Resource Efficiency of the Ski Industry in New Zealand

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Abstract

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Resource Efficiency of the Ski Industry in New Zealand:
An Analysis of Resource Consumption Patterns
Associated with Snow Sports

By Axel Reiser

Skiing and Snowboarding are popular recreation activities in New Zealand, as well as constituting important components of the winter tourism product. The 2001 snow season witnessed record visitor numbers. Skier days have increased by more than 10% compared with the previous year to 1.254 million. The traditionally "nature related" activity of skiing, however has increasingly often been discussed in the light of excessive resource consumption and pollution of alpine environments. Since no research on resource efficient management of ski fields has been undertaken in New Zealand, this study examined environmental awareness and actions of ski field managers, resource consumption benchmarks (water and energy use, solid waste production), along with resource use related visitor behaviour.

Two separate surveys were undertaken to collect relevant information from ski field managers and ski field visitors. While a census of managers across New Zealand was conducted with a mail-back questionnaire (all 27 ski fields were contacted, response rate 44%), the visitor survey was undertaken on-site at six selected ski fields in Canterbury/South Island (total responses: N=259). Analysis of the survey results showed that managers generally acted to protect the environment and resources, however, at different levels for the various indicators measured. Energy use and air pollution were rarely perceived to be environmentally important. Accordingly, only few actions were undertaken to reduce energy use. This is surprising, since energy consumption proved to be a major feature of ski field management. Given the additionally large amounts of water consumed (mainly for snowmaking) and solid waste produced on the mountain, skiing has to be classified as a resource intensive activity. Resource consumption is intensified further, when the impacts associated with tourists being transported to, and from, the mountain are considered. Energy use

for "ski trip transport" within New Zealand is two times larger (180 MJ) than energy use associated with ski field infrastructure use (90 MJ) on a per skier day basis.

There are several options to improve the environmental performance of ski fields, ranging from modernising equipment, optimising snowmaking and providing efficient transport alternatives. Additionally, increased cooperation between ski field managers, local governments and research institutes could potentially result in environmentally smarter operational practices. Internationally, New Zealand's ski areas compare relatively well, mainly because of limited on-mountain entertainment and accommodation development, which keeps resource consumption and pollution low compared with European and North American ski fields. However, this research also indicated that New Zealand's ski field visitors increasingly demand facilities and services similar to those overseas, which in turn may result in larger environmental impacts. New Zealand is generally believed to be a green and nature-related destination and its ski areas still blend well into the natural environment. Hence, there is some potential for the New Zealand ski industry to develop a unique product in such a way that it is both, sustainable and distinguishable from other international markets.

Keywords: Snow sport, resource consumption, resource efficiency, downhill skiing, snowboarding, benchmarking, environmental awareness

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List of Abbreviations

Institutions, Organisations and other Abbreviations:

Abbreviation	Full Name
AEE	**Assessment of Environmental Effects**
ANOVA	**Analysis of Variance**
CA	**Conservation Act**
CMS	**Conservation Management Strategy**
CO_2	**Carbon Dioxide**
CSA	**Canterbury Snow Sport Association**
DoC	**Department of Conservation**
EECA	**Energy Efficiency and Conservation Authority**
EIA	**Environmental Impact Assessment**
EMS	**Environmental Management Systems**
FIS	**Federation International de Ski**
GCV	**Gross Calorific Value**
GG 21	**Green Globe 21**
IPCC	**Intergovernmental Panel on Climate Change**
MED	**Ministry of Economic Development**
MfE	**Ministry for the Environment**
NCV	**Net Calorific Value**
NSAA	**National Ski Areas Association**
RMA	**Resource Management Act**
SAANZ	**Ski Area Association of New Zealand**
SACC	**Ski Area Citizens Coalition**
TIANZ	**Tourism Industry Association New Zealand**
TNZ	**Tourism New Zealand**
USDA	**United Stated Department of Agriculture**
WTO	**World Tourism Organisation**
WTTC	**World Travel and Tourism Council**

Units of Measurement:

Abbreviation	Name	Abbreviation	Name
m	**metre**	**km^2**	**square kilometre**
km	**kilometre**	**l**	**litres**
g	**gram**	**m^3**	**cubic metre**
t	**tonne**	**vkm**	**vehicle-kilomentre**
ha	**hectare**	**pkm**	**passenger-kilometre**
a	**acre**	**J**	**joule**
m^2	**square metre**	**KWh**	**kilo watt hour**

Symbol	Name	Factor
k	**kilo**	**10^3**
M	**Mega**	**10^6**
G	**Giga**	**10^9**
T	**Terra**	**10^{12}**

CHAPTER 1 - INTRODUCTION

1.1 General Context

Skiing has evolved since the first hunters in Norway used "wooden planks" as a means of transport to travel efficiently over snow-covered landscapes. In the early years people manually carved their skis from wooden planks; today "carving" has become the buzzword of the latest skiing fashion-trend, referring either to the high-tech ski and snowboard equipment, which is no longer made from wood alone or to the latest "skiing/boarding-style".

The emergence of skiing as mass sport originates with the introduction of snow groomers at the 1964 Olympic Winter Games in Innsbruck, which saw the first large scale employment of machinery for the preparation of the ski field. Following this, the advancement of ski slope preparation equipment and the development of purpose-built high altitude ski resorts in France changed the nature of skiing from a pure natural resource based recreation to a facility-dependent, and often "nature-disconnected" sport[1]. Thus, this research assumes that today's average "snow sport recreationist" values the amount and quality of facilities and service available at the mountain more than an area's natural features (Bieger, 1999).

In the 1990s the introduction of the term "snow industry" instead of "ski industry" became necessary when snowboarding emerged as a popular sport after its invention by Poppen and Burton in 1977 (Williams, Dossa & Fulton, 1994). Hudson (2000) reports that snowboarding has had the greatest commercial impact on the ski industry since the invention of quick release bindings. Apart from the impact related to the emergence of new activities, skiing itself has undergone a number of notable changes in the last five years through the invention of so-called "carving skis" and "fat skis". These technological developments in the ski market may be seen as a reaction of the ski industry to the challenges put forward by the snowboard market. Also, changes in leisure behaviour of western societies may have supported the trend to technical sophistication,

[1] The importance of natural resources (mountains) remains unchanged compared with the early days; however, the focus of skiers' and snowboarders' interests has changed. Ski areas are today distinguished by their facilities rather than by their natural features. Trail map designs, for example, support this assumption, since these 'tourist maps' usually manipulate the natural environment to better display lift facilities and trails (putting the man-made features into the foreground). The Remarkables (Queenstown) trail map is a typical example for matching the features of the natural environment to suit the display of the facilities.

as for instance described by Buckley (2000) for current trends in nature, eco- and adventure tourism.

Concomitant with the development of the ski industry comes an increasing use of resources. This includes the consumption of materials, water, energy, and natural areas, which in turn result in the production of waste, wastewater, emissions, and degradation of the environment. Resource use is not only a result of technical devices used by the ski fields and material used by recreationists, but it also stems from the increasing mobility of ski field users. This mobility is an inevitable consequence of consumers living in urban centres and ski fields being in more remote mountain areas. Ski tourism, in particular, typically involves travel for a long distance, as, for example, in the case of Australians having a skiing vacation in Queenstown, New Zealand. Few New Zealand ski fields are accessible by convenient public[2] transport services. Hence, many skiers and snowboards use private cars to access ski fields.

Resource consumption and conservation is a major global concern. This was expressed at the Rio Summit in 1992, and the subsequent release of international protocols to protect the planet. One example is the Kyoto Protocol (1997), which aims to curb emission of greenhouse gases that are assumed to affect global climate by inducing a warming of the atmosphere (Intergovernmental Panel on Climate Change [IPPC], 2001). Globally, the largest amounts of anthropogenic greenhouse gas emissions result from energy use. New Zealand is one of the signatories to the Kyoto Protocol, and the government intends to ratify the protocol in August 2002. Once New Zealand has ratified the protocol, the Country is obliged to reduce greenhouse gas emissions to 1990 levels. Despite New Zealand's commitment to meet the criteria, emissions continue to increase (Ministry of Economic Development [MED], 2000), and of these transport is a major contributor. In 1999, fuel combustion associated with transport accounted for 43% of New Zealand's total CO_2 emissions (ibid).

[2] Definition of 'public transport' for this thesis: commercial, collective transport options, such as commercial coaches (more than ten passengers) and commercial mini-vans (up to ten passengers). Public transport in the context of this research is understood as collective transport rather than the inclusion of New Zealand's ski field in the public transport system (e.g. Mt. Hutt becoming a regularly serviced bus stop of Christchurch's "Red bus' network). The word 'public' is therefore used as an antonym to 'private' transport modes (e.g. private car/4WD).

1.2 Research Context

Tourism is a significant and growing sector in the New Zealand economy, and Tourism New Zealand (TNZ) has proved its ability to market the country's attractions successfully. However, industry stakeholders including the Tourism Industry Association New Zealand (TIANZ), Government, and tourism researchers have realised a potential gap between the global marketing campaign of a "green and clean" image and the predominant practices of tourism operators and businesses throughout the country. The need to close this gap is reflected as a unifying theme of the New Zealand Tourism Strategy 2010 (Tourism Strategy Group, 2001).

Ski areas are part of the tourism industry, as well as they are recreation facilities for New Zealanders. The domestic ski market is "mature" (i.e. the proportion of New Zealand's population participating in snow sport remained stable over recent years)[3], and skier days have mainly increased by the attraction of more international visitors (New Zealand Ski Council, 2001). Thus, New Zealand's ski areas are competing on a global market. Since they need to adapt their operations to constantly and rapidly changing demand, development will be unavoidable in the future (Initiative Alpen in Not, 2001a; Loppow, 2000). In recent years, new trends have forced ski areas to offer new services such as comfortable high-speed lift facilities, terrain parks, half pipes, and ungroomed but patrolled terrain for so-called "freeriders", who want to enjoy a sense of adventure. In some North American resorts (e.g. Vail – "Adventure Ridge") huge on mountain entertainment complexes create revenue with non-skiers all year round and are seen as the new "must-build" facility by some experts (Best, 1998; Bieger, 1999; Michel, 2001). It is difficult to fulfil these demands without compromising the requirements of sustainable development, that is, "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs" ("Brundtland Report", World Commission on Environment and Development [WCED] 1987, p. 5).

[3] The recent introduction of special priced season passes (started by Mt. Ruapehu in 2000 and followed by most commercial ski fields in 2001 and 2002) might have had some impact on the participation rates among New Zealanders. However, no studies or figures are available yet, and indicate any significant change in participation.

1.3 Why Should Skiing and Snowboarding Be Sustainable?

The World Tourism Organisation (WTO) advises: "Downhill skiing is a high volume activity, which must be carefully planned in order to develop the necessary infrastructure, service areas, and transportation access without generation of environmental problems" (McIntyre, Hetherington & Inskeep, 1993, p. 24). Buckley et al. (2000) go even further in noting that ski resorts are "one of the most intensive forms of tourism development in mountainous areas". Consequently, many studies have focused on biophysical impacts of snow sport on the environment (Böhringer, 1996; Buckley et al., 2000; Holden, 1999 and 2000; Wardle & Fahey, 1998 and 1999). Few studies, however, have been conducted to assess the sustainability of alpine skiing and snowboarding taking into account the impacts and benefits on all three environmental spheres: the natural, the economic, and the socio-cultural environment (Bachleitner, 1998; Bieger, Müller, Elsasser & FIS, 2000a; Brandner, Hirsch, Meier-Dahlbach, Sauvain & Stadler, 1995; Williams & Gill, 1999).

Skiing and snowboarding are outdoor activities that are highly dependent on an intact natural environment, although the development of snow sports in the last 25 years strongly supports the assumption that skiers and snowboarders value infrastructure higher than natural assets (personal observation). This contradiction can create serious problems and misunderstanding associated with the interpretation of environmental statements and preferences of snow sport recreationists. While skiers and snowboarders may value the sight of a pristine mountain landscape during their lunch break (from an comfortable on-mountain restaurant providing a full food and beverage service, complete with central heating, etc.), they may not do so if they had to enjoy the same view from a basic mountain hut. The same applies for some typical nature-related alpine skiing activities (such as an off-piste decent into the next valley, which is not developed for down hill skiing) or the experience of certain natural occurrences in mountainous environments (such as snow storms), which are only enjoyed due to the infrastructure provided (lift access and central heated shelter). New Zealand's ski areas offer a suitable setting to study such phenomena, as they range from basic (club fields) to moderately developed fields of international standard. Especially in the case of Canterbury's many club ski fields, skiers and snowboarders may have a high place attachment and recreate at their ski field not only in winter, but also in summer. Furthermore, the dependency of skiing and snowboarding on sufficient natural snow cover may suggest a high awareness of global warming issues amongst skier or the ski industry. Several studies discuss the issue of climate change

and skiing (Abegg & Elsasser, 1996; Elsasser & Messerli, 2001; IPCC, 2001; König, 1998; König & Abegg, 1997).

In the broader context of ski field management in New Zealand, skiing should be sustainable because of the …

- Vulnerability of the (high) alpine environment – "the higher the more fragile" (Initiative Alpen in Not, 2001b) and potential threats to biodiversity;
- Dependency of the activity on an intact and functioning cultural, economic and natural environment. The latter is particularly important for New Zealand, since the alpine environment is a major tourist attraction (Booth & Cullen, 2001);
- High resource demand of the activity, due to infrastructure needs. Specifically a potentially higher energy and water consumption, as well solid waste production, compared with other mountain recreation activities, such as tramping (Buckley, Pickering & Warnken, 2000);
- Climatic dependency of the activity on sufficient natural snow cover.

1.4 Research Objectives

1.4.1 Scope and Importance of Research

This thesis contributes to increasing the knowledge about sustainable management practices for ski areas; that is, how to preserve the natural state of winter recreation areas to the maximum possible degree. One would think that skiers, snowboarders and ski field operators have a natural interest in management practices that ensure a long-term future of their sports. However, a review of literature on environmental damage resulting from ski area operation suggests the opposite. Hence, it is important that recreation researchers guide ski area operators in optimising their environmental management practices. Invariably, these practices aim to reduce resource use (which often constitutes the highest costs of ski field operations). Becoming more resource efficient and, hence, reducing costs could additionally help reduce the "price explosion" experienced by the ski industry in recent years (Breiling, 2001; Meβmann, 1998), and ensure that skiing/snowboarding remains an affordable sport.

"Sustainable tourism development" is a complex term, encompassing many meanings to different people. This study will only provide insight in some aspects of sustainable (ski) tourism. Moisey and McCool (2000, p. 3) capture the core of the discussion on sustainable tourism in five "…pathways and pitfalls confronting tourism as it seeks an appropriate role in the world". The author adapts these five points to demonstrate which aspects of sustainability are researched and discussed in the remainder of this thesis (Table 1). The core focus of this thesis is on measuring resource consumption and deriving benchmarks for ski areas in New Zealand. This will contribute to the "search for indicators" (item 3, Table 1). A second focus will be on providing background information for future planning and implementation of sustainability measures specific to the New Zealand context. To be able to draw a complete picture, both main players of the snow sport industry; the ski area providers and the recreationists/tourists will be examined in the thesis. McCool and Moisey (2000) indicate that achieving sustainable management at ski areas will require involving more stakeholder groups than ski area managers and visitors (item 5, Table 1). In the literature review this finding is acknowledged and other stakeholder groups are briefly introduced. It is, however, argued that in the New Zealand context, and due to the thesis' environmental focus, the analysis of managers' environmental actions and awareness and ski field visitors' behaviour are the two most important components of sustainable ski field management – and therefore a key first focus for research on this topic.

Table 1: Pathways and Pitfalls in the Search for Sustainable Tourism

Point	What?	Is it part of this thesis?
1	The meaning of sustainable tourism	Brief discussion in this thesis with strong focus on "(invisible) environmental effects" of snow sport tourism and recreation
2	Integration of the larger economy and linkage with scale of consideration.	Not discussed in this thesis.
3	The search for indicators – how do we know if sustainable tourism is indeed sustainable without a set of measurable variables that indicate progress?	Core focus of this thesis.
4	Planning and Implementation – sustainable tourism does not just happen, it occurs only with explicit decision-making processes that consider what futures are plausible and desirable and the pathways to them.	Discussed in this thesis.
5	Forms of knowledge and public participation – achieving sustainable tourism will require a variety of individuals, agencies and programmes, each using different forms of knowledge and each involving those affected by the decision.	Discussed/introduced in this thesis.

(Source: McCool and Moisey, 2000, p. 3)

1.4.2 Research Context: Understanding the Global and the New Zealand Snow Sport Market

To enable sound judgement on the environmental issues considered in the research objectives it is essential to first provide background information on skiing and snowboarding in New Zealand:

Leading Questions include:

- What are the important definitions for the research context?
- What is the shape of the global ski market?
- What is the structure of a ski area/field[4]?
- How is the New Zealand snow sports market structured and how important is it in economic and social terms?
- How vulnerable is New Zealand's snow sport industry to climatic changes?
- What is the environmental legal background for ski area operation in New Zealand?

Answers to these questions provide a broad research context for the substantive research outlined in the following.

1.4.3 Research Objectives & Questions

Objective I: Assessment of Environmental Awareness of New Zealand's Ski Area Management

Awareness and "good will" of managers are basic requirements for the introduction of sustainable development at New Zealand's ski fields. "Objective I" provides a first qualitative insight into both – environmental awareness and "good will".

Research Questions:

- Are New Zealand's ski field managers environmentally aware?
- How committed are New Zealand's ski field managers towards environmental best practice?

Objective II: Measurement & Definition of Benchmarks

The backbone of any accreditation and auditing scheme is the comparison of business practices against a benchmark set by prior industry analysis (auditing and benchmarking are explained further

[4] In the remainder of this thesis, the word 'ski area' will be used as a general term for recreation facilities offering infrastructure that makes alpine skiing and snowboarding possible (lifts, ski slope services, etc.). In the New Zealand context a ski area is commonly called a ski field. Hence, if the discussion refers to New Zealand specifically the word 'ski field' is applied.

in Chapter 2). "Objective II" provides first estimates of benchmarks for resource use throughout New Zealand's ski area industry. Three selected areas of resource use are analysed.

