to leave the designated trails and enter sensitive areas of the Hallig and salt marsh. Main tourist activities during the season are hiking,

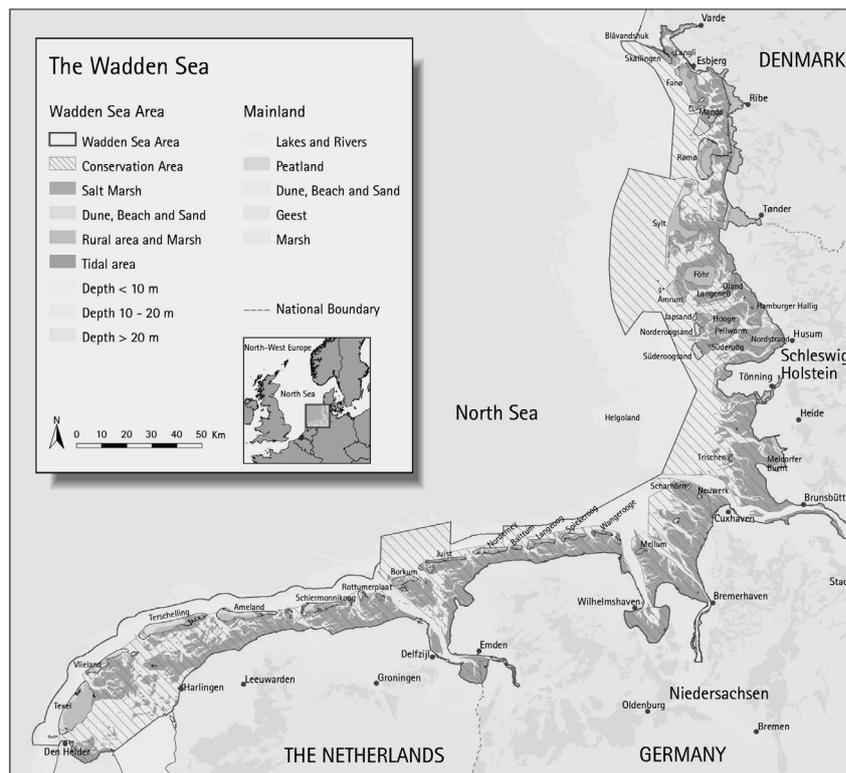


Figure 7.1: The Wadden Sea area [Essink et al., 2005]

cycling, bathing and bird-watching. Facilities for visitors including National Park stations and a restaurant are located at the main land and on the Hallig.

4.3. Sampling

Data were obtained from surveys administered onsite at Hamburger Hallig in spring and summer 2009. Both dates were selected due to their expected high-use visitation. Different days were included to compare data between highly frequented weekends with work days. The spring survey includes the Whitsunday weekend and work days. The summer date was chosen considering the holiday of nearby federal states. During one week in May and June 2009 (Mai 28 to June 3) and one week in August 2009 (August 7 to 13), visitors of the Hallig were approached at the National Park border, and asked to complete a survey onsite. Surveys were administered according to weather conditions for each day from 11:00 to 6:00 p.m. Trail users returning from the Hallig were asked if they were willing to participate in the survey. All in all, 86% of the approached visitors participated in the survey.

4.4. Data analysis

Study data were processed using SPSS to calculate descriptive statistics such as measures of central tendency, frequencies, and between-group comparisons using t-tests. A correlation was used to examine the relationship between reported encounters and visitors' perception of crowding. Differences in motivations for visiting Hamburger Hallig were explored by an independent samples t-test. Relationships between independent and dependent variables were examined using one-way analysis of variance (ANOVA). All significant chi-squares were calculated at a 95% confidence level (significant at $p = 0.05$).

5. Results

The presentation of survey results is divided into two main sections: (a) descriptive statistics of the sample population (visitor and trip characteristics) and (b) crowding effect analysis (reported encounters and crowding perception).

5.1. Description of the sample population

Table 7.3 (p. 70) gives a general summary of descriptive data. Results from perceived encounters and crowding measures are presented in the following section. In general, the population in this study ($N=509$) consisted of middle-aged visitors (mean age of 54 years), and almost 50% female and 50% male. Respondents were mainly tourist (60%) who visited the Hamburger Hallig as a day trip during their stay at the North Sea coast.

Most groups were small and the most common group size was two (modus of group size = 2 or 58.7% of respondents), the average study participant travel together with

Variable	Mean	Modus	SD	Min	Max
Age	53.28	47	13.18	16	82
Gender (0=female, 1=male)	0.50		0.50		
Group size	2.81	2	1.98	1	18
With children (0=no)	0.22		0.47		
Origin (0=place of holiday, 1=place of residence)	0.41		0.49		
Mode of travel (0=hiker, 1=cyclist)	0.66		0.47		
Holiday at Northsea (0=no, 1=yes)	0.75		0.43		
First time visit (0=no, 1=yes)	0.60		0.49		
Visits per year	9.64	1	30.66	1	300
Length of stay (in min)	146.01	120	71.53	30	390
Visiting Hallig again? (0=no, 1=yes)	0.96		0.19		

Sample size: N=509

Table 7.3: Summary of descriptive data

another adult person. Only 7 percent of people were on their own and 3 percent came in groups larger than 6 visitors. 22% of respondents were accompanied by a child. Almost 41% were local residents that live within a radius of 50 km of the Hallig. Sixty-six percent of respondents reported that they explored the Hallig by bike. The remainder of the sample were hiking.

Overall, the study sample represents a very heterogeneous population with substantial “Hallig and North Sea” experience. Nearly 75% of the tourists indicated a previous visit at the North Sea coast. 60 percent of respondents have been on the Hallig before and visit the area regularly (80 percent of the sample visits the Hallig 1 to 5 times a year). Respondents were asked to indicate the number of minutes they spend on the Hallig. The range is widely distributed (SD=71.53) and the majority of the sample remained for 120 minutes on the Hallig.

5.2. Motivation for visiting the area

Respondents were questioned on their motives for coming to the area (see Table 7.4, p. 71). They were measured on a six-point Likert scale with 1 = very important and 6 = not important at all. The most highly sought experiences were “Nature experience”, “Common getaway”, and “Get away from daily routine” as their main reason for visiting the Hallig. Motives based on education or visiting of facilities were near the mid-point rating and considered as not so important. Difference in motives for visiting the Hallig were found for the variable origin of respondent.

When comparing ratings of tourists and local residents by a t-test, four motives were identified that were significantly different: a) nature experience ($t=-2.210$, $p=0.028$), b) physical activity ($t=2.744$, $p=0.006$), c) environmental education ($t=-$

Variable	All		Tourist		Locals		t	p
	Mean	SD	Mean	SD	Mean	SD		
Nature experience	1.35	0.74	1.29	0.62	1.44	0.87	-2.21	0.03*
Common getaway	1.74	1.25	1.71	1.21	1.78	1.31	-0.65	0.52
Get away from daily routine	1.81	1.18	1.79	1.15	1.82	1.23	-0.24	0.80
Physical activity	1.82	1.07	1.93	1.11	1.67	0.99	2.74	0.01*
Nature observation	1.93	1.17	1.85	1.03	2.05	1.34	-1.74	0.08
Solitude and tranquility	2.22	1.34	2.23	1.30	2.21	1.40	0.19	0.84
Environmental education	2.72	1.63	2.39	1.36	3.18	1.87	-5.49	0.00*
Visiting cafe/restaurant	2.95	1.62	2.95	1.58	2.94	1.67	0.05	0.96
Visiting NP stations	3.39	1.62	3.14	1.50	3.77	1.71	-4.40	0.00*

Scale values ranges from 1 = very important to 6 = not important at all

**Significant at 5% level*

Table 7.4: Independent samples t-test - Motives for visiting Hamburger Hallig

5.492, $p=0.000$), and d) visiting NP stations ($t=-4.403$, $p=0.000$). Tourists reported a relatively higher importance on nature experience, environmental education and visiting NP stations, whereas locals attached more importance to physical activity.

5.3. Analysis of crowding effect indicators

This section summarises reported encounters and crowding perception of visitors of Hamburger Hallig. Both social carrying capacity indicators reported encounter and perceived crowding were measured using a 9-point crowding scale. Respondents were asked to indicate on this scale how many visitor they encounter during their visit on the Hallig trail and if they felt crowded because of high visitor numbers at the survey day. The initial proposed relationship between the “reported encounter” and “perceived crowding” was examined by Pearson’s correlation (r). The strength of association between the pair of variables is statistically significant with $r = 0.27$ (correlation is significant at a 0.01 level) and supports the theoretical model that reported encounter is positively correlated with perceived crowding.

5.4. Reported encounter and influencing factors

Based on the analysis of measurement of reported encounters on a nine point scale (see Figure 7.2), about 26.5% of the visitors report a lot of encounters (= 8-9 on the scale) on their way to the Hallig and back (mean=5.92).

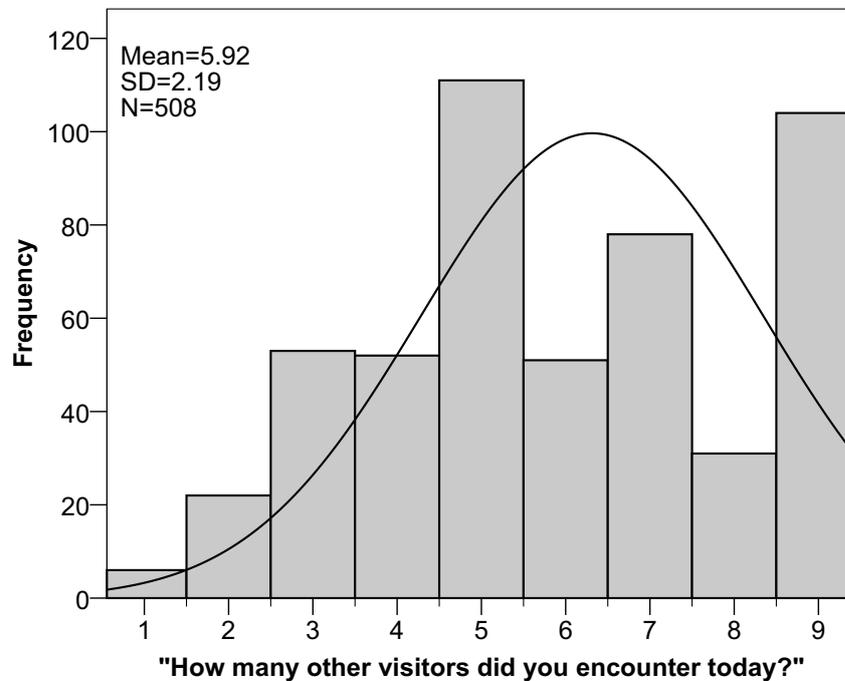


Figure 7.2: Histogram - Reported encounters during visit (1 = very few to 9 = a lot of other visitors)

In contrast, only 5.5% of all visitors state few encounters (=1-2 on the scale). A one-way ANOVA test was used whether several means for different conditions or groups are equal across one variable. It proved that ratings for perceived encounters and crowding were different for the tested factors including sampling day, activity, origin of respondents, experience and group size and if they are different from overall means. The null hypothesis is that the four tested factors means are equal to overall mean. Significant differences of the means from overall means depend on the between groups and within groups variance. A greater between-groups-variance indicates a greater likelihood of significant difference and a greater within-groups-variance indicates a reduced likelihood. The F-value is based on the ratio of these two measures. Results for analysis of variance are shown in Table 7.5 (p. 73).

Variable	Reported encounter			ANOVA	
	N	M	SD	F	p
Sampling day					
<i>Work day</i>	238	5.33	2.06	34.6	0.00*
<i>Weekend</i>	270	6.44	2.17		
Activity					
<i>Hiker</i>	171	6.13	2.28	2.5	0.12
<i>Cyclist</i>	337	5.81	2.14		
Origin					
<i>Tourist</i>	301	5.75	2.14	4.7	0.03*
<i>Local</i>	207	6.17	2.23		
Experience					
<i>First time</i>	198	5.83	2.10	0.6	0.45
<i>Frequent</i>	310	5.98	2.25		
All	508	5.92	2.19		

*Significant at 5% level

Table 7.5: Differences in reported encounters by situational and individual factors

It can be seen that while analysing reported encounters, the significance for the variables activity and experience is above 0.05 and the null hypothesis is accepted. Sampling day ($F=34.555$, $p=0.000$) and origin ($F=22.301$, $p=0.031$) differ significantly from overall encounter rating. The null hypothesis is rejected and there is a relationship between these factors and the encounter ratings. Consequently, this result supports hypothesis 1 and 3. As shown in the table, reported encounter means on weekends (mean=6.44) are considerably higher than during the week (mean=5.33). Local residents (mean=6.17) report more encounter than tourist (mean=5.75). As stated before, activity ($F=11.721$, $p=0.118$) and experience ($F=2.805$, $p=0.445$) showed no significant differences. Hypothesis 2 and 4 can be rejected for reported encounters.

5.5. Perceived crowding and influencing factors

The sample reported a very low level of perceived crowding (see Figure 7.3, p. 74). When asked if visitor numbers on the Hallig trail are a cause for feeling crowded, 78.4% answer that they feel not crowded at all (= 1-2 on the scale). The mean value of perceived crowding was 1.87 (between not at all crowded and slightly crowded). The analysis of variance (Table 7.6, p. 75) showed a significantly higher level of crowding for the factor sampling day ($F=6.053$, $p=0.014$). The mean value of the visitors crowding perception on work days was 1.69 (between not at all crowded and slightly crowded), while perception on weekends was 2.04 (slightly crowded).

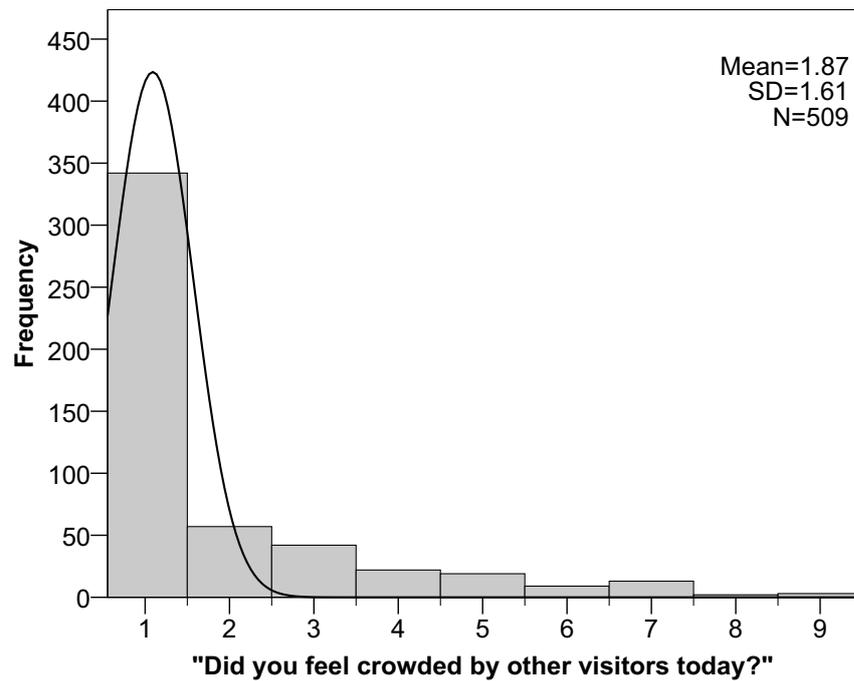


Figure 7.3: Histogram - Perceived crowding during visit (1 = not at all to 9 = extremely crowded)

This result support hypothesis 1 whereas crowding perception is higher on weekends by trend. Activity ($F=2.823$, $p = 0.094$), origin of visitors ($F=0.062$, $p = 0.804$) and experience ($F=0.853$, $p=0.356$) showed no significant differences. Hypothesis 2, 3 and 4 can be rejected for perceived crowding.

6. Discussion and conclusion

This article examined the motivation, reported encounters and perceived crowding of visitors to Hamburger Hallig in the spring and summer of 2009. It applied established theoretical and methodological approaches to evaluate the occurrence of crowding effects in this particular area of the German North Sea coast.

The study provides data on the relevance of crowding effects in a coastal National Park by applying established crowding measurement methods, namely a nine-point crowding scale [Shelby et al., 1989]. Results demonstrated that visitors to Ham-

Variable	Perceived crowding			ANOVA	
	N	M	SD	F	p
Sampling day					
Work day	239	1.69	1.4	6.1	0.01*
Weekend	270	2.04	1.76		
Activity					
Hiker	171	2.04	1.76	2.8	0.09
Cyclist	338	1.79	1.53		
Origin					
Tourist	302	1.86	1.62	0.1	0.80
Local	207	1.89	1.61		
Experience					
First time	199	1.95	1.75	0.9	0.36
Frequent	310	1.82	1.52		
All	509	1.87	1.61		

*Significant at 5% level

Table 7.6: Differences in crowding perception by situational and individual factors

burger Hallig are characterised by a heterogeneous visitor composition of local residents and domestic tourists with different motivations and who mainly visited the area for hiking or cycling. Accordingly, the study results show the relationships between situational and personal factors as well as encounter perception and crowding effects. A significant relationship was found between both indicators and the situational factor on the sampling day. Reported encounters varied over sampling time and were constantly on a high level especially during Whitsun.

Similar results were observed for perceived crowding, although results varied to a small degree. Respondents to this study seem to tolerate high visitor numbers in terms of reported encounters but did not necessarily feel disturbed by the high numbers. Even the experience of crowding effects does not necessarily result in a displacement effect as an overwhelming majority reported that they intended to return to the Hallig. Nevertheless, this does not indicate that they were content with every aspect of their experience or conditions in this area.

Based on the capacity judgement developed by Shelby et al. (1989) 21.6% of the study sample showed suppressed crowding caused by high visitor numbers (when 0-35% of respondents felt crowded). The indicator of crowding effects was calculated by collapsing points 3 to 9. A perception of crowding effects stated by 0-35% of respondents imply that crowding is likely limited by situational or natural factors and the area offers a unique low-density experience. Also, in comparison with findings of other European crowding research, respondents crowding perception on Hamburger Hallig seems to be at the low end of the scale. Arnberger and Mann (2008) showed in an aggregation of 16 crowding studies undertaken in European

forest settings that the proportion of respondents who perceived crowding ranged from 10 to 64%. Study findings correspond to findings of a study in the region in which visitors found the level of tourist activity to be acceptable. Also in a study on highly frequented Hallig Hooe in the Wadden Sea National Park the level of crowding perception seemed to be low and around 20% of respondents reported some degree of crowding [Kalisch and Klaphake, 2007]. Study results have also shown that visitors to the Hallig tend to tolerate high visitor numbers. In comparison to national and international crowding research [Vaske and Shelby, 2008] the recreational use level on Hamburger Hallig seems to be beyond social carrying capacity.

6.1. Off season versus high season

The study has demonstrated that reported encounters and crowding perception varies by time or season of use. During holidays and weekends perceived visitor encounters increased temporarily on the Hallig trail, but did not cause significant higher crowding rating on the 9-point crowding scale. All in all, respondents reported a very low level of perceived crowding even though encounter level was perceived as high during weekends and holidays.

6.2. Hiker versus cyclists

Hypothesis 2 is rejected for reported encounter and perceived crowding whereas hikers and cyclists show no difference for how they perceive condition when using the Hallig trail. The previously assumed conflict cannot be confirmed during the time the survey took place. Both recreational activity groups evaluate the trail use conditions in the same manner.

6.3. Local residents versus tourists

The personal factors that seemed to have had an effect on reported encounters included the origin of visitors. Local residents tend to rate the level of encounters higher than tourists. Arnberger and Brandenburg (2007) stated that high use levels may be seen as a threat to local residents personal recreation space and cause stronger negative evaluation of locals. Furthermore, in comparison with local residents the majority of tourists are expected to have the lowest level of bonding with the site [Hammit et al., 2004]. As Hamburger Hallig is a popular everyday leisure-time recreation area for local residents this aspect might be the reason for their sensitivity as well. No significant difference between both user groups was found while measuring perceived crowding.

6.4. First-time versus frequent visitors

The hypothesis 4, in which visitors with past experience will report greater crowding perception than first-time visitors, can be refuted. Results from previous studies showed that previous site experience was an important factor in the evaluation of

crowding effects [Arnberger and Brandenburg, 2007]. Unlike those results experienced, visitors in this study showed no significant differences from first-time visitors in reported encounters and crowding perception. An explanation might be the use of temporal displacement by frequent visitors which was expressed by respondents surveyed during weekdays. Experienced visitors adjust their use pattern and avoid a trip to Hamburger Hallig on public holidays like Easter or Whit.

Overall, research results imply that a nine point crowding scale is applicable and provide useful data about crowding perception and explaining factors. The data supported the relationship between subjective crowding perception and the time of season and origin of visitors. As the Hamburg Hallig offers great opportunities for nature tourism and experiencing the Wadden Sea National Park, its future development needs to be managed with care. So far, visitor numbers do not seem to show signs of overuse.

A unique feature of the area is that visitors can experience the Wadden Sea National Park and a Hallig without a time-consuming ferry crossing. An increase in visitor numbers may become a feature in the future given the growth in popularity of weekend trips in German tourism trends. It can also be expected that popularity will rise since the designation of the area as a UNESCO World Heritage site in 2009.

Social carrying capacity of recreational settings is managed by defining appropriate indicators and standards of quality for social conditions [Manning, 2007]. To maintain a high quality visitor experience and the ecological integrity of Hamburger Hallig, indicators and standards of quality will have to be formulated and controlled by a monitoring programme. Adequate management actions should be implemented when monitoring data show an increase in crowding effects.

