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SUSTAINABILITY OF NATURE-BASED TOURISM

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ANNE TÖRN

SUSTAINABILITY OF NATURE-BASED TOURISM

Academic dissertation to be presented, with the assent of the Faculty of Science of the University of Oulu, for public defence in Kuusamonsali (Auditorium YB210), Linnanmaa, on December 14th, 2007, at 12 noon

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Abstract

Nature-based tourism has increased considerably during recent years, which has raised questions about the tolerance of ecosystems experiencing growing visitor numbers. The present thesis focuses on the ecological and social sustainability of nature-based tourism in protected areas and their surroundings. The objective of the ecological studies was to determine the effects of tourism on vegetation, soils and risk of introduction of alien plant species. The social survey investigated whether opinions concerning nature conservation and tourism by local people are dependent on socio-economic and demographic factors. The studies were carried out in Oulanka and Pallas-Ounastunturi National Parks, and in the Ruka and Syöte regions, in northern Finland.

This research demonstrated that nature-based tourism (hiking, horse-riding and skiing) affected boreal forests, altering vegetation, soils and trail networks. The major effects were; reduction in vegetation cover, including of different life-forms, changes in plant species composition, soil chemistry and soil erosion. Trampling decreased plant cover more on slopes compared to flat terrain. Moreover, downward trampling reduced the plant cover more than did upward trampling. In addition, horse riding resulted in the introduction and establishment of a range of alien plant species. In general, ecological changes due to nature-based tourism were inevitable even when there were limited numbers of visitors.

Respondents to the survey were classified into three groups according to their opinions concerning nature conservation and tourism development: (i) supporters of nature conservation, (ii) critical to nature conservation and (iii) critical to tourism development. The majority of respondents were supporters of nature conservation. However, opinions were strongly dependent on the socio-demographic background of the respondents, such as residential area, age, level of education and indigenousness.

Since the impacts of tourism were dependent on the characteristics of plants and habitats and the quality of activities, case-specific planning, monitoring and rapid responses are the most efficient methods in avoiding irreversible environmental damages. Furthermore, close co-operation between different stakeholders and detailed scientific information about the ecological, economic and social elements of sustainability are needed to promote a sustainable development of nature-based tourism.

Keywords: alien species, ecological sustainability, nature-based tourism, residents, social sustainability, soil, tourism, trampling, vegetation

To my loving family

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List of original papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals:

I Törn A, Rautio J, Norokorpi Y & Tolvanen A (2006) Revegetation after short-term trampling at subalpine heath vegetation. Annales Botanici Fennici 43: 129-138.

II Törn A, Siikamäki P & Tolvanen A (2007) Trail and vegetation impacts of different types of recreational use – comparisons between hiking, skiing and horse riding. Manuscript.

III Törn A, Siikamäki P & Tolvanen A (2007) Can horse riding induce the introduction and establishment of alien plant species through endozoochory and gap creation? Manuscript.

IV Törn A, Siikamäki P, Tolvanen A, Kauppila P & Rämet J (2007) Local People, Nature Conservation and Tourism in Northeastern Finland. Ecology and Society. In press.

Contents

1 Introduction

1.1 Sustainability of nature-based tourism

Tourism has multiplied in recent decades, with tourism based on natural resources increasing most dramatically (Mowford & Munt 1998, Fennell 1999, Hall & Page 1999, Franklin 2003). The growth has increasingly concentrated on pristine environments and protected areas. For example, in Finnish National Parks the total annual visitor number was 1.6 million in 2006, which was over five percent higher than the previous year. Nowadays, nature-based tourism is considered one of the most important industries in many countries (*e.g.* Mowforth & Munt 1998, Sun & Walsh 1998, Fennell 1999, Hall & Page 1999, Saastamoinen *et al.* 2000, Franklin 2003). Clean, quiet and distinctive natural environments are the main features that attract tourists to visit the northern region of Europe (*e.g.* Järviluoma 1999, 2006). At the same time, with the increasing visitor numbers, the forms of nature-based tourism have diversified (Urry 1990, Poon 1993). This kind of boom leads to increasing concern about the impacts of tourism on fragile environments (*e.g.* Buckley 1994). The attractiveness of nature as a stimulus to tourism may in fact decrease due to the detrimental effects of tourism on the environment (Kuss & Grafe 1985).

There is hardly any tourist activity that does not rely on environmental resources (Hunter & Green 1995). Nature-based tourism has been defined in many ways; initially it was defined as travelling in relatively undisturbed areas (Boo 1990), including also the respect of nature. Nowadays, the definition includes the environmental, social and economical aspects of tourism in general (Mowforth & Munt 1998, Swarbrooke 1999) in order to achieve a ‘balanced’ or ‘wise’ use of natural resources, for example, including conservation of natural environments and well-being of local residents in planning and development actions (Ecotourism Society 1993). Ecotourism has been defined as ecologically sustainable tourism that includes both environmental and cultural aspects (Figgis 1993). It has also been defined more strictly as tourism with natural resources, sustainable management, conservation and also the concept of environmental education (Buckley 1994). The definition by Filion *et al.* (1994) included responsible behaviour of visitors and a social concept of tourism development.

The idea of sustainable tourism has arisen during the last two decades from the concept of sustainable development in the report, Our Common Future

published by the Brundtland Commission (WCED 1987). In this report sustainable development is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987). In the discourse on the sustainability of tourism, the ecological dimension is often the primary aspect, natural resources constituting a key element in tourism development. However, social and economic aspects should also be taken into account (*e.g.* Redcliffe & Woodgate 1997). Sustainable tourism ought to be seen as an attempt to reconcile conflicting sets of values with regard to the environment (Hall 1998). Ecological sustainability involves present generations conserving natural heritage and biodiversity and maintaining essential ecological processes for subsequent generations. Moreover, from a social perspective, nature-based tourism is an important part of local employment and services and thus also regional economies, while at the same time assuring the quality of life of local residents, maintaining environmental values and providing quality experiences for tourists (Williams & Fennell 2002). To maintain and develop sustainable tourism, development should sustain the properties of host communities, landscape, habitats, economy, the tourism industry and also develop understanding and leadership amongst the different stakeholders in an area (*e.g.* Bramwell & Lane 1993, Hawkes & Williams 1993, Lane 2005).

Nature conservation and tourism development have a long and partly shared history (*e.g.* Saarinen *et al.* 2000). According to Budowski (1976), the relationship between nature conservation and tourism can be divided into three forms; coexistence, conflict and symbiosis. Coexistence implies that the views of operators in nature conservation and tourism are divergent and their interactions are limited. Coexistence may transform either into conflict or into symbiosis. Conflict arises in a situation where tourism has detrimental effects on the environment or when there is little interaction between tourism and conservation. Symbiosis is a complex relationship, whereby the protection of the environment can be enhanced by tourism due to the advantages of interaction between conservationists and the tourism industry. The relationship between nature conservation and tourism has changed over the last fifty years. In the 1950s, the relationship between tourism and conservation was generally one of coexistence until, in the early 1970s, both environmental awareness and mass tourism rose in western societies, and began to come into conflict (Page & Dowling 2001). Unplanned tourism may lead to severe ecological and social problems in tourist destinations (Inskeep 1994). These problems have led to the promotion of the concept of ecologically sustainability of tourism. At the same time the idea of

mutual relationship between tourism and nature conservation has been created (Hall 1998, Butler 1999).

Although theoretical predictions and models have been developed concerning the relationship between nature conservation and tourism (*e.g.* Budowski 1976, Clarke 1997, Hunter 1997), only a few empirical studies have been conducted to investigate this relationship (*e.g.* Fiallo & Jacobson 1995, Macleod 2001).