Research Questions:

- How much energy is consumed per skier day? (for infrastructure and for snowmaking)
- How much water is consumed per skier day? (in ski field facilities and for snowmaking)
- How much solid waste is produced per skier day?

Objective III: Assessment of Snow Sport Recreationists and Tourists

The behaviour of people recreating at ski areas is an important factor. "Objective III" aims to gain some insight into skiers and snowboarders' behaviour in three selected behavioural areas:

Research Questions:

- What is the demographic profile (general and snow sport related) of the recreationists and tourists?
- What man-made facilities do skiers and snowboarders value most? (degree of "facility dependency")
- What is the "transport behaviour" of snow sport recreationists/tourists?
- What is the "waste disposal behaviour" of snow sport recreationists/tourists?

1.4.4 Justification of Research Structure

The author of this study believes that resource consumption of ski areas is only partly controllable and managed by the ski area operator. The recreationists' behaviour contributes a significant part to the overall resource consumption. It is a short sighted and limited belief that improved resource efficiency can be achieved via the introduction of more efficient technology and improved management structures only. Currently, there are financial limits to introducing more efficient technology in New Zealand ski market. Hence, it is crucial to find less expensive strategies to improve the industry's performance. There might be a considerable potential to influence recreationists to behave more efficient without large capital investments. A prerequisite to such attempts is a detailed analysis of current consumer behaviour. This study did not attempt to address environmental issues directly, since biased responses to hypothetical questions were expected. Instead, three main areas that were expected to have the highest potential of being environmentally damaging were researched without reference to the environment.

1.5 Structure of Thesis

Figure 1 provides an overview of the thesis structure. Brief comments on the content of each chapter are made. Arrows indicate the flow of information from one chapter into another.

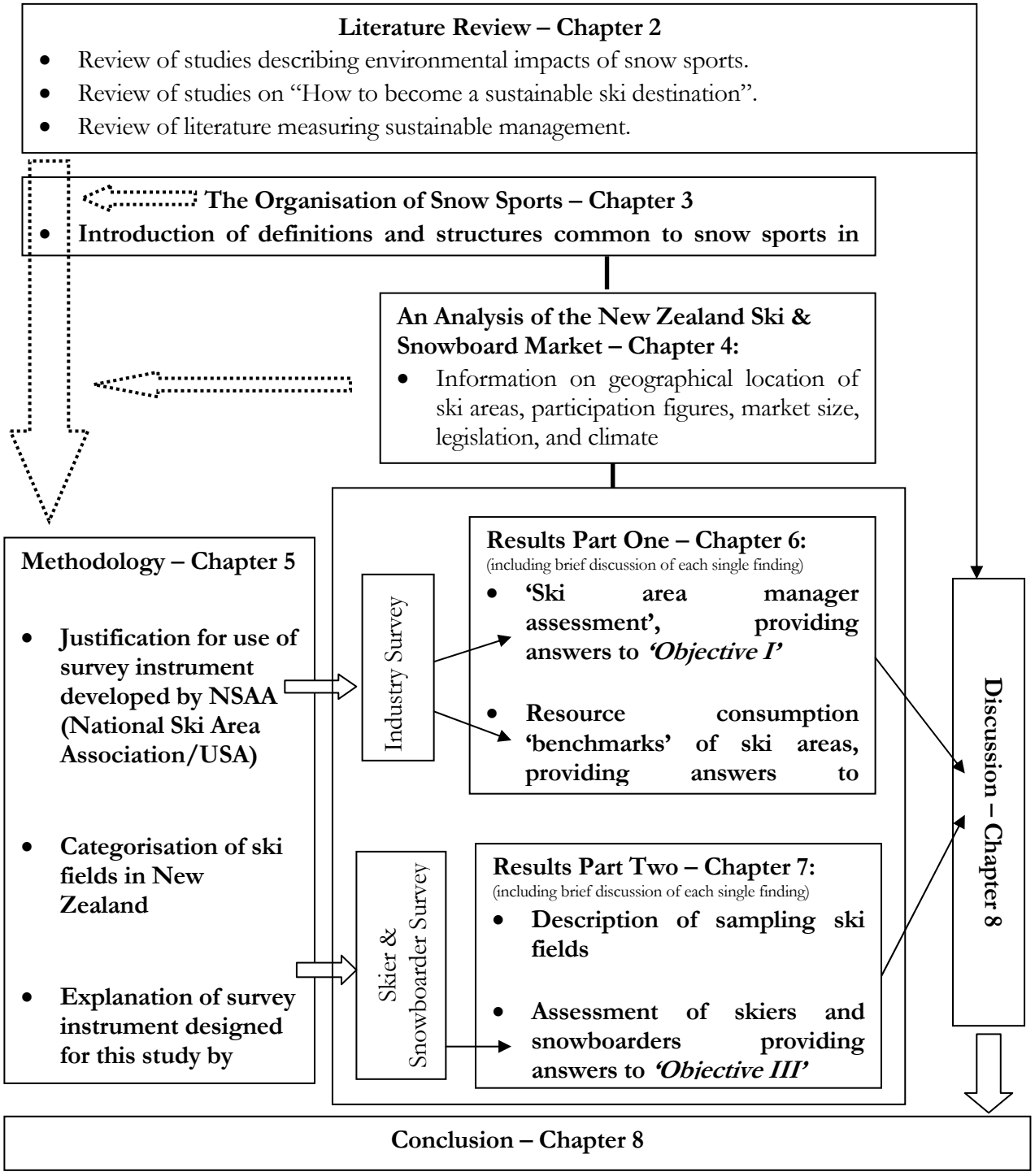

Figure 1: Overview of the Thesis Structure.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

In the previous chapter, it was argued that skiing, as a recreation/tourist activity, and ski areas should be managed in a sustainable way. Reference was made to four main points justifying the demand for sustainable development. Three referred to specific threats to the natural environment (global and local), whereas only one emphasised the importance of a functioning economic and social environment. This bias reflects the focus of this thesis, rather than the actual importance of each environmental sphere for the long-term future of snow sports as recreation activities and as an industry. Consequently, this chapter does not review research on the economic or social impacts of skiing, but presents many examples of studies documenting impacts on the natural environment.

After an overview of various specific impacts on the natural ski area environment, the reader is introduced to some models and concepts of sustainable ski area management that consider all three environmental spheres. This is necessary to clarify possible links between the spheres, to assess the importance given to each sphere by different studies, and most importantly, to analyse conflicting objectives of ski area management based on either an ecological perspective or an economic perspective. The sustainability models and concepts are then illustrated by some industry case studies at various ski fields. The case studies focus only on projects with a primary interest in the natural environment, in line with the two themes of this thesis:

- How "green" are New Zealand's ski fields?
- How "green" are New Zealand's skiers and snowboarders?

The literature review is structured in three parts, which are arranged from the specific to the general. Section 2.2 presents an overview of the impacts associated with the development and the management of ski areas. Section 2.2 deals with concepts and models that aim to implement ideas of sustainable development into the management of ski areas. The problem of how to measure sustainability in tourism is debated in section 2.4. Recent discussions on tourism eco-labels and environmental awards (e.g. Green Globe 21 [GG 21]) in general are considered. Finally, conclusions are presented in section 2.5.

2.2 Environmental Impacts of Snow Sports Activities

A considerable number of studies deal with specific environmental impacts of ski area development at different locations worldwide. Some of those impacts may be specific to a single location; others are common to ski area development in general. While early studies focused on environmental impacts that are spatially confined to the ski area itself, more recent studies take a broader approach and include large-scale problems[5], such as the influence of global warming on skiing. This broader view has included economic and socio-cultural effects of skiing, which usually impact on the wider communities and countries hosting the ski areas. Examples are the calculation of multiplier effects or induced economic impact studies (Bieger, Laesser, Ludwig & Caspar, 2000b; PriceWaterHouseCoopers Consulting, 2000; Stynes & Sun, 2001; Ski Area Association of New Zealand [SAANZ], 2000). The following sections discuss the environmental impacts of ski area construction and extension, operation of the facilities (on-site issues) and transportation (a local and a global issue).

2.2.1 Impacts Resulting from Ski Area Construction and Extension

The sustainability potential of an alpine ski area is partially determined during its planning process (Brandner et al., 1995). Table 2 lists the main development actions (and associated case studies) with a potential to damage a ski area's local environment.

Table 2: Ski Area Development Actions with Potential to Result in Environmental Damage

Development Action	Source
Access solutions (road or gondola construction).	Commission for the Environment for Remarkables Ski Field (1976); NSAA "Green Room" (2001a)
Track construction for maintenance purposes (on-mountain facilities, power lines, lift lines...).	Walter (2001, p. 8-9); Streicher et al. (2001, p. 4)
Logging for trail construction (not relevant).	Ski Area Citizens Coalition (2001)
Trail grading and resulting vegetation loss or long-term erosion problems.	Walter (2001, p. 8; p. 18); Wardle & Fahey (1998 and 1999)
Capacity of sewage treatment plant – future demand prediction.	National Ski Area Association (NSAA) "Green Room" (2001a)
Power supply.	Schweizer & Preiser (1997); Lowe & Lloyd (2001),
Management of construction process in high alpine environment.	Aspen Ski Company (2000); Bieger et al. (2000a); Brandner et al. (1995); Schendler & Lane (2000); Streicher et al. (2001).

[5] See for example: *Climate Change*: Abegg & Elsasser, 1996; Colling, 1998; Elsasser & Messerli, 2001; König, 1998; Walter, 2001. *Transport*: Stettler, 1997; Meier, 2000; Müller (ed.), 1999. *Fossil Fuel Combustion:* Landespressebüro Salzburg, 1997; Müller & Flügel, 1999.

The major worldwide growth of the ski resort industry (1970-late 1980s) took place in an era with limited public environmental awareness. Many mistakes made in these times are now irreversible or can only be reversed with significant financial input (Böhringer, 1996). Today, many of these operations suffer limited cash-flow (Michel, 2001), which diminishes the interest in, and potential for, environmental action. Financial constraints are not always, however, the reason for little environmental action. This is clearly demonstrated by the French "station de neige", highly lucrative operations demonstrating little interest in environmental protection (e.g. Tignes in Bieger et al., 2000b). In fact, these completely artificial villages, built in the high alpine environment for the sole purpose of skiing, were the prototype of severely modified alpine landscape without appropriately addressing key environmental issues, such as solid waste disposal, fresh water management and sewage treatment (Walter, 2001).

In New Zealand, most ski areas developed out of club activities, which means that the sites were chosen in an "historical" process (Pearce, 1977). The transition from club ski fields to commercial fields (e.g. Coronet Peak, Mt. Hutt) was demand driven (Pearce, 1977), and proximity to population centres was obviously a major determinant of the development of commercial ski fields. For example, Mt. Hutt, being located near to the city of Christchurch, had the customer base to support commercial development, whereas the ski field on Ball's Pass in Mount Cook National Park, being far away from major centres, had to shut down. An example of a solely commercial development is that of the Remarkables Ski field near Queenstown. Environmental issues – mainly concerning road construction, but also social issues (displacement of trampers) – were central in this development (Commission for the Environment for Remarkables Ski Field, 1976).

2.2.2 Impacts of Ski Area Operation

Management practices typical to ski area operation are the central interest of this thesis. The following major environmental issues have been identified for ski area management:

- Trail preparation (grooming)
- Snowmaking
- Summer use of ski areas
- Environmental impacts of general facility operation
  - Energy consumption
  - Solid waste production and management
  - Sewage management

These issues are discussed in the following sections.

Impacts of Ski Trail Preparation (Grooming)

One of the main threats to ski field vegetation is the preparation (grooming) of trails with snow groomers. Vegetation damage can result from snow compaction –allowing insufficient ventilation and causing rotting of vegetation – or from direct mechanical damage of the topsoil level when snow cover is insufficient. Vegetation loss will eventually result in long-term erosion damage of the topsoil. A recent snow grooming impact study of the Southern Lakes region (Wardle & Fahey, 1999) showed that the New Zealand flora (in particular, most tussock grass species) is more resistant to impacts from trail grooming than European alpine pastures. New Zealand vegetation seems to recover after some years of exposure to responsible grooming – that is, ensuring groomed areas have sufficient snow cover[6]. Given appropriate grooming practice, no long-term erosion problems are expected (Wardle & Fahey, 1998 and 1999). This is in contrast to some European and North American findings, which showed that alpine plant communities (especially alpine pastures) are vulnerable to grooming and skiing (Böhringer, 1996; Heiselmayer, 1998; Hinterstoisser, 1998; Reimooser, 1998; Wardle & Fahey, 1998). Severe erosion problems were often observed as a result (e.g. Fellhorn Bahn GmbH, 1997; Walter, 2001).

Environmental Impacts of Snowmaking

Snowmaking was initially considered to be beneficial for the environment, since it protects vegetation with a dense layer of snow. Today, however, the merits of snowmaking are heavily debated between conservation groups and ski area managers (Best, 2001). The problems are far-reaching and are not yet sufficiently researched. Newesely (1998), for example, reported on the negative impacts associated with artificial snow, namely: lack of oxygen, reduced insulation capacity due to higher snow density, increased erosion, and a shorter vegetative period for plants because of delayed snowmelt in spring.

Another controversial topic is the application of additives (e.g. Snomax®)[7] in the snowmaking process. While environmentalists claim additives are responsible for environmental damage to

[6] Research results provide conflicting advice on sufficient snow cover figures. The figures range from 30cm to 60 cm of compacted snow (Wardle & Fahey, 1998). Snow compaction is a complex process, and different weather patterns can create very different snow packs. A highly compacted layer of wet snow will protect vegetation better from mechanical damage than a snow pack of similar depth consisting of less loosely compacted dry snow. Therefore, ski areas avoid specifying the minimum snow pack at which they open (Böhringer, 1996), since they, firstly, do not want to compromise their economic goals (personal observation) and, secondly, cannot specify a single figure that could easily be communicated to the public.

[7] 'Snomax' is a protein added as condensation kernels to the water during the production process of artificial snow. See Brown (1997).

vegetation and groundwater systems (Initiative Alpen in Not, 2001c), ski area operators and the snowmaking industry quote studies proving the safety of artificial additives (York®Snow International, 2001; Vermont Ski Areas, 2001) and emphasise their advantages, such as increased efficiency of water consumption[8]. There are no restrictions on the application of Snomax at New Zealand's ski fields, apart from occasional monitoring by DoC [Department of Conservation] to ensure that the concentration of the additive in the water samples remains under a certain level. Although the direct run-off is not of potable quality, Snowmax is not considered a problem by the industry or regulatory agencies, since the additives (a specific freeze-dried protein; York®Snow International, 2001) quickly disperse in the aquatic system of the ski basin (staff of Mt. Hutt snowmaking department, personal communication, 8th November 2001). However, this author did not find scientific studies addressing the application of snowmaking additives in New Zealand. Interviewed ski field managers and snowmaking staff were also not aware of such studies for New Zealand (Porter Heights, personal communication, 18th July 2001; & Mt. Hutt, personal communication, 8th November 2001).

Fresh water consumption is another major environmental concern (Kröll, 2000; National Ski Area Association [NSAA], 2001a; Streicher, von Stockar, Schmied & Keller, 2001). Snowmaking is a heavy user of water; it is, in fact, the main use of fresh water resources in modern commercial ski areas (e.g. Aspen Ski Company, 2000). The possible negative consequences for the alpine ecosystem of snowmaking interrupting the natural water cycle include water quality degradation due to snowmaking additives, influence on stream levels and consequently on aquatic life, erosion due to increased melting water flows in springtime, and destabilisation of the ecological balance caused by changed water flow patterns (Best, 2001; Initiative Alpen in Not, 2001d; Ski Area Citizens Coalition, 2001). Again, the use of water for snowmaking is debated, with the NSAA stating that this water use is non-consumptive (NSAA, 2001a; NSAA, 2001b p. 2-49), while German legislation and environmental groups consider water use associated with snowmaking as consumptive and therefore of concern (Initiative Alpen in Not, 2001d).

[8] Besides the better quality of the artificial snow for skiers, Snomax also has some environmental advantages. The additive increases efficiency of snowmaking, so that the volume of produced snow per unit of water can be increased by up to 15-30%, depending on the climatic conditions. This reduces not only water use but also the energy consumption of the snowmaking system (Snowmaking department of Mt. Hutt ski field, personal communication, 8th November 2001; Clarkson, 1996).

Further important concerns of snowmaking are the large energy use (Breiling, 2001; NSAA, 2001a), soil and vegetation damage during installation of the system (underground pipes, hydrants) (Streicher et al., 2001), and noise disturbance of operating guns (Kröll, 2000). All of these problems are linked to the use of snowmaking equipment.

The conflicting results of studies conducted at different locations suggest that the severity of the environmental consequences caused by snowmaking is determined by the local ecosystem. The low density and low intensity of use[9] of New Zealand's ski areas seems to create fewer environmental problems than in Europe (Walter, 2001) and some regions of North America (Best, 2001). Competition over water resources is a common problem in Europe and North America (Best, 2001), but is not of the same importance in New Zealand.

2.2.3 Summer Use of Ski Areas

Europe's alpine resort-based tourism visitor volumes peak during winter. In Switzerland, for instance, about 84% of revenue on average across all tourist aerial cableway providers is generated during the winter season (figure refers to the 1999/2000 season; Michel, 2001). This concentration of visitor volumes during the winter months suggests that ski tourism is probably the largest contributor to environmental degradation at Europe's alpine resorts[10]. Summer use of ski areas, however, is putting even more environmental pressure on these already-stressed areas.