Finally, the findings presented in the article are limited to ten days in the whole tourist season which itself is highly dependent on variations in weather conditions. The visitor survey was also conducted only on one Hallig/Island in Wadden Sea area. The results may not be transferable to all hot spots within the park. Based on these limitations, further empirical research is recommended to apply and evaluate the concept of encounter and crowding in German coastal areas.

7.2 Manuscript 2

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“Application of an image-based conjoint analysis approach to evaluate visitors’ preferences for recreation conditions and density in Wadden Sea National Park, Germany”

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Abstract: This article applies a conjoint measurement approach to study visitors’ preference for hypothetical recreation scenarios on the trail to Hamburger Hallig, Germany. Normative standards that visitors are expected to have about appropriate recreational use levels are measured by determining the relative importance of four situational variables. Following recent research results, an image-based conjoint analysis approach was applied to evaluate crowding perception in a German coastal national park. The purpose of the measurement is to decompose a set of factorial designed attribute bundles, so that the utility of each attribute can be inferred from the respondent’s overall evaluations. The trail conditions were depicted by digitally manipulated images, displaying combinations of different use levels with various visitor numbers, mixes of user types, presence of car traffic on trail and placement within the images. Separate conjoint models were calculated for different visitor subgroups. Relative importance values placed on the four attributes were compared to identify varying preferences for recreation conditions. Overall, number of visitors and car traffic on the trail to the Hallig influenced visitors’ ratings the most. Crowding ratings strongly increase when visitor use level is high and car traffic is included in the scenario.

Keywords: *Congestion, density, preferences, national park, conjoint analysis*

1. Introduction

Many national parks in central Europe are faced with high visitor numbers and multiple activity types causing negative social and ecological impacts. Increasing use level has generated concerns about the capability of these areas to endure the relating implications. Managers of recreation areas have to make decisions on how to maintain the integrity of the natural resources and to provide a high quality recreation experience at the same time. Various social conditions within the area such as use density, visitor composition and behaviour strongly influence the quality of the recreational experience.

Outdoor recreation literature substantially documents congestion and social carrying capacity of recreation areas in North America [Vaske and Shelby, 2008] and to an increasing extent in Europe [Arnberger and Mann, 2008]. The research shows that high visitor numbers and unwanted behaviour can diminish visitors' recreation experience as increasing use levels and encounters among visitors leads to overcrowding effects [Manning, 2007]. Most of previous studies used single-item questions to explore the perception of crowding during the stay by applying verbal crowding scales [Vaske and Shelby, 2008].

A weakness of these studies is that visitor ratings on single-item scales provide limited information about the complex phenomenon and multi-dimensional problem of crowding perception in outdoor recreation. The use of verbal descriptions based on research in North American wilderness areas may be improper to cover the complexity of high use recreation areas. Conventional survey techniques have limitations when uncovering the multivariate nature of visitor preference for recreational experience and supporting complex management decisions [McCormick et al., 2004]. For this reason, stated preferences analysis has been established in recreation and leisure research to understand how individuals make choices among competing recreational opportunities [Louviere and Timmermans, 1990]. Contemporary research in outdoor recreation management used stated preference techniques including stated choice and conjoint analysis to apply quantitative estimates of the relative importance visitors of recreation areas place on certain attributes of setting conditions [Lawson and Manning, 2002]. Several studies in recreation research have proven the usefulness of stated preference analysis in leisure context including studying the impact of user fees at public recreation patterns [Schroeder and Louviere, 1999, Morey et al., 2002], assessing the relative importance of quality indicators of rural areas for recreation purpose [Goossen and Langers, 2000], model recreation demand for rock-climbing [Hanley et al., 2002], determining visitors' preferences for recreation facilities [Perdue, 1995, Ross et al., 2003] and evaluating public preferences concerning recreational management alternatives [Lieber and Fesenmaier, 1984, Lawson and Manning, 2002, Bullock and Lawson, 2008, Semeniuk et al., 2009, Smyth et al., 2009].

Applied to the topic of crowding research, the methods have been found to provide more valid knowledge into how visitors prefer recreation setting attributes and evaluate the topic in a more holistic way by reflecting the multi-attribute issue [Haider, 2002, Arnberger et al., 2004, Lawson et al., 2006]. In addition, stated preference techniques have a predictive ability for management decisions based on the respondents' statements [Arnberger and Haider, 2007b].

Primary purpose of this study was to determine the importance of recreational attributes which are expected to influence visitors' perception of crowding. Therefore, a conjoint measurement approach was applied to identify the key attributes which are influencing the occurrence of crowding effects on the trail to Hamburger Hallig and evaluate the influence of each attribute and their levels on visitors' scenario rating.

2. Material and Methodology

2.1. Application of conjoint analysis in outdoor recreation research

In the last decades, stated preference methods are widely spread in the marketing and economics of transport literature and extended to environmental topics [Louviere and Timmermans, 1990, Hensher, 1994, Adamowicz et al., 1998]. Since the 1970s, conjoint analysis has been applied in academic and industrial context as major technique to value costumers' tradeoffs among multiattribute products and services [Green and Srinivasan, 1978]. Introduced into marketing literature (i.e. new product planning, pricing policies, advertising), conjoint measurement tasks are used to determine the contribution of the independent variables and their respective values (utilities) for the consumers' preferences of a good.

The basic idea is to decompose a set of attributes combinations so that the utility of each attribute can be deduced from the respondents' evaluation. The research technique is used to evaluate how respondents develop preferences for services and measure the trade-offs people make when making a decision. Experimental conjoint analysis estimate partial utilities or so called part-worths from aggregated individual evaluations of the stimuli's [Green and Srinivasan, 1978].

Conjoint measurement approaches have been employed successfully in the field of recreation and tourism research. In the last two decades, conjoint analysis was applied worldwide to various recreation settings including accessing the willingness to pay for individual attributes of deer-hunting trips in Delaware, USA [MacKenzie, 1990], evaluating public preferences for forest use management [Dennis, 1998], evaluating crowding norms in a marine environment at the Great Barrier Reef, Australia [Inglis et al., 1999], examine norm measurement approaches in Acadia National Park, USA [Manning et al., 1999], effect of tour jeep density on recreation benefits in Arizona, USA [Behan et al., 2001], estimating day use social carrying capacity in Yosemite National Park [Manning et al., 2003], deer hunters' preferences on hunting leases in Alabama, USA [Hussain et al., 2003], preference heterogeneity among day non-motorised, day motorised and overnight visitors in Okefenokee wilderness, USA [Lawson, 2006] and acceptance of management actions for minimising recreation impacts in coastal areas in Hawaii, USA [Needham and Szuster, 2009].

2.2. Utilisation of image-based approaches

Digital image editing technology has been used to visualise social setting conditions in terms of visitor numbers by using photos [Manning et al., 1996, Manning and Freimund, 2004, Manning, 2007, Arnberger et al., 2004, Arnberger and Haider, 2007b]. The main reason is that in high-use areas with complex interactions between different visitor types verbal descriptions might be inappropriate. Studies of visitor preferences for trail use conditions demonstrate the capability of multivariate visual

methods to describe recreation settings in a more realistic way [Arnberger and Haider, 2007b]. Computer-edited images can be used to improve a short narrative description of scenario attributes and support the respondent to have an idea about the scenarios.

There are several benefits of visual profile descriptions used to provide realistic descriptions of social recreation conditions [Green and Srinivasan, 1978, Manning et al., 1996, Manning and Freimund, 2004]:

1. Certain attributes may be difficult to describe in few words
2. Respondents may better understand and appreciate the presented options
3. Images may enhance the realism of the task
4. More attributes can be meaningfully included in the full-profile method
5. Visualisation may lead to a higher homogeneity of perceptions as it is less open to individual interpretation than written descriptions
6. More interesting and less fatiguing for respondents

Visual approaches were used in various settings, for example to study acceptable use levels at ski areas during summer in British Columbia, Canada [Needham et al., 2004], visitors' preference for alternative levels of a campsite impact attribute in Yosemite National Park, USA [Newman et al., 2005], trail impact attribute in Acadia National [Manning, 2007].

2.3. Study objectives and area

The purpose of this study was to develop a better understanding of the general preferences of visitors to nature-based recreation area in terms of crowding-related standards of quality. The study explored the relative importance of four selected attributes that are expected to influence visitor's evaluation of social conditions on the trail to Hamburger Hallig. Respondents' preferences of hypothetical scenario conditions were measured using an image-based conjoint measurement approach. By asking visitors to rate trail conditions portrayed in terms of different attributes and attribute levels, the method allows to find the relative importance of the scenario attributes under study [Green and de Sarbo, 1978].

In the study, respondents were provided with a set of eight scenarios and asked to indicate their level of preference for each scenario. The approach was applied to evaluate how each selected attribute contribute to the overall utility of each constructed scenario. The conjoint rating question required visitors to weigh among the hypothetical social conditions on the trail and reflect the relative importance visitors place on the presented attributes. Main assumption is that the total utility of a given scenario can be calculated from the sum of all partial utilities derived from the four attributes. Data base of the conjoint analysis are respondents' rating for the scenarios. In detail, study objectives are 1.) to understand the process by which visitors develop their preferences for certain recreation scenarios and perceive the situation as crowded, 2.) to evaluate the importance of relevant scenario attributes to visitors, 3.) to identify the most or least desirable levels of scenario attributes for the recreation experience and 4.) to compare the utility estimates of different subgroups of visitors.

Study area is the uninhabited island of Hamburger Hallig located in the Wadden Sea National Park in Schleswig-Holstein, a federal state in the north of Germany. In 2009 the coastal tidal region together with Dutch Wadden Sea was added to the UNESCO World Heritage List. The German North Sea coast is one of the major tourist areas in Germany and contributes to 37 % of people's income on the Schleswig-Holstein North Sea coast. The west coast receives almost 2 million overnight stays and 14 million day visitors per year. One of the tourist hot spots are the "Northfriesian Halligen". During tourist season from April to October around 100,000 people visit the Hamburger Hallig [Gätje et al., 2002]. The popular spot is visited by both tourists and locals for a day trip as it is the only possibility at the North Sea coast to experience an island/Hallig by foot. Visitors are not allowed to leave the designated trails and enter sensitive areas of the Hallig and salt marsh. Especially in summer month visitors use the dam which connects the mainland with the Hallig for a hiking or cycling tour. The 4 km long dam consists of a small road which can be used by cars and a small pedestrian path.

3. Study methods

3.1. Sample and procedure

Data were collected from visitors to Hamburger Hallig located in the German Wadden Sea during spring and summer season 2009 (N=509). The average age of the respondents was 53.3 (SD=13.18) with a modus of 47. Sixty-six percent of respondents reported that they explored the Hallig by bike. The remainder of the sample were hiking. Respondents were mainly tourist (60%) who visited the Hamburger Hallig as a day trip during their stay at the North Sea coast. Almost 41% were local residents that live within a radius of 50 km of the Hallig. Forty percent of respondents visit the area for the first time. When asked if cars should be banned from the Hallig around 53% of respondents agree.

3.2. Conjoint scenarios

During the on-site survey participants were provided with eight conjoint scenarios and were asked to evaluate them on a six-point Likert scale. Key attributes expected to influence visitors' crowding perception were identified and combined in stimuli. Then respondents were asked to rate the hypothetical recreation scenarios. The attributes were selected on the basis of crowding literature review, interviews with local stakeholders and results from a pilot study conducted in 2008. A review of literature showed the importance of certain attributes when evaluating factors influencing crowding perception. As the number of attributes determine the numbers of stimuli and four attributes relating to crowding perception were selected:

1. Number of visitors on the trail section (Attribute 1): Numbers of visitors on the trail have been found to be a vital predictor for acceptable use level conditions [Manning et al., 1996, Arnberger et al., 2004]. The density of hikers and cyclist was depicted from 3 to 12 visitors on a 150 m section of the Hallig trail. In order to present realistic visitor numbers, the maximum number of visitors in the scenario was derived from counting results during the pilot study in 2008. Following results from past research mentioned before, preference for photographs was used to measure normative standards for acceptable visitor numbers and social conditions on the trail to Hamburger Hallig. Respondents' perception of crowding is expected to increase when visitor numbers increase.
2. Presence of car traffic on the road (Attribute 2): The presence of cars on trail was chosen due to research results that visitor tend to rate less negatively to human influences as long as these influences are perceived to fit into the recreational setting [Behan et al., 2001]. To gauge visitors support for car traffic on the road a car was included in half of the scenarios. Respondents' crowding ratings are expected to be higher on scenarios with a car present.
3. Proportion of hikers and cyclist (Attribute 3): To assess potential conflicts between visitors the main user groups were portrayed in different proportions (2:1). As kind of use and characteristics of those encountered during the trip is expected to have an effect on crowding ratings, four photographs show more hikers than cyclist and four picture more cyclist than hikers [Manning et al., 1999, Arnberger and Haider, 2007b].
4. Placement of users within the image (Attribute 4): The attribute describes the placement of visitors in the fore- or background of the image. Therefore the visible trail section was divided into two equal zones. It is hypothesised that more visitors in the foreground of the image would negatively affect ratings for the scenarios due to violations of personal space [Arnberger et al., 2004].

3.3. Construction of stimuli

A part-worth utility model was selected to describe respondents' attribute preference function. For the conjoint analysis eight computer-generated scenarios were developed and each contained of four attributes. Each image showed a part of the combined road and path to Hamburger Hallig with a combination of four attributes, one with four levels and three with two levels (see Table 7.7).

Attribute	Attribute levels
1. Number of visitors on the trail to/from Hallig	3 visitors on the trail 6 visitors on the trail 9 visitors on the trail 12 visitors on the trail
2. Presence of cars on the road to/from the Hallig	Cars using the road No cars using the road
3. Proportion of hikers and cyclist	More cyclist than hikers (2:1) More hikers than cyclist (2:1)
4. Placement of visitors in the image	In the background In the foreground

Table 7.7: List of attributes and levels used in the conjoint measurement task

The number of profiles was determined to assure a certain balance between the maximisation of the extent of information obtained from the experiment and the overburden effect of respondents. To create the images GIMP 2.6-U Image Manipulation Program was used. The computer-edited colour photographs were printed in A4 (210 x 297 mm) size and combined in a booklet. Given that one attribute had 4 levels and the other two levels, $4 \times 2^3 = 32$ possible scenarios would represent a full factorial design. To generate a smaller subset of scenarios an orthogonal fractional factorial design was created by using SPSS Conjoint 17.0 Software. This step was necessary to reduce respondent burden and present a manageable amount of images during the survey. Orthogonal fractional factorial design (every combination of two attributes occurs with the same frequency in the resulting profiles) leads to eight scenarios to be evaluated by respondents (see Table 7.8, p. 85). The use of fractional factorial designs allows removing options that will dominate or be dominated by all other options. Following literature, a main effect only conjoint model ensures the absence of multicollinearity between attributes and assumes that all interactions present in the stimuli are negligible. All settings are similar in the physical appearance (i.e. image section, weather conditions) except the different combinations of attributes.

Scenario	Visitor	Car traffic	Proportion	Placement
1	6	No	More hikers	Foreground
2	9	No	More cyclists	Background
3	3	No	More cyclists	Foreground
4	6	Yes	More cyclists	Background
5	3	Yes	More hikers	Background
6	9	Yes	More hikers	Foreground
7	12	Yes	More cyclists	Foreground
8	12	No	More hikers	Background

Table 7.8: Stimuli and attribute levels

3.4. Profile presentation

The visitor survey consisted of two components. In the first part of the questionnaire visitors were asked in an on-site interview about their socio-demographic characteristics and visit-related questions including length of stay, group size, origin, activities, and motives and crowding perception. The second part included a visual approach with different hypothetical visitor use scenarios on Hamburger Hallig. Stimuli were presented in a full-profile-method and arranged in random order as starting point bias can be neglected when measuring visitors' norms [Manning et al., 2002]. Visitors got a brief explanation that the images contain a typical section of the Hallig trail with different use conditions (see Figure 7.4, p. 86). They were asked to first look over the entire set and to rate the conditions in the eight scenarios on a 6-point scale from 1 = I would not feel crowded at all to 6 = I would feel extremely crowded. By applying a rating task respondents are asked to grade their perceived benefit on a defined numbered scale. Rating scale distances are assumed as being similar for respondents and therefore preference ratings are used as metric data.



Figure 7.4: Example trail scenario (stimulus 7)

Instructions:

In the following eight scenarios you see a part of the trail to Hamburger Hallig. Each image shows a different number of hiker, cyclist and cars using the trail section. Please study all pictures carefully and then answer the following question!

Question: *Would you feel crowded by the presented number of visitors from 1 = not at all crowded to 6 = extremely crowded'?*

3.5. Model estimation

Estimations of part-worth utilities indicate the influence of each attribute on respondents' preferences. Therefore, the relative importance is calculated by composing the overall preference measure. Ordinary least square (OLS) regression was used to evaluate the results of the conjoint measurement and estimate the parameters of particular utility specifications from the rating data conditional on the design matrix of attribute levels [Louviere and Timmermans, 1990]. Effect coding was used to estimate regression coefficients [Lawson et al., 2006]. The partial utility scores derived from the four attributes reflect the importance of each attribute and its associated level.

To determine the importance of the four attributes the relationship between the attributes and utility must be specified. The most commonly used model is the linear additive model which assumes that the overall valuation or utility derived from any combination of attributes of a scenario is given by the sum of the separate part-worths of the attributes.

A part-worth function model is used in this study to describe respondents' attribute preference function. The equation is presented as:

$$s_j = \sum_{p=1}^n f_p(V_{ijp}) \quad (7.1)$$

with s_j respondent's preference for j th stimulus and f_p is the function denoting the part-worth of different levels of V_{ijp} for the p th attribute

Ratings of respondents (s_j) can be modelled as a linear combination of attributes. Overall preference for a scenario and the estimated part-worths (β_n) can be determined by:

$$s_j = \beta_0 + \beta_1[\text{Number}] + \beta_2[\text{Cars}] + \beta_3[\text{User type}] + \beta_4[\text{Placement}] \quad (7.2)$$

with

s_j = utility or rating scores for a recreation scenario with a given level of each attribute

Number = number of visitors on the trail from or to the Hallig ranging from 3, 6, 8, and 12

Cars = presence of cars in the scenario (0=No, 1=Yes)

User type = Proportion of hikers and cyclist

Placement = Placement of visitors within the image

and β_0 to β_4 = coefficients of the model to be estimated

The preferences assigned to eight stimuli were analysed with the conjoint procedure to estimate the part-worths for each level of each attribute. The estimated part-worths, analogous to regression coefficients of the linear multiple regression method, provide a quantitative measure of the preference for each attribute level, with larger values corresponding to greater preference. Part-worths are expressed in a common unit, allowing them to be added together to give the total utility, or overall preference, for any combination of attribute levels. Cases with missing values or equal ratings across all scenarios were eliminated and excluded. For example, visitors who rate all scenarios as "feel not at all crowded" were excluded from analysis.

By dividing the part-worth of an attribute by the sum of the part-worths of all attributes the relative importance value for a certain attribute can be estimated. Attributes and levels are the independent and ratings of the interviewed person for the presented scenarios variables the dependent variables. Using the regression coefficients (which are analogous to part-worth utility scores), the importance of all combinations of the four attributes and their levels were calculated.

4. Study results

4.1. Ratings for recreation scenarios

Visitors were asked to rate each hypothetical recreation scenarios in terms of crowding perception measures by a six-point Likert scale from 1 = would not feel crowded at all to 6 = would feel very crowded (see Table 7.9).

Scenario	Rating for recreation scenario (in %)					
	1	2	3	4	5	6
Scenario 1 (6/N/H/F)	56.3	21.7	14.1	4.9	2.0	1.0
Scenario 2 (9/N/C/B)	51.6	23.5	14.6	6.7	3.0	0.7
Scenario 3 (3/N/C/F)	80.5	13.6	3.7	0.7	0.5	1.0
Scenario 4 (6/Y/C/B)	16.3	18.0	28.9	18.3	10.6	7.9
Scenario 5 (3/Y/H/B)	25.7	21.2	28.1	12.3	7.4	5.2
Scenario 6 (9/Y/H/F)	10.1	11.6	23.5	22.5	17.0	15.3
Scenario 7 (12/Y/C/F)	1.7	5.7	19.8	20.7	22.7	29.4
Scenario 8 (12/N/H/B)	28.1	23.0	24.7	14.3	7.4	2.5

From 1=not at all to 6=very crowded

Cronbachs Alpha = 0.850

Table 7.9: Would you feel crowded by the presented number of visitors from 1 “not at all crowded” to 6 “extremely crowded”? (N=405)

Cronbach’s alpha was used as internal consistency statistics by estimating how consistently individuals respond to the items within a scale [Vaske, 2008]. It measures the extent to which item responses correlate with each other. The reliability analysis in this study includes respondents’ ratings for the eight scenarios. Cronbach’s alpha reliability coefficient ranges between 0 and 1. The more Cronbach’s alpha coefficient is closer to 1.0 the greater the internal consistency of the items in the scale. Overall, the analysis indicates an acceptable level of internal consistency (Cronbach’s alpha=0.850).

4.2. Conjoint measurement

In the conjoint measurement task visitors judge the value of varying recreation scenarios by combining the individual amount of utility provided by each attribute (most and least important attribute). Table 7.10 shows the utility (part-worth) scores for each attribute level, their standard errors for each factor level for all respondents, mean scenario ratings and Pearson's R model fit statistic.