1.2 Ecological impacts of nature-based tourism

Research on the ecological impacts of recreation and nature-based tourism started in Fennoscandia during the 1970s (*e.g.* Wielgolaski 1978), which is considerably later than, for instance, in North America and Great Britain, where vegetation studies had been carried out in the 1920s and 1930s (Meinecke 1928, Bates 1935, 1938). Many detailed recreation ecological studies were undertaken in the 1970s through to the 1990s in North America, Europe and Australia (*e.g.* Goldsmith *et al.* 1970, Bayfield 1971, 1973, 1979, Liddle 1975, Cole 1978, Sun & Liddle 1991, 1993a, 1993b, 1993c, Waston *et al.* 1993).

The effects of tourism on the environment can be classified as physical and/or biological (*e.g.* Davies 1978, Sun & Liddle 1991, 1993a, Whinam & Comfort 1996). Physical effects include changes in soil, track formation, littering, water pollution and changes in sunlight and precipitation (*e.g.* Chappell *et al.* 1971, Chapin & Shaver 1981, Kevan *et al.* 1995, Forbes *et al.* 2001), whereas biological impacts include for example, changes in vegetation (*e.g.* Hammitt & Cole 1998, Tolvanen *et al.* 2001, Forbes *et al.* 2004), the risk of spreading alien species (*e.g.* North 1991, Lonsdale & Lane 1994) and disturbance to wildlife animals (*e.g.* Hammitt & Cole 1998).

Recreational activities have diversified over the past half century, for example, horse riding has become more and more popular (*e.g.* Landsberg *et al.* 2001). However, there is still quite little known about the impacts of different activities, especially in high latitude environments including boreal and subalpine northern European regions.

The response of vegetation to trampling is a combination of resistance, tolerance and resilience (Cole 1995b). The overall tolerance of vegetation to trampling depends on the combined resistance and resilience of each species (*e.g.* Cole 1995a, 1995b). Resistance of vegetation to recreational use has been defined as the amount of trampling that vegetation can sustain (*e.g.* Sun & Liddle 1991, Cole & Bayfield 1993, Cole 1995b). Another definition used for resistance is the

level of trampling needed to cause a given amount of change in vegetation (Liddle 1975, Cole & Bayfield 1993). The term resilience means the ability of vegetation to recover from damage after trampling (Kuss & Hall 1991, Cole & Bayfield 1993). Resilience has been defined as the amount of recovery that can occur after a given amount of trampling (Cole & Bayfield 1993). Tolerance combines both of these terms and considers the ability of vegetation both to resist and to recover after disturbance (Cole & Trull 1992, Cole & Bayfield 1993). Tolerance can also be defined as the number of passes that the vegetation can tolerate and still have at least 75% cover one year after trampling (Cole & Bayfield 1993).

There are relatively few studies concerning the impacts of nature-based tourism on northern high latitude environments especially in Finland. Studies published by international researchers have been principally carried out in southern or central parts of Finland (*e.g.* Kellomäki & Saastamoinen 1975, Kellomäki 1977, Nylund *et al.* 1979, Malmivaara *et al.* 2002). There are, however, a few studies concerning the nature of northern Finland published in international journals (Hoogesteger 1976, 1984, Hoogesteger & Havas 1976, Tolvanen *et al.* 2001, Törn *et al.* 2006).

1.3 Social dimensions of nature-based tourism and nature conservation

Studies of the social dimensions of nature-based tourism and nature conservation have concentrated on the impacts of developments of a particular (protected) areas on local communities and the relationship between hosts and guests (*e.g.* Affeld 1975). Effects of tourism development on local communities are often categorised in three parts: i) economical effects, for example tax revenue, increased jobs, additional income, inflation and local government debt, ii) sociocultural effects, including increased intercultural communication, effects on traditional cultures and increased criminality, and iii) environmental effects, such as crowding, pollution and littering (Andereck *et al.* 2005). Tourism is often perceived as a potential economic base, improving quality of life by means such as employment, tax revenues and economic diversity, and also providing new services, natural, cultural and recreational opportunities (Ap & Crompton 1993). The importance of traditional forms of land use, for example agriculture, in the development of tourism has been seen as an alternative to enhance economic wealth in northern Europe (*e.g.* Parks *et al.* 2002). However, the negative social

impacts of tourism on the individual level are in general concrete; the peak period is full of work and long working days, but on the other hand, seasonal tourism may cause seasonal unemployment (*e.g.* Winter-Ebmer & Zweimuller 1999). Moreover, peaceful villages may change into congested tourist destinations, which may also change the life of local residents. The main aims of social sustainability are socially equal development and equality between peoples. Other aims are enhancing the possibility of local residents to influence, the confirmation the identity of community and improvements in the way of life of local residents (McIntyre 1993, Goodall & Stabler 1997, Dowling & Fennell 2003).

1.4 Aims of the study

The rapid increase of nature-based tourism has led to concern about the effects of tourism on the state of the environment and maintaining tourism activities at an ecologically and socially sustainable level. The scientific knowledge of the state of the environment (including vegetation and soil), the impacts of tourism (impacts of different activities and characteristics of tourism) and the tolerance of different habitats to specific activities such as trampling is important, especially for the management of protected areas. Information about the potential impacts of nature-based tourism, effective methods and indicators based on scientific results are needed when planning and managing tourism.

The main purpose of the present multidisciplinary study is to understand the ecological and social sustainability of nature-based tourism in protected areas and their surroundings. The main objectives of the ecological studies were to determine potential effects of tourism on natural environments with a focus on vegetation and soils by asking the following research questions (papers I, II and III). First, how the timing and direction of trampling influences the revegetation dynamics (I). Vegetation cover was compared after trampling in early, mid- and late season and between trampling up and down slope on fjell slopes. Second, how different activities (hiking, cross-country skiing and horse riding) can affect trail and vegetation characteristics (II, III). Third, how different plant lifeforms responded to trampling (I-III). Fourth, how the impacts of different recreational activities on trails and vegetation vary among forest types (mesic, semi-dry and dry forest types, II). Fifth, the impacts of horse riding on the introduction and establishment of alien plant species (II, III). Introduction and establishment of alien species was studied by manipulating the levels of disturbance, horse manure and seed rain of dwarf shrubs in a boreal forest. Social study (IV) focused on the

opinions of the local people about nature conservation and tourism development and on how the background of respondents affected their opinions. Investigated factors and measured variables are represented in Table 1.

Table 1. Factors and measured variables investigated in the present thesis. The original papers are referred to by Roman numerals.

Factors and measured variables	I	II	III	IV
Factors under investigation				
Slope of trampling	X			
(flat and slope)				
Direction of trampling	X			
(upward and downward)				
Timing of trampling	X			
(early, mid and late seasons)				
Recreation activity		X		
(hiking, skiing and horse riding)				
Forest type		X		
(mesic, semi-dry and dry)				
Disturbance factors			X	
(disturbance, manure and seed)				
Attitudes towards nature conservation and tourism				X
Measured variables				
Plant cover, density and biomass	X	X	X	
Soil properties		X	X	
Trail dimensions		X		
(width and depth)				
Species diversity		X	X	
Opinions of respondents				X

2 Material and methods

2.1 Ecological studies (I-III)

2.1.1 Study sites

The studies were conducted in Pallas-Ounastunturi National Park (Pallas-Yllästunturi National Park since 2005) (I, II) (Fig. 1) in northern Finland, and at Oulanka National Park (II, III) (Fig. 1) and in Ruka region (II) (Fig. 1), in northeastern Finland. Location and characteristics of the ecological study sites are shown in Table 2. Annual visitor numbers are approximately 125 000 at Pallas-Ounastunturi National Park (Metsähallitus 2006); 75 000 tourists visit the park during the summer season and 50 000 in winter. The Oulanka National Park had 183 500 visitors in 2006 (Metsähallitus 2007), and the amount of visitors had increased three times between 1992 and 2006 (Puhakka 2007). Tourism is concentrated in summer.