While the introduction of snowmaking has extended ski seasons and shortened the summer recovery period for the alpine environment, attempts of many ski areas worldwide to develop as all-year mountain resorts (Mill, 2001) increasingly restrict this recovery period. In Europe, agricultural summer use of high alpine pastures has been traditional long before tourism or skiing developed. The pressure to develop high alpine pastures has been estimated to have lowered the tree line in the Alps by about 200 – 300m altitude (Fellhornbahn GmbH, 1997). After the introduction of skiing,

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[9] There are only 24 ski fields in the New Zealand Southern Alps, occupying less than 0.08% (93 km² in total; Upjohn, 2001) of the total land area (110,000 km², Jeanneret & Wanner, 2001), while there are approximately 1950 ski areas (Lewis and Wild, 1995; cited in Hudson, 2000a) in the European Alps, occupying about 3% (5800 km² in total, Hudson, 2000a) of the total land area (180,000 km², Jeanneret & Wanner, 2001). The difference in skier day visits to the two alpine areas is even more dramatic. There were approximately 910,000 skier day visits to New Zealand's ski areas in 1996 (New Zealand Ski Council, 2001), while 190 million skier day visits were made to resorts in the European Alps in the same year (Lazard, 1996; cited in Hudson, 2000a).

[10] This does not mean that ski tourism is a main contributor to environmental damages in the Alps in general. The statement refers to damage witnessed at developed all-season resorts (e.g. Zermatt) only.

the high alpine pasture often suffered even more stress (Pröbstl, 1991). There is contradictory evidence on the harmful or beneficial environmental effects of year-round tourism in alpine environments (Kröll, 2000; NSAA, 2001a; Pröbstl, 1991).

Although signs of excessive pressure on the alpine ecosystem resulting from "triple-use" of the high alpine zone (winter tourism – skiing, summer tourism – tramping/hiking, agriculture – dairy) are well documented (Hudson, 2001a and 2002; Poulton, 2002; Pröbstl, 1991), there is a trend toward ski fields increasingly offering "facility-based" summer outdoor recreation. Most popular is (downhill-) mountain biking[11]. There is conflicting academic evidence on whether the benefits of mountain biking (increased visitor volumes, additional recreation opportunity) outweigh the additional environmental pressure[12]. In New Zealand, only a few ski fields offer year-round recreation activities, and none of the ski fields has agricultural summer use. The development of outdoor education centres at Temple Basin (Arthur's Pass National Park) and Craigieburn Valley demonstrate alternative and more environmentally friendly possibilities for summer use of ski areas. It should be noted that at these two named New Zealand locations, the ski area infrastructure is not used (and is totally unsuitable) to promote mass alpine summer tourism, such as mountain biking.

2.2.4 Environmental Impacts of General Facility Operation

Energy consumption

Literature on energy management of ski areas is scarce. Todd and Williams (1996) surveyed field managers in 46 North American ski areas on the perceived importance of several environmental issues. Energy issues were of medium to low importance (ranked 9th in a list of 13), with only 17 of the 46 locations implementing energy conservation programmes. Generally, little is reported on how energy savings could be attained. This lack of detail is also apparent in Buckley et al.'s (2000) study on environmental management of alpine tourist resorts in Australia.

The most comprehensive overview of energy use associated with skiing and snowboarding is found in a Swiss study on "sport and traffic" (Stettler, 1997). Stettler provided quantitative data on many aspects of skiing and snowboarding, such as transport energy use, and equipment and infrastructure related energy use, in aggregated form only. Stettler (1997) reported that in terms of per capita and

[11] Over 150 out of 400 US resorts offered trails and lift services to mountain bikers in the summer of 1997 (Blumenthal, 1997).

[12] Compare: Literature review on environmental impacts of mountain biking by the NZ MTB Net (2002).

per session energy use, snow sport activities (alpine skiing, snowboarding, ski touring, and cross-country-skiing) are energy intensive and are well above the average energy use per sport session (including facility based sport, such as swimming, and outdoor sports, such as diving).

The NSAA (2001c) addressed energy management as an important issue. In their first industry assessment of North America's ski areas (NSAA, 2001b), the degree of implementation of energy saving measures was researched, and the total energy use and the total savings after the implementation of energy saving measures were assessed. Based on these data, the NSAA calculated preliminary "Ski Area Environmental Footprints" to allow for a comparison with other industries (NSAA, 2001b, p. 2-49). The results are not yet broken down into energy consumption for separate business areas (energy use for facilities, snowmaking, lifts, and vehicles), but provide first indications of the total environmental impact resulting from energy consumption.

Generally, it appears that quantitative data are not collected on a regular basis, either by the industry itself or by academics. Only recently have some single operators (Aspen Ski Company, 2000) or industry associations (NSAA "Green Room", 2001a) begun continuous documentation of energy consumption figures as a first step to identify inefficiencies in their operational practices.

Solid waste management

Despite being ranked least important (13th of 13 items) in Todd and Williams's (1996) study, waste reduction and management generally receive considerable attention from ski area management in Europe, North America and Scandinavia. The Sustainable Slopes Assessment 2001 (NSAA, 2001b p. 2,14,15) revealed that many waste reduction and recycling programmes are already in action. A study from Sweden (Rayborn, 1997) showed that the implementation of waste management planning is of interest to ski destination managers and is probably closely linked to energy conservation in mountain regions, where disposal is only possible at a distance from the location of consumption. Waste management plans are traditionally important for (mega) events, such as Winter Olympic Games or world championships (depending on the visitor volumes). The solid waste disposal concept developed for the Alpine Ski World Championships 2003 in St. Moritz/Ponteresina (Weckert, 2001) could serve as a guideline for future waste management at ski areas.

Sewage management

Sewage management is a delicate topic to most ski area operations (Commission for the Environment of Remarkables Ski Field, 1976). Todd and Williams (1996) found that North America's ski area managers ranked sewage facilities as second out of the environmental management activities of most importance to their operations. Additionally, the Sustainable Slopes Assessment 2001 (NSAA, 2001b, p. 2-6) found that water quality management and wastewater management are already among the most implemented practices in North America's ski areas and are in compliance with the principles set out in the Environmental Slopes Charter (NSAA, 2001c), a document defining the standard of environmental best practice for North America's ski area industry.

No specific literature on wastewater management at New Zealand's ski fields could be found. Most ski areas in New Zealand operate with sewage/septic tank systems. The efficiency and security of these wastewater management systems are hard to analyse, and few studies have assessed the operation of such systems at alpine locations. Some industry reports on failed septic tank solutions are available (Miller, 2001). In the 1970s, the environmental impact report for the proposed Remarkables ski field construction (Commission for the Environment of Remarkables Ski Field, 1976) included the recommended construction of a sewage treatment plant (oxidation ponds) near the proposed base facility (Booth & Cullen, 2001). After a seven-year "planning struggle" (Booth & Cullen, 2001, p. 332), this was eventually realised, and the oxidation ponds are still used by the ski area today. At New Zealand's club fields, it may be valuable to consider research on solutions to backcountry human waste, such as compost toilets (Chapman, 1993), for ski fields.

2.2.5 Impacts of Transport and Traffic

The evolution of modern tourism is closely connected with the development of public mobility and, in particular, private transport modes. Since much equipment has to be carried for skiing and snowboarding, this is a particular consideration for snow sport tourism (Trösch & Messerli, 2000). It is argued that transport may contribute more than the actual recreation activity itself to the total energy use and CO_2 emissions (Stettler, 1997). Stettler found that the ratio of energy use for transport to energy use for infrastructure and equipment varies between 3:1 (skiing) and 8:1 (alpine ski touring/ski mountaineering). An analysis of all environmental impacts resulting from tourism reveals the significance of the transport component (Bieger, 1998). Bieger structured the tourism

experience in seven general components, three of which refer to transportation. The dominance of transport is further increased when transport to activities at the destination site is considered (Becken & Simmons, 2002). Müller and Flügel (1999) estimated that, in Switzerland, over 90% of all CO_2 emissions associated with tourism are due to transport.

Trösch and Messerli (2000) studied transport behaviour of winter sports recreationists in Switzerland, from an ecological economist's perspective. They showed that high financial costs would be involved to transfer skiers from their private cars to public transport. The construction of competitive (in terms of travel costs, convenience, and travel duration) public transport modes to alpine resorts would be extremely expensive, both because of the mountainous terrain, and because road access to the ski areas already exists[13] and mostly cannot be cheaply replaced by public transport alternatives[14]. In the same context, Müller (1999) compared the traffic and public transportation management of several alpine communities. On the basis of their studies, they present a list of twelve recommendations for future traffic management at tourism destinations. A key finding is that, despite the success of local stand-alone projects (e.g. pedestrian zones, free public transport, etc.), the environmental quality of a tourism destination can only be increased or preserved when inter-destinational travel (i.e. to and from the destination, including day trips) is included in the management concept. Finally, research results are available exploring measures that encourage tourists to change their transport behaviour (Frey-Marti & Laesser, 1996).

2.3 Realising Sustainable Management of Snow Sports

Since humans are at the core of sustainability discussions, the parties involved in the organisation and management of snow sport destinations will be discussed first. Secondly, research analysing the conflict around the different views on the meaning of sustainability is examined. Some concepts and models facilitating sustainable development, as well as some case studies, are introduced in section 2.3.3.

[13] Ski areas in Switzerland and elsewhere in Europe have usually grown out of existing villages and rely on the transport infrastructure of the village. Therefore, access roads are usually not financed by the ski area.

[14] Some Swiss resorts have managed to become "car-free" (e.g. Zermatt, Saas Fee, Grindelwald), providing only rail access to their ski area base village. These resorts, however, are up-market, do not cater for day visitors, and already had traditional rail links (with the mountain railway usually constituting a tourist attraction in its own right).

2.3.1 The Human Dimension of Snow Sports

Understanding key participants and stakeholders, including their common goals and potentially conflicting viewpoints, is crucial. Hudson (2001a, 2001b, 2002) presents a range of different viewpoints on skiing. Following Hudson, a set of "points of view" for five different stakeholder groups can be identified: ski operators/businesses; skiers & snowboarders (Table 3); environmental groups; employees and residents; and government/regulatory agencies (Table 4). It is important to acknowledge that the perspectives of each group have to be seen in a North American context. Thus, the relevance for New Zealand needs to be verified, especially because research on the interaction of stakeholders in the New Zealand snow sport industry does not exist.

For the purpose of this study, the most important stakeholder groups are recreationists (skiers & snowboarders) and ski area operators; hence, they are looked at in more detail (i.e. the viewpoints of these two groups are related to the New Zealand context). Other stakeholders are not discussed any further here; neglecting their perspectives does not, however, imply that these are irrelevant to this study. The design of this research project was limited to two detailed surveys of ski area managers (operators) and skiers and snowboarders.

Table 3: Illustration of the "Points of View" of Ski Operators and Skiers & Snowboarders

Stakeholder Groups	Points of View
Ski Operators / Businesses	• Developed ski areas occupy a tiny percentage of land and accommodate recreation for millions of people. • Skiing is less damaging than other economic alternatives. • Skiing is a low impact activity. • There is a lack of scientific basis for many arguments. • Environmentalists are too extreme. They make outrageous claims that they then back down on. • The issue of ski areas in national parks is essentially political.
Skiers & Snowboarders	• Limited research on skiers and their environmental commitments has produced contradictory results. • A Roper survey discovered that skiers were especially worried about the environmental results of development and growth. • Skiers overall are more concerned about the environment than are all other sport participants. • Skiers overall do not believe that ski areas are helping the environment.

(Source: based on Hudson, 2001b)

For the New Zealand context, it is true that ski areas occupy only a very small proportion of mountainous terrain. Altogether, New Zealand's ski areas occupy approximately 93.23 km^2 of land

(Upjohn, 2001), which equals 0.08% of the Southern Alps' total land area (110,000 km^2, Jeanneret & Wanner, 2001). Furthermore, it can be assumed that only around one-third (estimate based on personal observation) of the area occupied by ski fields is used intensively (snow grooming, snowmaking, used for building, etc.); the rest is so-called off-piste (ungroomed) ski terrain.

Concerning all other points highlighted in Table 3, there is not much research available in New Zealand. Thus, only some cross-referencing from related studies is attempted. The documentation of the application to construct the Remarkables ski field in Queenstown (Commission for the Environment for Remarkables Ski Field, 1976) suggests that the viewpoint that "environmentalists are too extreme" may also apply to New Zealand. On the basis of scientific studies, it cannot be decided whether skiing is a low impact sport in New Zealand; however, studies on impacts of snow grooming showed that New Zealand's vegetation might be less fragile than Europe's plant species (Wardle & Fahey, 1998 and 1999). There is no available research on environmental perceptions of skiers and snowboarders in New Zealand of which this author is aware.

Table 4: Illustration of the "Points of View" of Other Skiing Stakeholders

Stakeholder Groups	**Points of View**
Environmental Groups	• Ski areas cause destruction of wildlife habitat, secondary impacts from private land development, and depletion of water supplies for snowmaking. • Downhill skiing is not an appropriate use of national parks. • Ski operators need to be convinced that survival without growth is possible.
Employees and Residents	• The development of skiing provides benefits, such as foreign exchange earnings, income, employment and economic diversification. • Environmentalists who want to restrict tourism fail to take into account that the town survives solely from the revenue brought by the visitors. • Skiing enables the financing of cultural buildings and tourism infrastructure that can be used by the local population. • Skiing can play a major role in the formation of local identity.
Government and Regulatory Agencies	• Ski areas have to be managed according to long-range plans, but these documents are at best "old, out of date, and inefficient". • Management plans for each national forest have resulted in widespread citizen involvement in the agencies' planning and policy-making process. • Coordination among the various regulatory federal agencies over ski area permit applications has been nearly non-existent. • States and local governments have environmental programmes that often overlap federal regulations. This can be duplicative, confusing, and frustrating.

(Source: based on Hudson, 2001b)

The Role of Marketing and Customer Behaviour for the Emergence of New Trends

Snow sport recreationists exert considerable influence on ski area operators through their purchasing behaviour (Hudson, 2001a, 2001b). For example, the successful creation of higher skier day numbers by the linking of several smaller ski areas to one big amalgamated mega resort (often called "ski-circus", e.g. Sölden in Austria, Flachau-Waggrain in Austria, Les Quatre Vallées in Switzerland, etc.) triggered a wave of similar developments all over the European Alps in the 1980s. Even today, many small, more remote winter sport destinations consider their best chance for revenue creation to be through linking their small resort with a new ropeway to one of the bigger resorts (Loppow, 2000). In the same way that skiers' desire to recreate at large ski areas sparked such development a decade ago, the more recent trend in Europe to recreate in more natural places may now work against the creation of additional mega resorts. Environmental criteria may play a role in this purchasing behaviour, as already observed for other areas of customer behaviour (Buckley, 2002; Font & Tribe, 2001; Spittler & Haak, 2001). Clearly, this is an important area of future research (Hudson & Ritchie, 2001; Holden, 2000), as more knowledge in the area of environmental marketing could help to promote environmental enhancement more efficiently.

According to Hudson and Ritchie (2001), potential exists for skiers to include environmental factors in their skiing decisions. In the United States, public awareness has already created independent environmental ranking schemes of ski areas, advising consumers to avoid ski areas that engage in environmentally harmful management practices (Ski Area Citizens Coalition, 2001). No scientific evidence is available, however, to suggest the degree to which this influences the destination choice of North American skiers. The effectiveness of such ranking schemes is doubted even by environmental organisations, who do not believe that skiers will base their destination decision on how environmentally friendly a ski resort is (Harbough, 1999; cited in Hudson, 2001a). Overall, it is important to better understand skiers' and snowboarders' attitudes toward the environment (Holden, 2000; Hudson & Ritchie, 2001).

While organisations such as the Ski Area Citizens Coalition hope that, in future, recreationists will consider the environment in their decision-making, observation of current trends in ski area development (Bieger, 1998 and 1999, Best 1998 and 2000) indicates the opposite. It seems that consumer expectations (or competition amongst ski areas themselves) are forcing ski areas to develop comparatively resource demanding on-mountain entertainment facilities. In this context,

Hudson (2001a) found that ski areas are no longer the main attraction in so called "ski towns". The growth of ski towns/regions can no longer be controlled by slowing or stopping ski area/facility development or expansion (Tejada-Flores, 1999; cited in Hudson, 2001a). Skier numbers have been stagnant in recent years, indicating that growth can only come in four-season resort development (real estate, restaurants, resort retail, golf, entertainment complexes, swimming pools, etc.), rather than from increased lift ticket earnings. The need for a year-round experience on the mountain puts pressure on operators in that they not only have to provide services related to skiing but also have to cater for broader customer needs, such as hospitality and entertainment services (Michel, 2001). This increases competition among ski fields, which, in turn, has implications for ski field management. This will be briefly discussed in the following section.

Competitiveness and Sustainability

In a highly competitive market[15], it is difficult for ski field operators to allocate enough resources (human, time and financial) to the active incorporation of new concepts, such as sustainable management (e.g. in the form of adapting an environmental management systems approach), in their business practices. For example, Hudson, Ritchie & Timur (2001) are currently assessing and comparing the competitiveness of ski tourism destinations using a specifically designed model of "destination competitiveness and sustainability" (Hudson et al., 2001). Furthermore, Hudson (2000) and his colleagues (2001) point out that, especially in the light of a mature global ski market, competitiveness is a barrier to developing strategies for sustainable destinations (see also Bieger (1998); Pechlaner & Osti, 2001). Thus, the concept of destination competitiveness becomes central to a customer-centred perspective on sustainable destinations (Hudson et al., 2001). Flagestad and Hope (2001) offer a first theoretical framework on strategies to gain competitive advantage over competitors, while at the time meeting the criteria of sustainable tourism as outlined by the WTO.