All	Attribute	Level	Utility	SE	Mean
N=405	Number of visitors	3	0.845	0.018	1.795
		6	0.308	0.018	2.155
		9	-0.138	0.018	2.425
		12	-1.015	0.018	3.000
	Car	Absent	0.988	0.010	1.702
		Present	-0.988	0.010	2.985
	Proportion	H:C=1:2	0.014	0.010	2.342
	Proportion	H:C=2:1	-0.014	0.010	2.345
	Place	Background	0.171	0.010	2.440
		Foreground	-0.171	0.010	2.247
	Constant		1.033	1.018	
	Model fit	Pearson's R	0.977		

From 1=not at all to 6=very crowded

Table 7.10: Utility scores for trail conditions by attribute levels and mean crowding ratings

Conjoint analysis output provides utility scores or part-worth estimates identifying preferences for each four attribute level and percentage of average importance of each attribute. It decomposes respondents' ratings of a recreation scenario into utility scores for each attribute which represent then influence of each attribute level. In the rating task, respondents could assign the same value to two or more options, which are leading to tied pairs. Conjoint analysis eliminates cases with missing values or equal ratings across all scenarios.

All in all, 104 respondents (20.4% of overall sample) showed no variance in rating the scenarios and were excluded from analysis. Pearson's R indicates a high internal validity of the model. Sign and the magnitude of the utility estimates indicate the relevance of each attribute level on mean ratings. Higher positive utility estimates indicate greater preference for a level. In addition, high negative utility indicates a refusal of attribute level as a potential source of negative recreation experience. The magnitude and sign of the averaged utility estimates indicate the relative influence of each attributes level [Needham and Szuster, 2009].

Coefficients for the attributes “number of visitors” and “car” have the a priori hypothesised signs. Study results show an inverse relationship between visitor numbers in the scenario and utility, with higher numbers corresponding to lower utility causing negative rating. Scenarios depicting 12 visitors showed the lowest utility. The absence of a car corresponds to a high positive utility, as anticipated. The attribute “proportion of users” and “placement of visitors” within the scenario have a rather small range and are close to zero.

In the conjoint measurement task, visitor’s total preference for the presented recreation scenario is a function of her or his part-worth utilities of each attribute. Utility estimations were used to identify the most and the least preferred scenario profile [Lawson et al., 2006]. The metric total utility can be calculated as shown in the equation [Backhaus et al., 2006]:

$$Gk = \mu + \beta Am + \beta Bm + \beta Cm + \beta Dm \quad (7.3)$$

with μ = constant utility estimate,

βAm = part worth utility of level m for attribute A,

βBm = part worth utility of level m for attribute B,

βCm = part worth utility of level m for attribute C

and βDm = part worth utility of level m for attribute D.

As expected, the most preferred trail setting profile (Scenario 3) included three visitors on trail and the absence of car traffic while the least preferred setting (Scenario 7) included twelve visitors and the presence of cars (see Table 7.11).

Stimulus	Total utility	Rank (utility)	Mean (rating)*	Rank (rating)	SD
Scenario 1 (6/N/H/F)	2.285	2	1.62	2	0.045
Scenario 2 (9/N/C/B)	1.899	3	1.70	3	0.048
Scenario 3 (3/N/C/F)	2.666	1	1.24	1	0.031
Scenario 4 (6/Y/C/B)	0.495	6	2.69	6	0.069
Scenario 5 (3/Y/H/B)	1.060	5	2.35	5	0.064
Scenario 6 (9/Y/H/F)	-0.265	7	3.15	7	0.077
Scenario 7 (12/Y/C/F)	-1.170	8	3.75	8	0.081
Scenario 8 (12/N/H/B)	1.176	4	2.25	4	0.061

From 1=not at all to 6=very crowded

Table 7.11: Total utility of scenarios and ranking

Research in visitors' normative standards indicate that different subgroups of visitors to the same recreation area differentiated by trip characteristics including activity type, attitudes towards resource conditions, may have different preference for use levels [Manning, 1999]. The average relative importance of each attribute on respondents' rating for four subgroups is displayed in Table 7.12.

	Subgroups	Attribute			
		Number	Car	Proportion	Placement
	All	44.2% (2)	47.0% (1)	0.6% (4)	8.1% (3)
I	Hiker	45.3% (1)	40.7% (2)	2.4% (4)	11.5% (3)
	Cyclist	43.4% (2)	50% (1)	0.3% (4)	6.2% (3)
II	Tourist	43.9% (2)	48.6% (1)	0.5% (4)	7.1% (3)
	Local	44.2% (1)	43.6% (2)	2.5% (4)	9.7% (3)
III	Frequent	44.6% (1)	44.2% (2)	1.5% (4)	9.6% (3)
	First time	43.1% (2)	50.4% (1)	0.7% (4)	5.8% (3)
IV	Cars allowed	50.1% (1)	34.2% (2)	3.9% (4)	11.8% (3)
	Cars banned	40.0% (2)	53.0% (1)	1.2% (4)	5.9% (3)

Numbers in parentheses show the relative importance rankings of attributes

Table 7.12: Relative importance for each attribute by subgroup

It provides a measure of the relative importance of each attribute. The values are computed by taking the utility range for each attribute separately and dividing by the sum of the utility ranges for all attribute. Thus, the values represent percentages and have the property that they sum to 100. Results show that the presence or absence of a car in the scenario has the greatest influence on overall rating (47%). There is a large difference in utility scores between scenarios containing a car and those without. Number of visitors accounted for 44% of importance. While placement of visitors in scenario (8%) and proportion between hiker and cyclist (1%) were the least important attributes for the perception of crowding effects. Figure 7.5 (p. 92) shows respondents' ratings for the eight scenarios, where the number of visitors shown in the scenario is on the x-axis and the proportion of visitors rating the scenario as crowded (5 or 6 on the 6-point scale) on the y-axis. The graph document a huge discrepancy in crowding ratings for scenarios where a car is present or not. The percentage of visitors perceiving the situation depicted in the image as crowded increases with the numbers of visitors in the scenario, but there is stronger increase when cars are included in the picture (red line).

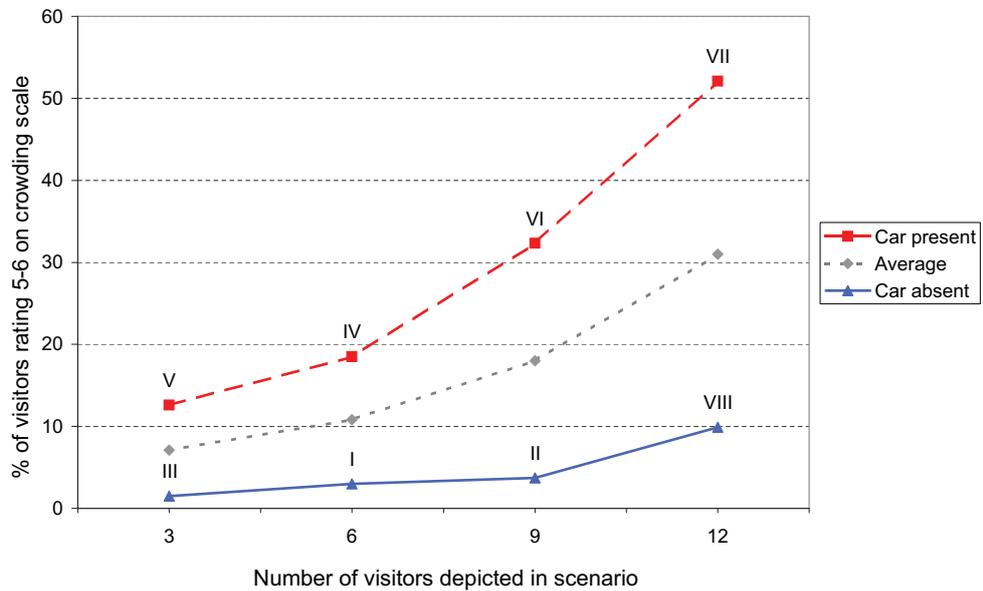


Figure 7.5: Crowding perception as a function of number of visitors depicted and percentage of visitors with explicit crowding perception (5 or 6 on response scale)

5. Discussion and conclusion

This article examines encounter and crowding perception of visitors on the trail to Hamburger Hallig. It applies an image-based conjoint measurement approach to evaluate the extent to which four selected variables influence visitors' rating for hypothetical scenario with varying social conditions. Understanding visitors' preferences for various scenario settings provide area management with information about appropriate use levels and activity types within the area.

As with research in other settings, study results show that most respondents had measurable preferences for the number of other visitors they found acceptable on the trail [Arnberger et al., 2004, Arnberger and Haider, 2007b, Manning, 2007]. Study findings detect the importance of the two attributes "number of visitors" and "presence of car traffic" influencing visitors' crowding perception on the trail to Hamburger Hallig.

All in all, the conjoint measurement approach substantiates to be an adequate method for evaluating preferences for recreation setting conditions. The method accounts for the complexity of social conditions on the trail and expose factors that influence visitors' ratings. Thereby, results provide insight into what visitors generally find to be adequate resource conditions. Consistent with previous research, the findings show that acceptability of the scenarios decrease when visitor numbers on the images increase.

Overall, respondents seem to prefer low use levels and the absence of car traffic on the trail to Hamburger Hallig. The crowding ratings strongly increase when use level is high and car traffic is combined in the scenario. Images without car traffic and displaying 12 visitors (Scenario 8) are rated as crowded by 10 percent of respondents, while crowding perception rise dramatically for the recreation setting illustrating car traffic and 12 visitors (Scenario 7). Around 52% of respondents evaluated this trail conditions as crowded. Consequently, the negative coefficients of the conjoint model support study hypothesis for the attributes "number of visitors=12" and "presence of cars".

The attribute "placement" did not influence visitors' rating to a substantial degree (8%). Previous research has shown that depicting visitors in the foreground lead to a refusal of the condition [Arnberger et al., 2004] which is supported by study findings as utility estimates for the "placement=foreground" are negative.

An implication of study findings is that there is no obvious inter-visitor conflict between hikers and cyclist on trail as coefficients for proportion of these activity groups are close to zero. The presence of car traffic was the most influential attribute for all respondents and influence crowding perception remarkably. A comparison of visitor groups shows that first time visitors and cyclists are less tolerant of the presence of cars than frequent visitors and hiker. Human elements in a predominantly natural landscape have been found to be more acceptable if the components are perceived to fit into the settings [Behan et al., 2001]. Study results indicate that the presence of cars on the trail to the Hallig seems to negatively affect non-motorised visitors' ability to attain recreational benefits and lead to increasing crowding perception. Strong positive judgements for the scenario depicting a low user density (Scenario 3) and the absence of cars suggest that privacy may be an important experience sought by visitors of the Hamburger Hallig. As visitors have been found to be sensible to site congestion an increase of user density would be evaluated as unfavourable.

Normative research of recreation in protected areas is conducted to identify a range of appropriate experiences that visitors seek and evaluate visitor standards of recreation quality to support management decisions within the area [Vaske et al., 1993, Lawson and Manning, 2002]. Each area has a range of carrying capacities depending on the type of recreation experience to be provided by local management [Manning et al., 2002]. From the management perspective social carrying capacity of Hamburger Hallig can be described rather in terms of an asymmetrical conflict of interest between motorised and non-motorised visitors than in absolute number of visitors to the area.

Study findings indicate that it seems to be feasible to increase the carrying capacity of the trail by reducing the car traffic.

5.1. Study limitations and further research

Study findings are limited to only one site in the National park region and may not be generalised to all places within the Wadden Sea area. The four scenario attributes are based on literature review, expert interviews and results of a pilot study. Nevertheless, it is possible that some salient attributes have been ignored and thus not been included in the study. Further research in the area may explore if different sets of attributes or attribute levels could lead to different results. Results also show a discrepancy between visitors' rating for the number of people in the scenarios and the actual use level during the survey. Further data analysis is needed to clarify the relationship between visitors' preferences, experiences they seek and their crowding perception.

In addition, further research might include the attitude of motorised visitors and their acceptance of potential management measures such as a strict use limit for car traffic on the trail.

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“Visitors’ evaluation of area density: Measuring crowding norms in Wadden Sea National Park, Germany”

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Abstract: Information about visitors’ evaluation of congestion and other negative impacts of visitor use levels constitutes an essential factor in the concept of a sustainable tourism management of large protected areas. This study evaluates visitors’ perception of area density and level of congestion in a popular coastal national park in Germany by applying an on-site survey. Respondents are asked to (a) evaluate social conditions in terms of congestion on a narrative nine-point scale, (b) indicate which scenario of a series of digital calibrated photographs most closely represent the condition they encountered and (c) indicate which scenario best portrayed the situation they expected during their stay. In the crowding models the correlation coefficients indicate significant positive relationships between actual density, reported encounter measurements and visitors’ tolerance of density. The number of contacts with others together with visitor’s attitude towards car traffic seem to be the most substantial factors of visitor’s evaluation of crowding effects.

Keywords: *Sustainable tourism, national park, density, perceived crowding*

1. Introduction

The concept of sustainable tourism constitutes the backbone of any contemporary management frameworks applied in large scale tourism areas. Thereby, area management objective is to provide an outstanding visitors’ leisure experience, while not degrading the site for future generations. Especially traditional coastal tourism destinations such as the Wadden Sea region are faced with high visitor numbers in summer months, which exerts pressure on the fragile environmental resources. In addition, the popularity of these sites strongly influences areas’ density and underlying level of congestion. To facilitate negative impacts of recreation activities and secure the integrity of coastal resources, increased attention must be given to suitable planning and area management [UNEP, 2009].

“Sustainable tourism should also maintain a high level of tourist satisfaction and ensure a meaningful experience to the tourists, raising their awareness about sustainability issues and promoting sustainable tourism practices amongst them [UNWTO, 2004].” The quality of visitor’s outdoor recreation experience and natural resources is highly related to the visitor use level within the area. Concerns about which extent of recreation use and activities can be accommodated in a given area without creating unacceptable social impacts have been framed by the concept of recreation carrying capacity [McCool and Lime, 2001]. In recent years, outdoor recreation research reveals that visitors have norms about the resource and social conditions that they regard as acceptable for a given setting [Manning et al., 1999]. Individual standards of appropriate level of encounter with other visitors have been found to considerably influence the quality of the recreation experience [Cole and Stewart, 2002]. Recent approaches measure individual norm for contacts with others, then aggregate the individual data to describe social norms [Shelby et al., 1996, Donnelly et al., 2000].

The relevance of understanding these encounter norms results from the requirement of local area management to provide recreation opportunities and experiences that ideally meet visitors’ expectations. Management decisions about an acceptable level of use within a recreational setting involve both a comprehensive understanding of social conditions in terms of crowding and substantial objectives for desired future conditions within the area. Relevant evaluative data can be gathered in visitor monitoring and on-site surveys and used to establish management standards in recreation areas.

Over the past 40 years, research in congestion and leisure literature in North America national parks and wilderness areas revealed that visitors of outdoor recreation areas tend to feel crowded when they encounter a higher number of people during their stay than considered as acceptable and which exceed their individual norm for seeing others [Vaske and Donnelly, 2002]. Social norms in outdoor recreation have been examined in North American leisure studies by both narrative and visual approaches [Vaske et al., 1993, Manning et al., 1996, Shelby et al., 1996, Ormiston et al., 1998, Donnelly et al., 2000, Manning et al., 2002, Vaske and Donnelly, 2002, Kuentzel and Heberlein, 2003, Manning et al., 2005, Needham et al., 2010] and to a smaller extent in Asia and Australia [Inglis et al., 1999, Kim and Shelby, 1998, Kim and Shelby, 2006, Hsu et al., 2007, Yagi and Pearce, 2007]. The majority of research in crowding-related norms and standards of experience quality have been undertaken in North American wilderness areas and to a lesser extent in frontcountry settings.

In Europe, social norms and encounter preferences in outdoor recreation and the integration of these results into adequate management frameworks received rather little attention. Only a small number of studies can be found including encounter preference of cross-country skier in Norway [Heywood and Aas, 1999], canoeists in an Austrian national park [Sterl et al., 2006] and national park visitors in Germany [Kalisch and Klaphake, 2007]. Most studies in the European context used the same theoretical foundation oriented towards the North American recreation

research, but differed in their methods of measuring visitors' perception of crowding [Arnberger and Mann, 2008].

The objectives of this study are to elicit the concept of recreational crowding in Germany and to reveal how relevant variables are related to each other. This study examines (a) visitors' perception and attitude towards encountering others in a popular Wadden Sea National Park by linking norms for social conditions (i.e. perception and preferences for contacts with others), (b) the evaluation of setting density (perception of crowding) and (c) if visitor groups differ in evaluating acceptable or unacceptable trail conditions. Therefore, park visitors are asked to answer several questions related to social conditions on the main trail including the perception of crowding and reported encounter applying both a narrative and visual approach.

2. Conceptual background

2.1. Crowding norms in outdoor recreation

Social and individual norms, as borrowed in the fields of sociology and social psychology, offer a concept for an evaluation of the acceptability of certain use levels in outdoor recreation areas. Norm measurements provide a theoretical and applied basis for addressing and informing recreation area management and generate useful data about visitors' preferences and standards for social and environmental conditions [Donnelly et al., 2000].

The concept of norms in outdoor recreation context involve that certain groups share and use standards to describe and evaluate the acceptability of social conditions in recreation settings [Shelby et al., 1996, Manning et al., 1999, Donnelly et al., 2000]. It is "(...) assumed that perceived crowding is an expression of individual judgement and socially shared norms about appropriate density at a given site and a given time [Kuentzel and Heberlein, 2003] (p. 351)." The adoption of different empirical methods revealed appropriate social conditions that are generally shared by a population of visitors [Manning et al., 2005].

When applying the concept of carrying capacity in outdoor recreation areas, the formulation of indicators and standards related to the quality of the visitor experience is essential. "Researchers have modelled the impact of visitor use on the quality of outdoor recreation experience by measuring social conditions (use level and encounter with others), psychological conditions (evaluation of encounters and perceived crowding) and social psychological conditions (encounter expectations and preferences) [Kuentzel and Heberlein, 2003] (p. 350)."

Encounter norms are defined as standards that individuals use when evaluating the acceptability and appropriateness of different levels and types of contacts with other visitors [Vaske and Donnelly, 2002]. Recent research into norms in outdoor recreation is based upon the work of Jackson's return-potential curve (1965), which aggregates personal norms of individuals to test the existence of social norms and

whether or not those norms are shared across groups. Following his logic data derived from visitor surveys (i.e. total number of encountered people and acceptability of the number) are plotted in a so called “social norm curve”, which indicates thresholds where resource conditions fall below acceptable standards [Shelby et al., 1996, Manning et al., 1999, Donnelly et al., 2000]. The norm curve traces the mean acceptability rating scores of respondents for having contact with other visitors for a given area and time interval. Recent research has mainly examined social norms of visitors engaging in different activities such as hiker and cyclist, at different locations namely in backcountry and frontcountry settings and according to their motivation [Carothers et al., 2001, Manning, 2007, Needham et al., 2010].

2.2. Preferences and expectations for social conditions

Visitors’ attitude towards density and appropriate social conditions in terms of preferences and expectations¹ for certain encounter levels have been found to affect visitors’ evaluation of the setting [Ditton et al., 1983]. “Expectancy and discrepancy theories suggest that dissatisfaction in recreation due to crowding is a function of the discrepancy between the number of others one expects to see while participating in the activity and the number one actually encounter [Schreyer and Roggenbuck, 1978] (p. 378).”

Recent research has shown that visitor groups in natural recreation areas can highly differ in their perception and tolerance of social conditions [Needham et al., 2010]. Recreation literature has demonstrated that visitors tend to feel more crowded if they have expected a lower numbers of contacts than they have actually experienced [Shelby, 1980, Ditton et al., 1983, Shelby et al., 1983]. Schreyer and Roggenbuck (1978) examined the influence of crowding expectations and have found that visitors have a specific expectation when participating in recreation activities. Shelby et al. (1983) evaluated individual and combined effects of encounters, expectations and preferences on perceived crowding. Visitors evaluate social conditions as crowded when the number of encounters with other visitors during their visit exceeds expectations, but not unconditionally when they exceed preferences.

Boaters’ perceptions of crowding have been found to be related to encounter expectations in specific river settings in the United States. Ditton et al. (1983) found in their study of boaters on the Buffalo National River, that floaters who felt crowded were more likely to report having seen more people and experienced more contacts than expected. In addition, visitors to natural recreation areas have been found to evaluate social conditions less negatively as long as those influences are perceived to fit into the recreational setting [Behan et al., 2001]. For example, non-motorised visitors might be disturbed by motorised visitors and more likely to rate these encounters as negative [Behan et al., 2001, Manning et al., 2010].

¹“Expectancy is the momentary belief that a particular act will be followed by a particular outcome [Schreyer and Roggenbuck, 1978] (p. 375).”

Large scale protected areas have different functions for the diverse visitor composition such as everyday environment for local residents or as a part of a travel destination for tourists [Arnberger and Brandenburg, 2007]. In this context, previous experiences in the area and origin (i.e. locals, regional visitors and tourists) influence visitors' evaluation of area density [Inglis et al., 1999, Kyle et al., 2004, Arnberger and Brandenburg, 2007]. First time visitors and inexperienced recreation area users have been found to be more tolerant of site congestion [Graefe et al., 1984]. In contrast, repeat visitors who are more familiar with the setting have reported greater crowding perception [Ditton et al., 1983].

2.3. Measuring crowding norms

Studies in crowding norms in North American recreation areas are conventionally conducted by applying quantitative research methods. Norm measurement approaches or norm evaluation techniques use narrative and/or visual descriptions of a range of recreation-related impacts and asked visitors to judge the acceptability of such conditions (see [Manning et al., 1999] for a comprehensive review). Thereby, encounter norm represent the standard for an appropriate use level and the actual reported encounter level represent an indicator of the social condition of an area (i.e. number of contacts with other visitors or acceptable distance to others). For example, encounter norms can be measured by asking respondents to evaluate a range of encounters with other groups per day along trails or to report the maximum number of acceptable contacts in an open-ended format. Subsequently individual statements are aggregated in a social norm curve and tested if they are shared across visitors [Manning et al., 1999].