Table 2. Location and meteorological characteristics of the study sites.

Location and meteorological characteristicss	Pallas-Ounastunturi National Park	Oulanka National Park/Ruka
Location	68º20'N, 24º07'E	66º22'N, 29º17'E/ 66º10'N, 29º08'E
Vegetation zone	Boreal forest, subalpine forest (Ahti *et al.* 1968)	Boreal forest (Ahti *et al.* 1968)
Annual mean temperature	-0.4 ºC to -1.0 ºC [a]	-0.0 ºC to 0.9 ºC [a]
Min. temperature	-38.0 ºC [a]	-38.2 ºC [a]
Max. temperature	29.5 ºC [a]	29.7 ºC [a]
Annual precipitation	451-706 mm [a]	453-594 mm [a]
Snow cover	November to late April [a]	November to late April [a]
Snow cover depth	0-73 cm [a]	0-87 cm [a]

[a]Finnish Meteorological Institute 2002, 2003, 2004

Fig. 1. Sites of ecological studies.

2.1.2 Experimental design and measurements

In study I, two separate experiments were carried out in 1999-2002 to determine if there are differences between: 1) trampling early, mid- and late seasons?, 2) trampling walking up or down fjell slopes? and 3) plant lifeforms in their responses to trampling?. To determine the effect of timing of trampling, 150 passes was applied on flat terrain either in (i) June, (ii) July or (iii) September 1999. The effect of direction of trampling on a slope involved applying 25 passes either (i) walking upslope or (ii) down slope (Table 2). Plant resistance to trampling was defined as 50% vegetation cover relative to the initial level 10 days after trampling, while the plant tolerance was defined as 75% of the initial cover

two years post trampling in study I. The method is a modification of Cole and Bayfield (1993). Full recovery was assumed to have happened at the point where plant cover did not differ significantly from initial cover. Cover analyses of individual plant species were carried out four times.

In study II, the effects of three different activities, (i) hiking, (ii) skiing (cross-country skiing) and (iii) horse riding on trail and vegetation characteristics were studied at Oulanka National Park and at Pallas-Ounastunturi National Park in 2001-2002 (Fig. 1) (except horse riding was studied at Oulanka National Park) by carrying out monitoring studies on trails and on horse resting sites. In the monitoring study, three factors were used: (i) type of use (hiking, skiing, horse riding), (ii) level of use (recreation, no recreation) and (iii) forest type (mesic, semi-dry and dry, except in skiing in Kuusamo where only mesic and semi-dry forest types were assessed). To study the effect of horse riding, study plots were placed on trails and at horse resting sites. Trail characteristics measured were trail width and trail depth. Cover of plant species, litter and bare soil were recorded in 2001-2002. Plant species were pooled into three groups: (i) evergreen and deciduous dwarf shrubs, (ii) forbs and graminoids and (iii) bryophytes and lichens.

To study the impact of horse riding on the introduction of alien species, vegetation and soil characteristics (third study, III) was conducted in 2002-2005. The study was a full factorial experiment with four factors: (i) disturbance, (ii) manure addition, (iii) seed addition (*Vaccinium myrtillus*, *Vaccinium vitis-idaea* and *Empetrum nigrum* seeds) and (iv) both manure and seed addition. In the disturbance treatment, organic material was completely removed to expose mineral soil. Manure treatment was applied by addition of 7.5 litres of horse manure per study plots. Seed addition treatment was carried out by adding seeds of 25 berries per each species, the amount represents natural seed rain of dwarf shrubs of the area (Hautala *et al.* 2001, Nuortila pers. obs). The number of shoots of each species germinating was recorded in 2002 and 2003. The plant biomass was measured in 2004. The concentrations of phosphorus of calcium, potassium and magnesium in the soil were measured in 2004. Also acidity, electrical conductivity and the content of organic matter and water in the soil were analysed.

2.2 Social study (IV)

2.2.1 Study sites

The study was carried out in the municipalities of Kuusamo and Pudasjärvi, in northeastern Finland. Kuusamo is one of the most attractive tourism destinations in Finland (Finnish Tourist Board 2005). Ruka is among one of the most popular ski resorts in the country (Vuoristo & Santasalo 1992). The oldest and most important conservation area for tourism and recreation in Kuusamo is Oulanka National Park. Recently, protected areas of old-growth forests were also established in southern Kuusamo after a long and difficult process. Conservation was related to land owned by state, private and common forest in the area of southern and northern Kuusamo. Syöte National Park was established in Pudasjärvi in 2000. Forest ownership in Syöte region is divided between state owned and private land. Besides nature, the main tourism attraction for Syöte National Park is based on the neighbouring Syöte ski resort area, which has well developed tourism facilities (Vuoristo & Santasalo 1985, 1992).

2.2.2 A survey

Data were collected via a mail survey of local residents in four areas in Kuusamo and two areas in Pudasjärvi in November 2002 and May 2003, respectively. These areas were classified as follows: (i) Ruka = tourism resort; (ii) Syötekylä = tourism resort; (iii) northern Kuusamo = neighbourhood of conservation area; (iv) southern Kuusamo = neighbourhood of conservation area; (v) Sarajärvi = neighbourhood of conservation area and (vi) Kuusamo town centre = town. Random sampling was based on regional postcodes and land register of the villages. In Kuusamo town centre, in northern Kuusamo and in southern Kuusamo, the questionnaire was sent to 200 households, whereas in Ruka, Syötekylä and Sarajärvi, it was sent to every household. In the survey, a 5-point Likert agreement scale was used. The measured socio-economic and demographic variables were: residential area, level of education, primary occupation, level of income, indigenousness, gender, age, land donation for conservation programme, land ownership, income from tourism, the frequency of contacts with tourists through work and the effects of nature conservation on household economy. In this study, the Budowski's framework (1976) was widened by creating a

schematic model as a framework focusing on the opinions of local resident towards nature conservation and tourism development (Fig. 2).

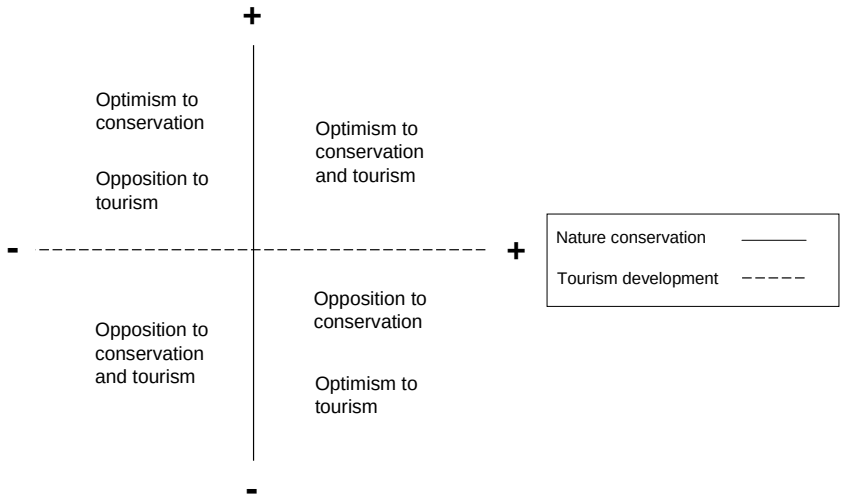

Fig. 2. Schematic presentation of the potential opinion groups towards the relationships between nature conservation and nature-based tourism.

Table 3. Description of residential area of respondents.