Ski area operators compete not only with each other, but also against other outdoor-recreation providers. Some of these may appear more "environmentally friendly" compared with ski fields, in

[15] The ski market is classified as highly competitive, because of:
(1) its global character (people are increasingly travelling to overseas destination for a ski holiday);
(2) the stagnation of worldwide skier numbers, leaving no room for further growth through new ski area development (this does not consider new ski area development trends in China, which could change the whole argument for the Asian ski market);
(3) increased competition from 'tropical destinations' (due to cheap long-distance airfares) offering a cheaper 'beach-product' as an alternative to the comparatively expensive ski product.
The consequence is an increased competition over the same or shrinking customer base, forcing ski area operators to gain a competitive advantage over their competitors. In the past, this competitive advantage was usually obtained by further developments.

part because of the now well established "ecotourism" market (Ökotourismus in Berggebieten, 2001). In Australia, for example, there are already several accredited operators (Australian Nature and Ecotourism Accreditation Programme) (Buckley, 2002) that may compete with ski destinations. Even in New Zealand, some tourism businesses (e.g. Adventure South) have joined the Green Globe 21 accreditation scheme. The integrity of "green businesses" is important in a competitive market, where image is both highly important and fragile. This may be even more critical in New Zealand, where a green and clean market image is promoted. First reports on the recent initiative of the NSAA in North America to increase the whole industry's environmental responsibility show that it could potentially be financially advantageous (at least in the long term) for ski area operators to be proactive and become leaders in environmental stewardship (Colorado Department of Public Health and Environment, 2002; NSAA, 2001a). The introduction of environmentally sound business practices, however, needs to be balanced with commercial goals (Bieger, 1998; NSAA, 2001b). More reliable research and information is needed to achieve such balance. The Aspen Ski Company is often referred to as a role model for environmentally responsible business practice that pays off economically and as competitive advantage. The environmental director of the company, however, recently reinforced the need for more research in the area and reported on the many difficulties his company faces "on the road to sustainability" (Schendler, 2001, p.293).

The Conflict Between Economy and Ecology

Interactions between ski operators, environmental groups, and government or regulatory agencies have the potential to result in conflict. A comparison of the three stakeholders' viewpoints, outlined in Table 3 for the North American context, reveals a conflict between human recreation and business values (operators), conservation values (environmental groups), and unclear regulatory liabilities (government). Such conflict is currently less evident in public debate in New Zealand[16], although examples of similar controversies concerning the existence of ski areas in national parks[17] or concerning specific environmental problems, such as sewage treatment, have been publicly discussed in the past. Essentially, such conflict could lead towards the development of sustainable management and planning practices, when the different stakeholder groups engage in discussion (Hudson, 1995; McCool & Moisey, 2000; Williams & Gill, 1999).

[16] Ski areas are currently not involved in public discussion on environmental conflicts evolving from their business practices or plans.

[17] At Mt. Ruapehu/Tongariro National Park, discussions on the ethics of having a commercial operation in a natural and cultural World Heritage Area have resulted in a non-development policy of the upper mountain, a truly exceptional regulation for a commercial ski field.

The discussion on competitiveness has briefly touched on the central conflict of many recreation facilities located in natural environments. According to a broad research base in the area of environmental economics, the conflict between ecological sustainability and economy is often a central barrier to implementing more environmentally sound management practices (Beckerman, 1994; Dobson, 1996; Hanely, Shogren & White, 1997). In the recreation and tourism context, one major impediment to overcoming the conflict seems to be a difference in the time frames relevant to economic and ecological interests. This point is illustrated by a comparison of the different "time horizons" of ecology and economy of alpine ski tourism (Brandner et al., 1995, p. 154) and serves as an explanation for the often incompatible objectives of business and environment (Table 5). To overcome the conflict between economic and ecological needs, it is important that research provides ski area managers with knowledge on competitiveness and visitor experience, along with biophysical and environmental considerations.

Table 5: Different "Time Horizons" of Economy and Ecology in the Context of Alpine Ski Tourism

TIME HORIZONS	**ECONOMY**	**ECOLOGY**
Short-term	1-2 years: Budgeting period of a construction business.	2-5 years: Time for re-establishment of vegetation clearances or disturbances due to trail construction.
Medium-term	4-10 years: Project planning time frame for a large-scale investment, e.g. new chair lift.	10-15 years: Example of the slow growth rates in the alpine zone: some alpine plants take about 10 years before they bloom for the first time (Swiss example *stengelloses Leimkraut*).
Long-term	15-20 years: Write-off period of a large-scale investment, e.g. a ski area.	50-100 years: The life cycle of alpine plants can exceed 50 years. Once damaged or destroyed regeneration can take up to this time (e.g. alpine beech forest).

(Source: adapted from Brandner et al., 1995, p. 154)

While this section has outlined the environmental problems ski areas face in the current global marketplace, the following section (2.3.2) reviews literature on the theoretical and practical introduction of sustainable management practices at ski area destinations. The above discussion leads to the conclusion that at least three requirements must be met before the manager of ski areas is prepared to think of becoming "greener". First, skiing will only become more sustainable if there is public discussion on conflict over environmental issues between stakeholders of the ski industry. Second, an agreement between all stakeholder groups on the future of skiing in the area has to be

reached. Third, a clear understanding is required of the "eco-project" types that can be realised within the existing financial and human resources constraints.

2.3.2 Models and Concepts of Sustainable Ski Area Management

Facilitating Sustainable Ski Area Management

For the implementation of sustainable practices to be successful, all contributing parties[18] have to be involved in the negotiations on the implementation process. Successful implementation can be assisted by public participation (Holden, 1999; McCool & Moisey, 2000). An example highlighting public participation is Hudson's (1995; 2000) model for greening ski resorts. The author names six key variables that contribute to the creation of "Green Ski Resorts": responsible tourists, responsible operators, responsible marketing, development and management, legislation, and conservation groups. The model provides a structure for discussing (or facilitating discussions on) the potential of implementing environmentally friendly management methods from a human scientist's perspective, rather than providing specific knowledge on implementation measures (see Hudson 2001a and 2002 for applications). Likewise, it does not feature operationalised and measurable indicators of its variables, but Hudson (2000) explores the interaction between them in discussion and by illustrating them with examples. It is the author's emphasis on the interactions between the variables that identifies the major difference to the discussion of the stakeholders' viewpoints in the previous section. The mere existence of different viewpoints on the part of different stakeholders does not necessarily provoke public participation. Public participation means that stakeholder groups have influence on the ski area decisions. Hudson's (1995; 2000) model formalises the interactions between stakeholders and reformats them in more goal-oriented groups[19], which in turn increases their influence on the ski area. Hence, Hudson's model outlines how the process of becoming a more sustainable ski area could be facilitated, but it does not define what a sustainable ski area is. This constitutes the main difference between Hudson's model and the more operationalised, conceptual frameworks presented in the following section.

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[18] This includes those stakeholder groups that could potentially contribute to the realisation of a specific project. For example, it might not be necessary to engage government agencies in the decision process of investing in a new more environmentally friendly snow groomer, while the investment in a new lift system benefiting the environment and the economy of an entire region might require the involvement of local government.

[19] For example, not all skiers will be part of the variable 'responsible tourists', but in regrouping themselves the environmental concerns of the 'responsible tourist' will be more likely to be noted by ski area management. Similar reformatting processes apply for the other variables (see Hudson, 2000a, p. 125-143).

Concepts of Sustainable Ski Area Management

The potential contribution of public participation is one of eight important factors in Brandner et al.'s (1995) "eight-factor programme" for sustainable development of ski tourism. The factors are operationalised into measurable site-specific indicators that were tested and applied to five different Swiss case study areas. In Brandner et al.'s (1995) model, all three aspects of sustainability that is economic, social and environmental dimensions – are considered, although the energy rich transport component is not included. Bieger et al. (2000) developed this model further for the Alpine Ski World Championships 2003, including more recent issues of sustainable tourism development, namely traffic flows, air quality and local "eco-projects" (Table 6).

While Brander et al.'s (1995) model had only developed indicators directly related to skiing (measuring soil instability or terrain suitability), Bieger et al. also developed indicators measuring environmental impacts indirectly related to snow sports, such as transportation. The importance of eco-projects, such as "sustainable building" (Schendler & Lane, 2000) or the use of recycled material (e.g. paper), is well documented in the sustainability report of the Aspen Ski Company (2000). Finally, Bieger et al. (2000) established an indicator measuring the input of volunteers. This idea is of relevance in the context of sustainable development for low-capital ski fields, such as New Zealand's club ski fields, which are largely dependent on voluntary work by club members. Just as the organisation of a mega event is dependent on voluntary work input, the work hours that would be required to introduce possible future environmental standards for ski areas at the club field level would have to come from club members and would most likely be unpaid. Therefore, a "voluntary working hours" index introduced by Bieger et al. (2000), although a social indicator, could also be a key indicator for the success of any new development at club fields.

Table 6: Indicators for the Assessment of the Sustainability of the Alpine Ski World Championships 2003

Environmental Spheres	Sustainability Indicators
Natural Environment	• Traffic flows and traffic structure • Fauna / flora on and off trails • Air quality • Utilisation of wilderness areas (or undisturbed habitats) and landscape regeneration • Realisation of environmental projects (or eco-projects)
Socio-Cultural Environment	• Cultural identity / significance of regional dialects • Knowledge of local population • Participation opportunities for local population • Tourism and sport awareness • Number of voluntary workers/number of working days spent by volunteers • Status of institutions and individuals
Economic Environment	• Cost-effectiveness of organisations/businesses • Stimulation of infrastructure construction with long-term benefits • Development of customer loyalty • Development of the overnight stay figures • Development revenue/skier day numbers of lift operations • Development of the destination market value • Development of the accrued value from tourism • Development of the destination/organisation and development of a knowledge data bank

(Source: translated and modified from Bieger et al., 2000a, p. 18.)

It is interesting to note that both models focus on a broad picture of managing the destination/ event, and seem to underestimate the importance of the many practical issues involved in the every-day operation of the ski areas (e.g. grooming, snowmaking). In Bieger et al.'s model (2000a) (Table 6), actions taken to improve the environmental performance of the ski area operation are summarised under the heading "realisation of environmental projects" (Bieger et al., 2000a, p. 20). One project proposal deals with sensible planning and organisation of the race infrastructure (slope preparation, organisation of start finish areas, minimising snowmaking infrastructure), and another seeks to limit the use of helicopters for the event. Although these issues are specific to each location (and in the example, to the specific event), it would enhance the knowledge of ski area management if guidelines for environmental best practice would be developed. Quantitative resource consumption benchmarks, such a minimum efficiency standard for snowmaking systems (water use and energy consumption) or other infrastructure, and "qualitative" recommendations for environmentally conscious management and planning, such as in the pollution prevention handbook published by the Colorado Department of Public Health and Environment (2002), could be included. Hence, more detailed studies examining important aspects of ski area management

(e.g. lift operation, snowmaking, grooming) need to be undertaken, to complement the broad concepts necessary to plan sustainable development at ski areas (Bieger et al., 2000a; Brandner et al. 1995).

2.3.3 Case Studies of Environmentally Friendly ("Green")[20] Ski Areas

This section presents case studies on "environmentally friendly" or "green" ski areas from various countries. A few academic studies on "greening ski areas" have been undertaken. Williams and Gill (1999) presented a growth management concept[21] for Whistler Mountain ski resort in Canada. The study appears superficial and did not provide hard data on any implemented green measures, but emphasized the importance of public participation in the political process of greening ski areas. Todd and Williams (1996) developed an Environmental Management Systems (EMS) framework for North American ski areas. Generally, the EMS concept is based on the idea of "self-improvement" of the industry or operation in question, and is therefore a proactive tool[22]. Todd and Williams conclude that, while there are already single (often stand-alone), "green" measures implemented, there remains a potential for formally integrating EMS into the management practices of the large North American ski areas.

Holden (1999 and 2000) analyses the environmental conflict associated with alpine skiing at Cairngorm in Scotland. He provides some interesting results on skier behaviour and the recreationists' attitudes to the environment (Holden, 2000), and also offers some general recommendations for improved sustainable management on a political level (Holden, 1999).

Ski areas in Australia have a relatively loose EIS (Environmental Impact Statements) process, in contrast with the more rigorous process of North American counterparts (Buckley et al., 2000). Apart from Buckley et al.'s study, little research has been undertaken in Australia and New Zealand. One reason might be the relatively small size of the snow sport market, as well as the small amount

[20] The terms "environmentally friendly" or "green" are preferred in this study to "sustainable' or "environmental sustainability", because the latter refer to a broader focus (including economic and social considerations) not apparent in most studies presented in this section. Some of the presented studies may use "sustainability" as a label for their actions, e.g. NSAA (2001a).

[21] A model developed with the intention to overcome some of the problems of the initial carrying capacity management concept.

[22] Key elements of an EMS are: policy development, analysis and improvement of planning processes, scrutinising of procedures and control measures, development of training and education programmes, improvement or development of effective internal and external communication strategies, and the introduction of adequate assessment and improvement tools (e.g. auditing, benchmarking).

of total land area occupied by ski areas. However, in relative proportions, New Zealand's snow sport destinations may not be less important to regional economies than those in North America.

In some cases, alpine communities have consulted academics and the snow sport industry in order to solve environmental problems associated with snow sports. In 1994, a survey of skiers and snowboarders in the United States revealed a very high public concern for the environment on the part of snow sport recreationists (NSAA, 1994, cited in Hudson, 2000, p. 125). In addition, environmental groups, such as the Ski Area Citizens Coalition (2001), put increasing pressure on ski area operators to manage their areas in more environmentally friendly way. In 2000, the North American ski area industry responded to this concern with the release of an environmental charter for ski areas. "Sustainable Slopes" is the first initiative of its kind in the world. It is structured to address the main resource-consuming activities of ski areas, and outlines principles underlying improvement in environmental management for these activities. The NSAA and other stakeholders additionally developed a survey instrument, in which each principle was translated into a set of specific environmental actions that ski area managers could take to meet the goal of the principle. The instrument allows for an assessment of the implementation levels of theses specific actions. The contribution of the NSAA to "green" ski area management and development is inherently different from most other approaches to "green" (or sustainable) management, because of its industry-based origin. For this very reason environmental groups in North America were very critical about the NSAA sustainable slopes programme, calling it a "greenwash" (Malkan, 2000) and claiming that the programme will not have any positive impact on the environment. In addition, the SACC also developed a scoring system allowing ski area customers to independently assess the environmental performance of North America's ski areas (Goodman, 2001; Malkan, 2001; SACC, 2001). A comparable initiative to the NSAA is the previously described sustainability concept for the Alpine Ski World Championships 2003 in St. Moritz/Ponteresina, Switzerland (Bieger et al., 2000a). The main difference, however, is that the initiator in this case was not the ski area industry, but rather the region (local government), supported by many industries, making the scope of the concept much broader (especially in the social dimension). The concept has been an ongoing process over several years, and it has triggered further accompanying studies, such as Streicher's et al. (2001) waste disposal programme.

Finally, single ski area operations have shown some environmental stewardship for some years. There are several examples (e.g. Castle, 1999; Holding, 2001; Hudson, 2002; Müller, 1999), two of which are presented below.

One of the most recognisable initiatives in terms of media presence (environmental marketing) comes from North America. The Aspen Ski Company, an operator of four ski mountains (Ajax, Highlands, Buttermilk, and Snowmass), created the world ski industry's first environmental director position in 1997. Since then, the company seems to have played a leadership role in environmental stewardship, at least in North America. In 2000, it became the world's first ski operation publishing a "sustainability report" (Aspen Ski Company, 2000; Schendler & Lane, 2000). This report is the result of development towards environmental excellence over the last few years and covers most areas of environmental interest (NSAA, 2001c). It compiles, for example, a full overview of the key resource indicators, such as energy and water consumption, and solid waste production and reduction.

In Europe, industry players have also initiated some environmental projects. A well-known example in the Northern Alps is the Fellhorn, a ski and tramping mountain near Oberstdorf in Germany. The mountain was developed as a mass ski tourism attraction in 1970s and 1980s, and included large-scale landscape modifications. The environmental pressure in the area was increased by intensive summer use of the ski area (tramping, grazing). In 1988, the Fellhorn Bahn GmbH (mountain operator) initiated a first environmental report, followed by the establishment of an environmental board that introduced a sustainable resort development plan (Fellhornbahn GmbH, 1997). The plan focused very much on vegetation reconstruction and avoidance of erosion damage, as well as visitor management and education (Böhringer, 1996; Robens & Blacek, unknown) and finally resulted in the creation of a nature conservation area within the ski area borders to protect an endangered bird species (*Birkhuhn*). The success of the project is documented in several brochures distributed to visitors today, as, for example, the "Umwelt-Fibel" (Fellhornbahn GmbH, 1997). Recently published scientific evidence supports the idea that the creation of a nature conservation area in the middle of the ski areas will be successful in the long run (Kröll, 2000).

2.4 Measures of Sustainable Management: Tourism Eco-labels and Environmental Awards

The initiatives and concepts analysed in the previous section will only be successful in the long run when they are successfully communicated to the public (Hudson 1995; 2000). Success in this context is understood as environmentally responsible actions becoming the standard for all operators in the ski area industry. It is assumed that environmentally responsible marketing can play a role in greening ski areas (Hudson, 2000). Eco-labels or environmental awards are possible means to gain public attention and therefore provide an incentive to improve environmental performance.

Before looking at one particular eco-label and its applicability for the ski industry, and in order to enhance the general understanding of the key terms used, some definitions are provided. In Section 2.4.1 a definition of "eco-labels" is introduced, and in Section 2.4.2 "auditing" and "benchmarking" are explained, and their mutual relationships and conceptual overlaps are discussed.

2.4.1 Tourism Eco-Labels

In recent years, there has been much academic interest in tourism eco-labels and environmental awards (Buckley, 2002; Font & Tribe, 2001). In Europe, especially, the number of labels has increased dramatically over the last 10 years, making it hard for the consumer to make sense of the "jungle of labels" and to assess the quality of each label (Spittler & Haak, 2001). Spittler and Haak (2001) scrutinised a number of eco-labels and concluded that they are not sufficiently systematic, and that quality has to be improved before consumers will base their purchase decisions on these labels. Other industries, such as organic agriculture, have already managed to introduce publicly accepted eco-labels (ibid).