In a visual approach, a series of photographs depicting a range of use levels or environmental impacts is developed. Respondents are asked to evaluate each image or indicate the photograph that illustrates the highest acceptable density. For example, in close-ended questions respondents are asked to rate the acceptable density displayed on every photograph on a Likert scale [Manning et al., 1999, Needham et al., 2004]. Visual approaches to measuring standards of quality and related indicators have been explored in a number of studies [Martin et al., 1989, Manning et al., 1996, Manning et al., 1999, Manning and Freimund, 2004, Needham et al., 2004]. The application of visual approach has been found to be more appropriate in situations in which use levels are high and may provide valid estimates of crowding-related standards [Manning, 2007].

Researcher have utilised various evaluative dimension (acceptability, preference, desirability, satisfaction, tolerance, etc.) to measure norms in different recreation settings. Respondents were confronted with different density levels that visitors may encounter during their stay and were asked to evaluate the hypothetical scenarios on a scale. The most commonly used rating scale was a nine-point scale measuring the acceptability ranging from -4 = very unacceptable to +4 = very acceptable [Kuentzel et al., 2008].

In recent years, visual approaches have been widely used in recreation research [Manning and Freimund, 2004]. On the one hand side, visual approaches have been proven to provide more realistic estimates of crowding norms as characteristics of visitors' encountered and situational variables are included in the research design [Manning et al., 1999]. On the other hand, it seems to be unrealistic to expect images to display all relevant variables of visitor use as they are static representations of a dynamic process. "Alternative measurement approaches can result in significantly and substantially different estimates of crowding norms [Manning et al., 1999] (p. 112)." Problems might result from different meanings to respondents and lead to significantly different personal and social norms. Difficulties to measure norms occur in higher density recreation areas caused by multiple expectations visitors have about appropriate conditions. In those areas less consensus among visitors who report a norm is expected.

Findings from studies indicate that encounter norms exist for particular types of encounter with certain types of visitors at particular places and for certain types of experience [Vaske et al., 1993]. Donnelly et al. (2000) compared data from 30 studies that used a single-item question asking visitors to indicate the highest number of encounters they would tolerate before the recreation experience quality changed. Norm prevalence² varied by type of resource (back- or frontcountry), type of encounter (no conflict versus conflict) and question response format (scale, categories). Compared with backcountry users, visitors to icon sites have more ambivalence about appropriate social conditions and are willing to tolerate more encounters [Kuentzel et al., 2008]. Respondents who reported that they encountered more visitor than their individual norm tend to report higher levels of perceived crowding than do respondents who report seeing fewer other visitors [Manning et al., 2002].

3. Methods and data

3.1. Study objectives and hypothesis

The objectives of this study are to analyse visitor's perception of crowding in Wadden Sea National Park, Germany and to determine interdependencies of variables. Conceptual relationships are verified with established research approaches applying contemporary measurement methods and tested by using observations from an on-site survey carried out in the study area. Reported encounter, perceived crowding and preferences for area density are measured with established approaches based on North American and European leisure research. The approach is based on the comprehensive crowding model in which visitor's perception of crowding is a function of actual density, reported encounters, preferences and expectations and area's situational factors [Shelby, 1980, Westover, 1989, Manning, 1999]. Visitors'

²The term describes the extent to which normative standards can be measured by determine the proportion of visitors that were able to specify an encounter norm [Donnelly et al., 2000].

perception of contacts with others during their stay and how they feel about seeing others are measured with a narrative nine-point scale and a series of photographs depicting different use levels which are likely to occur within the area.

In detail, the following hypothesis were assembled and tested. When the number of visitor within the area increases, people are very likely to report more contacts with other visitors [Shelby, 1980]. For that reason, it is expected that individual's perception of encounters with others rises in relation to actual density (H1). In addition, visitors will feel more crowded when experiencing more contacts (H 2), especially in times when the recreation setting receive many visitors (H 3). Both actual density and reported encounter are hypothesised to be positively related to visitors' perception of crowding [Shelby et al., 1983]. Visitors' tolerance of high density conditions on the trail is related with individuals' perception of crowding. The perception of crowding is low when visitors have a high tolerance of crowded situations on the trail (H 4). In addition, visitors' expectations for encountering other people are related to their perceptions of crowding (H 5). Accordingly, when visitors encounter more other people than expected, they will feel more crowded [Shelby et al., 1983, Tseng et al., 2009]. The crowding perception and evaluation of contacts with others is expected to differ among visitor groups.

3.2. Data collection and survey questions

On-site interviews were carried out on five days in May/June and five days in August 2009. All in all, 509 visitors of Hamburger Hallig were interviewed. Surveys were administered according to weather conditions between 11:00 am to 6:00 pm. All trail users returning from the Hallig were asked if they were willing to participate in the survey (around 86% of approached visitors completed a questionnaire).

The questionnaire used in the on-site survey consists of three main parts: (a) general respondent profile, (b) visitors motives and experiences³, and (c) perception of crowding. Part I (respondent profile) is designed to gather information including gender, age, origin of visitor, and mode of travel. In part II respondents are asked about motives for their visit and experience. Part III (crowding perception) contains a verbal and a visual approach to measure visitors crowding perception during their stay.

A crowding-based model following recent research in recreational crowding (see Figure 7.8, p. 107) is developed to examine the relationship between individual's perception of crowding or negative evaluation of density and its explaining factors. In detail, five measures of the complex recreational crowding concept based on previous study findings are applied in the study. The questionnaire incorporated a narrative and a visual crowding measurement approach derived from North American and European recreation literature and is adapted to the specific area conditions.

³The effect of visitor motives and experiences on the perception of crowding is outside the scope of the manuscript and discussed in Manuscript 1 [Kalisch, 2012].

In the verbal approach, respondents are asked to report their perception of crowding using the established single-item 9-point crowding [Heberlein and Vaske, 1977]. A visual approach is applied by developing a series of eight digital manipulated photographs showing the trail to the Hallig with varying levels and types of user to measure encounter norms [Arnberger et al., 2004]. The number of visitors at a given time along a 150-m section of the trail has been illustrated on eight digitally adjusted images (see Figure 7.6 and 7.7, p. 104).



Figure 7.6: Example of hypothetical scenario: Low density condition

Based on visitor counting (visitors per hour) during a pilot study conducted in 2008, the images were constructed with four different use levels. The lowest use level was represented by 3 visitors per trail segment and the highest by 12 visitors. Survey respondents got a brief explanation that the images contain a typical section of the Hallig trail showing different use conditions that are likely to encounter during their stay. They were asked to look at the entire set of images in a first step and to rate the conditions in the eight scenarios on a 6-point scale from 3 = I would not feel crowded at all to -3 = I would feel extremely crowded in a second step.

In detail, the relevant variables of the study are:



Figure 7.7: Example of hypothetical scenario: High density condition

(a) Actual density

The actual number of people per unit area is a descriptive term measured by visitor counting, that is conducted by observers in the area. Actual density objectively determines the relationship between people and space they occupy. The variable was measured by the visitor flow per hour between 10 am and 6 pm at the day of survey.

(b) Reported encounter

Respondents were asked to rate the density on the trail to Hamburger Hallig at the day of the survey on a verbal nine-point scale ranging from 1 = I have meet only a few other visitors to 9 = I have meet a lot of other visitors. In addition, respondents were asked to indicate which of the eight scenarios most accurately depict the density on the trail they encountered during their visit to the site. Visitor numbers shown within the image constitute respondent's perception of experienced contacts during their trip.

(c) Perceived crowding

Perceived crowding is the subjective, negative evaluation of the number of encounters with others. In the narrative approach, respondents were asked to report their perception of crowding (“Did you feel crowded by the number of visitors encountered?”). Response options were presented on a nine-point Likert, ranging from 1 = not at all crowded to 9 = extremely crowded. Besides, respondents were asked to indicate the photograph that depicts the density on the trail they have experienced during their stay. The individual rating for the specific image on the 6-point scale constitute the second measurement of visitors’ perceived crowding.

(d) Visitors’ tolerance of social conditions on the trail

Visitors’ tolerance of density on the trail was measured by the visual approach. Using the hypothetical scenarios respondents were also asked to evaluate trail conditions of the eight photographs. A summated rating index was calculated for individuals’ valuation of the eight images (3 = not at all crowded to -3 = extremely crowded). Negative values on this index represent less tolerance for high density conditions on the trail.

(e) Expectations for areas’ density at the survey day

Expectations for trail density were gathered by asking which scenario represents the situation they had expected to experience on their way to the Hallig in the best way. The number of visitors depicted in the image represents respondent’s expectation of density during their stay.

(f) Visitor’s attitude towards car traffic

As car traffic has been found to influence the perception of crowding in the pilot study, visitor’s attitude towards cars on the trail was included in this study. To assess respondent’s attitude four of the eight presented scenarios display a car driving on the trail to Hamburger Hallig. In an additional question, respondents were asked if they approve or disapprove car traffic within the area. Accordingly, respondents are categorised as “opponents” or “proponents” of motorised visitors.

4. Study results

4.1. Sampling and descriptive data

The study population consists of middle-aged visitors with a mean age of 54 years and an equated mix of females and males (see Table 7.13, p. 106). Respondents in this study are mainly tourist (around 60%) who visited the Hamburger Hallig on a day trip during their stay at the North Sea coast. The majority (66%) reports that they explored the Hallig by bike. Almost 75% of the surveyed tourists indicate a previous visit at the North Sea coast. More than 60% of respondents have been on the Hallig before and visit the area regularly.

Variable	Mean	Modus	SD	Min	Max
Age	53.28	47	13.18	16	82
Gender (0=female, 1=male)	0.50		0.50		
Origin (0=tourist, 1=regional resident)	0.41		0.49		
Visitor type (0=hiker, 1= cyclist)	0.66		0.47		
Had visited the region (0=no, 1=yes)	0.75		0.44		
Had visited the area (no=0, 1=yes)	0.61		0.49		
Car traffic (0=proponent)	0.53		0.50		
Reported encounter (Narrative)	5.92	5	2.19	1	9
Reported encounter (Visual)	7.98	9	3.00	3	12
Perceived crowding (Narrative)	1.87	1	1.61	1	9
Perceived crowding (Visual)	2.64	1	1.68	1	6
Expectations	7.16	3	3.31	3	12
Tolerance	11.38	8	10.24	-16	24
Actual density (visitor/h)	52.79	41	18.38	19	79

Sample size: N=509

Table 7.13: Descriptive data of sample

Almost half of the respondents oppose car traffic on the trail mainly caused by the protection status of the area. All in all, respondents report a high level of encounters and in contrast a very low level of perceived crowding. Mean value of the narrative reported encounter measurement is 5.92 (encountered rather many other visitors). In the visual approach, most of the respondents report that the image showing nine other visitors on the trail section represented the density they encountered at the day of survey. When asked about their perception of crowding on the narrative 9-point scale the mean value of visitors' evaluation is 1.87 (between not at all crowded and slightly crowded). In total, 21.6% of the sample perceives trail conditions as crowded (3-9 on crowding scale). In contrast, the mean on the visual 6-point crowding scale is 2.67 (between slightly and rather crowded). In the visual approach, 59.6% of respondents perceive the situation they experienced as crowded (2-6 on crowding scale). A trail scenario showing more than six people best illustrates visitors' expectation for trail density. Tolerance for density on the trail shows a high variability (SD=10.24) and summated ratings range from 24 to -16. Furthermore, actual density during the survey is varying from 19 to 79 counted visitors per hour.

4.2. Correlation of relevant crowding variables

To analyse the strength of the linear association between the relevant variables in the crowding model, bivariate correlation coefficients (Spearman Rho) are used (see Figure 7.8, p. 107).

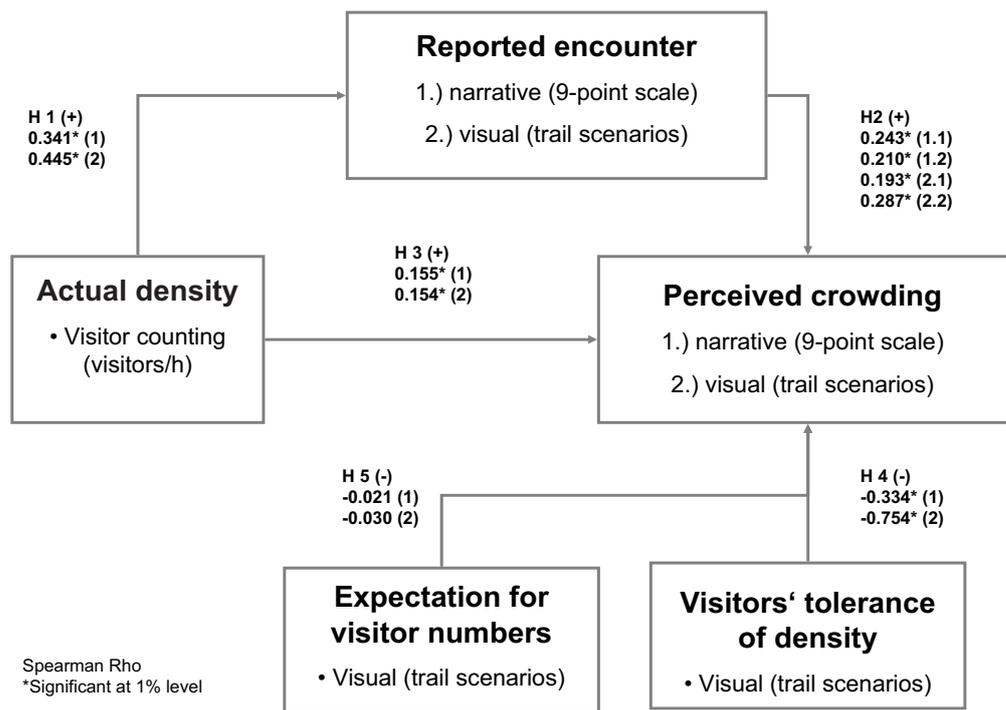


Figure 7.8: Bivariate correlation in crowding model

The sign and value of the coefficient (r_s) indicates the direction and strength of association between a pair of variables (effect size).

(H 1) Actual density and visitor contacts with others

The correlation between actual density and reported encounter is 0.34 for the narrative and 0.45 for the visual approach. Both measurements are significant at a 1% level and show a typical relationship [Vaske and Shelby, 2008]. Study results indicate that high density increases the number of encounters with other visitors and support hypothesis 1.

(H 2) Reported encounter and perceived crowding

The findings also reveal a positive relationship between reported encounters (evaluated on the narrative nine-point scale) and both narrative and visual measurement of perceived crowding, $r_s=0.24$ and 0.21 ($p<0.01$), indicating that higher numbers of encounters increases visitors' perception of crowding. Also the relationship between number of encounters gathered in the visual approach and both measurements of crowding are positive with $r_s=0.19$ and 0.29 ($p<0.01$).

(H3) Actual density and perceived crowding

Only a minimal, positive relationship exists between actual density within the area and perceived crowding ($r_s=0.15$, $p<0.01$) for both measurements.

(H4) Visitors' tolerance of density and perceived crowding

Visitors' summated crowding ratings for the eight trail scenarios is negatively correlated with the overall evaluation of the perceived situation on the nine-point crowding scale ($r_s=-0.33$, $p<0.01$). The effect size indicates a typical relationship suggesting that visitors with a high tolerance for crowded trail conditions tend to evaluate the experienced situation as not crowded. The relationship between tolerance and the measurement of perceived crowding in the visual approach even revealed a substantial relationship ($r_s=-0.75$, $p<0.01$) and support hypothesis 4.

(H 5) Expectations for contacts with others and perceived crowding

As expected, study results indicate that if visitor's encounter expectation is high, the overall perception of crowding is lower. Nevertheless, hypothesis 5 is rejected as the correlation coefficients shows only a minimal relationship ($r_s=-0.02$ and -0.03 , $p>0.05$).

In summary, the effect sizes of the bivariate correlations show that the perception of crowding is typically related to reported encounters and area's density and substantially related to visitor's tolerance of density. Between perceived crowding and visitors' expectations only a minimal relationship has been discovered.

4.3. Social norm curve

The mean social norm curve for respondent's evaluation of the hypothetical trail scenarios is illustrated in Figure 7.9 (p. 109). As shown in the graphs, visitors evaluate the four scenarios without displaying car traffic as positive, starting with 2.7 on the six-point crowding scale for the scenario showing 3 visitors. Even the most crowded scenario depicting 12 people on the trail section was rated positive with 1.2. When cars are included in the trail scenarios visitor's crowding ratings are lower (-1.2 the six-point crowding scale for the scenario with 12 visitors and car) and crossing the neutral point zero, which represents the "minimum acceptable condition" (see Manning et al. 1999).

A Mann-Whitney test is used to compare the ratings of opponents and proponents of car traffic. As stated before non-motorised visitors are expected to feel disturbed by motorised visitors and more likely to rate these encounters as negative [Behan et al., 2001, Manning et al., 2010]. No significant differences between the mean ratings of the two groups were found in the scenarios without car traffic. In contrast, the result for scenarios, which include car traffic, is significant. Opponents rate the scenarios more negatively and the minimum acceptable condition is reached for this group, when confronted with a scenario displaying six visitors and a car on the trail section.

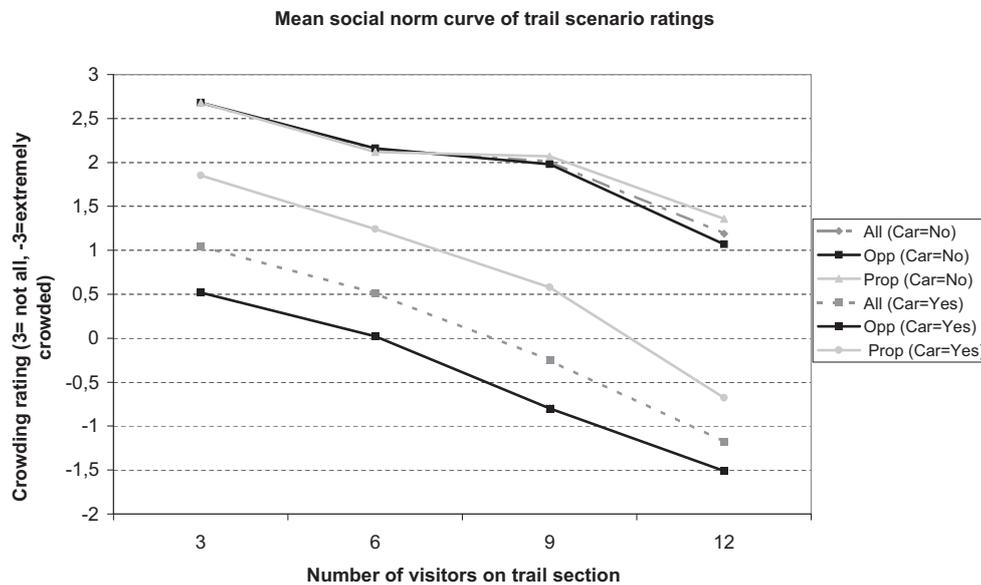


Figure 7.9: Mean social norm curve of trail scenario ratings

5. Discussion and conclusion

This article examines the density, encounters and crowding relationship in a popular coastal National Park in Germany. It applies conventional theoretical and methodological approaches to address topics that have received rather little attention in German recreation areas. A comprehensive crowding model is applied on Hamburger Hallig in Wadden Sea National Park by adopting two established approaches to measure visitors' perception of crowding. A social norm curve proposed by Manning et al. (1999) is constructed from the average evaluations for the eight hypothetical trail scenarios by using respondents' ratings for the photographs.

All in all, the proposed causal relationships between visitors' perception of crowding and its explaining factors (see Figure 7.8, p. 107) are verified by the effect size indices of the bivariate correlation. The hypotheses 1 to 4 are supported by the correlation values (r_s). The relationship between visitors' expectation and perceived crowding is negative as expected, but not on a significant level (H 5).

When measuring the relationship between actual density and reported encounters

in the North American National Park context, Vaske (2008) revealed in an analysis of aggregated data that the correlation coefficient ranged from 0.15 to 0.75 with an average correlation of 0.49. In this study, the relationship is also positive with 0.34 and 0.45 depending on the measurement approach. Research in the relationship between actual density and perceived crowding revealed a positive and significant effect with an observed correlation ranging from 0.10 to 0.61 with an average of 0.21 [Vaske and Shelby, 2008]. In comparison, this relationship has been found to be rather small with 0.16 and 0.15.

The application of visual approach based on hypothetical scenarios with varying trail use levels have been found to reveal relevant factor influencing visitor's perception of crowding and provides substantial results in terms of the measured strength of relations. In comparison with narrative nine-point crowding scale, an imaged-based measurements might describe trail conditions more realistic and include relevant factors, in this case the car traffic, which are not incorporated in the narrative approach [Manning, 1999].

Visitors to Hamburger Hallig have been found to tolerate high numbers of contacts with others, which might be caused by the fact that the majority of visitors to Hamburger Hallig are aware of the probability to encounter many others during their trip. The norm curve of visitors' evaluations of social trail conditions revealed mainly positive ratings for the scenarios. When confronted with photographs excluding car traffic respondents even evaluate scenarios with 12 people per 150m trail section as rather not crowded (between 1 and 2 on six-point scale). In contrast, when a car is present in the scenario, the photograph is evaluated as rather crowded (between -1 and -2 on rating scale).

Overall, trail conditions with 12 users and excluding car traffic are acceptable to all users. When use levels increase to six people or more and a car is included into the scenario, respondent's evaluations of the trail conditions decreases drastically, as documented by the decrease in the mean social norm curve. Even though the number of encounters has been found to significantly influence visitors' perception of crowding. Visitors' attitude towards car traffic seems to be another substantial factor in the models, which is demonstrated by applying a visual approach.

Around 20% of respondents have not any negative feelings against area's density, which indicates that as long as encounters with other groups are not considered to be disturbing, they do not result into a perception of crowding [Manning, 2007]. Visitors of popular recreation areas have more ambivalence about appropriate conditions and have been found to tolerate high numbers of encounters [Kuentzel et al., 2008].