Residential area (Location)	Municipality	Conservation area	Year of conservation	Size of the conservation area	Intensity of tourism (visitors per year)
Northern Kuusamo (66º17', 29º22')	Kuusamo	Oulanka National Park	1956, extended 1982 and 1989	277 km^2	173 000 (Metsähallitus 2005)
Southern Kuusamo (65º36', 29º33')	Kuusamo	Network of protected areas	1998	200 km^2	17 000 (Tapaninen, M, personal communication)
Sarajärvi (65º43', 27º30')	Pudasjärvi (Taivalkoski, Posio)	Syöte National Park	2000	299 km^2	34 000 (Metsähallitus 2005)
Ruka (66º07', 29º13')	Kuusamo				350 000 (Finnish Tourist Board 2005)
Syötekylä (65º31', 27º58')	Pudasjärvi				31 000 (Finnish Tourist Board 2005)
Kuusamo town center (65º56', 29º15')	Kuusamo				

2.3 Statistical methods

Ecological studies (I-III) were analysed using the repeated measures ANOVA and factorial ANOVA (univariate ANOVA).

In the social survey (IV), a factor analysis was used to reduce the 17 statements into smaller sets of underlying factors. The statements related to nature conservation and tourism development were analysed by using principal component analysis (PCA) with varimax orthogonal rotation. Hierarchical cluster analysis and squared Euclidean methods were used to classify respondents into groups based on PCA results. Chi- (χ^2) tests were performed to investigate if cluster membership was dependent on the socio-economic and demographic variables of respondents.

All statistical analyses were performed with SPSS for Windows 12, a statistical software application (SPSS Inc. 2003).

3 Results

3.1 Ecological sustainability

3.1.1 Impacts of timing and direction of trampling (I)

The timing of trampling had no impact on the total plant cover or on the cover of any plant lifeforms. After 150 passes, the total cover was reduced by 59% relative to initial cover and remained above the resistance level (= 50% compared to initial cover, Cole 1995b). Two years after trampling treatments, the tolerance level (= 75% compared to initial cover, Cole 1995b) for total cover was reached only in treatments trampled in June. Three years after trampling, the tolerance level had almost been reached in all treatments (72%), but full recovery had not yet occurred.

Downward trampling reduced the total vegetation cover and the cover of evergreen dwarf shrubs more than did upward trampling, but only during the year in which trampling occurred. The effect was six-fold in trampling downward than trampling upward. However, the resistance level of 50% was not exceeded in either treatment, as on average, the total cover was 66% relative to initial cover. The cover of vascular plants decreased directly after trampling, while the bryophytes showed a slower response to the treatment. Also the recovery of vascular plants occurred more rapidly compared to bryophytes. However, the cover of lichens increased in all treatments. Evergreen dwarf shrubs need more time to recover than deciduous dwarf shrubs. Forbs and graminoids showed little response to trampling and they recovered completely in the four-year study period.

3.1.2 Impacts of different recreational activities (II)

The impacts of recreational use on trail characteristics were related both to recreational activity and forest type. In addition, vegetation reacted differently to hiking, skiing and horse riding. Hiking reduced the vegetation more than did skiing. However, the cover of bryophytes and lichens was higher on the skiing track compared to forest sites, while the cover of litter and soil was lower. Horse resting reduced significantly the covers of dwarf shrubs, bryophytes and lichens.

Hiking trails were wider than horse riding trails, whereas horse trails were as deep as hiking trails, even though the annual number of users was 150 times

greater on the hiking trails. Hiking trails were widest in dry forest type, whereas horse trails were widest in mesic forest type. When tested together hiking, skiing and horse riding, the total plant cover was decreased more in mesic forest compared to dry and semi-dry forest types. Whereas horse resting reduced the vegetation cover most in semi-dry forest type.

Twenty three plant species/genera only occurred in the forest and not on hiking trails, including dwarf shrub, forb, bryophyte and lichen species/genera. The only plant species that appeared to benefit from hiking was *Juniperus communis*. *Lycopodium annotinum* only occurred in forest plots, not in trail plots near both hiking and skiing trails in both research sites. Eleven plant species or genera occurred only on forest not on a skiing trail, including forb, graminoid and lichen species or genera. In total, ten species or genera occurred only in skiing trail and not in neighbouring forest plots, this count includes forb, tree, bryophyte and lichen species or genera. Only *Vaccinium uliginosum* and *Barbilophozia lycopodioides* were sensitive to horse riding, while 26 species or genera occurred only in horse trails, but not in adjacent forest, including forb and graminoid taxa.

3.1.3 Impacts of recreational horse riding (III)

Manure addition resulted in the establishment of 15 species of graminoid and forb species on the study plots, that were otherwise absent from the boreal forest habitat studied (Appendix 1). The total shoot density and the density of shrubs was lower in disturbed plots than undisturbed plots, while the densities of sown shrub seedlings and manure seedlings (seedlings of plants whose seeds are carried in manure) were higher in disturbed plots relative to undisturbed plots. However, the difference between undisturbed and disturbed plots in total shoot density and the density of dwarf shrubs nearly levelled out during the study period. Two years after treatment, total biomass was lower in disturbed plots relative to undisturbed plots (Fig. 3). However, the biomass of manure seedlings was 4.4 times greater in disturbed plots relative to undisturbed plots (Fig. 3). The concentration of phosphorus, calcium, magnesium and potassium were also significantly higher in disturbed plots compared with undisturbed plots.

Natural shrub seedlings were found only in disturbed plots without manure addition. The density of adult shrubs was lower in manure addition treatment compared with plots without manure addition in disturbed plots. In disturbed plots with manure addition total biomass was higher than plots with no manure addition (Fig. 3). The biomass of sown shrub seedlings was lower in disturbed

plots with manure addition than plots without manure addition. The phosphorus concentration in soil was the only measured nutrient, the concentration of which was higher due to manure addition in both disturbed and in undisturbed plots. The concentrations of calcium, magnesium and potassium were also higher in disturbed plots with manure addition.

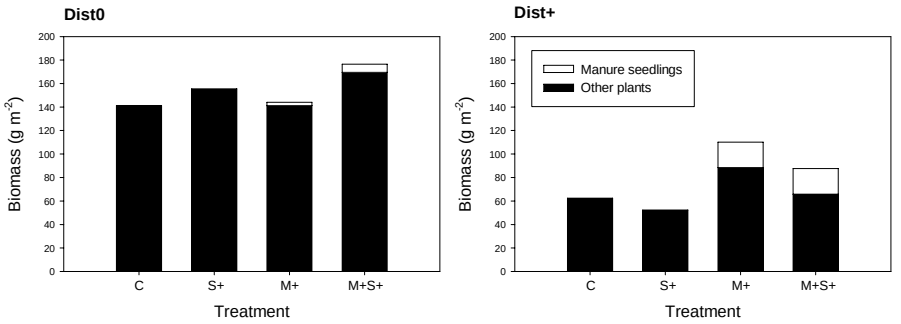

Fig. 3. Total biomass (other plants than manure seedlings) and biomass of manure seedlings in undisturbed (Dist0, *df* = 20) and disturbed treatments (Dist+, *df* = 40) after manure and seed addition. C indicates control, M+ manure addition treatment and S+ seed addition.

3.2 Social sustainability

3.2.1 Opinions towards nature conservation and tourism development (IV)

By the means of cluster analysis, respondents were classified into three different groups according to their opinions towards nature conservation and tourism development: (i) supporters of nature conservation, but quite neutral to tourism development (57.7%), (ii) critical to nature conservation, but quite neutral to tourism development (30.5%) and (iii) critical to tourism development, but quite neutral to nature conservation (11.8%) (Fig. 4).