Eco-labels are "tools" used to provide assurance to consumers that products or services have met certain levels of environmental performance. "Since eco-labels are voluntary, these act as soft policy instruments, complementing the more traditional command-and-control mandates" (Salzman, J. 1997; cited in Lee, 2001, p. 317). Lee finds that eco-labels need to be:

- endorsed and verified by independent parties;
- compliant with product specifications according to product category;
- product and performance related (Lee, 2001, p. 317).

To provide hard evidence on the environmental impact of tourism products, and if environmental sustainability is to be a successful part of management practices of tourism businesses, more than eco-labelling has to be done. The establishment of "effective benchmarking, accreditation, best practice and auditing" will be necessary (Issaverdis, 2001, p. 579).

2.4.2 Auditing – the Central Concept

"Auditing" is the central concept, containing elements of benchmarking, accreditation, and best practice. All four concepts are related and have some overlap (Figure 2). Eco-labels do not necessarily formally contain any of these concepts, and, therefore, depend very much on the quality of the awarding organisation (Buckley, 2002). It is, however, important to note that some eco-labels require an audit or focus on one or two of the single concepts.

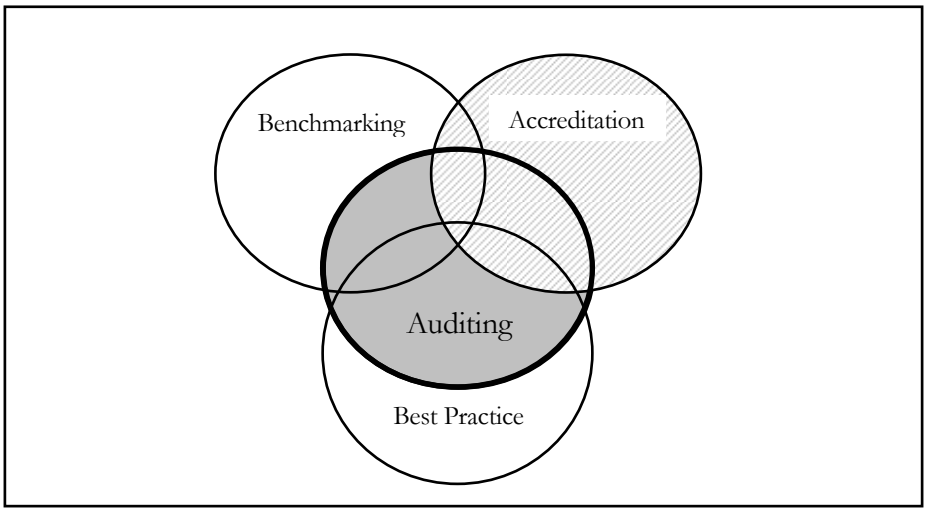


Figure 2: Benchmarking, Accreditation, Best Practice, and Auditing Systems Model
(Source: Issaverdis, 2001, p. 580).

Definition of Best Practice and Accreditation

To provide some understanding of the meaning of best practice and accreditation, the two concepts are briefly defined.

- Accreditation provides the "means of establishing the extent to which a business meets industry nominated standards, encourages the delivery of consistently high quality products, and promotes continuous improvement" (Issaverdis, 2001, p. 583).

- "Best practice is the optimal approach to operations management relative to levels of performance in comparable firms and operations" (Pigram, 1998; cited in Issaverdis, 2001, p. 587).

No studies in the field of environmental auditing of ski areas in New Zealand have yet been conducted. Thus, the author of this study believes that the establishment of resource consumption benchmarks (see below) is the most suitable first step toward filling this gap. Best practice guidelines for New Zealand's ski area industry and accreditation constitute later steps that can build on this research results. Therefore, they are not further discussed here. In the following section the two concepts in the focus of this thesis - benchmarking and auditing - are explained.

Benchmarking and Auditing

Benchmarking is a continuous process of "gathering information both internally and externally and the use of this information to improve the performance of an operation" (Issaverdis, 2001, p. 581). Moreover, a benchmark is a "point of reference from which measurements and comparisons of any sort may be made" (Büyüközan & Maire, 1998, cited in Issaverdis, 2001, p. 581). The following characteristics are important for benchmarking:

- "Proper selection of the target features and practices to be emulated;
- Careful selection of the organisations chosen to compare performance;
- Effective monitoring and feedback systems to ensure outcomes are improved" (Pigram, 1998; cited in Issaverdis, 2001, p. 582).

The process businesses undergo to identify and confirm benchmarks is called auditing (Issaverdis, 2001)[23]. Goodall (1995, p. 33) distinguishes several types of environmental auditing. The two generic types are "Full Audits" and "Partial Audits". Full audits are further subdivided into "Corporate Full Audit", "Life Cycle Full Audit", and "Site Full Audit". Partial audits are subdivided into eight categories, each corresponding to a single aspect of a tourism business or operation. The most appropriate audit for assessment of ski areas appears to be the "Site Full Audit". This is defined as the assessment of "environmental impacts of operations from a specific site, including the external environment, especially the local community". Goodall (1995) provides some examples of what can be scrutinised: checking energy efficiency of technical systems, waste recycling and disposal practices; evaluating water recycling and disposal of effluent; checking noise levels; and checking water quality of lakes or bathing beaches.

[23] Other studies define auditing more broadly, e.g. the Regional Wood Energy Development Programme in Asia (1997, p. 27) defines an energy audit as a systematic method of identifying and accounting for energy flows.

In contrast with the general belief that environmental initiatives will be costly to the operator, it is often found that these procedures benefit the financial bottom line of the business. Therefore, it is not the environmental outcome that provides the true benefit of benchmarking, best practice, auditing and accreditation, but rather the efficiencies gained from the scrutiny of an operation (Issaverdis, 2001).

Green Globe 21 (GG 21) is an example of a private auditing organisation for tourism that promotes environmental awareness and sustainable management practices, and builds on the establishment of benchmarks for various performance indicators (Buckley, 2002; GG 21, 2001). The GG 21 affiliation, benchmarking and certification services fulfil the criteria for benchmarking and auditing outlined in the previous section. The Tourism Industry Association New Zealand (TIANZ) and the New Zealand Government currently support businesses in New Zealand to become GG 21 certified.

2.5 Conclusion

The requirements for transforming snow sport into a sustainable tourism/recreation activity have proven to be a complex topic. Various stakeholders have different and often conflicting viewpoints on the significance of the impacts associated with skiing and snowboarding. The impacts are commonly structured in environmental, socio-cultural and economic categories. Concepts for sustainable management were examined in this literature review; however, only the environmental impacts of ski areas have been considered in detail. In narrowing the focus to environmental issues, this thesis deals with "greening" ski areas rather than with making them sustainable. Despite the environmental focus, it was important to examine broader concepts, including economic and social dimensions. Economy and social structure often define the borders within which environmental actions are possible.

The overview of studies on environmental impacts of snow sport clearly demonstrated the need for more research in the area in New Zealand. In Europe, and to a lesser extent in North America, more research has been undertaken. Visible impacts, such as vegetation damage and resulting erosion problems, have been well documented, although there is little research available on "less visible" environmental impacts resulting from ski areas' resource consumption. The many conflicting research results, in particular for snowmaking, make it difficult to assess the significance

of different environmental concerns, with one exception. Current studies showed that transportation to and from ski areas constitutes the single biggest environmental challenge associated with snow sports and requires urgent attention. Solutions must be found in a holistic rather than an isolated approach. Economic considerations, due to mature markets resulting in strong competition among ski areas, seem to dominate the industry and hinder environmental initiatives. However, many examples of environmental stewardship at different locations worldwide show that a considerable number of ski area managers and local authorities are aware of their environmental responsibility. Some of these examples – both holistic approaches and isolated projects dealing only with a specific problem – were reviewed to demonstrate some possibilities for mitigation actions.

A key commonality of several holistic studies on "greening" of ski areas is the introduction of quantifiable indicators measuring the current practice and helping to determine progress in the future. Indicators vary among the contemporary literature cited, and measuring resource consumption did not seem to have been of major importance until very recently. Apart from the industry initiative of the NSAA, the few academic studies on resource consumption of ski areas have mostly focused on providing a comparison with other leisure sport activities or have presented findings related only to one specific project or location. The lack of a detailed industry analysis is surprising, since a common set of resources are used by the operation of virtually all services and facilities offered by ski areas. Hence, this thesis provides a first detailed analysis of the resource consumption patterns of New Zealand's ski area industry.

The review of contemporary literature in the field of environmental auditing showed that the establishment of benchmarks, against which future performance can be compared, is central to the measurement and subsequent management of environmental performance. Thus, the monitoring of water use, solid waste production, and energy use appears to be a key starting point to capture the "less visible" environmental impacts associated with snow sports. Another advantage of the quantitative benchmarking approach is that additional environmental impacts resulting, for example, from transportation or consumption of equipment, can also be reported in energy units, and can consequently be included in an overall environmental footprint of snow sports. This allows for comparison with other industries.

The literature on auditing also highlighted the fact that mere measurement of resource consumption benchmarks and comparison with previous results or with competitors does not necessarily enhance environmental performance. Benchmarking has overlap with best practice, and both are vital parts of environmental audits. Research attempting to foster the introduction of environmental audits for ski areas is required to provide additional insights into the business practices related to resource consumption. The literature review found that few studies have attempted to do so, with the NSAA again being an exception. The NSAA has developed a standard for environmental best practice for the ski area industry against which each ski area operation can be measured. Consequently, this study builds on the methodology developed by the NSAA. This study includes a detailed analysis of snow sport recreationists, since their energy consumption for transportation to and from the ski area has been identified as important by Swiss studies.

In summary, there appears to be significant research gap in the area of ski area management, with none of the contemporary literature attempting to provide a full and detailed picture of resource consumption associated with snow sports. Given that the current New Zealand government is expected to support international environmental agreements, such as the Kyoto Protocol, that extreme climatic events will occur more often, and that landfill space will become ever scarcer, the industry is expected to require support in becoming more resource efficient in the future. Detailed and complete analysis will enhance recommendations for improved resource efficiency. Hence, this thesis will provide a detailed analysis of resource consumption of an entire ski area industry (New Zealand) and complement such findings with a detailed analysis of ski area visitors' behaviour related to resource use.

CHAPTER 3 – THE ORGANISATION OF SNOW SPORT

3.1 Snow Sport and Snow Sport Tourism

The expression "snow sport" is not clearly defined in the literature, but is mostly used in conjunction with alpine skiing, snowboarding, and cross-country skiing. All snow-based recreational activities, such as ski touring/mountaineering, ski-jumping, Nordic combination, biathlon snow-mobiling, sledge-dog racing, tobogganing, and any other activity that "relies on snow", should be encompassed by the term snow sport. Most winter sport tour operators would use "snow sport" as a summary term for the spectrum of popular, recreational, mostly resort based, winter sport activities. The term is however not synonymous to "winter sports", which encompasses all sports that naturally are played in winter environments or wintertime (e.g. at cold temperatures, on frozen waterways/lakes/grounds, or in snow covered landscape). Snow sports are professionally represented at an international level (e.g. for sport competitions, such as the Olympic Winter Games) by the national skiing bodies or associations. In practice, snow sport is used as the modern term for skiing and snowboarding, the two most popular snow sport activities. In this thesis snow sport is applied as such.

The distinction between snow sports as recreational or sport activities, as opposed to snow sport as a tourism activity is blurred. Hudson (2000), for example, used "winter sport" interchangeably with skiing, snowboarding and cross-country skiing. A closer examination of the literature on sport tourism provides more precise classifications of alpine skiing, cross-country skiing and snowboarding. Both "tourism" and "sport" are complex concepts, which manifests in a large number of definitions (Gammon & Robinson, 1997; Green & Chaplin, 1998; Higham, 1999). Hinch and Higham (2001, p. 49) define sport tourism as:

> *Sport-based travel away from the home environment for limited time, where sport is characterised by unique rule sets, competition related to physical prowess, and a playful nature.*

This definition encompasses a day trip as well as an overnight ski holiday. For the purpose of this research a ski tourist "… is any person engaged in travelling to and staying in places outside their usual environment for a minimum of" TWO " nights, but not more than one consecutive year for" leisure, business or any other reason, and who engages at least once in skiing or snowboarding

(Statistics New Zealand, 1999) [24]. Apart from ski tourists as persons travelling for a minimum of two nights, two other types of ski area visitors can be distinguished. Persons travelling for a day only without staying overnight are called "day-trippers", whereas those staying ONE night are defined as "weekend-trippers" in the context of this research. The deviation of this definition from the WTO standard can be justified by the context of this research project, because it is assumed that a day-tripper, weekend-tripper and tourist differ from each other in their travel and skiing behaviour. Since the analysis of transport behaviour of skiers and snowboarders is a main focus of this thesis, the distinction of the three different visitor groups is important for this study.

The definitions above indicate that skiing and snowboarding do not have to be the main purpose of the trip. For a clearer understanding of the ski tourist, it is useful to provide a more sophisticated distinction between different types of ski tourists according to their main travel motivation. Ski tourists with the main purpose of skiing and snowboarding can be classified as "single sport tourists". Any other tourist can be classified into one of the groups along a "sport tourism continuum" (Figure 3). The continuum ranges from tourists who watch a (snow) sport event, to tourists, who visit ski areas along with other tourist attractions (active recreational tourism). All of the different types have distinctive needs and demands characteristic to their focus (broad or specialised). Thus, an analysis of ski and snowboard tourists should consider the different characteristics outlined for each "type". In the discussion of transport behaviour and facility dependency, the different foci should be considered. In particular, when making recommendations for visitor management at ski areas the different "ski tourist types" must be considered.

In conclusion, snow sports are any on-snow activities (recreational and professional) confined to special purpose alpine resorts or "managed" (safety measures are taken to prevent recreationists from avalanche hazard, for example through the use of explosives or constant monitoring of the area) alpine winter environments. The activities need to be popular, appeal to a mass market and rely on some sort of specialised equipment.

[24] This definition differs from the WTO definition in the New Zealand Tourism Satellite Account 1995 (Statistics New Zealand, 1999), where the number of minimum nights spent away is defined as ONE.

Categories of Sport Tourism

Sport and Tourism Continuum

Sport Tourism → **Tourism Sport**

Sport-Event Tourism		**Event Sport Tourism**			**Single Sport Tourism**	**Multiple Sport Tourism**	**Active Recreational Tourism**
One single sport event is the main focus of travel.		Sport event is trigger for travel, but not the single main focus.			Playing sport is the main purpose of travel.	Playing a variety of sports is the main purpose of travel.	Sport is a secondary purpose for travel. Sport is a "Tourist Activity"
Strong competition focus.		Weak competition focus			Low / No competition focus.	No competition focus.	Competition focus cannot be specified.
Interest is focused on one type of sport only.		Interest is focused on a set of sports.			Interest is focused on one type of sport only.	Interest is focused on a set of sports.	Interest in a set of sport is a prerequisite, but no focus on a single sport or a set of sports is existent
active	passive	active		passive	active	active	active
competitive		competitive	non-competitive	non-competitive	non-competitive	non-competitive	non-competitive
Extreme destination focus		High destination focus		Moderate destination focus	Moderate destination focus	Low destination focus	No destination focus

Figure 3: Categories of Sport Tourism (Source: based on Gammon & Robinson, 1997; Green & Chaplin, 1998; Higham, 1999. All cited in Hinch & Higham, 2001).

3.2 The Structure of the Snow Sport Industry

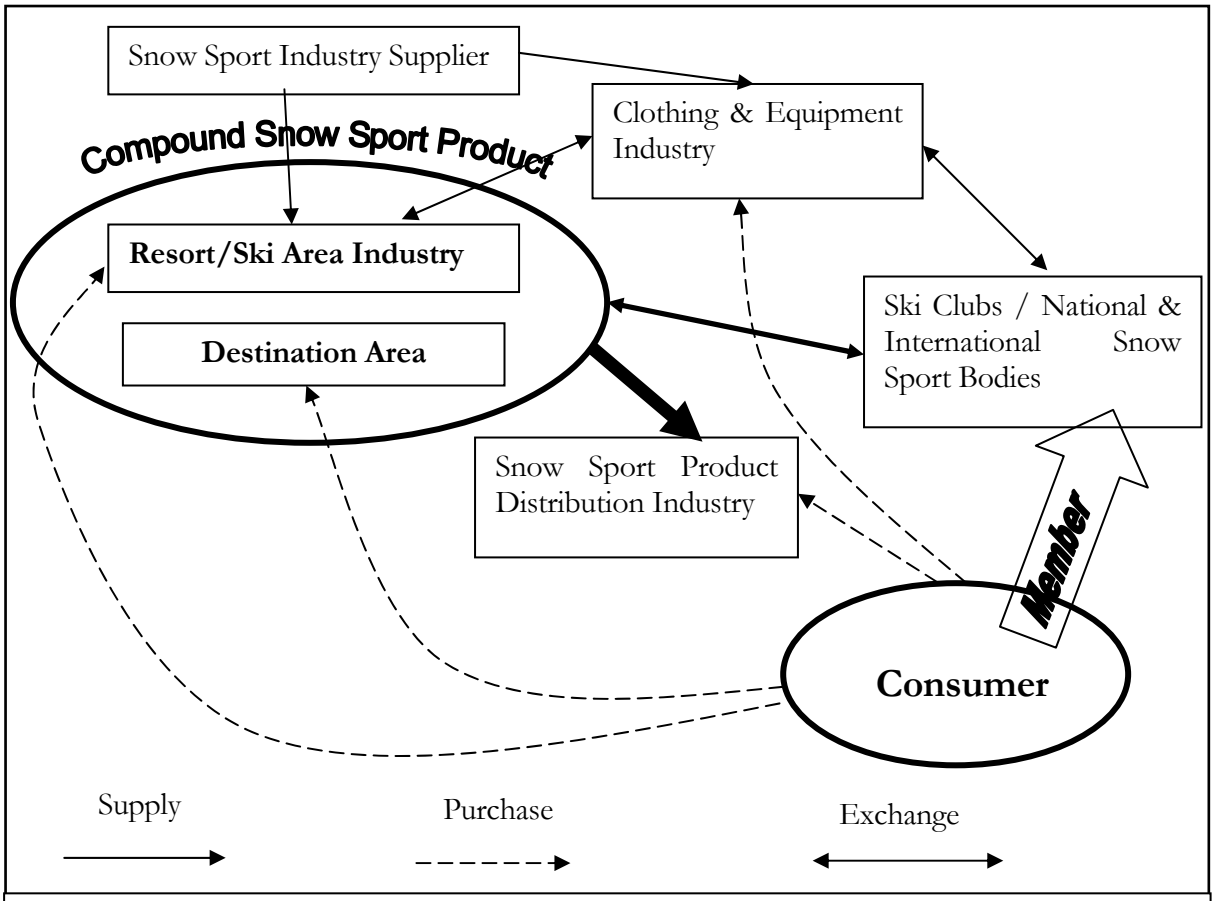
Hudson's "Snow business" (2000) provides a possible structure of the snow sport industry, by analysing separately the "Distribution of the Snow Sport Product", the "Consumer", and "Destination Planning and Operations". Other studies structured single parts of the industry, such as the ski area and destination area (Flagestad & Hope, 2001; Hudson & Shephard, 1998) or ski lift operations (Michel, 2001) for their specific research purpose. This author suggests structuring the "snow sport system" (

Figure 4) around its two main elements: the "consumer" and the "compound snow sport product". The latter is the composition of different products and services usually purchased by the consumer as one compound product. The single products and services can be categorised into four different classes. These are the "ski product" (mountain transport, ski school, etc.), the "bed product" (hotels, apartments, restaurants, etc.), the "village ambience" (after-ski product, shops, entertainment, etc.), and so-called "across destination services" (medical service, infrastructure, etc.).