A sustainable tourism concept obliges area managers to provide opportunities for high quality visitor experiences and to preserve natural environments protected from negative tourism-associated resource impacts [Cahill et al., 2008]. The measurement of crowding perception as an indicator for recreation experience quality is widely used in recreation and leisure research to facilitate an understanding of acceptable and unacceptable conditions in recreation areas.

Research results might provide a basis for formulating standards of quality that can be used to inform management actions [Needham et al., 2004]. In this study, crowding perception is mainly related to a disturbance of the recreation experience by car traffic and to a smaller extent to the encounter of many other visitors. Therefore, a combination of information provided by the area management about (a) the possibility to encounter cars on the trail and (b) the probably higher number of contacts on weekends and especially during summer months would help to clarify and improve visitors' expectations [Shelby et al., 1983]. Furthermore, a restriction of car traffic could improve trail conditions in terms of congestion, but is very likely to be refused by both local residents and tourists. Local authorities have to implement balanced management measures, which also consider the needs of local residents and regional visitors.

At popular recreation areas a negative evaluation of the recreation experience may result from various factors, for example the waiting time to access services and facilities or the ability to take a picture without someone in the way [Kuentzel et al., 2008]. Although different factors were considered in this study, they represent only a subset of possible indicators for recreation use on the trail. Thus including indicators such as visitor behaviour and the displacement of crowding-sensitive visitors might enhance the model.

As longitudinal studies on encounter norms are missing, no information about changes of norms over time or re-shapes of use patterns is available [Kuentzel and Heberlein, 2003]. Repeat measurement could be implemented to collect new data to observe norm changes over time. A limitation of the visual approach results from the fact that photographs depict static descriptions of trail conditions.

Reichhart and Arnberger (2010) included computer animated scenario presentations to integrate motion-related factors. The interaction between hiker, cyclist and motorised visitor in terms of different travelling speed and space requirements could be depicted by digitally calibrated films and expand this research design.

7.4 Manuscript 4

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“Measurement and simulation of visitor contacts: Comparing actual density and visitor’s perception of encounters with others in Wadden Sea National Park, Germany”

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Abstract: This paper describes the application of a computer-based simulation model of spatial and temporal visitation patterns in Wadden Sea National Park, Germany. Information on visitor characteristics and travel patterns were collected with an on-site survey including a visual approach to measure visitor-based standards for trail encounter rates. A Java-based model was developed to simulate encounters of survey respondents with others. The findings of the study demonstrate that simulations are a useful tool for evaluating indicators of quality in terms of numbers of contacts between visitors within the area. The patterns of visitation are heterogeneous and differ at specific dates such as work days and weekends. In the model the number of visitors’ encounters range from 16 to 303. Visitors are found to describe their encounter perception close to simulation results and their perception of contacts of others is related to a definite number of other visitors. Study findings demonstrate that the simulation of the spatial and temporal flow of visitors can be used to reveal a significant relationship between objective area density and visitor’s subjective encounter perception. The results of the simulation model are used to approximate an appropriate daily use level within the area that can be accommodated without reducing visitor’s recreation experience.

Keywords: *Visitor flow, computer simulation, actual density, encounter rate, crowding, national park*

1. Introduction

Many people who visit large scale protected areas have the desire to experience an environment that is unspoiled or at least appears to be relatively unaffected by human activities. Growing interest in natural environments leads to high levels of visitation in recreation areas especially during summer months. Large visitor numbers may threaten visitors’ experience of nature. On the one hand, recreation in protected areas such as the German North Sea coast provides visitors with outstanding experiences in unique natural settings.

On the other hand, it constitutes a challenge to protect the environmental resources and maintain the quality of visitor experience for future generations.

The nature of visitor use patterns is inevitably connected with social (i.e. congestion and visitor conflicts) and environmental (i.e. trail erosion, disturbance of wildlife) impacts [Graefe et al., 1984, Manning, 1999]. Local authorities have to find the balance between the objectives of nature conservation and providing a wide range of visitor activities at the same time. Thereby, visitor use of protected areas must be managed to minimise environmental and social impacts [Lawson, 2006].

Aggregation of study findings in the North American context generally show that increasing use levels and relating encounters among visitor lead to an increase of negative social impacts in terms of crowding and visitor conflicts [Shelby et al., 1989, Vaske and Shelby, 2008].

Thereby, high user density and encounter rates between visitors influence the quality of the recreation experience, as a high number of contacts may lead to crowding perception for at least some visitors. In this context, visitors' encounters with others constitute a "hard to measure" indicator variable, which is difficult to determine through direct observation including inter-group encounter rates throughout the course of the day or season [Wang and Manning, 1999, Lawson, 2006]. Also the amount, type, timing, and location of visitor use have serious impacts on the quality of the natural resources and visitor experiences. In addition, uneven visitor use patterns with peaks during holidays and a concentration on certain portions of an area lead to temporary congestion in terms of visitor numbers [Lucas and Shechter, 1977].

An effective site management is dependent on reliable data about visitor use patterns such as spatial and temporal flows [Muhar et al., 2002]. In addition, local authorities must understand visitor's needs, goals and desires and identify the types and amounts of use that can be accommodated in a park without violating social resource conditions [Lawson et al., 2009]. Most European National Park authorities collect some data on the level of public use of parks of fairly different quality. In many countries current practise in visitor monitoring varies between recreation areas from simple "best guess" estimates to elaborate long-term monitoring programs including automated visitor counters. In Central Europe, systematic sampling strategies to generate visitor use profiles in national parks are limited and most results are based on unstructured counts, which are extrapolated [Cessford and Muhar, 2003].

Computer-based modelling (as an imitation of real world systems) has been found to be an effective tool to facilitate monitoring of recreation use in protected areas [Lawson, 2006, Lawson et al., 2009]. Simulation models have been developed and used to approximate the relationship between visitor use levels and indicators of recreation experience quality including number of contacts between individuals [Smith and Krutilla, 1974, Lucas and Shechter, 1977, Potter and Manning, 1984, Underhill et al., 1986, Gimblett et al., 2001, Manning et al., 2003].

The knowledge about associations among crowding related indicators of quality, such as number of encounters and the actual visitor density in recreation settings

in Europe is rather limited [Arnberger and Mann, 2008]. Nevertheless, managers of these areas rely on data collected about visitor flow within the area when developing indicators and standards of quality for area's recreation experience.

The purpose of this study is to develop a better understanding of the relationship between spatial-temporal distribution patterns and number of contacts between visitors in Wadden Sea National Park, Germany by comparing visitor counting data and simulated encounter rates with measurements of visitors' subjective perception of contacts with others. A simulation model is developed to assess how often visitors encounter each other on the trail and if there are any relations between actual density and visitor's perception of contacts in terms of reported encounter. To clarify these questions, daily visitor use patterns are estimated to understand complex spatial-temporal relationships among different types of variables and provide an empirical basis for managing visitor use in a manner that maintains the quality of visitor's experience.

2. Conceptual background

2.1. Measuring visitation patterns

Capturing visitor movements in recreation areas is essential when assessing the complex nature of visitor travel patterns [Wang and Manning, 1999]. Tourists move around within a region, visit various attractions and undertake several different activities during their stay. Spatial-temporal movements of tourists can be analysed from a geographic perspective on a macro and micro level. On the macro level, motions from one location to another are measured on the regional level. Whereas, simulations on the micro level are used to describe the way that visitors use and spread within a recreation system [Xia and Arrowsmith, 2005].

In the social context of recreation use, the number and activities of visitors have been found to be essential in defining the quality of recreation experience [Jacobi and Manning, 1999]. Crowding in large scale protected areas in terms of overabundance of others has been found to have an impact on the quality of the visitor experiences [Manning, 1999]. When analysing visitors' perception of social impacts differences have been found between socially accepted and/or preferred visitor numbers. Research has also shown that additional factors must be integrated including reported encounters, namely number of people that visitors encounter during the trip and perceived crowding, as a negative evaluation of these encounters. "Moreover the number and types of encounters with other parties were found to be useful proxy for the disruptions of solitude [Smith and Krutilla, 1974] (p. 188)."

So far, effects of varying encounter levels on visitor's evaluation of crowding have been examined in numerous on-site surveys [Cole and Stewart, 2002, Vaske and Donnelly, 2002]. Visitor use patterns in recreation areas and underlying encounter levels have been found to vary considerably at different places and times, including the number of visitors, the activities they are engaged in, group sizes, and the areas and facilities that they use [Cessford and Muhar, 2003]. Thus, collecting baseline data on visitor use is essential to support planning and management of protected areas. These information are the basis to 1.) assess impacts of recreation use to natural resources, 2.) estimate the quality of the visitor experience and 3.) support visitor facility planning such as trails [Pettebone et al., 2010].

Each visitor movement inevitably leads to contacts with others in terms of encounter and overtaking. The measurements of trail encounters between visitors have been found to be rather difficult as they occur at unknown intervals and at unknown locations [Lawson et al., 2008]. Facilities and services in national parks may be unused for most of the time in the year, but for short periods, their carrying capacity may be exceeded. Area management must understand the spatial and temporal patterns of daily visitor use when protecting important park resources [D'Antonio et al., 2010].

The quantitative analysis of visitor flows is fundamental to a better understanding of the complex interactions of visitor use. To generate relevant information subjective evaluation data gathered in surveys are combined with objective counting data in visitor simulation as an imitation of real-world processes over a definite time frame [Wang and Manning, 1999].

In recent years, several visitor counting methods have been applied for direct and indirect observation of visitors in protected areas [Cessford and Muhar, 2003, Arnberger et al., 2005]. In detail, available methods to collect and analyse visitation data are external visual observation, stationary internal observation, roaming internal observation, mechanical counters, registration, permits, surveys, indirect estimations, aerial surveys [Watson et al., 2000]. Direct counting methods such as observational techniques and surveys are capable to provide area managers with comprehensive use estimations and information about recreation use patterns and behaviour.

2.2. Modelling spatial and temporal visitor use data

The first applications of simulation modelling are dated back to the 1970th and 1980th [van Wagendonk and Cole, 2005]. The wilderness travel simulation model (WTSM) was designed to estimate number, type and location of encounters between different visitors during their stay. Research objectives were to study congestion externalities associated with increased visitor use levels in the Spanish Peak Area, USA [Smith and Krutilla, 1974] and examining complex recreation use patterns on a section of the Appalachian Trail, USA [Potter and Manning, 1984].

After first implementations in remote wilderness areas a second generation emerged since the 1990th after computer simulation capabilities improved [Chang, 1997, Wang and Manning, 1999]. Chang (1997) examined the theoretical relationship between visitors' queuing time, crowding perception and satisfaction in a National Park in Taiwan to provide recommendations for park managers. A series of studies used simulation modelling in North American wilderness areas and national parks to analyse areas' social carrying capacity and management options including visitor use on carriage road in Acadia National Park [Wang and Manning, 1999], backcountry camping use at Isle Royale National Park [Lawson, 2006], backcountry recreational use in John Muir Wilderness [Lawson et al., 2006] and user capacity research in Yosemite National Park [Lawson et al., 2009]⁴.

In detail, computer-based simulations have been developed to:

1. Describe existing visitor use levels in large recreation areas with dispersed visitor use patterns
2. Identify potential trouble spots within the area that may warrant management attention
3. Monitor "hard to measure" indicator variables that are inherently difficult to measure through direct observation including inter-group encounter rates throughout the course of the day or season [Wang and Manning, 1999, Lawson, 2006]
4. Provide an approach for a "proactive" management of areas' carrying capacity by estimating the number of visitors that can be allowed to use an outdoor recreation area without violating standards of crowding-related indicators, such as the number of encounters among hiking groups [Manning et al., 2003, Lawson et al., 2008]
5. Test the effectiveness of alternative visitor use management practices

Simulations of visitor flow in outdoor recreation areas as a quantitative description of human movement patterns operate paradigms such as discrete-event simulation, cellular automata and multi-agent simulation [Itami, 2006]. In general, the main approaches are: (a) trace simulation by directly simulate travel itineraries collected in the field, including visitor arrival time, visited locations, routes, duration of stay and (b) probabilistic simulation models that are based on representative sample of visitor trip itineraries and (c) rule-based simulation that use autonomous agents with own physical mobility, sensory and cognitive capabilities [Manning et al., 2005]. Trace models directly mirror an existing pattern of recreation use and can be used to generate specific parameters including the number of encounters [van Wagtenonk and Cole, 2005].

⁴For a comprehensive insight into theoretical and applied research on human spatial behaviour in outdoor leisure settings see Gimblett & Skov-Petersen (2008).

Simulation modelling in outdoor recreation means capturing, representing and modelling the characteristics of the physical environment (i.e. systems of paths and trails) and the behaviour of visitors (i.e. interaction with the environment and with each other). The basic assumption is that all recreation activities at a certain destination take place in a definite spatio-temporal framework. Changes in visitor's position are measured in absolute location information using a defined coordinate system. Spatial and temporal data (i.e. time of day, duration, travel speed) are the foundation of any attempt to simulate these interactions. To evaluate the relationship between spatial behaviour and potential visitor conflicts, comprehensive data is needed including trip itinerary data (i.e. routes, visited points of interest, travel speed, direction), visitor loads at particular locations, shares of activity types, seasonal, weekly and daily visitation patterns and physical environment components. For example, the recreational use of an area can be described by number of visits, number of (individual) visitors, visitor load (i.e. visitor hours), visitor flow (i.e. persons/hour/direction) and visitor density (i.e. persons/length unit of trails) [Taczanowska et al., 2008, Taczanowska, 2009].

Currently two main approaches are used to model visitor flows in outdoor recreation areas: (a) a combination of computer simulation modelling with artificial intelligence technologies and geographic information systems (GIS) to simulate visitor use in protected natural areas such as RBSim2 and MASOOR and (b) a second generation of Wilderness Travel Simulation Model (WTSM) by using the dynamic simulation package Extend [Wang and Manning, 1999, van Wagtendonk and Cole, 2005]. The first group of applications uses individual based models with object oriented programming technology. The second group of applications simulates the visitor's behaviour based on an empirical probability distribution based on surveys. Both application groups use rule-based dynamic models, which are able to change behavioural variables of the visitors and are discrete-event simulation models because the visitors are simulated individually [Lawson et al., 2008].

3. Methods and data

3.1. Study method

On the basis of previous research presented in the chapter before, this study applies a trace model to estimate visitor use patterns. The model depicts an existing pattern of recreation use and reconstructs actual encounter between visitors. Contacts between visitors at current use levels are simulated to understand the effect of increasing visitor numbers on the subjective reported number of encounters. Specific parameters, such as the number of encounters that occur between different visitor types (hiker, cyclist and car) and time of season are included to evaluate the quality of visitor's recreation experience as a function of actual density and reported encounter.

Recreation use patterns are examined to clarify when and to what degree are visitors using the trail (peaks) and what seasonal time periods are sensitive in terms of overall visitor numbers (congestion). The relationship between actual density (based on counting data) and visitor's reported number of encounters (based on visitor survey data) is analysed by comparing the number of encounters between parties, date and location with visitors' subjective statement in the survey. Potential visitor conflicts at specific times and areas of congestion can be portrayed and identified by the computer model. In a next step, the simulated numbers of encounters can be compared with visitors' reported encounter.

All in all, study procedure is:

1. Adding visitor use patterns of survey respondents' individual trip based on arrival and departure time
2. Adding dummy visitors to the model based on counting data during the survey dates based on departure and arrival numbers
3. Simulating the movements of visitors on the trail
4. Compare visitors' subjective perception of contacts with others with simulated encounters

3.2. Study area and site characteristics

The study area is Hamburger Hallig located in Wadden Sea National Park in Germany (see Figure 7.10, p. 119). It has a size of approximately 50 ha and is connected with the mainland by a causeway. From the national park border to the car park on the Hallig, the trail is 3,300 m long. The trail to Hamburger Hallig includes a pedestrian path and a small road. There is only one central access point to the trail at the main land. The whole island is part of Zone 1 ("Wild area with no public access") of the national park and an important breeding area and resting ground for seabirds. Visitors are not allowed to leave the designated trails and enter sensitive areas of the Hallig and salt marsh. Main tourist activities during the summer months are hiking, cycling, bathing and bird-watching. So far, little valid and reliable information exists about use patterns and temporal visitor distribution on Hamburger Hallig.

3.3. Data collection and survey questions

Baseline data on recreation use is implemented as input information to design a simulation model for the Hallig trail. Relevant data are gathered in direct observations by recording the number of visitors per half hour at the entrance of the study area and extrapolated. The simulation input variables are (a) descriptions of the system being modelled and (b) collected trip itinerary data including mode of travel on the trail, duration of stay and visitors' perception of contacts with others and crowding.

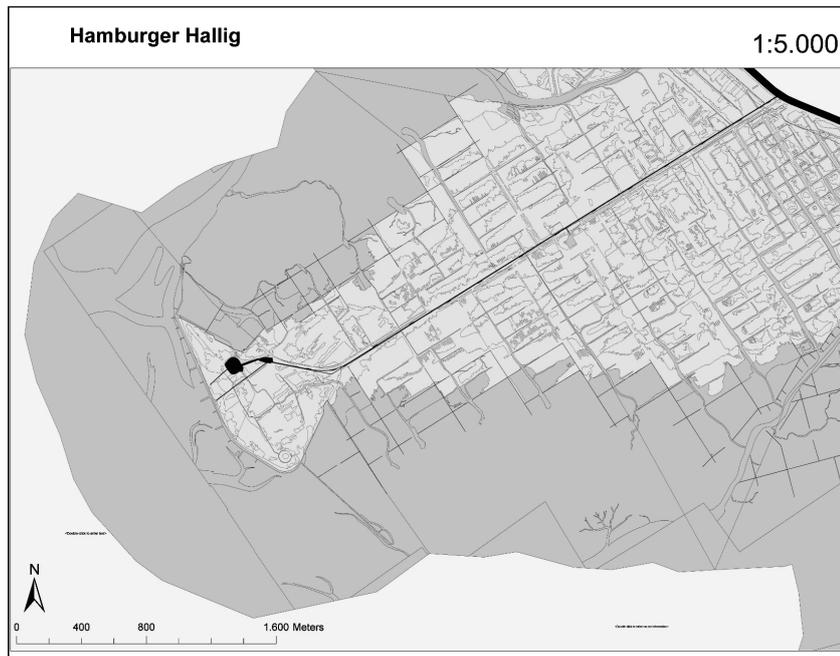


Figure 7.10: Area map

Hence, 509 visitors of Hamburger Hallig are surveyed at the main entrance of the area during an on-site survey in spring and summer 2009. Social characteristics of visitors and data about their trip itineraries are collected using an on-site survey from May 30 to June 2 and August 8-13, 2009. The questionnaire includes questions concerning visitors' perception of contacts with others in a verbal and visual approach. Respondents are asked to report (a) their perception of encounters on a nine-point Likert, ranging from 1 = very few contacts to 9 = a lot of contacts with other visitors and (b) their perception of crowding on an established nine-point scale, ranging from 1 = not at all crowded to 9 = extremely crowded [Vaske and Shelby, 2008].

In addition, respondents are asked to choose from a set of photographs, which best portrayed the number of other visitors they have encountered during their stay. A series of eight hypothetical scenarios show a typical section of the trail that can be seen at any one time. Four levels of "people per viewscape (PPV)" are included in the scenarios: 3, 6, 9 and 12 visitors [Manning, 2007]. The images are shown in random order and respondents are asked to choose from a set of photographs, which best portrayed the number of other visitors they have encountered during their stay and how they evaluate the encountered trail scenario on a scale from 1 = I would not feel crowded to 6 = I would feel extremely crowded by the presented number of visitors.

3.4. Simulation model parameters

The simulation model is designed to approximate the visitor flow on the linear trail to Hamburger Hallig. Recreation use conditions during the survey period reconstructed by applying the input variables shown in Table 7.14 and calculating the Java-based simulation model depicted in Figure 7.11 (p. 121).