The most important factors in the classification of respondents were the residential area, age, level of education, primary occupation, indigenousness, the frequency of contacts with tourists through work and the effects of nature conservation on household economy. On the other hand, gender, level of income, land ownership, land donation for conservation and income from tourism did not affect opinions concerning nature conservation and tourism development. Clear

differences in the opinions of residents between the areas were not found. Age and contacts with tourists through work differed between residents in conservation areas, tourism areas and town. The residents living close to conservation areas were older and they had fewer contacts with tourists through work than the residents in tourism areas and town.

The most critical opinions concerning nature conservation were presented by a high proportion of local residents living in close proximity to protected areas. On the other hand, a greater proportion of residents living near tourist resorts and farther from conservation areas had positive opinions towards nature conservation and tourism development.

The amount of supporters of nature conservation decreased with increasing age. Approximately 70% of the respondents with an intermediate or higher educational level or being employee, entrant or returnee of municipality were categorised as supporters of nature conservation. The proportion of the supporters of nature conservation decreased with decreasing frequency of contacts with tourists through work. A clear majority (81%) of the respondents who had reported that nature conservation caused benefits to household economy and 63% of respondents who reported that nature conservation had no effects on household economy belonged to category of supporters of nature conservation.

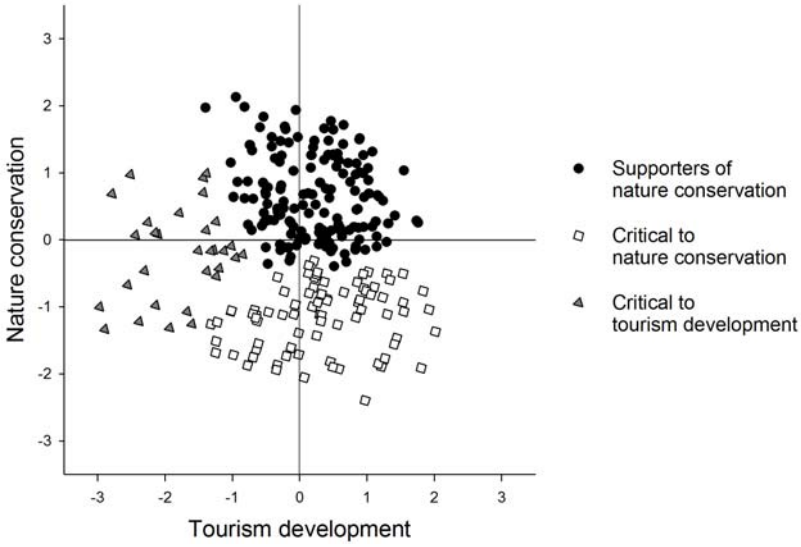

Fig. 4. Biplot of the hierarchical cluster analysis.

4 Discussion

4.1 Ecological impacts of nature-based tourism

According to this investigation, nature-based tourism affected vegetation, soil and trail networks both directly and indirectly, showing that boreal forests and subalpine heaths were fairly sensitive to the pressure from nature-based tourism (I-III). Ecological change due to nature-based tourism was inevitable even when there were a limited numbers of visitors (I-III). These results are consistent with other studies on the ecological impacts of nature-based tourism, i.e. the negative impacts of hiking on vegetation showed a non-linear pattern: reductions in vegetation cover and density occurred quickly at relatively low trampling intensities, but as the intensity of trampling rose the rate of deterioration declined (I, *e.g*. Dale & Weaver 1974, Kellomäki & Saastamoinen 1975, Sun & Liddle 1993a, 1993b, 1993c, Hammitt & Cole 1998, Tolvanen *et al.* 2001, 2004, Monz 2002). Thus, the most harmful effects often arose when hikers use informal trails (I, Hill & Pickering 2006). In study I on subalpine heath, 150 and 25 passes reduced about a half of the plant cover compared to initial cover on flat terrain and on slopes, respectively. Depending on the vegetation type, visible trails can be formed as soon as 10-25 persons use the same route, and a threshold level for significant disturbance to vegetation cover seems to occur between 75 and 300 passes, with lower thresholds more typical than higher thresholds in boreal forests (Tolvanen *et al.* 2001). However, the recovery of vegetation in the subalpine heath occurred rapidly, if disturbance was not prolonged (I). In this investigation, the major effect of nature-based tourism was mechanical trampling of vegetation and soil, which led to wear and tear of vegetation and soil (I-III).

4.1.1 Trampling impacts in relation to direction and timing

In study I, topography influenced the vulnerability of a habitat to disturbance. Trampling decreased plant cover on slopes at lower levels of use compared to flat terrain (I). The sensitivity of vegetation on slopes to trampling and their slower recovery were due to the combined effects of higher trampling pressure per pass and water erosion especially during snowmelt period (I, Whinam & Chillcott 2003). However, the direction of low-level trampling on a slope had only a short-

term effect on vegetation, because of the relatively rapid recovery of the vegetation (I).

Contrary to expectations there was no consistent response in the vegetation to variation in the timing of trampling between trampling early, mid- and late seasons (I). This was most probably due to the short-term nature and low intensity of the trampling treatments and the large variation in plant cover between individual trails (I).

4.1.2 The impacts of different activities

Hiking reduced the cover and the occurrence of plant taxa more than did cross-country skiing and horse riding (II). Skiing had the least direct effect (II, Bliss & Wein 1972, Hernandez 1973, Webber & Ives 1978), but the effect occurred over a wider area (II, Price 1985). In general, activities in the snow-free period can cause more damage to vegetation than activities during periods of snow-cover, due to direct impacts on plant shoots and root systems and also on soil when there is no snow cover. Even snow depth between 1 and 25 cm is sufficient to reduce trampling impacts (Felix *et al.* 1992, Hammitt & Cole 1998). Even though the trampling impact of skiing in this study was less than that of hiking and horse riding, skiing can have a wide range of effects on vegetation. For example, mechanical pressing by machines can compact the snow and delay the timing of snowmelt, which affect plant growth (*e.g.* Grabbherr 1985, Price 1985, Emers *et al.* 1995). Changes in micro-climate, especially in humidity and light conditions due to skiing activities are also common (Warble & Fahey 2002). Impacts can also be caused by cutting-down trees and removal of rocks (*e.g.* Pickering & Hill 2003). Direct impacts on cushion plants can occur from snow groomer blades and tracks when snow cover is thin (Fahey *et al.* 1999, Warble & Fahey 2002). Changes in species composition due to the range of impacts from skiing can be cumulative (*e.g.* Bayfield 1979, Grabbherr 1985). For example increases in moss species due to snow grooming and skiing have been found (II, Warble & Fahey 2002).

Horse riding had the most pronounced effects on plant species/genera (II-III) and trail characteristics compared to hiking and skiing (II). Horse trails were narrower than hiking trails, but just as deep, even though the number of users on the horse trails is lower (II). The narrowness of horse trails relative to hiking trails may be because these trails are more recent and because horse tour groups tend to travel in single line (II). The greater negative ecological impacts of horses per

capita relative to the hikers have also been found in other studies (*e.g.* Weaver & Dale 1978, Liddle 1997, Cole & Spildie 1998). It seems that instead of the quantity of users, the quality of activity and the impacts of certain activity should have a more pronounced role in the planning and management of tourism.

4.1.3 Relationships between the characteristics of plants and response to trampling

The variation in tolerance of plants to nature-based tourism was primarily due to the characteristics of plant morphology that promote durability (I-III) and the characteristics of plants to regenerate (I, III). In study I, vascular plants were rapidly affected by trampling resulting in decreased cover (I). However, vascular plants recovered within two years after trampling (I), the tendency being similar to earlier herbivory studies by Chapin and Chapin (1980). Bryophytes had a slower response to trampling than other plant groups (I). This was in line with earlier studies showing a delayed response of slow-growing species to trampling (I, see also Callaghan & Emanuelsson 1985, Forbes *et al.* 2004). Lichens appeared to tolerate trampling quite well. However, the increase in the cover of lichens after trampling might have been due to lichen tissue crumbling to smaller particles and those pieces' ability to grow. The increase in lichens might also be a consequence of the removal of protective vascular vegetation, improving microclimatic conditions for lichens (Tolvanen *et al.* 2004). The recovery of evergreen dwarf shrubs was slower than the recovery of deciduous dwarf shrubs (I). Forbs and graminoids tolerate trampling rather well and they recovered in four years (I). In general, recovery rates appeared to be associated with photosynthetic and growth rates, which are higher in graminoids, forbs and deciduous dwarf shrubs than in evergreen plants in these types of habitats (Chapin & Chapin 1980, Karlsson 1989).