The "snow sport system" presented in

Figure 4 describes the industry in a simplified manner. The system is not suitable for marketing purposes or an economic analysis of the snow sport industry, since the connecting arrows neglect the exchange character of purchase and supply activities (monetary compensation) as well as the links to other industries, other community services and society in general. It is the intention of the system to clarify the following issues:

- The snow sport product is a "compound product";
- The consumer can purchase via the distribution industry or from the provider;
- The consumer can purchase the compound product or only parts of it;
- The two major sectors "clothing & equipment" and "distribution industry" operate independently from the destination/ski area sector;
- The ski resort/area and the "destination" are often seen as one unit by the consumer, but they are often two independent components managed under different jurisdiction;
- The relations between, and the importance of, each sector may be very different depending on region or country.



Note: The relationships in this system are simplified. For example, the consumer receives the product in return for his purchase. This would require another "supply" arrow pointing from resort industry back to the consumer. Only the most important arrows contributing to an understanding of the "industry" are displayed. The author is aware that this neglects some aspects and restricts general applicability of the system.

Figure 4: Snow Sport System: Each Box Symbolises One "Element" or "Sub Industry".
(Source: adapted from Flagestad & Hope, 2001, Fig. 6, p. 457)

The distribution and manufacturing industries are systems in themselves, and are usually not related to the destination or ski area, i.e. are not particularly tourism-specific. Hence, neither is considered directly in this research project. In conclusion, each of the components of the snow sport system has its own resource consumption mix. In this thesis, however, only the environmental impact resulting from resources consumed by skiers and snowboarders (excluding equipment) and of ski areas is analysed. Clearly, if a "greening" of the snow sport industry is to be successful, various groups and industries have to be addressed through different tools (e.g. taxes, regulations, accreditation schemes).

3.3 The World Ski & Snowboard Market

The world snow sport market is mainly concentrated in Europe, Japan and North America. For most other locations featuring developed resorts (see Hudson, 2000) snow sports are either a curiosity (e.g. Argentina) or the market size is small, with Scandinavia (Sweden, Norway, Finland) being an exception within the cross-country skiing market. New Zealand is an example of a small market, however, that does not mean that the New Zealand snow sport market is unimportant for the domestic economy or within the domestic leisure participation (Chapter 4).

Many snow sport statistics do not distinguish between alpine skiers, snowboarders, or cross-country skiers; neither do they distinguish between combined resorts, alpine resorts or Nordic resorts. It is estimated that there are between 65-70 million skiers worldwide, with the USA (approx. 15 million skiers) and Japan (approx. 14 million skiers) constituting the two largest single skiing nations. In 1993 downhill skiing and snowboarding accounted for about 55 million participants, while the remaining 10 to 15 million were cross-country skiers (Cockerell, 1994, cited in Hudson, 2000, p. 26). The importance of ski tourism can already be estimated from Hudson's worldwide destination profiles, indicating that the number of destinations trying to attract international customers has increased in the last decade. The WTO (cited in Holden, 2000) estimates the number of snow sport enthusiasts crossing international boarders at 15 to 20 million, which accounted for 3-4 % of the total annual international tourist arrivals in 1998.

Hudson's key finding was that globally the snow sport markets are mature (2000). In fact, since the 1980s snow sport participation figures have dropped in the western world; the market volume (skiers days), however, could be maintained because the recreationists participated in their sports more often. In addition, the North American ski area industry experienced a decline from 735 operating resorts in 1982 to 490 in 2001 (Hudson, personal communication August 2002). However these statistics are misleading since the number of resorts is meaningless in the light of ski area amalgamations into mega resorts. This author could not find any reliable statistics on the number of operating lift systems worldwide between the 1980s and today, and whether this number has increased or decreased with the number of resorts decreasing. Provided these trends are still the same today, it is hard to understand that resorts worldwide are still expanding (in terms of building new lift facilities in undeveloped areas) (Best, 2000; Colorado Wild, 2002; Office de Tourisme de Val Thorens, 2002) in the competition over a stable customer base. However, Hudson's review of

the world ski market is based on literature from 1994-1996 with only few recent sources. Against the background of the changes the snow sport market has undergone since 1998 (e.g. the emergence of snowboarding and carving skis) these figures are likely to need updating. Snowboarding has grown to be established as a "statistical category" in its own right. Some countries with potential for rapid growth in the years to come, such as China, are not even included in Lazard's (1996, cited in Hudson, 2000, p. 28) overview of "Skiing Worldwide". Since no recent data are available (reflecting for example recent equipment development), this summary draws on possibly outdated data. Cordell and Super (2000) further supported this assumption by recognising an increased participation in so-called technology driven adventure activities, such as skiing and snowboarding for the US market.

3.4 The Organisation and Structure of Ski Areas

Key elements or features (factors) of ski areas are briefly explained in the following section. Since consumers chose the areas according to personal preference, the ranking of the importance of different facilities constitutes valuable information for ski area management. Consequently, an analysis of what is important to the skier and snowboarder is essential for successful management of such operations. Due to the environmental focus of this thesis, factors that are potentially important to resource consumption are described in more detail.

3.4.1 Ski Area Management and Operation

The early literature on ski area development seems to be based on European studies (Hudson, 2000). Hudson cites French studies from the 1970s to the 1990s (Preau, 1970 and Pearce, 1995) describing the "Chamonix type development" as a ski resort grown out of a traditional alpine village with the mountains as the main tourist attraction - compared with the "Les Belleville type development", a purpose built ski resort financed with urban capital, and facilities as main attractions. In North America, the "alpine village" does not exist and ski resorts are usually designed as "green field" developments by one single corporation, sometimes even traded on the stock market. Mill (2001) provides a standardised approach to resort management with a unique overview of any aspect important for the design and operation of a ski resort, including for example capacity calculations and site feasibility criteria. Brandner et al. (1995) additionally offered site feasibility criteria (Table 7), attempting to guarantee the construction of a sustainable ski area. Mill's (2001) guidelines add to the site feasibility criteria of sustainable development some more practical

information on ski area planning and development. The summary of Mill's guidelines serves as a reference for the description of New Zealand's ski areas in Chapter 4 and for the categorisation of New Zealand's ski areas in Chapter 5.

Table 7: Important Aspects of Mountain-based Resorts

Topic	Content	Reference
Classification	Designation of resort types according to their potential for real estate development, their national or international popularity, and their natural and man-made features	Page 120
Development	Development Process: Chart, which can serve as a checklist for development projects. Includes a detailed overview of all aspects of the physical site analysis	Figure 5.1; page 121
Site	Site inventory form; structured in different criteria, which can be measured. Measure provided in form.	Figure 5.2; page 126-127
Capacity	Table to calculate "Terrain Capacity" and "Density per Acre Estimates" (figures are based on North American studies, but applicable in NZ)	Table 5.1; page 134 and Table 5.2 page 136
Capacity	Definition: SAOT (skiers at one time) and PAOT (persons at one time)	Page 134 / 135
Ski Runs	Construction and maintenance guidelines	Page 137
Ski Lifts	Definition: RHCM (required hourly capacity of mountain)	Page 139
Base Area	Calculation-Guide to determine the percentage of visitors needing overnight accommodation (useful for hypothetical calculations, since mid-mountain accommodation is not provided at New Zealand's commercial mountains).	Page 145

(Source: adapted from Mill, 2001)

Table 8: Selected Factors for Sustainable Ski Tourism Development and Corresponding Criteria

Factors	**Criteria** (measured via indicators)
Demand for Ski/Snowboard Tourism	Current trends and future expectations
Snow Reliability	Altitude and aspect
Lawfulness of the Impacts from Landscape Modification	Legality of landscape modifications Quality of the approval processes Legality of the use planning with regard to the specific national planning frameworks
Environmental Suitability	Terrain suitability for ski / snowboard tourism Regeneration potential of the natural environment Soil stability Suitability of water resource utilisation Planned terrain use
Site-Specific Potential of Flora and Fauna	Importance of habitats Identification of special habitats (e.g. of endangered species, etc.)

(Source: Brandner et al., 1995, author's translation from German).
The factors macro-economic significance, micro-economic, political links are not further described here, since the focus of this thesis is on environmental sustainability.

The criteria outlined in Table 7 and Table 8 can be adapted to any kind of ski area. An appropriate co-ordination of the elements of the "compound ski product" (see

Figure 4) depends on planning guidelines and experience to allow for necessary adaptation of these guidelines.

The organisational structures to achieve good coordination of ski area facilities (lifts, base facilities, toilets, etc.) and other important tourism infrastructure (accommodation, entertainment, etc.) differ significantly. Flagestad and Hope (2001) developed a model of destination organisational structure, which is a useful tool for understanding the functioning of ski areas. The model clearly shows that the management of ski areas does not only depend on the organisational structure of the ski area operation, but also on the broader structure of the destination[25]. The model classifies ski area destinations on a continuum ranging from the "community model" on the one hand, to the "corporate model" on the other. The latter is characterised by the dominance of a powerful ski corporation and a few independent operators. Local government and the local tourist board have only limited influence in this case. In contrast, traditional ski destinations are made up from a multitude of operations with the ski corporation (mountain transport) being only one of them. In this situation local government and a tourist board typically manage and coordinate the destination.

3.4.2 Important Attributes and Features of Ski Areas

In a study on ski area service quality, main attributes have been disaggregated into "features" and "services" (Hudson & Shephard, 1998, p. 61). For example, customers at Verbier ski resort (Switzerland) demanded better snowmaking and grooming of pistes, and faster lifts. The 12-category-attribute list developed in the Swiss case study can be adopted for studies in other ski areas. Other systematic approaches to structuring the "ski product" have resulted in similar lists (e.g. Flagstad & Hope, 2001). Table 9 compiles the most important attributes and features of ski areas. Hudson and Shephard's (1998) approach is contrasted with the more categorised one of Flagstad and Hope (2001). The detailed compilation of attributes and features is an accurate illustration of the "compound ski product" introduced at the beginning of this chapter.

[25] The destination can include one or several village(s)/community(ies), a variety of businesses, one or several ski area(s), etc. or just be one single corporation.

Table 9: Attributes of Ski Areas in Comparison

Attribute List (Hudson & Shephard, 1998)	Flagestad and Hope's model (2001)	
Ski Shops Ski Lift Services[1] Ski Slopes Services[2] Mountain Restaurants	(Compound) Ski Product	Mountain Transport Ski School Ski Rental Mountain Food & Beverage Security (medical, avalanche, hazard & trail marking) etc.
Accommodation	Bed Product	Hotels Pensions Apartments Restaurants
Restaurant & Bars in Resort Shops/Supermarkets Characteristics of Other Skiers	Village Ambience	Village Food & Beverage. After-Ski Product Shops Entertainment etc.
Tourist Information Services Medical Services in Resort Other Resort Services Tour Operator Service	Across Destination Service	Information Medical Services Transport Police Post & Telecom Banks, etc.

1) Note: In the original source (Hudson & Shephard, 1998) "ski lift services" were called "ski slopes", consisting of: variety and number of marked trails of slopes / number of lifts / limited queuing / speed of lifts /off-trail skiing / accessibility of bottom lift / well linked & well planned / ability to ski to resort (village) / skiing hours.
2) Grooming of trails / information services / snow making ability / availability of first aid (medical & emergency services) / control of skiers numbers / separate snowboarding areas / maintenance of lift services / friendliness of lift staff / availability of toilets / lift queue management.

The categories "Ski Lift Services" and "Ski Slopes Services" (Table 9) are most relevant for this study, since they constitute the core activities of ski area organisations. It is assumed that some of the attributes in these categories (e.g. grooming of pistes, snow making ability, and number of lifts) contribute considerably to the resource consumption of ski areas. The evaluation of environmental impacts associated with accommodation, equipment industry, and other tourist facilities existing in winter sport destinations are beyond the scope of this research. A typical ski area that is best described by the community model, fits the scope of this research project. However, in the case of the "corporate model" all attributes and features (including some of the areas excluded from the research scope above) could be part of the "ski resort" (ski area), hence would be included in the analysis of resource consumption of a ski area. This is, for example, the case for the Aspen (Colorado, USA) ski company. Therefore, it needs to be highlighted that, whenever aggregated resource consumption figures are compared across destinations, it needs to be clarified which attributes and features were accounted for in the resource consumption analysis.

Michel (2001) also found that "suitability and accessibility of ski areas by private transport", "Ski Slopes Services", and "Ski Lift Service" were very important to skiers/snowboarders in Switzerland. To expose comfortable transport to ski areas as a vital part of a successful ski product constitutes an important finding. Flagestad and Hope (2001) partly included transport in the "across destination services", but did not emphasis its importance. Following Michel, the analysis of transport behaviour of recreationists has been included in the research design of this project.

3.4.3 Structuring Ski Areas: The "Mountain Experience"

Traditionally aerial cableway providers were transport service operators. However, with skiing developing into a mass sport, it became necessary to offer a variety of marked and secured trails as an additional service component. Today, even this is no longer sufficient to attract visitors, in the highly competitive snow sport market (Michel, 2001). In the previous section the attributes and features of the "ski product" (including the ski area) have been presented. It is therefore justified to say that a ski area no longer sells "skiing" (or "snowboarding") as a product, but a "mountain experience" (ibid).

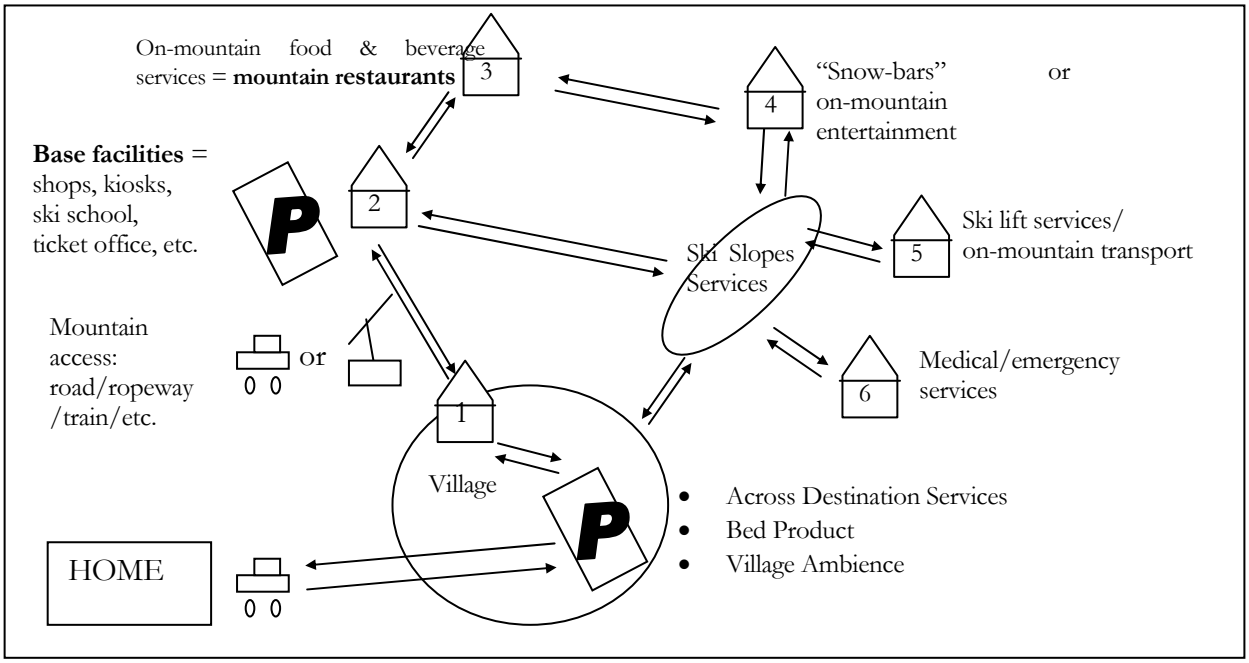


Figure 5: The "Mountain Experience"
(Source: adapted from Michel, 2001, p. 60; Hudson & Shephard, 1998; Flagestade & Hope).