Variable	Description	Value
<i>Survey data (N=509)</i>		
Date	Survey date	29/05-02/06/2009 08/08-13/08/2009
Visitor type	Mode of travel	Hiker or cyclist
Duration	Duration of trip	Time in minutes
Arrival	Time of arrival	Time
Encounter	Reported encounter	Rating on 9-point scale*
Crowding	Perceived crowding	Rating on 9-point scale**
<i>Direct observation</i>		
Visitor type	Mode of travel	Hiker, cyclist or car
Counting data	Number of visitors counted when entering the area	Total number of hiker, cyclist and cars
	Number of visitors counted when leaving the area	Total number of hiker, cyclist and cars
Departure	Time of departure	Time
Arrival	Time of arrival	Time
<i>Constant data</i>		
Trail length	Distance from NP border to Hallig	3,300 m
Speed	Average travel speed***	Hiker: 1.35 m/s Cyclist: 4.45 m/s Car: 5.56 m/s

*From 1=very few to 9=a lot of other visitors

**From 1=not at all crowded to 9=extremely crowded

***derived from FGSV (2001) and own measurement

Table 7.14: Variables applied in the visitor flow simulation

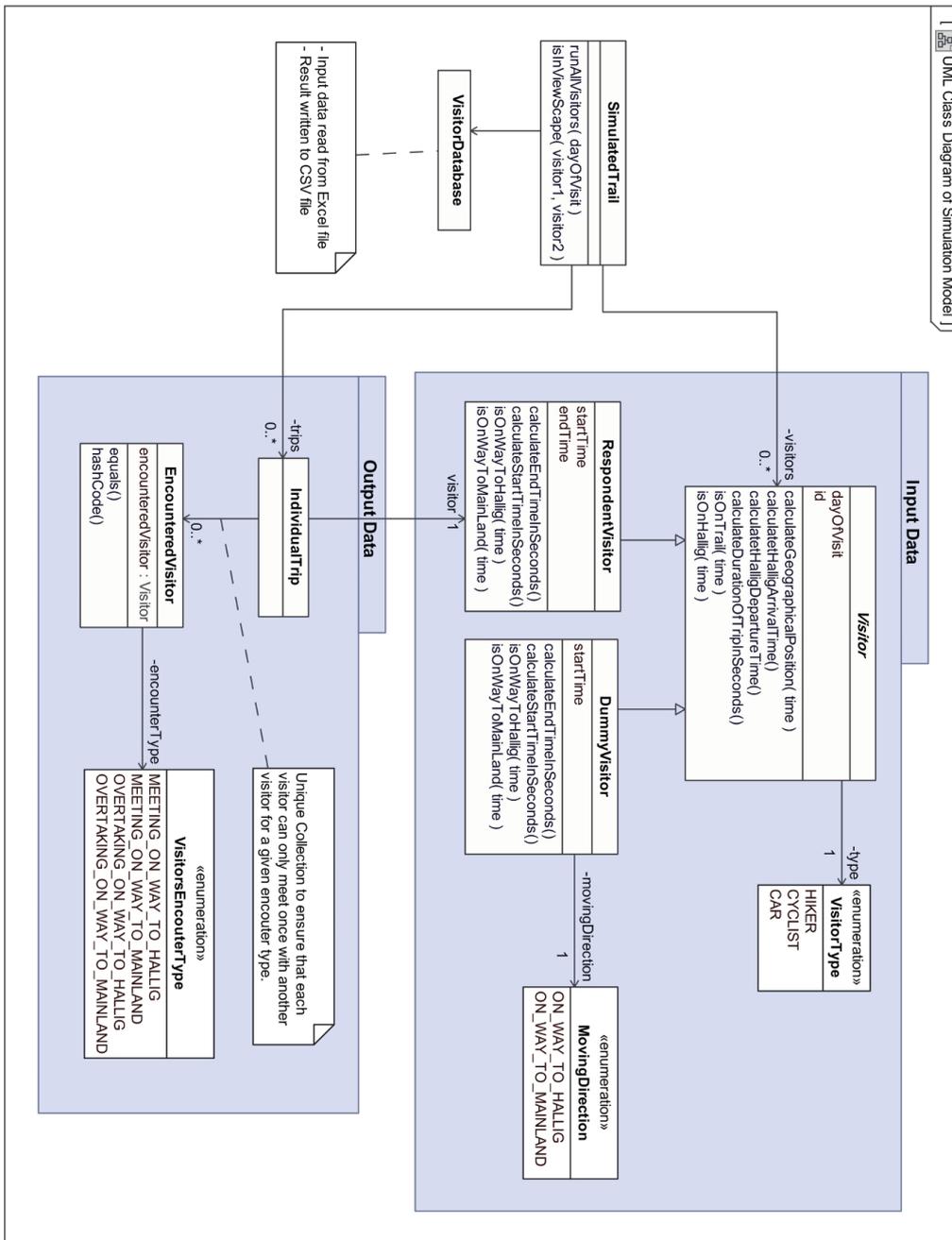


Figure 7.11: Class model of the java-based simulation approach

To build the model three components are needed: (a) input variables, (b) algorithms and (c) expected output data. These data together with a set of information about transit time on the trail for each visitor type provides adequate information to build a model of respondents' encounter during the stay [Smith and Krutilla, 1974]. The use of date and arrival time and average travel speed [FGSV, 2001] allows a simulation of the geographic position of every individual at every point of time. The development of a model enables a continuous simulation of time and space movements.

Respondents' trip itinerary data, including, date of visit, time of entrance, duration of stay and mode of travel on the trail were applied from the on-site survey. The developed simulation model is an event-driven simulator. The discrete time intervals determine for any user within the system to change her state and move on along the defined trail segment. The amount of time a visitor spends on the trail is determined by the assumed travel speed and duration of stay on the Hallig itself.

Visitors counted during the observation are included in the model as dummy visitors to calculate respondents' number of encounters. Thereby, visitor encounters in the model are defined as contacts between visitors when meeting (visitors approaching each other from opposite direction on the same trail segment) or overtaking (another visitor passes going in the same direction) each other [Lucas and Shechter, 1977, Potter and Manning, 1984]. Each contact between respondents and counted visitor inside a defined range is counted and written out in a database [Gimblett et al., 2001]. In this study, 150 m is assumed as a range of viewcape caused by the specific landscape of Wadden Sea region (no elevation and trees)⁵.

4. Study results

4.1. Descriptive

Survey results reveal that respondents have an average age of 54 (Modus=47, SD=13.18). Around 66 percent of the sample reports that they explored the Hallig by bike. The remainder of the sample were hiking. Surveyed visitors are mainly tourist (60%) who visited the island as a day trip during their stay at the North Sea coast. Nearly 41% are regional residents that live within a distance of 50 km of the Hallig. Around 40% of respondents visit the area for the first time. The narrative measurement of encounters shows that about 27% of respondents contact a large number of other visitors (8-9 on the nine-point scale) on their way to the Hallig and back (Mean=5.92, SD=2.19). In the visual approach, one third of the sample indicates that a scenario depicting nine visitors on the 150 m trail section represented the density they experienced during their trip (Mean=7.98, SD=3.0).

⁵Length of a typical viewcape of a trail, which can be seen at one time, is around 100 m [Lawson et al., 2009].

Additionally, the visual measurement approach is used to evaluate how visitors respond to experienced level of density. Approximately 51% of respondents perceive trail conditions they experienced as not crowded (1-2 on six-point crowding scale). Apart from that about 16% of the sample rates the experienced situation as crowded (5-6 on six-point crowding scale). Visitors' mean rating for the experienced trail condition is 2.64 (Modus=1, SD=0.08). There is a significant difference among visitors who have met low numbers of others during their trip and respondents who experienced high density conditions (ANOVA, $F=19.84$, $p<0.05$). As expected, the first group perceived trail conditions as less crowded when compared with those who encountered high numbers of other visitors.

4.2. Results of visitor counting

In Table 7.15, the results of visitor counting are shown in terms of hiker, cyclist and car use level per day (average) on the trail.

Survey date	Day*	Total**	Hiker	Cyclist	Car	Visitor Flow***
All		4160	971	2448	741	
29/05	WD	224	50	126	48	28
30/05	WE	334	82	162	90	41.75
31/05	WE	632	128	405	99	79
01/06	WE	596	145	356	95	74.5
02/06	WD	152	57	61	34	19
08/08	WE	557	144	313	100	69.63
09/08	WE	538	99	354	85	67.25
10/08	WD	450	70	319	61	56.25
11/08	WD	348	100	185	63	43.5
13/08	WD	329	96	167	66	41.13

*WD=Weekday, WE= Weekend

**Visitors counted when entering the area

*** Mean counted visitor per h

Table 7.15: Results of visitor counting - Numbers of visitors entering the area

The majority of visitors are cyclists (59%), followed by hikers (24%) and visitors exploring the area by car (17%). Visitors are counted by direct observation when enter the trail at the national park border. Average visitor flow per hour for each group is calculated per day by summing the number of visitors that pass through the trail during the course of the survey time and dividing by the total number of survey hours. All in all, the area hosted 4,160 visitors during the ten survey days. In general, weekends attract considerably more visitors with a peak at Whitsunday weekend (May 31 and June 1, 2009) than weekdays. During weekends between 334

and 632 visitors are entering the area between 10:00 am to 18:00 pm with an average visitor flow of 42 and 79 visitor per hour. When visiting the Hamburger Hallig at weekdays it is more likely to encounter low visitor numbers with a range from 152 to 450 visitors and an hourly visitor flow of 19 and 56. There is a significant higher visitor flow when comparing results for weekends and weekdays (ANOVA, $F=429.9$, $\text{Eta}=0.68$, $p=0.00$).

The visitation peak to the Hamburger Hallig is between 12 am and 1 pm with weekends receiving a second peak between 2 and 3 pm (see Figure 7.12). During weekdays most visitors enter the area between 1 to 2 pm.

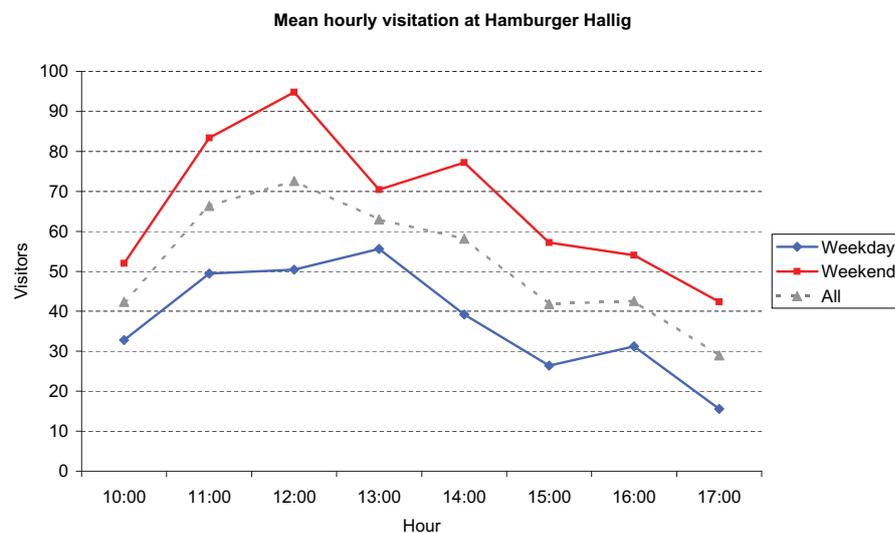


Figure 7.12: Mean hourly visitation at Hamburger Hallig

4.3. Results of encounter simulation

Principal objective of this visitor flow simulation is to generate a set of outputs concerning visitor use level and visitor encounters [Lawson et al., 2006]. The estimates of the average number of encounters of survey respondents with other visitor per unit of time allow a detailed breakdown of encounters between visitor types including cyclists and hikers (encounter rates per day and visitor type). Average encounter rate per trip based on the simulation are shown in Table 7.16 (p.125). The average number of encounters per respondent is calculated by summing the total number of encounters determined in the simulation model divided by the number of respondents.

	Encountered hikers	Encountered cyclists	Encountered cars	Encountered visitors
Mean	36.54	52.84	11.90	101.28
Median	35	38	9	88
Modus	29	26	5	48
SD	16.27	42.6	9.03	55.56
Min	2	4	0	16
Max	81	215	51	303

N=509

Table 7.16: Descriptive data of simulated encounters based on survey respondents

Simulation results reveal that survey respondents have encountered between 2 and 81 hikers (median=35), 4 and 215 cyclists (median=38) and 0 to 51 cars (median=38) during their trip to the Hallig and return.

4.4. Comparison of simulated encounters by visitor types and day of the week

An Mann-Whitney test is used to compare the results of the encounter simulation model (continuous variable) between a) hiker and cyclist and b) weekdays and weekend (see Table 7.17, p. 126). As expected, hikers (mean=151.2) encounter more other visitors compared to cyclist (mean=75.5). When comparing results of the two groups, the number of encounters with other visitor is two times higher when hiking on the trail than cycling (Mann-Whitney test comparing hikers and cyclists: $z = -4.21$, $p < 0.001$). Looking at median of encountered visitors at weekdays and weekends, we found that the probability of encountering high numbers of visitors also differ significantly (Mann-Whitney test comparing weekdays and weekends: $z = -9.82$, $p < 0.001$). As expected, it is more likely to have many contacts with others on weekends (mean=123.6) than at weekdays (mean=76.1).

4.5. Comparison of simulation results and visitors' perception of contacts

An analysis of variance (ANOVA) reveals that those who reported meeting a high number of visitors in the narrative approach, also encountered many other people during their stay calculated in the simulation model ($F=8.74$, $p < 0.001$). Figure 7.13 (p. 126) shows that those who stated to have seen only a few other visitors (1 or 2 on scale) on average encountered around 70 visitors during their trip compared with more than 130 of those who evaluate their perception with 9 ("encountered a lot of other visitors today"). The hourly visitor flow, which was observed during the visitor counting, ranges from 37 for those who have encountered a few other visitors to 63 who have met a lot of.

	Hiker	Cyclist	Weekday	Weekend
Encountered visitors	151.21	75.5	76.1	123.6
t	15.66**	-10.99**		
Encountered hikers	32.6	38.5	29.0	43.1
t	-3.89**	-11.18**		
Encountered cyclists	98.2	29.9	38.7	65.3
t	19.95**	-7.62**		
Encountered cars	21.4	7.1	8.4	15.0
t	19.63**	-9.18**		
N	171	338	239	270

**Significant at 1% Level

Table 7.17: Simulated encounters by visitor type and day of the week

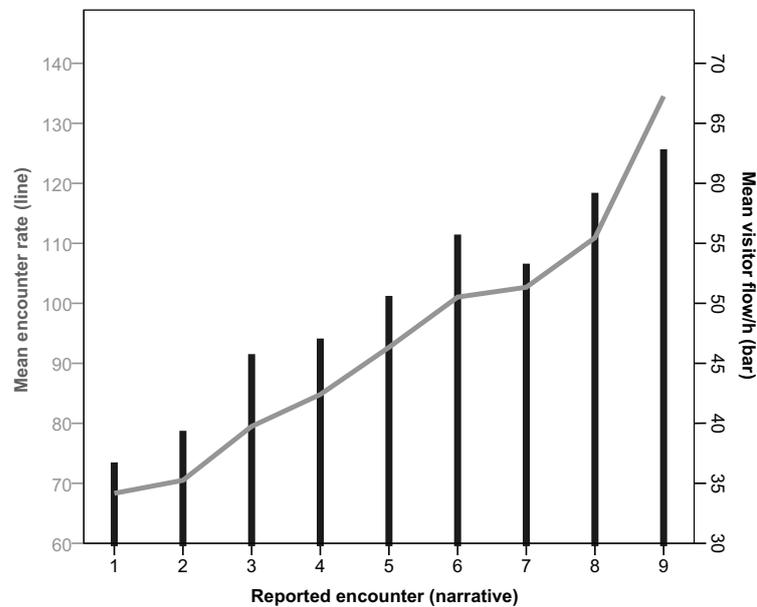


Figure 7.13: Reported encounter (narrative), estimated encounter rate and visitor flow/h

As expected, the relationship between reported encounter measured in the visual approach and estimated encounter rates show analogous results. Figure 7.14 (p. 127) demonstrates that those who have chosen a scenario depicting a low density situation (3 visitors on trial section, which most closely represented the condition they encountered during their visit) on average encountered about 74 visitors during

their trip compared with more than 136 of those who have chosen a scenario showing 12 visitors ($F=33.02$, $p<0.001$). In addition, the hourly visitor flow ranges from 40 (for those who choose a 3-visitor scenario) to 64 (for 12 people on the trail section).

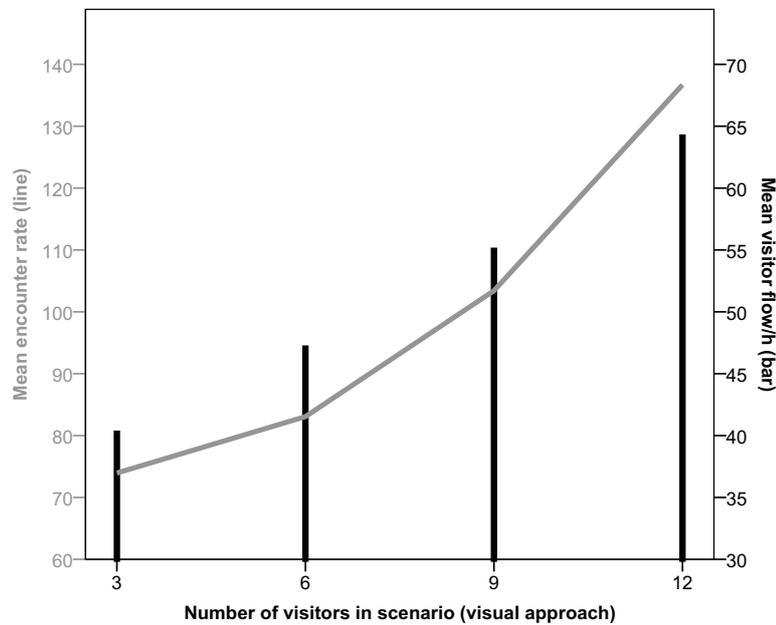


Figure 7.14: Reported encounter (visual), estimated encounter rate and visitor flow/h

4.6. Relationship between simulation results and visitors' perception of contacts

To better understand the relationship between respondents' perception of contacts with others measured in the narrative and visual approach and estimated encountered rates, those two variables were tested for association using a Pearson's R correlation statistic. The Pearson's R correlation identified a typical, positive linear relationship ($r=0.34$) between visitors' reported encounter and results of the simulation model ($p<0.001$). A comparison of the association between visitors' reported encounter in the visual approach and simulation results reveals an analog correlation ($r=0.41$, $p<0.001$). These findings confirm a significant relationship between objectively measured encounter rate on the trail and respondents' subjective perception of contacts.

5. Discussion and conclusion

Study findings illustrate the potential of a Java-based simulation of visitor use patterns as a tool for estimating objective encounter rates and evaluating visitors' reported encounter associated with areas' actual density during different times in a coastal recreation area. It demonstrates that it is feasible to develop a computer simulation model of visitor use on a linear trail with different types of visitors. The simulation can inform area management about the temporal distribution of visitor use and resulting encounters of visitor on the trail as a "hard to measure indicator variable". Therefore, a computer-based simulation is used to represent the complexity of recreation use patterns where field-based measures might fail to capture trail encounters as they occur in unknown intervals in a course of a day [Lawson et al., 2008].

In the simulation model empirical input data such as duration of the trip and travel speed is applied to simulate recreation days on the trail and to build a dynamic computer simulation model of visitor use encompassing both vehicle and pedestrian travel. Detailed visitor data presented in this paper are based on visitor counting, which enable a reliable simulation of spatial and temporal flows on the trail and counting of the number of contacts between visitors. The perception of contacts with others is gathered in an on-site survey and compared with simulation results of respondents' trip to the Hallig. In summary, results indicate that the combination of monitoring and survey data gained by different methods allow an in-depth analysis of visitor perception of encounter as a basis for a sustainable management of recreation areas.

The visitor use level is heterogeneous distributed over the sampling days and highly dependent on the day of the week. During weekends and public holiday encountering high use levels is very likely. Furthermore, various use levels have been found during the course of a day. Results of visitor counting on Hamburger Hallig support results from other studies in German large scale protected areas that there is visitation peak 11 am and noon and a second in the afternoon between 2 and 3 pm [Hellmuth, 2007].

Recent research on recreation use suggests that the number of other visitors encountered along trails constitute an essential indicator of the quality of visitor's recreation experience [Manning, 2007]. Estimated number of encounters shows a heterogeneous distribution of visitor use during the season and even at a course of day. This finding is important when evaluating the results of actual on-site congestion measurements. Survey respondents at the same sample day may have experienced different encounter and congestion levels dependent on departure and arrival time. Study findings expose that the amount of visitor encountered on the Hallig trail calculated in the simulation significantly correspond with visitor's encounter evaluation.

Visitors of Hamburger Hallig have been found to describe their encounter perception close to simulation results and that their perception of contacts of others is related to definite number of visitors. In the context of a coastal recreation area, the application of a visual-based measurement may result in more realistic estimations

of perceived crowding due to the fact that the scenarios portray a typical description of a trail section, which can be found within the area [Manning and Freimund, 2004].

Currently, managers of protected areas mostly rely on best guesses about recreation use and relating social impacts. Information on temporal component of visitor use as provided by this study might be useful when setting standards of quality for carrying capacity management [Wang and Manning, 1999]. The result of the simulation model can be used to approximate the maximum daily use level within the area that can be accommodated without reducing visitor's recreation experience [Manning, 2007]. As expected, the level of use (visitor flow) and the underlying encounter rate effect visitor's perception of contacts with others. Scenarios depicting a high density (12 people on the trail) are evaluated as crowded and expected to disturb at least for some of the visitors to Hamburger Hallig. Therefore, findings from the simulation model as presented in Figure 7.14 (p. 127) indicate that an encounter rate of more than visitors per trip might reduce the quality of visitor's recreation experience. These encounter rates together with a high visitor flow (particularly between 11 am and 1 pm during weekends) have been observed during weekends and public holidays (Mean=123.6). As a result area's social carrying capacity might be exceeded during these periods and at specific times of the day (Figure 7.12, p. 124). Thus, the area is expected to have a range of capacities that depend on type of recreation experience quality, which should be provided within the area and based on a management decision [Manning et al., 2002].

5.1. Study limitations and further research

Study data are collected as part of an ex-post survey, allowing the possibility of visitor's recall error [Lawson et al., 2003]. Applying trip diaries and GPS devices may overcome this limitation. In addition, the use of GPS devices might be suitable to track visitor's movements to gain more insight on the relationship between area density and visitors' perception of social conditions it. This technique allows a much more detailed examination of spatial patterns of visitor use than is possible through observational or survey techniques [D'Antonio et al., 2010]. Regional visitor use patterns could be detected by agent-based simulation of hikers and cyclist by including nearby areas of the national park.

8 Syntheses - PART C

This synthesis merges and discusses the findings of all four papers and relates them to the overarching research questions, which are posed in the introduction (Part A). The four manuscripts (Part B) expose specific and detailed information on different aspects relating to these central questions. This chapter summarises (a) the underlying research problem and (b) the methodological contributions of findings from manuscripts in relation to previous studies and their results, which are documented in the scientific literature. Subsequently, it is discussed how these methodologies can contribute to visitor management within the study area, namely the Wadden Sea region. Recommendations for further research are stated at the end of this chapter.