Twenty-three plant taxa were absent from hiking trails, including broad-leaved forbs, dwarf shrubs with shallow roots and bryophytes (II, *e.g.* Hoogesteger & Havas 1976, Forbes 1994, Arnesen 1999). *Juniperus communis*, a sharp-needled coniferous shrub was the only species growing only on hiking trails (II). The species may be completely avoided by hikers and may thus have gained competitive advantage from disturbance. Skiing-tolerant species were often early succession species (II), which appear to benefit from the increased light with clear-cutting of the forest along the trails. Twenty-six species were only found in

the horse resting areas, being mostly forbs and graminoids, many of which did not grow naturally in the forest (II).

4.1.4 Relationship between habitat type

Habitat characteristics affected the trampling tolerance of vegetation and soil (II). Hiking trails in mesic forest type were narrower but deeper than in drier forest types (II, Fig. 5). The impact of hiking on trail width decreased from dry to mesic forest types, whereas the trend was reversed for trail depth (II). This might be due to the fact that in open, dry landscapes hikers appear more likely to go off-trail. In mesic forests, hiking is likely to be concentrated on trails due to the higher and more closed vegetation compared with drier forests. Another likely reason for greater trail depth is the thicker soil organic layer in mesic forest compared to drier forests. Relative changes in vegetation due to hiking were slighter in dry and relatively dry forests compared with mesic forest types (II, Kellomäki & Saastamoinen 1975, Kellomäki 1977). On the other hand, the impacts of horses on vegetation were greatest in semi-dry forest type, which was dominated by native forest species (II).

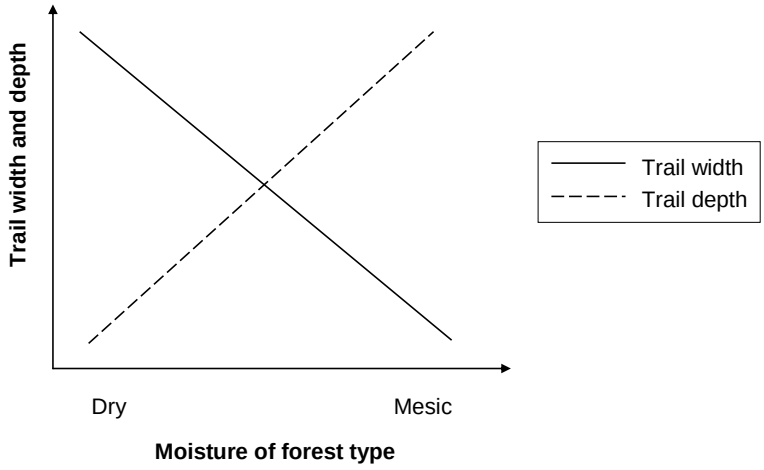

Fig. 5. Schematic presentation on the dependence of trail widths and depths on the moisture conditions (dry to mesic) after recreational use (hiking and horse riding). In reality, relationships are not linear.

4.1.5 Alien species

Nature-based tourism increases the threat of the introduction and establishment of alien species (III, *e.g.* Usher 1988, Macdonald *et al.* 1989), which poses an essential risk for biodiversity in protected areas. Alien plants are species that grow outside their natural habitats, even outside their natural distribution. This causes a concern, because the main aim of protected areas is to maintain and conserve the native flora. The risk of the introduction of alien plant species is dependent on, for example, the type of vegetation (*e.g.* Whinam *et al.* 1994), latitude (*e.g.* Weaver & Dale 1978, Whinam & Comfort 1996), and climatic conditions (Macdonald *et al.* 1989). However, few studies have assessed alien species in northern latitudes. Also, even worldwide there are very few studies that have used experimental methods to assess the risk of alien species being introduced into protected areas as shown in this experimental study (III). Alien species are usually fast-growing and they spread effectively. Study III indicates that alien species can be introduced and established themselves in protected areas through horse riding. In this investigation, 15 forb and graminoid species grew in boreal forest plots when horse manure was added (Appendix 1). Horses had eaten seeds which remained viable in the digestive tract. As a result manure contained seeds of alien species as well as serving as a favourable growing environment for alien plants (III, Appendix 1). Disturbance further enhanced the establishment of the alien species, providing space for the seedlings and increasing soil nutrient level (III, Appendix 1). These results (I) are in line with the plant competition theory by Grime (1973) stating that new colonising habitats can be created for a great number of plant species after anthropogenic disturbance. It is important especially when former habitats become unsuitable (Hall & Kuss 1989, cited in Liddle 1997, Forbes *et al.* 2001). Not only alien species benefited from disturbance, however. Exposure of soil created open gaps and microhabitats, which were crucial for the emergence of the seedlings of native shrubs. Emergence and establishment of seedlings is almost completely prevented in habitats with dense vegetation layers (Chambers *et al.* 1991, Eriksson & Fröborg 1996, Hautala *et al.* 2001). Horse trails can therefore be important for the spread of both alien species (Saunders *et al.* 1991) and native shrubs (Chapman & Bannister 1990).

4.2 Social impacts of nature-based tourism

According to the survey, the majority of respondents were classified as supporters of nature conservation and quite neutral to tourism development, which may indicate a coexistent relationship according to the classification by Budowski (1976). However, the number of respondents in other categories was also relatively large indicating that local communities are heterogeneous (IV, Ryan & Montgomery 1994). Furthermore, opinions were strongly affected by the socio-economic background of the respondents (*e.g.* Brougham & Butler 1981, Kinzig *et al.* 2005).

Since the socio-economic variables such as age and contacts with tourists through work, were not uniform between conservation areas, tourist resorts and town, clear differences in the opinions of residents between the areas were not found. A greater proportion of elderly respondents were critical to nature conservation, compared with young and middle-aged respondents (IV, Haralambopoulos & Pizam 1996, Fredline & Faulkner 2000), while more positive opinions among older people (Brougham & Butler 1981) and age-independence (Ryan & Montgomery 1994, Tomljenovic & Faulkner 2000) have also been found. The negative opinions of older residents might be a consequence of personal experience of the conservation process and tourism near their residence or fear that conservation may negatively affect their standard of living.

Respondents having higher level of education and income had more positive opinions towards tourism than ones with lower level of education and income (IV, Heinen 1993, Haralambopoulos & Pizam 1996). However, no effect of education on opinions towards tourism has been also presented (Weaver & Lawton 2001). Respondents born outside the area were more positive in their opinions towards nature conservation and also quite neutral in opinions towards tourism development than native respondents (IV). In other studies, it has been shown that the longer respondents live in the community, the more negative they are towards tourists and tourism (Brougham & Butler 1981, Liu & Var 1986, Allen *et al.* 1988). There was also an interconnection between the frequency of contact with tourists through work and the opinions towards nature conservation (IV). Respondents who had more frequent contact with tourists through work were more supportive of nature conservation (IV). Contacts with tourists are apparently connected with the source of income from tourism and the perception that tourism improves the level of employment, local services and income. According to this study (IV) and others, people working in the tourism industry or who are

dependent on tourism are also more likely to have positive opinions about tourism than those not employed in the tourism sector (Pizam 1978, Ryan & Montgomery 1994, Cottrell *et al.* 2006).