The "mountain experience" includes several "sub-products" (see house-symbols 1-6, Figure 5), each securing a unique proportion of the diversified customer expectation (Müller, 1998; cited in

Michel, 2001). Overall customer satisfaction can only be met when at least some of the "sub – products" (called attributes in the previous section) are offered. The systematic description of the compound ski product "mountain experience" provides a structured background to distinguish between "ski area types". Depending on the ski area, the sub-products (e.g.on-mountain restaurant or entertainment services) are either offered by individual [providers (as displayed in Figure 5) or one single provider offers them. Accordingly, resource consumption audits at such different locations need to address more than the ski area corporation, if the audits measure the total amount of resources consumed in association with the "mountain experience". The structure of New Zealand's ski areas is generally simple, making the measuring of resource consumptions relatively easy.

The following chapter describes the typical New Zealand "mountain experience", outlines the geographical location of ski fields, and provides information on market size, visitor numbers, some information on the legislative framework ski fields are operating in, and information on the interrelationship of climate and snow sport with special reference to New Zealand.

CHAPTER 4 – AN ANALYSIS OF THE NEW ZEALAND SKI & SNOWBOARD MARKET

4.1 Introduction

With its mountainous terrain, New Zealand offers many options for ski area development. Unlike in the European Alps, New Zealand's ski areas are only sparsely scattered across the two main islands. While the South Island accounts for most of the ski fields (24 out of 27), the North Island's ski area at Mt. Ruapehu is the country's largest. In New Zealand, ski fields are located at the fringe of the Alps, whereas premium terrain and snow quality of the higher ranges are exclusively available to heliski customers. This is in contrast to European ski fields of the Central Alps that are often situated at high altitudes.

In New Zealand, there are 118 operating lift facilities (Upjohn, 2001), of which 24 are chair lifts, the rest comprises T-bars, platter lifts and rope tows. Compared with Europe or North America this is a very small scale industry. For example, the Trois Vallees Ski-Circus in France alone offers 200 lifts, of which 35 are gondola systems, and about 600 km of groomed trails (Office de Tourisme de Val Thorens, 2002). The existence of club ski fields, a form of non-commercially run ski field operations, is unique. This is a basic type of ski field compared with commercial ski areas. In the following, New Zealand ski field providers and consumers are discussed.

4.2 Ski Fields – New Zealand's Main Player in the Market

New Zealand's ski fields have a less complex structure of the "mountain experience" than discussed for European resorts. New Zealand's ski fields have no on-mountain developments apart from the base facility complex (or base lodge). The base facilities at commercial ski fields offer all services available at the ski field, apart from "ski lift services" and "ski slopes services" (Figure 6). A major difference from most European and American ski area developments is that there is no ski trail link between village and ski areas in New Zealand. The village development in New Zealand is also different from most other major ski area destinations. Development of additional services apart from the base facility (accommodation, entertainment, restaurants) on the ski mountain or near the base of the ski mountain has purposely been avoided and restricted to the nearest village. Planners considered this solution more beneficial (environmentally, socially and economically) for both skiers and locals (Cooper, Dempsey & Lucas, 1990).

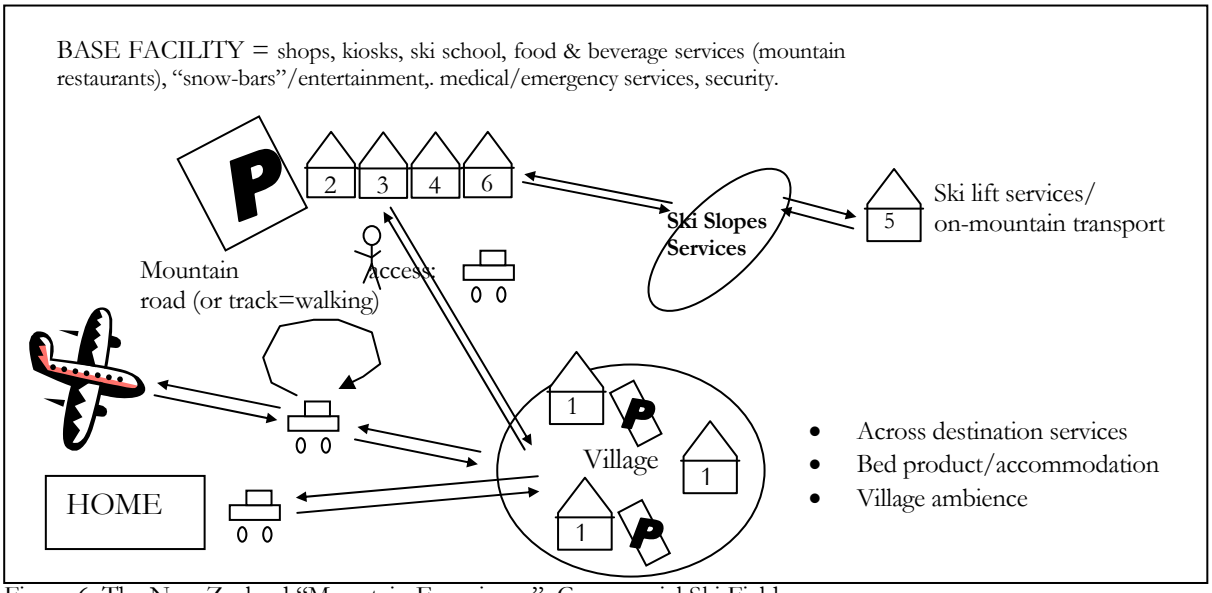


Figure 6: The New Zealand "Mountain Experience": Commercial Ski Field
(Source: adapted from Michel, 2001, p. 60).

It is important to distinguish between international commercial, national commercial and club ski fields in New Zealand[26], in particular regarding the structure of the "mountain experience". Clubs offer on-mountain accommodation and have no link with a specific village, making them stand-alone and independent of the services provided by other operators or communities (Figure 7).

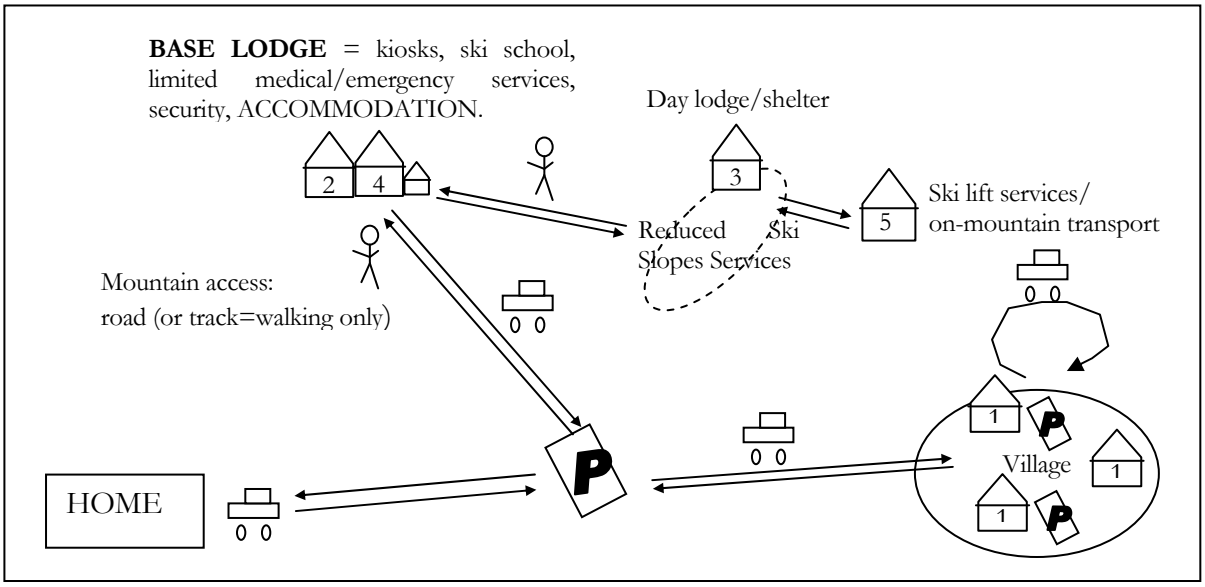


Figure 7: The New Zealand "Mountain Experience": Club Field
(Source: adapted from Michel, 2001, p. 60).

[26] The detailed categorisation of New Zealand's ski fields elaborated on in the methods chapter. The categorisation is an important part of collecting data and analysing the results.

Commercial ski fields are the most important players in New Zealand ski industry. Wholesalers of snow sport package holidays, for example, 'ski express', a ski-package trip wholesaler operating in the New Zealand domestic market (owned by Tourism Holdings Ltd.), are not very strong in the New Zealand market. Powerful wholesalers, such as the TUI group in Europe, do not exist – meaning that most skiers (at least domestic) organise their trips individually. Skiing packages are mostly sold in Australia, while other packages (e.g. SKIWI by STA travel) are rather promotional partnerships with ski areas of several tourism companies, trying to improve their off-season business (e.g. rental campervan company, rental car companies, travel offices). An example is the brochure published by "ski express" offering packages combining the products of single accommodation providers, a big car rental company, an airline, and a ski area company owning three South Island ski fields. A brief, informal review of skiing marketing material available in New Zealand (brochures, flyers, etc.) showed that skiing and snowboarding is mainly marketed by the ski areas, and, to a lesser extent, by other industries (e.g. clothing and equipment).

4.3 Geographical Locations of Ski Areas

Figure 8 shows the location of ski fields in New Zealand. There are three main skiing regions in the country. Mount Ruapehu in the North Island, Canterbury, and Otago around the townships of Queenstown and Wanaka.

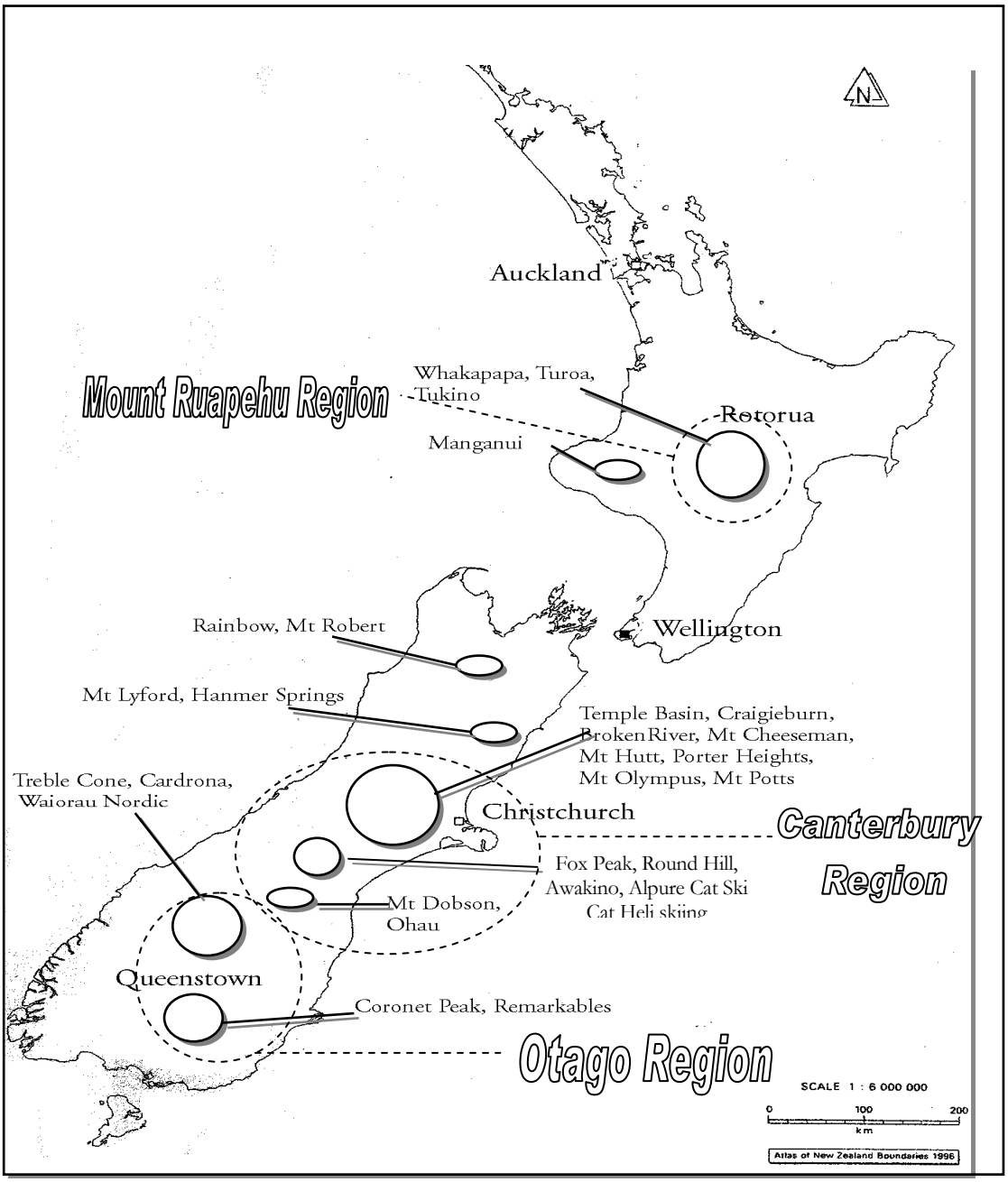


Figure 8: Geographical Location of Ski Fields in New Zealand
(A list of all ski fields that operated during the 2001 season in New Zealand is compiled in Appendix 3).

4.4 Key Characteristics of the New Zealand Snow Sport Market

Worldwide, New Zealand's share of all skier visits is estimated to be 0.28%, which makes the country's significance in the world of skiing comparable to Andorra or Chile (Hudson, 2000). In these statistics only New Zealand's commercially operating ski fields were included, since the market share (counted in skier days) of the club fields is only about 3% of the total New Zealand market volume. Hudson (2000a, p.37) classified New Zealand as a "curiosity ski destination, which has compelling scenery, but little in the way of challenging skiing". It can be assumed that international visitors come to visit New Zealand's slopes because of the relative "emptiness" of the Southern Alps and the nature-focused, scenic skiing experience. This underpins the dependency of ski areas in New Zealand on the environment.

4.4.1 Key Market Statistics

At the Ninth New Zealand Geographic Conference Pearce (1977) pointed out that the growth of New Zealand's domestic ski market had not kept up with that in Europe, USA, and Japan. Despite some new ski field developments since the late 1970s (e.g. Remarkables, Snow Farm), New Zealand's domestic ski market appears to be steady (mature). The size of the active domestic market was estimated to be 8% (256,000) of the population in 1997, and 15% (468,000) of the population were at least interested in skiing (AC Nielsen Skier Profile, cited in New Zealand Ski Council, 2001). It is possible that recent developments and trends (carving, snowboarding, season pass sales) could have increased participation levels. Further research in this area is required.

A similar trend applies to equipment sales, which appear to have remained steady since 1985 (New Zealand Ski Council, 2001). In 2000 snow sport activities achieved a turnover of $45.9 million (up 5.5% compared with 1999). In total it was estimated that snow sports contribute $100 million to the New Zealand economy (New Zealand Ski Council, 2001). On an international scale, compared with the 'Compagnie des Alpes', one of the biggest European ski corporations (Bieger et al., 2000a), the New Zealand ski market appears relatively small (Table 10). However, on a local scale, studies (e.g. TIANZ, 2002; SAANZ Research Report, 2000) proved the importance of 'skiing' for the economy.

Table 10: Comparison of New Zealand's Ski Industry with the French Ski Corporation CDA

Figures (1998/99)	**Compagnie des Alpes /France (CDA) (12 resorts, e.g. Les Menuires)**	**New Zealand Ski Industry (14 commercial ski fields)**
Skier days	19,616,000	1,004,000
Turnover	US$ 190	US$ 24
Profit	US$ 13	??
Number of full time staff	1308	60-80
Domestic market share	25% of French ski market	97% of NZ market
Source	Bieger et al. (2000a)	NZ Ski Council (2001)

The "South Island Ski Field Research - 2000 Season" (Tourism News, 2001) estimated that 114,000 skiers and snowboarders visited the five major South Island fields. These visits accounted for almost 600,000 skier/snowboarder days. The total skier/snowboarder days at all commercial ski fields were estimated to be 1,054,000 in 2000 (New Zealand Ski Council, 2001). Most ski field visitors are skiers, with snowboarders constituting 35% of all visits to New Zealand's ski fields. In 1999, men outnumbered women by a ratio of about 3:2 – a narrowed gap compared with 2:1 in 1998. The South Island experienced an increase of snowboarder visits from 31% in 1999 to 39% in 2000 (TNZ, 2000).

In 2001 a record 1,254,000 million visits were made to the 14 commercial ski areas included in the annual ski area monitoring of TNZ. These are 150,000 more than in the last record year 1994. Ski Areas Association executive director Miles Davidson credited the success to a combination of positive effects, such as the widespread season passes, pre-season sales and good snow and weather conditions allowing for a longer season (Ombler, 2002).

4.4.2 International Visitors

International visitors constitute an important part of the New Zealand snow sport market. It is assumed that some of the industry's growth can be explained by increased international visits. For example, in 1976, 5,000 Australian skiers crossed the Tasman (Pearce, 1977), compared with 30,000 in 2000 (New Zealand Ski Council, 2001). In 2000, international visitors accounted for 25% of all ski visits, and over 30% of international visitors in the South Island were repeat visitors. Almost half (45%) of international skiers/boarders used pre-paid packages. However, overall independent travel is more popular than package travel, with the proportion of visitors on package travel decreasing markedly since 1998 (New Zealand Ski Council, 2001).

Australians (45% of all international ski visitors) are most important, while Japanese rank second (13% of international ski visitors), UK visitors third (12% of international ski visitors), and visitors from the USA rank fourth (7% of international ski visitors) (New Zealand Ski Council, 2001). A comparison with the overall arrivals from these countries to New Zealand (TNZ, 2001) reveals that 5.2% of all Australians visiting New Zealand skied on 'Kiwi-slopes', 5.7% of all Japanese, 4.0% of all UK visitors, and 2.4% of all Americans experienced New Zealand's ski fields. Finally, the share of all other international visitors who made their way to a ski field was 2.7%.