8.1 Research problem

The starting point of this dissertation is the increasing demand for outdoor recreation opportunities and the limited supply of appropriate natural environments, which together create a challenging management task. Shifts in lifestyles and recreation patterns are expected to influence the amount and type of recreation use in National Parks in the coming decades. Beginning in the late 1960s and early 1970s, the concept of social carrying capacity on federal lands in North America came to the forefront of public land planning because of the need to ensure adequate protection of natural resources and the quality of the visitor experience gained from various recreation activities [Seidl and Tisdell, 1999]. This social component of carrying capacity frameworks refers to the level of recreation use that can be accommodated in large scale protected areas without diminishing the quality of visitor experience [Lawson et al., 2003]. In recent years, carrying capacity management is successfully implemented in North American national parks by (a) defining the degree of resource protection, (b) defining the type of visitor experience to be provided, (c) monitoring conditions over time and (d) adopting adequate management practices to ensure that acceptable conditions have been maintained [Manning et al., 2003]. Thereby, successful management is based on the formulation of sufficient management objectives and the development of associated indicators and standards of recreation quality.

In first evaluations of social carrying capacity and congestion in wilderness areas conducted in the United States, a negative relationship between density and visitor satisfaction has been assumed, which results in a wilderness area management objective to provide opportunities for solitude mandated by legislation [Westover,

1989]. In the following decades, the concepts of encounters, crowding, and encounter norms or standards that individuals use to evaluate encounters with others as acceptable or unacceptable, have been intensively studied in various types of recreation areas [Shelby, 1980, Graefe et al., 1984, Shelby et al., 1989, Manning, 1999, Arnberger and Mann, 2008, Vaske and Shelby, 2008]. Thereby, the relationship between area density and perceived crowding is mediated by the individuals' perceptions of the number of people in the area [Vaske and Donnelly, 2002].

Study findings revealed that visitors have strong preferences for the number and types of other groups that they wish to encounter during various recreation activities [Ditton et al., 1983]. In addition, recreation studies have examined the situational and cognitive influences on perceptions of crowding in natural settings [Gramann, 1982, Ditton et al., 1983, Shelby et al., 1983, Kuentzel and Heberlein, 1992], including whether social norms exist for certain recreational activities [Roggenbuck et al., 1993, Heywood and Aas, 1999, Inglis et al., 1999] and how they could be measured [Manning et al., 1996].

Following an intuitively logical causal ordering, models of congestion in recreation areas predict that actual use levels (area density) influence the number of contacts between visitors (reported encounter) and that these encounters influence visitors' negative evaluation (perceived crowding).

The perception of crowding varies across recreation settings, by time and season of the year, resource availability and accessibility, and imposed management measures [Shelby et al., 1989]. Crowding norms held by visitors vary by type of resource (frontcountry versus backcountry settings), type of encounter (no-conflict versus conflict contacts), and question response format [Donnelly et al., 2000]. Visitors' perception of crowding seems to be higher at more accessible locations (i.e. icon sites) and during high season periods. In summary, the main research objectives in the U.S. context were to (a) examine social and facility indicators of social carrying capacity (e.g. crowding, encounters), (b) gauge thresholds when social impacts become inappropriate, (c) expose the extent of conflict among different activity groups and (d) support local area management strategies for minimising impacts (e.g. visitor education, regulation).

In contrast, Arnberger and Mann (2008) identified in their review of research in visitors' perception of crowding in the European context, a low number of studies with diverse methodological approaches (i.e. scale types, data collection methods). An integrated and standardised "European approach" to measure crowding related issues in recreation areas is missing and is mostly based on theoretical foundations from North American recreation literature. Any approach must be adjusted to the specific background of Central European outdoor recreation areas, which differ from North American national parks in terms of accessibility, area, use level, management framework and visitor motivation [Haider, 2006]. Research into expected or appropriate social densities in popular Central European recreation settings, which in most cases are located next to metropolitan areas, is important because of high use levels and various, sometimes competing, recreation activities.

8.2 Study objectives and methods

Starting from these assumptions and driven by the limitations of research in the European context, a research approach for a German, large-scale protected area setting is developed to (a) evaluate visitor use levels and visitor's perception of crowding in a popular coastal national park in the north of Germany and (b) identify appropriate social indicators to evaluate recreation quality on Hamburger Hallig located in the Wadden Sea National Park "Schleswig-Holsteinisches Wattenmeer". The high number of people visiting the German North Sea coast has generated a number of concerns about the ability of these areas to sustain appropriate levels of social and resource conditions and impacts, especially in the summer season.

In detail, the primary purpose of this dissertation is to explore visitor encounters, norms and perceived crowding and their interrelationships and thus the identification of appropriate social indicators to measure recreation quality. A case study research design is applied to assess the social carrying capacity of recreation use and identify various determinants of visitor's crowding perception and their interrelationships. The dissertation concept is applied to:

- Evaluate how visitor characteristics such as experience, motive and type of activity differently influence the evaluation of recreation conditions within the area (Manuscript 1)
- Determine the importance of the key attributes presented in a visual description that are expected to influence visitors' perception of crowding (Manuscript 2)
- Examine visitors' attitudes and tolerance towards seeing others during their trip to Hamburger Hallig and the social norms regarding acceptable and unacceptable trail conditions (Manuscript 3)
- Estimate the association between actual density, visitors' subjective perception of contacts with other visitors and objective encounters rates on the trail to the Hallig by applying a visitor flow simulation (Manuscript 4)

The basic measurement concepts and the set of variables are based on analysis of best practise from North American and European research into social carrying capacity. They are adjusted to the different basic context of a German national park and the Wadden Sea area. In addition, the study advances multivariate, imaged-based analysis and compare transfer the concept of congestion in outdoor recreation areas.

Study procedure includes four steps:

1. Estimation of visitor use level on the trail to Hamburger Hallig by visitor counting (actual density)
2. Design and implementation of an on-site questionnaire administered to public trail users at the Hamburger Hallig trailhead (reported encounter and perceived crowding)
3. Data analysis of participants' responses to variables to determine levels of site congestion
4. Discussion of management strategies and recommendations for the Hamburger Hallig

The primary data for the investigation was collected at ten days in spring and summer 2009 in an on-site survey and an accompanying visitor observation on the small island (N=509).

8.3 Summary of main results

The dissertation findings presented in the manuscripts (Part B) support and expand former North American and European study findings in concerning social carrying capacity and crowding of outdoor recreational use in protected areas, which are presented in the following section.

8.3.1 Visitor characteristics and evaluation of social conditions (Manuscript 1)

To evaluate if there are potential social carrying capacity related problems within the area, it is crucial to assess the relationships between specific site characteristics (i.e. area density), visitor characteristics (i.e. experience) and individuals' evaluation of use levels (i.e. reported encounters and perceived crowding). In the first manuscript, visitors' perception of contacts with others and evaluation of these encounters is addressed by examining if visitor's perception of crowding is measurable at a popular, day trip destination with the established nine-point crowding scale.

Overall, respondents reported that encounters vary over sampling time but are consistently at a high level, especially during holidays (including Whitsunday). Significant differences in the perception of contacts with others emerge in a comparison between weekday and weekends. The majority of visitors report having encountered lower numbers of other visitors during weekdays and a significant higher number at weekends, implying that weekends and holidays are a potential problem period at Hamburger Hallig. Respondents seem to experience high visitor numbers in terms

of reported encounters, but do not necessarily feel disturbed by the high numbers. This supports findings from previous research, which revealed that strong feelings of crowding do not occur as long as encounters with other groups are not considered to be disturbing [Manning, 2007].

In general, visitors of Hamburger Hallig have a low crowding perception (21.6% of respondents felt crowded with a rating of three and more on the nine-point-crowding scale), suggesting that a major threat due to high visitor numbers does not exist [Vaske and Shelby, 2008]. Only during public holidays and fine weather conditions, actual density may increase to a degree that visitors evaluate trail conditions as crowded (i.e. up to 31.3% at the Whitsunday weekend). Based on the capacity judgement developed by Shelby et al. (1989), the percentage of respondents of the study sample showed “suppressed crowding” (when 0-35% of respondents felt crowded) caused by the number of visitors present within the area¹. Gramann and Burdge (1984) explained this phenomenon by a process of self-selection in which visitors of popular recreation areas tend to be tolerant of seeing many other people and are able to accommodate themselves psychologically to their presence. In addition, higher levels of social stimulation may enhance the recreation quality for those visitors who enjoy watching people or performing groups and family oriented activities [Altman, 1975, Kaplan and Kaplan, 1989]. Another explanation might be that positive effects of high visitor numbers have been reported as they reduce safety concerns [Arnberger et al., 2010].

The study confirms results of earlier research that visitors to popular outdoor recreation areas tolerate high visitation rates. Mann (2006) revealed in his study in the “Naturpark Schwarzwald” that overall perception of crowding is low (80% of respondents did not feel crowded). Also a comparable study within the Wadden Sea region on Hallig Hooge [Kalisch and Klaphake, 2007] showed that only a minority feel crowded by the number of visitors on the island. On the popular island only 7% of respondents experienced disturbance due to other visitors. Most visitors to these popular recreation areas may expect to see many other individuals and search for different experiences, which are not always negatively affected by high density.

8.3.2 Preference for social trail conditions (Manuscript 2)

One weakness of research designs that measure visitors’ crowding perception on single-item scales is that they provide limited information about the complex and multi-dimensional phenomenon of congestion in outdoor recreation [Arnberger et al., 2004]. The use of verbal descriptions only may be inappropriate to cover the complexity of high visitor use recreation areas.

¹The indicator of perceived crowding is calculated by collapsing points 3 to 9. A negative evaluation is stated by 0-35% of respondents and implies that crowding is likely limited by situational factors and the area offers a unique low-density experience [Shelby et al., 1989].

In general, multivariate measurement approaches have been found to reveal more detailed information about conflicts among different activity groups and visitors' preferences for the presence of others [Stockdale and Hale, 1982, Haider, 2002, Reichhart and Arnberger, 2010]. They have demonstrated that the perception of crowding has multiple determinants and cannot be considered by an one-dimensional concept. For that reason, a multivariate visual approach is developed and included in the case study to analyse the importance of recreational attributes that are expected to influence visitors' perception of crowding. A series of digitally manipulated photographs are constructed to reveal visitors' preferences for social conditions on the trail to Hamburger Hallig. Study findings detect the importance of two main attributes, namely "number of visitors" and "presence of car traffic", which influence respondents' preference for the presence of others.

A negative evaluation of the hypothetical scenarios strongly increases when use level is high and car traffic is included in the photographs. As expected, people seem to prefer low use levels and the absence of car traffic on the trail to Hamburger Hallig. Study findings also imply that an expected inter-visitor conflict between hikers and cyclist does not exist.

The existence of asymmetrical relationships between activities leads to conflicts that occur when the presence of an individual or group interferes with the goals of another individual or group [Donnelly et al., 2000]. Recent research has found potential conflicting encounters such as non-motorised visitors and motorised recreationists, and visitors may feel disturbed because the social goal and behaviour of those encountered interfere with their own motivations [Vaske et al., 2000, Carothers et al., 2001, Vaske and Donnelly, 2002].

As a result, some recreation activities may be considered more negatively than others, which contribute to greater feelings of crowding when participants in them are encountered [Gramann, 1982]. Study findings approve those results by indicating that the presence of car traffic on the trail to the island seems to negatively affect non-motorised visitors' ability to achieve recreational benefits and lead to increasing crowding perception.

8.3.3 Visitors' encounter norms (Manuscript 3)

The methodological challenge of this dissertation is to adapt different methods to evaluate visitors' perception of crowding in the specific European and German context. The main objective of the third manuscript is to clarify if the number of encountered visitors constitutes the most important dimension of crowding norms and to test the relationship between the various factors of congestion. A comprehensive crowding model is applied on Hamburger Hallig by adapting two established approaches to measure visitors' perception of crowding namely a narrative and visual approach.

Study findings verify a relationship between visitors' perception of crowding and its explaining factors including actual density, reported encounter, visitors' tolerance for area density and expectations and support findings from aggregated crowding research [Vaske, 2008]. High correlations have been found between (a) actual density and reported encounters and (b) visitors' tolerance of density and perceived crowding when using an image-based management approach.

A social norm curve [Manning et al., 1999] is constructed from visitors' average evaluations of the eight hypothetical trail scenarios. There are mainly positive ratings for the scenarios, even when depicting a high density situation. Respondents evaluate scenarios, which show 12 people per 150m trail section and excluding cars on the trail, as rather not crowded. In contrast, when car traffic is present, the photograph is evaluated as rather crowded. Results showed that the number of contacts with others is an explaining factor, but car traffic constitutes the most important dimension and it strongly influences visitor's preferences for use levels.

All in all, around 20% of respondents have not any negative feelings against area's density, which indicates that as long as encounters with other groups are not considered to be disturbing, they do not result into a perception of crowding [Manning, 2007]. Visitors have been found to tolerate high numbers of contacts with others, which might be explained by the awareness of the likelihood of encountering many others during their trip (more than 40% have visited the island before). People visiting popular recreation areas may have more ambivalence about appropriate conditions [Kuentzel et al., 2008].

Most of the visitors to Hamburger Hallig expect a nature experience and annoyance from car traffic may not be part of their anticipated experience. In this context, an imaged-based approach might describe trail conditions more realistic and include relevant factors, in this case the car traffic, which are not incorporated in the narrative measurement [Manning, 1999].

8.3.4 Simulation of visitor flow (Manuscript 4)

Simulation models are useful tools for assessing so called "hard to measure" indicators of quality such as the number of contacts between visitors or perception of crowding [Lawson, 2006]. In recent years, computer-based simulation modelling has been found to constitute an effective tool to address and analyse visitor conflicts, examine social and ecological impacts, understand human spatial behaviour in natural settings and support the decision-making process of local management authorities in recreation settings located in protected areas [Wang and Manning, 1999, Gimblett et al., 2000, Cole and Daniel, 2003, Lawson, 2006, Taczanowska et al., 2008].

The fourth manuscript expanded on these findings by describing reported encounters, crowding norms, and the simulated contacts between respondents and other visitors derived from a simulation model. A visitor flow model was constructed to obtain information about inter-group encounter levels based on visitor counting and results of the on-site survey.

Study findings demonstrate the potential of a Java-based simulation of visitor flows as a tool for estimating encounter rates and evaluating visitors' reported encounters and their association with area's actual density. Visitors have been found to describe their encounter perception close to simulation results and the subjective perception of contacts with others is congruent with the objective simulated number of encountered visitors on the trail to Hamburger Hallig.

In both encounter-measurement approaches (verbal and visual), visitors describe their encounter perception close to simulation results. The simulated number of encounters shows a heterogeneous distribution during the season and even during the course of a day, which has an impact on actual on-site congestion measurements. As individual encounter rates can range from 24 to 75 encounters per trip during the course of a weekday and from 57 to 303 during weekends, respondents' perception of crowding should be expected to vary accordingly. The linking of visitor use levels (descriptive data) to individual's evaluation of density in terms of reported encounter can be used to manage the quality of visitor's recreation experience [Itami, 2006]. Combined findings from the simulation model and the survey results indicate that an encounter rate of more than 120 visitors per trip, which can be observed during weekends and public holidays, might reduce the quality of visitor's recreation experience.

8.4 Management implications

8.4.1 Translation of study results into management frameworks

North American recreation research revealed that effective recreation area management relies highly on understanding visitor perceptions and behaviour [McCool and Clark, 2007]. Visitor surveys and models of visitor flow could enhance the knowledge of use patterns and improve general understanding of the relationship between perception of crowding and density. The findings described here hold implications for area management.

They might help area managers and planning authorities to define specific management goals in terms of desired resource and social conditions and design target oriented management measures for Hamburger Hallig and the region. These decisions about appropriate visitor management in national parks are extremely complex and depend on value choices. Visitor management frameworks such as Recreation Opportunity Spectrum (ROS) can be used to support a sustainable tourism concept in large scale protected areas [Ahn et al., 2002]. The ROS concept

has typically been applied in North America at a regional level and supports the development of recreation experiences by classifying areas according to environmental conditions and recreational activities. Federal land management agencies have used the framework to classify areas based on their distinctive recreation and resource conditions and opportunities.

Different land classes within the area are defined ranging from “primitive” to “high developed” areas and offer different opportunities for various recreation activities and experiences. Physical (i.e. accessibility), managerial (i.e. range of regulations) and social criteria (i.e. number of encountered visitors) are used for the definition of classes [McCool and Clark, 2007].

Applying these frameworks requires a site-specific adjustment to Wadden Sea National Park conditions with a rich diversity of stakeholders and interests. Thereby, reliable data about visitor use distribution and levels is needed [Ankre, 2009]. Following principles of management frameworks, an approach for the Wadden Sea National Park region needs quantitatively measured social and ecological indicators at specific sites in order to reveal situations, where standards of quality are no longer maintained or are exceeded.

Therefore, the obtained results are useful in supporting management in the national park region and may provide an empirical foundation for the application of a carrying capacity framework such as Recreation Opportunity Spectrum (ROS). Information collected about the visitors’ preferences for different use levels and individuals’ perception of density could help to define management goals.

A management framework can be adopted by (a) designating management zones and areas of conflicts in terms of carrying capacity for the whole NP region (i.e. use levels, types of recreation activities) and (b) defining indicators and standards of quality for the recreation experience for each zone and subsequently developing measurement measures [Manning et al., 1999]. The indicators can be monitored by on-site surveys to ensure that standards are maintained. If not, appropriate management measures have to be imposed (i.e. zoning, rationing, limit use).

In addition, these frameworks take account of concerns about desired future conditions and can be used to support capacity decisions and the implementation of management measures. Nevertheless, it is crucial to point out “(...) that researchers and managers need to consider more than the three concepts examined here (reported encounters, encounter norms and crowding) when attempting to understand and manage natural resources [Vaske and Donnelly, 2002] (p. 267).”

Furthermore, results could offer practical information about the area and provide visitors with realistic expectations about use levels within the area [Fredman and Hörnsten, 2004]. “Information about the range of opportunities, from low to high density, allows people to select an experience which best fits their preferences and expectations [Shelby, 1980] (p. 54).” Knowing the preferences and needs of certain user groups enables the design of better offers and ensures that protected areas are accurately portrayed so that unrealistic visitor expectations are avoided, for example, knowing that a majority of hikers enter the area between 11 and 12 am.

Although the concept of unlimited access to public lands in Germany exists, it is increasingly recognised by area managers that changing recreation areas to accommodate higher usage may also change the characteristics of those places and related visitor experiences. In comparison with North-America, German national parks usually follow an open-access policy. In addition, restrictive management strategies such as the limitation of visitor numbers or even closing specific areas might not be an option because the national park also serves as a recreation area for local residents and regional visitors. Nevertheless, in recent years, areas in Germany have started to impose use limits or rationing, for example on bird watching activities in Müritz National Park [Brüggemann, 2007].

A significant number of visitors may relocate and would use alternative areas in the vicinity of the park and transfer their recreational use to areas that were less affected by high use levels before [Arnberger and Brandenburg, 2007]. By excluding certain outdoor recreation activities from some areas that are sensitive and by allowing uses in other parts, a zoning approach may reduce both negative ecological and social impacts. Transferred to the situation in Wadden Sea National Park, natural and sensitive parts could be excluded from advertising and “mass tourism” and maintained for more nature oriented visitors.

8.4.2 Management implications for Hamburger Hallig

The objective of this thesis is to evaluate if high visitor numbers and intensity of use can compromise a recreational experience and lead to visitor conflicts in terms of congestion, and how this can be measured in a national park context in Germany. Based on the findings presented in this thesis, it can be concluded that:

1. The application of the nine-point crowding scale on Hamburger Hallig revealed that respondents reported a low level of perceived crowding even though high numbers of encounters were reported during weekends and holidays.
2. The development and use of a multivariate visual approach revealed “number of visitors” and “presence of car traffic” as the main factors of visitors’ perception of congestion.
3. The results indicate that carrying capacity of recreation use on Hamburger Hallig can be described in terms of a conflict of interest between proponents and opponents of car traffic on the trail, rather than in absolute number of visitors to the area.

A sustainable tourism concept and more nature-based recreation oblige area managers to provide opportunities for high quality visitor experiences and to protect natural environments from negative tourism-associated resource impacts [Cahill et al., 2008].

As the Hamburg Hallig offers great opportunities for nature tourism and experiencing the Wadden Sea National Park, its future development has to be managed with care. In fact, determining thresholds of visitor use in protected areas depends on the degree of resource protection and the type of recreation experience that will be provided.

As the popularity of Wadden Sea National Park is expected to increase, caused by its status as a World Heritage area since 2009, demand for access and use can obstruct conservation goals. Expected damage to the ecological integrity of sensitive environments, reduction of the quality of user experiences and conflicts among stakeholders regarding appropriate management responses might be a negative consequence. Local authorities are faced with challenges that could include the consideration of use thresholds in terms of carrying capacity and require a visitor management framework as described before. Thereby, a monitoring of use levels and visitor flows at selected sites within the area can help to ensure (a) the perpetuation of the natural character of the site and (b) that visitors' recreation experience is not compromised by issues such as congestion and visitor conflicts.

This circumstance strongly suggests that managers should take the opinions of repeat visitors and local residents into consideration when making decisions affecting Hamburger Hallig.

All in all, a crucial question remains as to how the outstanding value of the Wadden Sea can be preserved while considering all the ecological, economic and social demands within the region.

8.5 Future directions of research

The presented study findings rely on the empirical data and variables included in the on-site survey design. Within this context, more research is needed on relevant variables and appropriate crowding measurement approaches.

Future research should include multivariate research designs to detect relevant variables influencing respondents' evaluation of crowding. Thereby, another potential area for future research lies in aggregating "social norm curve" data to discover the main drivers of visitors' crowding perception and common patterns of visitor reactions. Long term studies, as documented in North American recreation literature [Kuentzel and Heberlein, 2003] can be used to observe the dynamic of crowding and encounter perception over years.