According to the results of the survey, the most critical opinions concerning nature conservation were presented by local residents living in close proximity to protected areas, since they regarded conservation as something that might reduce employment and incomes. Dependence on the resources of these areas for their livelihood might be a reason for the negative opinions (Trakolis 2001). In generally, when local stakeholders had an opportunity to participate in the planning process from the very beginning, they had more positive opinions towards the development of their residential area than those who did not participate in the planning process. In general, the majority of negative attitudes towards nature conservation are influenced by: i) lack of involvement of local people in the development, ii) lack of perceived benefits from protected areas, and iii) interaction between local people and conservation administrators (Fiallo & Jacobson 1995).

Results of the survey show that people in the developed world can have similar limitations towards nature conservation and tourism development as those living in developing countries. Critical opinions of local residents may be related to the planning tradition of the region. Sustainability of nature-based tourism may not be achieved by a top-down regime, which is common especially in developing countries (*e.g.* Tosun 1999, 2000). Critical opinions and insufficient commitment of local people to the planning process may therefore hinder the development in these areas.

4.3 Implications for sustainable management

One main target of the development of nature-based tourism, including in national parks, is to increase the amount of visitors (*e.g.* Puhakka 2007). For example, in Syöte National Park the annual number of visitors is likely to double by 2010. In Pallas-Yllästunturi National Park (earlier Pallas-Ounastunturi National Park) the annual number of visitors is expected to increase to 500 000, which is 60% higher than present visitor numbers (*e.g.* Puhakka 2007). Consequently, careful planning is necessary to meet both the multiple needs of the growing numbers of tourists and the conservation goals of protected areas.

The right of public access has largely shaped the development of nature-based tourism throughout Fennoscandia. This allows for free access and use of

both public and private land, for example for recreational purposes. Nowadays, increasing tourism entrepreneurship poses challenges for planning and management of protected areas, because the basic regulations of the right of public access allowing activities based on one's own muscles is not any more enough. Entrepreneurship needs permission for special activities carried on in protected areas, for example, mountain biking, horse riding as well as reindeer and dog sledding are either allowed only on specific trails or totally forbidden. Reindeer sledding and horse riding are also licensed trades in Syöte National Park (*e.g.* Puhakka 2007).

Case-specific planning, separately for different activities and habitats (I-III, *e.g.* DeLuca *et al.* 1998, McCool & Patterson 2000, Cole 2002, Forbes *et al.* 2004), done sufficient early, combined with monitoring and rapid responses to perceived negative impacts are the most efficient methods in avoiding irreversible environmental damages. For example, based on the results from study II, horse trails might be better restricted to drier forest types and avoid mesic habitats. However, it is quite difficult to estimate the most suitable habitat for hiking, because of the heterogeneity between measured variables (II). In land use planning the ranking of habitats is one useful method, especially preventing environmental degradation (Rossi & Kuitunen 1996).

However, if damages have already appeared, complete closure of trails (*e.g.* Forbes *et al.* 2004), zoning the recreational use and rolling or grading of trails (*e.g.* DeLuca *et al.* 1998, Forbes *et al.* 2004) are useful methods. The establishment and improvement of artificial structures using stairs, duckboards and trail covering, especially at the most sensitive sites such as steep slopes, may help to protect these areas (*e.g.* Forbes *et al.* 2004).

One important goal of nature conservation is to preserve the native species composition of the protected areas. Therefore, the spread of alien plant species, for example, due to horse traffic will set up new challenges for the management of the protected areas (III). The impacts of alien species on natural ecosystems are unpredictable and still largely unknown. However, the ten-rule presented by Williamson (1996) were one in ten alien species are likely to become establish in a new habitat, and a further one of these ten is likely to be aggressively invasive, should be remembered. To avoiding further damage by alien plants species, methods for the early detection and removal of alien species are needed. The existence of the recreational horse riding in protected areas should also be carefully reconsidered. However, if horse riding is allowed in protected areas, the spread of alien species should be reduced by collecting manure, limiting the

number of animals in wilderness (Cole 2002), feeding horses with hay that has been treated to prevent seed germination and by removal of any alien species that do become established.

Due to rapid decline in the importance of traditional extractive industries in rural and peripheral areas, the development of tourism is seen as an alternative development tool in northern Europe (*e.g.* Parks *et al.* 2002). Nevertheless, critical opinions and insufficient commitment of local people to the planning process may hinder the development process of an area. It has been shown that when local stakeholders had an opportunity to participate in the planning process from the very beginning, they had more positive opinions towards the development of their area, than those who did not participate the planning process (IV). Thus, involving local stakeholders should be a crucial component of planning of the areas, which can result in a deeper understanding of the issues, and should result in more legitimate and sustainable policies (Fig. 6). Investigating the opinions of local residents and other stakeholders is necessary for local and regional tourism planning and management, because they give the tools and the knowledge for defining socioeconomic sustainability of tourism development in a local context (IV).

Research on the ecological and social impacts of tourism will bring authority to the sustainable planning and management of nature-based tourism (Fig. 6). Effective methods, practical indicators and tools based on scientific research help to predict the effects of nature-based tourism. Early detection of impacts is important, because restoration is a costly and slow. Reconciling ecological, social and economic values and objectives is the basis of sustainable planning for nature-based tourism (Fig. 6).

4.3.1 Planning and managing frameworks

Many methods have been developed to measure the sustainability of tourism for the environment and local community. Some methods have been developed for measuring the ecological impacts of tourism, while others are more general planning methods that include social components of tourism. The concept of carrying capacity has been closely linked to sustainability of tourism since 1960s (*e.g.* Wagar 1964, Mathieson & Wall 1982, Hendee *et al.* 1990, Pigram & Jenkins 1999). However, there are limited situations where the concept of carrying capacity is appropriate (*e.g.* Wagar 1974, Stankey & McCool 1984, McCool & Lime 2001). New, more sophisticated planning and managing methods have been

developed, for example: Limits of Acceptable Change (LAC), Participatory planning (PP) and Community-Based Ecotourism (CBET) and Social Impact Assessment (SIA) and these will be further discussed.

The LAC has been used to identify an acceptable amount of impacts in a specific area, usually in large wilderness areas, where the number of visitors is relatively high (*e.g.* Hendee *et al.* 1990, Stankey *et al.* 1990, McCool 1994). The LAC is used also by Metsähallitus in managing the use of National Parks in Finland. Sustainability indicators for identifying LAC should be sensitive, applicable, relevant, easy to measure and cost-efficient (Kangas *et al.* 2007). The results and methods of this research (I-III) might be used as a part of the LAC process in Oulanka and Pallas-Ounastunturi (Pallas-Ylläs) National Parks.

Butler (1991) suggests that tourism planning is too often reactive rather than proactive. In general, planning for tourism should contain strategic, political and optional levels, especially in protected areas, to ensure that the needs of local residents, for example, for homes, jobs and income are met. According to the results of the survey (IV) participation of local residents needs to be incorporated into the planning process if tourism is to be sustainable. Participatory Planning (PP) was developed during the 1970s. Earlier approaches tended to consist of only top-down methods such as surveys of tourists and experts' opinions, while nowadays the principles of participation as a part of bottom-up framework are favoured. This includes participation at local scale, transparency, common responsibility, flexibility and educative orientation as parts of the development process (Driskell 2002). Therefore, many practical tools have been developed for participatory planning, with semi-structured interviews (SSI) a principal tool. Other tools include, key informant interviews, focus groups iteration, probing, observation, seasonal calendars and timelines. Another tool for taking local residents into consideration in tourism planning is CBET (Community Based Ecotourism), which is based on the economic benefits for local people generated by supporting the conservation of biodiversity (Kiss 2004). It is used nowadays by the most international conservation organizations. Social Impact Assessment (SIA) was developed for identifying social changes, such as in services, employment, norms and values of a society. The methods used in the study IV might be useful in many cases when planning and managing the areas for sustainable nature-based tourism.