The four scenario attributes used in this study are based on literature review, expert interviews and the results of a pilot study. Nevertheless, it is possible that some attributes have been ignored and thus not been included in the study. On the one hand, visual approaches have been found to be more effective than verbal explanations in considering visitors' encounter perception.

On the other hand, they are a static description and may not be able to extract all relevant information from the respondents, for example the influence of travel speed [Yagi and Pearce, 2007]. Computer animated presentations included in the survey design could be a useful tool in evaluating the dynamic factors related to visitors' perception of crowding [Reichhart and Arnberger, 2010].

Furthermore, the relationship between motivations for visiting large scale protected areas, visitor's pre-trip expectations and preferences for social conditions within the area, needs to be further explored.

Also, additional research needs to be undertaken into the relationship between visitors' support for the management measures imposed to control the impacts of recreation use and the perception of crowding [Bullock and Lawson, 2008, Cahill et al., 2008]. Including this factor into surveys in Wadden Sea region might be useful in gauging visitors' preferences and acceptance of alternative management actions, and how such actions might alter visitor experiences.

As stated before, unacceptable social conditions (in terms of high density) within a recreation area may lead to displacement effects and coping behaviour. High visitor numbers, proximity to others and unwanted visitor behaviour have been found to influence the respondents' decision to shift their use to less popular areas [Arnberger and Haider, 2007b, Arnberger et al., 2010]. Visitors who are sensitive to congestion use spatial displacement (visiting alternative, low-use areas) or temporal displacement (visiting during out-of-season or off-peak times only) [Moyle and Croy, 2007]. Including these effects an regional and national off-site survey could reveal visitors' displacement and coping behaviour of locals and tourists and assess potential recreation pressure on recreation areas in the vicinity.

Additionally, a better understanding of visitor characteristics can be useful in addressing the relationship between expected demographic change and recreation use patterns. An ageing society may lead to a diversification of recreation demand and a shifting of temporal visitor flow within the national park region. Also, future impacts of climate change on recreation opportunities in the Wadden Sea area and related changes of use patterns might be crucial. Evaluating the relationship between the bioclimatic and meteorological conditions, and observed visitor frequencies and various kinds of outdoor recreation activities can support the research [Brandenburg et al., 2007].

9 Appendix

9.1 List of Manuscripts

7.1 Manuscript 1

Author: Dennis Kalisch

Title: “Relevance of crowding effects in a coastal National Park in Germany - Results from a case study on Hamburger Hallig”

Status: Published in *Journal of Coastal Conservation* (16 March 2012), pp. 1-11, doi:10.1007/s11852-012-0195-2

7.2 Manuscript 2

Author: Dennis Kalisch

Title: “Application of an image-based conjoint analysis approach to evaluate visitors’ preferences for recreation conditions and density in Wadden Sea National Park, Germany”

Status: Submitted for publication in *International Journal of Tourism Research*

7.3 Manuscript 3

Author: Dennis Kalisch

Title: “Visitors’ evaluation of area density: Measuring crowding norms in Wadden Sea National Park, Germany”

Status: Presented as a fullpaper at the *2nd International Conference on Landscape Economics, July 4-6, 2011, Padua/Italy*

7.4 Manuscript 4

Author: Dennis Kalisch (*), Timmo Freudl-Gierke (**), Jana Hoymann (***)

Title: “Simulation and measurement of visitor contacts: Comparing actual density and visitor’s perception of encounters with others in Wadden Sea National Park, Germany”

Status: Submitted for publication in *Landscape and Urban Planning*

(*) Development of paper concept and visitor flow model; statistical analysis; preparation and submission of manuscript

(**) Implementation of visitor flow model

(***) Development of visitor flow model

9.2 Questionnaire and recreation scenarios

Visitor Survey Hamburger Hallig 2009



My name is Dennis Kalisch from Technische Universität Berlin. In the course of my dissertation I conduct an on-site survey in cooperation with the "Zweckverband Hamburger Hallig". We are interested in visitor's expectations and opinion. Answering the questions will only take 10 minutes. We appreciate your cooperation!

A. Questions concerning your day trip...

1. Approximately how many hours did you spend on the Hallig? _____ Hours

2. How many people are accompanying you? Adult _____ Children _____

3. How did you explore the Hallig?
 By foot By bike
 By car Other _____

4. Where did you start your daytrip to the Hallig?
 a) Holiday area: _____
 Postcode of home town: _____
 Abroad: _____
 b) Place of residence: _____

Go ahead with question 6

5. Have you ever been to the North Sea coast region of Schleswig-Holstein before? No Yes
 If yes, how often? _____ times

6. Have you visited the Hallig before? No Yes
 If yes, how often per year? _____ times

7. Which of the following attractions did you visit during your stay?

Show Hallig map! Multiple answers allowed!

- | | |
|---|--|
| • Amsinck-Haus (1) <input type="checkbox"/> | • Wattwerkstatt (4) <input type="checkbox"/> |
| • NP-Station Schafberg (2) <input type="checkbox"/> | • HalligKrog (5) <input type="checkbox"/> |
| • Saltmarsh trail (3) <input type="checkbox"/> | • Bathing area (6) <input type="checkbox"/> |

9.2 Questionnaire and recreation scenarios

1. Which of the following activities did you undertake on your way to and on the Hallig itself?

Read all items to respondent!

- | | | | |
|---------------------|--------------------------|-----------------------|--------------------------|
| • Nordic Walking | <input type="checkbox"/> | • Bicycle tour | <input type="checkbox"/> |
| • Hiking | <input type="checkbox"/> | • Dog walking | <input type="checkbox"/> |
| • Walking to Hallig | <input type="checkbox"/> | • Bird watching | <input type="checkbox"/> |
| • Jogging | <input type="checkbox"/> | • Picnic and relaxing | <input type="checkbox"/> |
| • Bathing | <input type="checkbox"/> | Other _____ | |

2. How important are the following reasons to you to visit the Hallig? Please indicate how important the following reasons were to you to visit the Hallig from **(1) "very important"** to **(6) "not important at all"**.

Show rating scale!

- | | | | |
|--|--------------------------|-----------------------------|--------------------------|
| • Nature experience | <input type="checkbox"/> | • Visiting restaurant/ café | <input type="checkbox"/> |
| • Get away from daily routine | <input type="checkbox"/> | • Environmental education | <input type="checkbox"/> |
| • Solitude and tranquility | <input type="checkbox"/> | • Physical activity | <input type="checkbox"/> |
| • Common getaway with family and friends | <input type="checkbox"/> | • Nature observation | <input type="checkbox"/> |
| • Visiting National Park stations | <input type="checkbox"/> | Other _____ | |

B. Questions concerning your perceptions...

3. How many other visitors did you encounter today? Please estimate the number on a scale ranging from **(1) "very few"** to **(9) "a lot of"** other visitors.

Your evaluation:

Ask question only, if Hallig has been visited before!

4. What has your impression been during previous visits? During previous visits I have encountered **(1) "very few"** to **(9) "a lot of"** other visitors.

Your evaluation:

5. Did you feel crowded by the number of other visitors? By the number of other visitors I felt **(1) "not at all crowded"** to **(9) "extremely crowded"**.

Your evaluation:

C. Questions concerning the series of pictures...

In the following eight pictures you will see a part of the trail to Hamburger Hallig. Each image shows a different number of hikers, cyclists and cars using the trail section. Please look at the pictures and answer the three rating questions!

1. Would you feel crowded by the presented number of visitors from 1 "not at all crowded" to 6 "extremely crowded"?
Show each picture!

Picture 1:	<input type="checkbox"/>	Picture 2:	<input type="checkbox"/>	Picture 3:	<input type="checkbox"/>	Picture 4:	<input type="checkbox"/>
Picture 5:	<input type="checkbox"/>	Picture 6:	<input type="checkbox"/>	Picture 7:	<input type="checkbox"/>	Picture 8:	<input type="checkbox"/>

2. Which picture shows a situation you have encountered during your trip? Please choose a picture.

Your choice: Image

3. Which picture represents a situation you have expected today? Please choose a picture.

Your choice: Image

D. Questions concerning attitudes and age ...

4. Will you visit the Hallig again? Yes No
 If no: Why not _____?

5. Do you generally oppose car traffic by tourist on the Hallig? Yes No
 If yes: Why _____?

6. What year were you born? Year of birth 19____

Thank you very much for your cooperation and have a nice journey home!

Nr.:	Interviewer:	Location of survey:	Date:	Time:
_____	_____	_____	_____	_____

Weather conditions:		Bright to cloudy		<input type="checkbox"/>	Sex:	
Sunny	<input type="checkbox"/>	Cloudy	<input type="checkbox"/>	Rainy	<input type="checkbox"/>	F <input type="checkbox"/> M <input type="checkbox"/>

Comments: _____

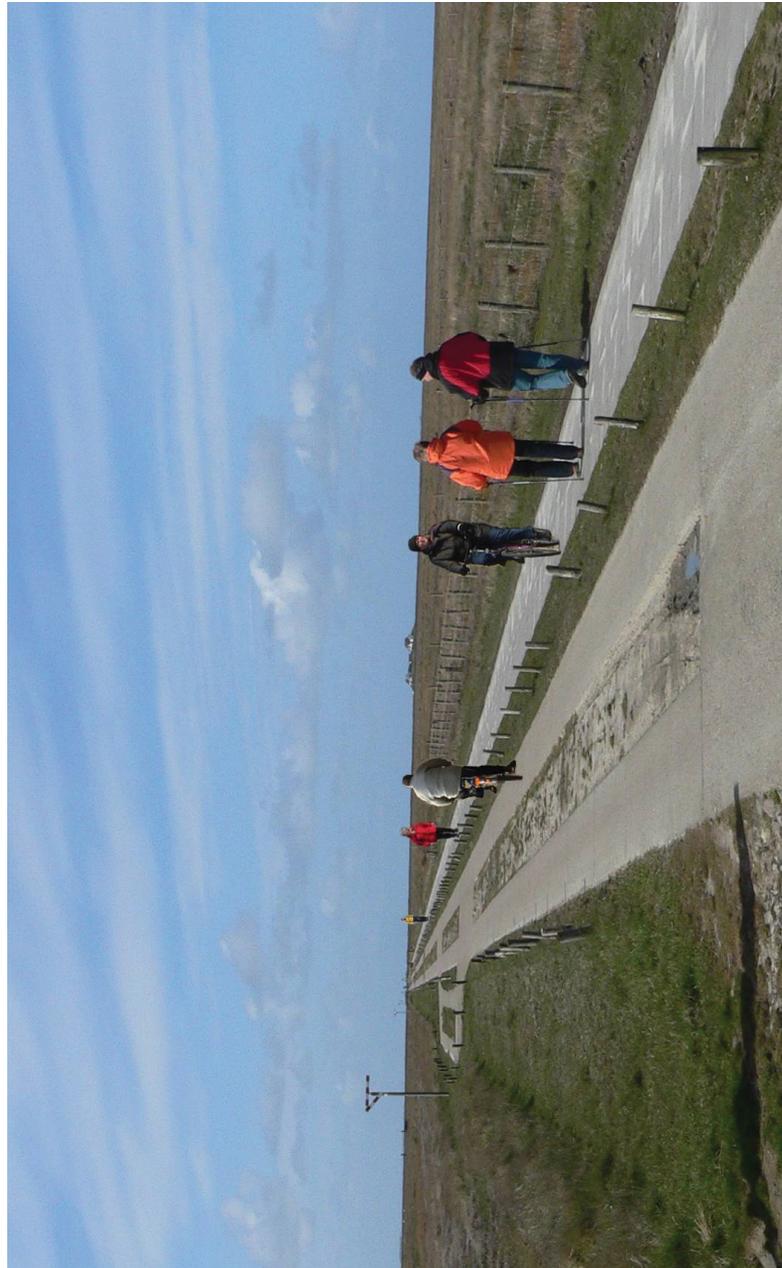


Image 1/8

9.2 Questionnaire and recreation scenarios



Image 2/8

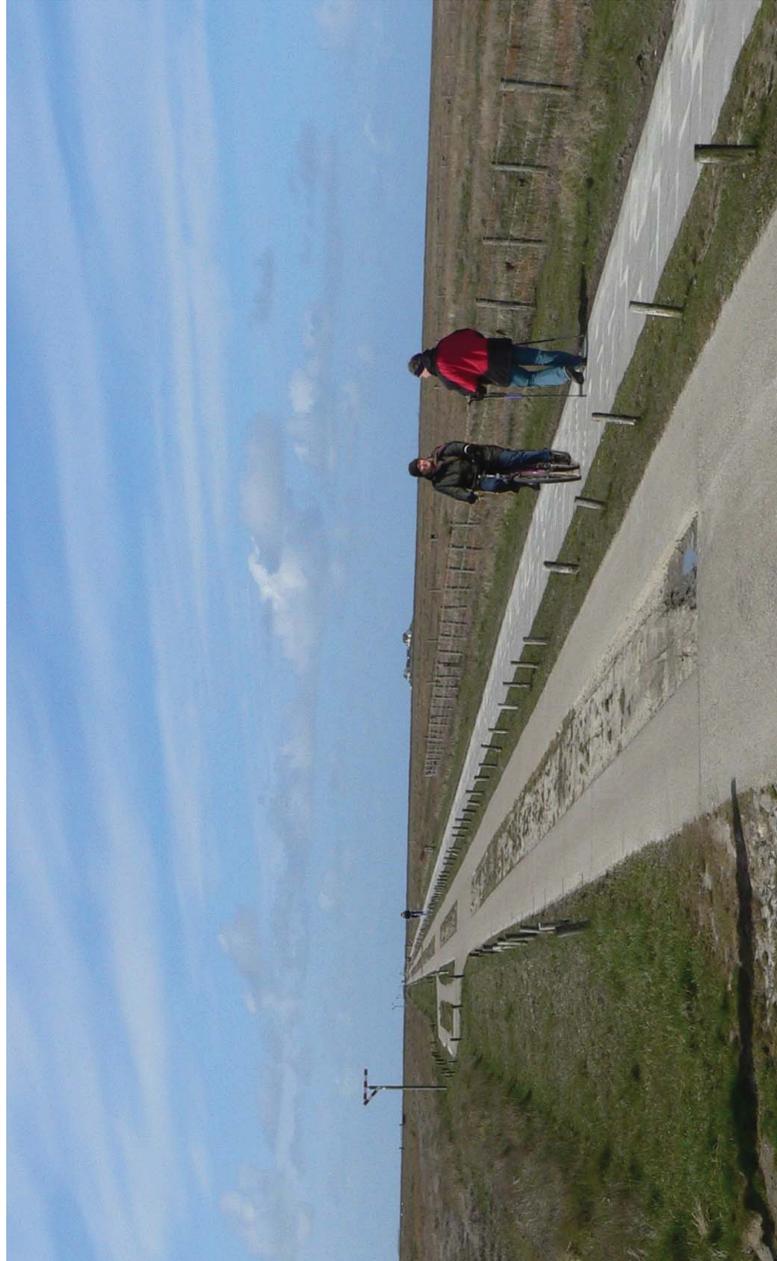


Image 3/8

9.2 Questionnaire and recreation scenarios

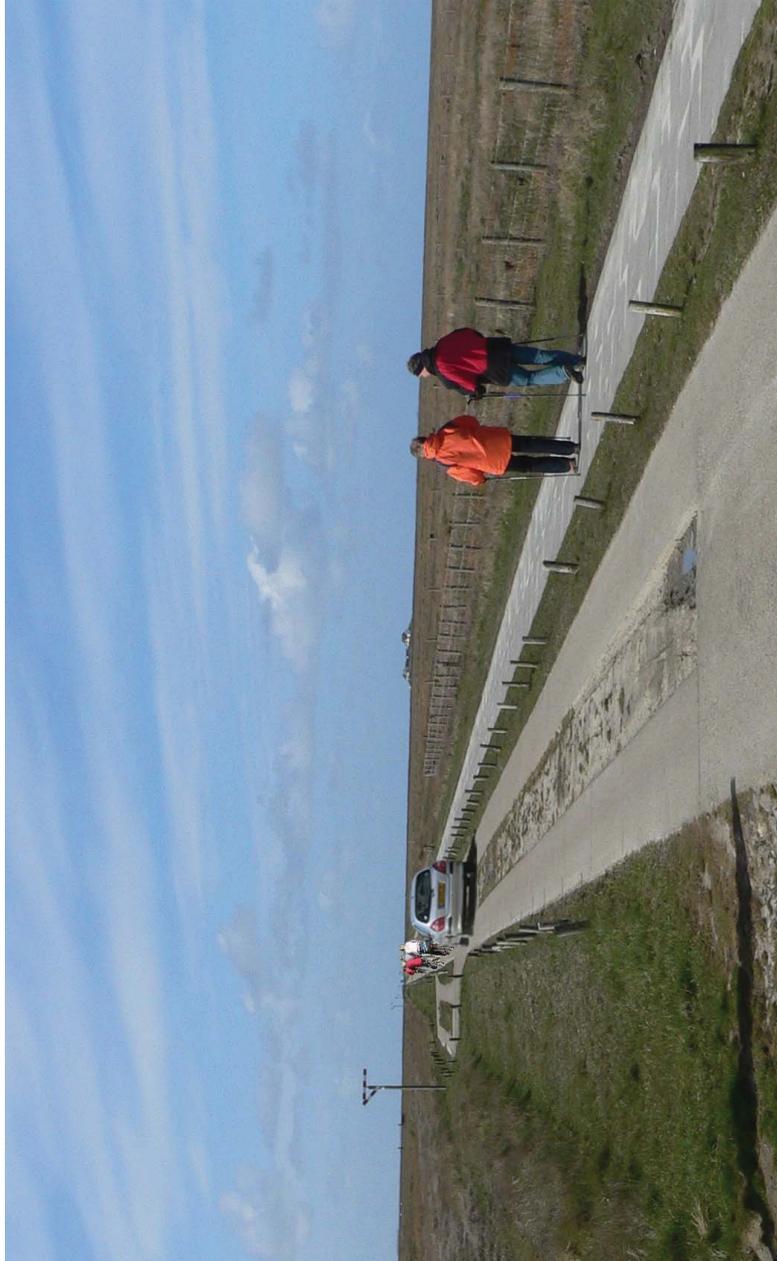


Image 4/8



Image 5/8

9.2 Questionnaire and recreation scenarios

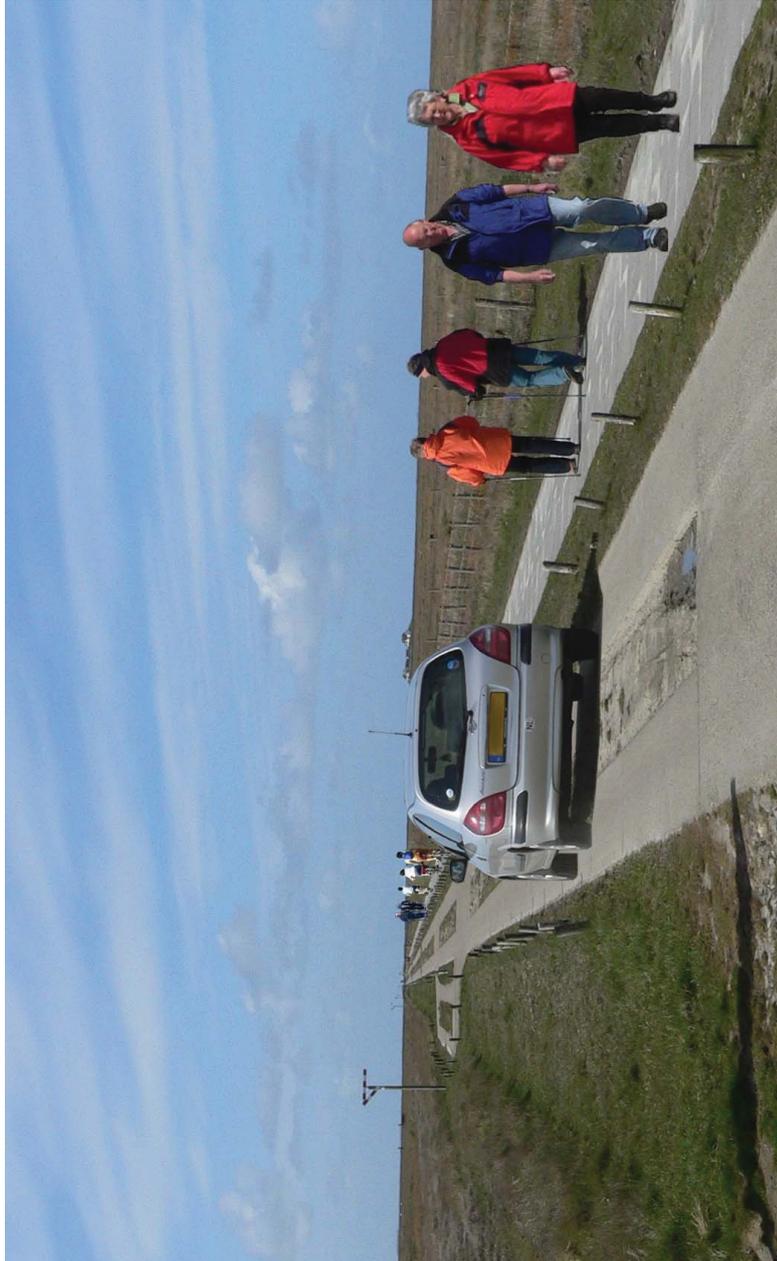


Image 6/8



Image 7/8

9.2 Questionnaire and recreation scenarios



Image 8/8

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High visitor loads and congestion in national parks can compromise the recreation experience and lead to visitor conflicts. The application of a multivariate measurement approach described in this thesis reveals detailed information about the perception of crowding and preferences for the presence of others in the Wadden Sea National Park. These findings should be important for relevant stakeholders when managing visitor numbers within the region.



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