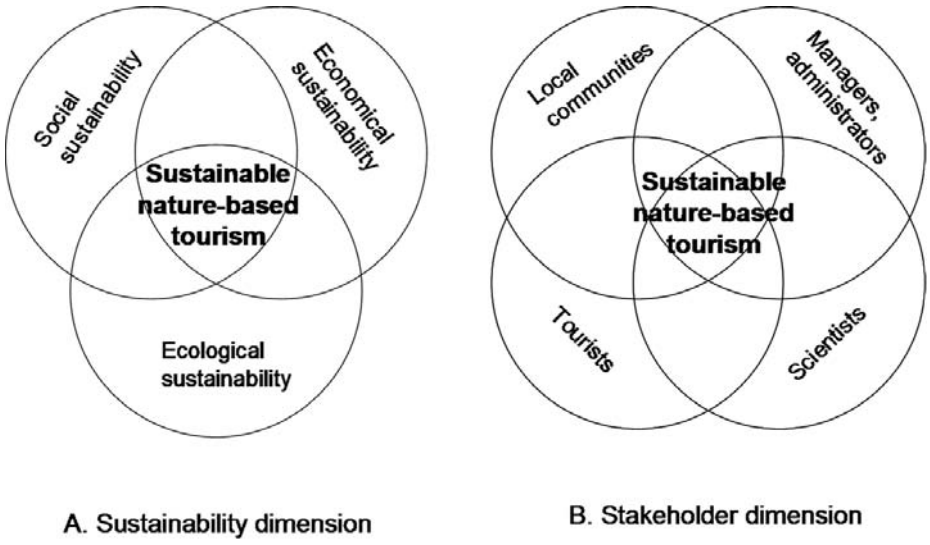

Fig. 6. Dimensions of nature-based tourism.

5 Conclusions

Ecological impacts are inevitable after low-level and short-term recreational use. However, the quality and quantity of ecological impacts are strongly dependent on factors such as the type of recreational activity and the characteristics of the habitat and vegetation. Trampling effects on slope terrain was 6-fold greater on slopes than on flat terrain. Moreover, trampling downhill had more negative effects on vegetation cover than trampling up the same hill. Hiking and horse riding reduced the cover of vegetation mostly due to trampling damage, while horse riding and skiing altered the composition of the vegetation more than hiking. Early successional species often become more common after skiing, while forbs and grasses benefit from horse riding. This might be due to changes in micro-habitat such as light, and soil characteristics including nutrient status and hydrology. Instead of focusing mainly on the quantity of users, the quality of activities and resulting impacts should be major considerations in the planning and management of nature-based tourism.

The most critical ecological effect of tourism found in this research is the risk of introducing alien plant species into protected areas by recreational horse riding. This is of concern as the main aim of protected areas is to maintain and conserve the native biota. Moreover, soil disturbance can enhance the invasion, with horse trails acting as dispersal corridors for alien species. These results are important for planning and managing the use of protected areas worldwide. Monitoring and further research into alien species and the role of tourism in facilitating invasions is urgently needed.

From on study of opinions of local residents it is clear that interest in nature conservation and nature-based tourism differs among local residents within the survey areas. Opinions depended on the socio-demographic background and values of respondents. Participation of local residents early in the planning process is likely to contribute to the development of more positive opinions about the development of their residential area. The survey demonstrates an effective method for analysing the opinions of local residents.

The main task for sustainable tourism development is to combine the conservation goals, local peoples' livelihood and economic prerequisities of tourism. Maybe sustainability should be seen rather as a process than an unambiguous situation. Sustainable development of tourism may not be achieved exclusively by an authoritarian regime (top-down) or an exclusively community-based approach (bottom-up). A detailed scientific analysis (both quantitative and

qualitative) of factors that effect tourism and impacts provides valuable information to managers when designing how areas are used. Effective research and monitoring methods and practical indicators are needed to anticipate and avoid ecological and social problems caused by nature-based tourism.

Management and planning should be targeted simultaneously at conserving biodiversity, at managing natural resources in an economically sustainable way, ensuring the social acceptability of management actions and providing high-quality recreation for visitors now and in the future. Ensuring the satisfaction of various sectors dealing with nature-based tourism needs long-term co-operation between various stakeholders in every stage of planning and management. Maintaining a balance between tourism and protection requires in-depth knowledge of ecological, economic and social aspects of sustainability.

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Appendix 1

Table A1. Plant species or genera found in the study plots and their origin according to Hämet-Ahti *et al*. 1998. (A) archaeophyte, common, (C) casual alien, found after 1950, (E) established alien, rare, and (N) native common. Treatments: (Dist0) undisturbed, (Dist+) disturbed, (C) control, (M+) addition of manure, and (S+) addition of seeds. Species found only in manure addition treatments are marked in bold.

Species	Origin of plant species	Dist0				Dist+			
		C	S+	M+	M+S+	C	S+	M+	M+S+
***Achillea millefolium* L.**	A	-	-	-	-	-	-	-	X
Calluna vulgaris (L.) Hull.	N	X	X	X	X	X	X	X	X
Carex sp.		-	-	-	-	-	-	X	X
***Chenopodium album* L.**	E	-	-	-	X	-	-	X	X
***Deschampsia cespitosa* (L.) P. Beauv.**	N	-	-	-	-	-	-	X	X
Deschampsia flexuosa (L.) Trin.	N	X	X	-	X	X	-	X	X
***Epilobium angustifolium* L.**	N	-	-	-	X	X	-	-	-
Empetrum nigrum L.	N	X	X	X	X	X	X	X	X
***Geranium sylvaticum* L.**	N	-	-	-	-	-	-	-	X
Ledum palustre L.	N	X	X	X	-	X	X	X	X
***Luzula pilosa* L. Willd.**	N	-	-	-	-	-	-	X	X
Pinus sylvestris L.	N	X	X	-	X	X	X	X	X
***Poa* sp.**		-	-	-	X	-	-	X	X
***Ranunculus repens* L.**	N	-	-	-	X	-	-	X	X
***Rumex* sp.**		-	-	-	-	-	-	X	X
***Stellaria media* (L.) Vill.**	A	-	-	-	X	-	-	X	X
***Taraxacum* sp.**		-	-	-	-	-	-	X	X
***Trifolium repens* L.**	A	-	-	-	-	-	-	X	X
***Tripleurospermum inodorum* Sch. Bip.**	C	-	-	-	-	-		X	X
Vaccinium myrtillus L.	N	X	X	X	X	X	X	X	X
Vaccinium uliginosum L.	N	-	X	X	X	X	X	-	-
Vaccinium vitis-idaea L.	N	X	X	X	X	X	X	X	X
***Veronica serpyllifolia* ssp. *serpyllifolia* L.**	A	-	-	-	-	-	-	X	X

Original papers

I Törn A, Rautio J, Norokorpi Y & Tolvanen A (2006) Revegetation after short-term trampling at subalpine heath vegetation. Annales Botanici Fennici 43: 129-138.

II Törn A, Siikamäki P & Tolvanen A (2007) Trail and vegetation impacts of different types of recreational use – comparisons between hiking, skiing and horse riding. Manuscript.

III Törn A, Siikamäki P & Tolvanen A (2007) Can horse riding induce the introduction and establishment of alien plant species through endozoochory and gap creation? Manuscript.

IV Törn A, Siikamäki P, Tolvanen A, Kauppila P & Rämet J (2007) Local People, Nature Conservation and Tourism in Northeastern Finland. Ecology and Society. In press.

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