In 1999, 16% of all international skiing visitors spent fewer than three days skiing or snowboarding; 33% between 3 and 6 days; 28% between 7 and 14 days; 14% between 15 days and one month, and 9% spend more than one month skiing. A single ski field was only visited for few consecutive days, suggesting that many visitors experience more than one field. Snowboarders generally stayed longer than skiers both in total and at a particular field. The Japanese market is particularly important, because the Asian snow sport recreationists seem to stay for longer at one location and in total than the average visitor (40% spent more than one month at ski fields) (TNZ, 2000).

4.5 New Zealand Legislation for Ski Field Operation

In New Zealand, the sustainable management of natural resources is regulated in the Resource Management Act (RMA), which was enacted in 1991 (Ministry for the Environment (MfE), 1999a). Under the RMA an Assessment of Environmental Effects (AEE) has to be undertaken for any new development project, including ski area extensions (MfE, 1999b). No studies on AEE for ski fields in New Zealand – as undertaken in other countries (Buckley et al.'s, 2000) – could be found. The legal situation for ski field managers in New Zealand gets more complex, when the field is located on Crown land managed by the Department of Conservation (DoC). In this case the RMA and the Conservation Act 1987 (CA) have to be met. Both the RMA and the CA are pieces of legislation that include modern recreation needs (Booth, 2001). Under the umbrella of the CA the legal requirements for ski fields are outlined in Conservation Management Strategies (CMS). These strategies depend on the Crown Land status of the area a ski field is operated in. For example, ski fields located in National Parks (Temple Basin) have to be operated according to the National Parks Act (Booth, 2001) and the specific Conservation Management Plans developed for the National Park. The legal requirements for ski areas (concessions) in Canterbury are, for example, compiled in the Canterbury CMS (DoC, 2000a and 2000b).

Most New Zealand ski fields are located on Crown land (Kaspar, 1992). Six ski fields are located in national parks[27], two in Forest Parks two (partly) in Recreation Reserves, and eight in Conservation Areas (DoC, 2000a and 2000b). These ski fields' expansion potential is limited, as is the development of accommodation (Pearce, 1977). For ski fields located on private land only the RMA applies. Nine ski fields, both clubs (4) and commercial fields (5), are located on freehold land (high country farm) with the club paying an annual lease to the farmer (Kaspar, 1992; G, Hassell, personal communication, 5th November, 2001)[28], or on privately owned land[29].

Despite the regulatory framework of the RMA and the CA, it is not guaranteed that ski fields are managed in a sustainable manner. Kaspar's (1992, p. 378) analysis of management practices at New Zealand ski fields showed, that "…the environmental consciousness of New Zealanders is very low and sustainable management of ski fields not more than a vision". New Zealand's legislation theoretically empowers DoC to implement sustainable management, however, Kaspar (1992, p. 379), noted that DoC was more "…involved in ski field planning than in the supervision of the operation and the fulfilment of environmental standards".

The Ministry for the Environment prepared an Environmental Performance Indicators Programme to assess environmental impacts in general. This was discussed in the "Outcome Evaluation" by the Parliamentary Commissioner for the Environment (2000) for its application in tourism. The concept of carrying capacity was one tool among many, because it has been recognised that the applicability of carrying capacities is limited. Williams and Gill (1999) identified the traditional focus on attempting to determine explicit use limits as the central problem. As a response, more workable concepts were developed (Boyd & Butler; 1996; Davis, 1999; Graham, Nilsen & Payne, 1988; Hendee, Stankey & Lucas, 1990; McCool, 1996 and 1998, Parliamentary Commissioner for the Environment, 1997; Tarrant & English, 1996; Ward, 1996)[30]. These concepts are potentially applicable for establishing legal environmental thresholds, but this has not yet happened in New Zealand. Additionally, the MfE report states that the ministry is taking a biophysical rather than a

[27] National Park: Whakapapa, Turoa, Tukino, Mt. Managanui, Mt. Robert, Temple Basin; Forest Park: Craigieburn, Broken River; Recreation Reserve: Remarkables (only a small part of the ski field is in the recreation reserve), Coronet Peak

[28] Mt. Olympus, Mt. Cheeseman, Awakino Cat Ski, Fox Peak, Hamner Springs (Amuri)

[29] Mt. Potts, Mt. Lyford, Cardrona, Waiarau Nordic (Snow Farm)

[30] E.g. Limits of Acceptable Change (LAC), Ultimate Environment Threshold (UET), Visitor Impact Management (VIM), all focusing on the protection of the resource. The Visitor Activity Management Process (VAMP) and Recreation Opportunity Spectrum (ROS) focus on the visitor experience. The Ecotourism Opportunity Spectrum (EOS) considers visitor experience and the environment.

sectoral approach to monitor environmental indicators. Therefore, tourism/recreation planners and authorities are not directly involved in the proposed monitoring process. This means that the data collected do not reveal the impact attributable to tourism or specific tourist activities, such as snow sports (MfE, 2000). All of this could be seen as indicative of the need for research identifying and quantifying the environmental impacts of tourism activities, such as skiing or snowboarding.

4.6 Importance of Climate for New Zealand's Snow Sport Industry

Several studies have examined the influence of climate change on winter sports in Australasia. Buckley (2000) and König (1998) investigated the sensitivity of Australian's snow cover to minor climate change, and concluded that Australia's snow cover will be greatly reduced, or absent including associated alpine flora and fauna, with only minor warming occurring. The World Wildlife Fund (WWF) in the UK investigated the impact of climate change on tourism at various destinations, among them Australian alpine areas and ski fields (Viner & Agnew, 1999). The study concluded that impact of global warming on the ski industry in Australia could be a terminal one. This may open up possible new investment prospective for New Zealand's ski fields, which are most likely to be Australian skiers' premier substitute. For this reason, it is likely that New Zealand's ski (tourism) operators observe the influence of global warming on Australia's ski areas with interest. Clearly, Australia is a key market for the New Zealand ski industry, and it is seen as both important to nourish the desire for skiing within Australia and to attract Australian skiers/snowboarders to New Zealand fields (Tourism News, 2001).

There are few studies exploring the consequences of climate change on New Zealand's snow sport industry (Wall & Badke, 1994). Comparable studies were conducted for Switzerland (Abegg & Elsasser, 1996) and Austria (Breiling, 2001). The two studies suggest that New Zealand's major ski fields could be located in areas that will be suffer severe snow cover problems as a consequence of global warming. This threat to the snow sport industry needs to be researched; in particular it needs to be investigated if measures, such as snowmaking are contra-productive in the long run, since they contribute to increased global warming while they only temporally improve the snow cover.

CHAPTER 5 - METHODOLOGY

5.1 Introduction

5.1.1 Overall Approach

The operation of ski fields requires the input of resources. The quantity of resources consumed depends on the management of the ski field buildings and equipment and on the technological standard of these. For this reason it is critical to examine the industry side of snow sport (in this research represented by the ski field managers). In particular, the management of water resources, energy and waste were of main interest in this study. However, resource consumption is also influenced by snow sport recreationists. Visitors influence resource consumption directly through their consumption behaviour (e.g. transport), but also exert some influence through demand and expectations of various services (restaurants, trail grooming, etc.).

To account for both types of resource consumption, the research project was divided into two stages. Stage one comprised an assessment of management practices at all ski fields currently operating in New Zealand, regardless of business size (ski field industry assessment). This part of the study surveyed ski field managers, ski field owners or club presidents. An existing survey instrument, developed by the National Ski Areas Association (NSAA, including US American and Canadian ski areas), was applied to research managers' environmental awareness and to estimate resource consumption (water use, energy use, solid waste production) benchmarks for ski fields in New Zealand. Stage two of the project (Skier & Snowboarder Survey) provided ski field customers' perspectives on infrastructure facilities and, additionally, estimated snow sport recreationists' contribution to the overall environmental impact of snow sport. To this end, the research focused on the recreationists' transport and waste-disposal behaviours.

The chapter is structured in three parts with the first one featuring a classification of New Zealand's ski fields that is important for the analysis of the results obtained from the two surveys undertaken in this research. The second part outlines the methodology applied to conduct the assessment of ski field managers' environmental awareness, and to measure resource consumption benchmarks. The third part explains the methodology used to undertake the on-mountain surveying of skiers and snowboarders and to analyse the obtained results.

Figure 9 illustrates the structure of the methodology and the central role of the classification of New Zealand's ski fields. Furthermore, the chart displays the approach of the topic from two opposite perspectives, the industry perspective and the snow sporter perspective.

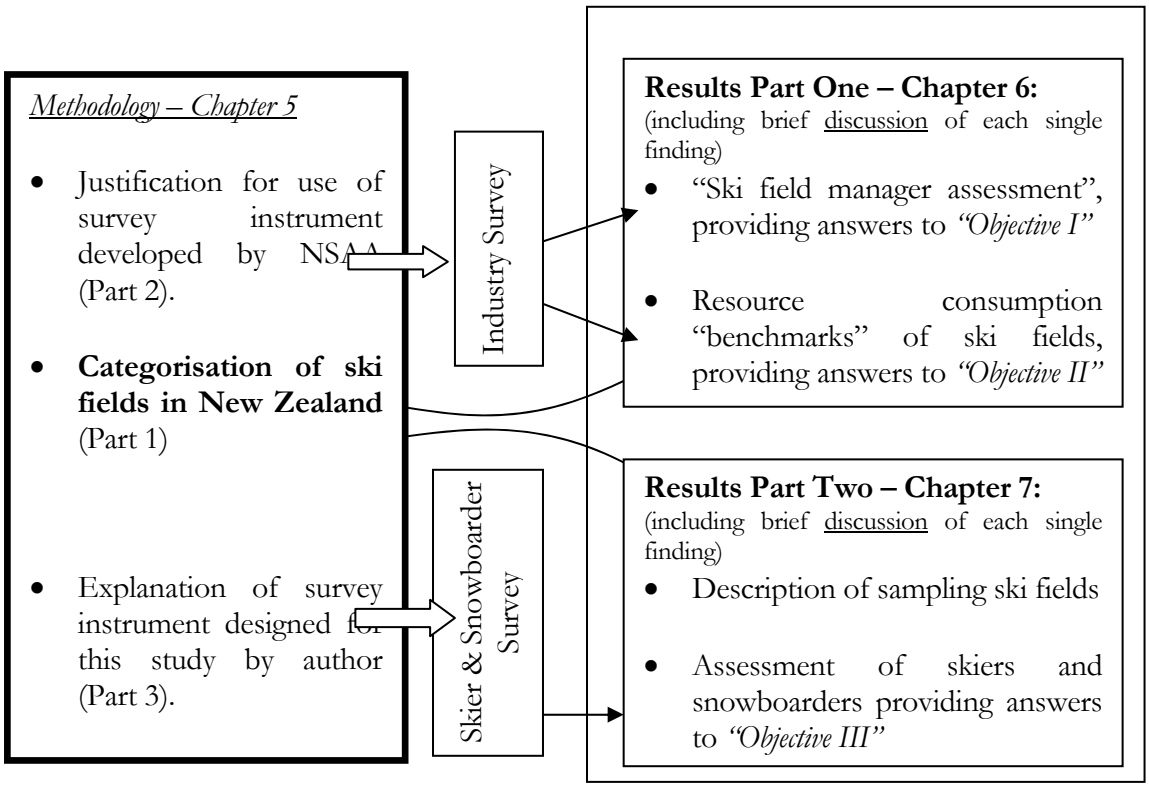


Figure 9: Structure of Chapter 5 – Methods (Note: the structure of the methodology also determines the structure of the two results chapters).

5.1.2 A Classification of New Zealand's Ski Fields

A structured approach to the analysis of New Zealand's ski field industry required a classification of existing ski fields. The "*ski field categories*" (Table 11) provide structure to all parts of this research. During the analysis of recreationists' behaviour (5.3Skier & Snowboarder Survey) the cate

commercial ski fields, club ski

fields, and heli/cat ski fields. Key characteristics and examples are presented in Table 11. A full list of all 27 ski fields, classified into the field categories can be found in Appendix 3[31].

Table 11: Key Characteristics of Ski Field Categories in New Zealand

[31] Following the criteria outlined in Table 11, the researcher categorised all New Zealand ski field as listed in the "Brown Bear New Zealand Ski & Snowboard Guide 2001" (Upjohn, 2001).

Category	Typical Features	Examples
International commercial fields	Intensive development, comfortable lift facilities (chair lifts), often intensive snowmaking facilities, intensive base facility development (shops, restaurants, etc.), visitor volume approximately 70,000 - 150,000 skier/snowboarder days annually and overseas marketing.	Mt. Hutt Cardrona
National commercial fields	Grooming machinery available, snowmaking (sometimes), no rope tows (usually platters or T-bars), visitor volume under 70,000 skier/snowboarder days annually, basic base facility development (commercial restaurant or bar).	Porter Heights Mt. Dobson
Special purpose commercial fields	Catering for niche markets or new trends, such as cross-country skiing or terrain parks; grooming and special purpose equipment is available (e.g. pipe-shaper), mountain transport available[32], base facilities developed to a similar standard than commercial operations.	Snow Farm Snow Park (opens in 2002)
Club ski fields	Club operated, commonly served by rope tow lift facilities, no or only very limited grooming, no snowmaking, basic to no commercial base facilities (restaurant, shops), visitor volumes unknown, but estimate between 1000–5000 skier days annually. On-snow (on-mountain) accommodation is provided at most club fields.	Broken River Craigieburn
Other: Heli/Cat field	Access to the field by helicopter or four-wheel drive. The field itself is served by a snow-cat or a rope tow. Located in remote backcountry fields usually only accessible with touring equipment and mountaineering experience; visitor volumes estimated at under 1000 skier/snowboarder days annually.	Mt. Potts Alpure Cat Ski

[32] Mountain transport means: lifts are provided, when required, such as at the "Snow Park". However, there are no lift facilities available at the cross-country skiing field "Snow Farm". This is a matter of fact and not a sign of basic development.

5.2 Ski Field Industry Assessment

The information on the ski field industry was collected via a mail back survey. The questionnaire (based on NSAA, 2001d) was sent to all 27 ski fields operating during the 2001 season in New Zealand. The ski fields were selected according to their listing in the "Brown Bear New Zealand Ski & Snowboard Guide 2001" (Upjohn, 2001). A data base on ski field managers contact addresses was developed using information provided by the Canterbury Snow Sport Association (CSA), the New Zealand Ski Council (Snow.co.nz, 2001) and the official web-sites of New Zealand's ski fields.

Overall, the survey questionnaire contained twenty sampling forms and was structured into two parts: *Environmental Assessment* and *Benchmarking*, whereby sixteen sampling forms referred to the environmental assessment part, three to the benchmarking part, and one was designed to obtain ski field managers' consent to use the data in the thesis. Managers were assured that, after completion of the project, anonymity of their ski fields would be maintained in written or oral presentation of the research, or in general discussion and that data would only be presented in aggregated form. A complete qualitative environmental profile (designed from the information gathered) of a single ski field will not be published in any form, except with written consent of the ski field.

5.2.1 Sample Preparation & Data Collection

While the design of the survey instrument for the two parts of the assessment was distinctively different, the sample preparation and data collection process for both parts was identical. To avoid duplication, this process is explained before the survey instruments for both parts are outlined in the following two sections.

The mail-back questionnaire was sent out along with a covering letter and a copy of the "Sustainable Slopes Charter" (NSAA, 2001c) (Appendix 5) to provide managers with the essential background. The covering letter outlined the research objectives and briefly explained the North American background of the survey instrument. In order to increase the response rate of the survey, two rounds of follow-up telephone calls were made, several email reminders were sent, and one follow-up letter was posted out, encouraging ski field managers to complete the questionnaire (details on the sampling process are compiled in Appendix 4).

5.2.2 Environmental Assessment of Ski Field Managers

As outlined in the research objectives, it is important to learn about the environmental awareness of New Zealand's ski field managers and to assess how committed they are toward operational best practice. The review of current literature and industry publications revealed that North America's ski field industry is currently undertaking several actions with very similar goals to the objectives of this research. Therefore, this part of the project is based on a methodology developed by the NSAA and various North American ski industry stakeholders. It appeared that the application of the NSAA's ski field assessment tool was an appropriate instrument to answer the research questions of this study. By using the "Sustainable Slopes Assessment – 2001" (NSAA, 2001d) the results of this study can be compared to those obtained in North America (NSAA, 2001b) on a common base (A detailed comparison is not an objective of this thesis, although it is planned to conduct such comparison in a following research project). In the following section, background information on the development and design of the NSAA survey instrument is provided.

The Survey Instrument

The "Sustainable Slopes Environmental Charter" (NSAA, 2001c) for ski fields was developed under guidance of the NSAA, the trade association for ski field owners and operators in North America. This association represents 332 alpine resorts and has 436 supplier members providing equipment, goods and services to the mountain resort industry. The charter was the outcome of a nine month long stakeholder process facilitated by an independent non-profit public policy and education organisation (the full charter is attached in Appendix 5). At the core of the charter is the formulation of voluntary environmental principles for ski field planning and operation. The principles are also applicable to New Zealand, because they are not based on any legal requirements specific to ski field operations in the United States (NSAA, 2001c). The principles are, rather, based on the desire to protect the mountain environment, incorporate ideas of sustainable development (such as increasing resource efficiency) and are in general, applicable to any skiing/snowboarding destination. In addition, a list of environmental actions (110 actions in total[33]) is provided for each principle that explains how the established goals could be achieved in practical day-to-day business.

[33] The environmental actions are structured into 4 categories and 16 sub categories.

Consequently, the NSAA designed a survey instrument assessing the degree to which ski fields implemented the environmental actions supporting the charter principles (NSAA, 2001d). The original instrument consisted of 25 single sampling forms, of which 20 were directly relevant for this research project. The five sampling forms not used for this research referred to the management of fish and wildlife, forest and vegetation, wetlands and riparian areas, visual quality, and education and outreach. Except for education and outreach, these sampling forms referred to the biophysical impacts of ski area operation, which have received significant research attention in the past. The focus of this research is on the"more invisible environmental impacts"resulting from resource consumption, such as global warming. In the context of global environmental issues the communication of environmental initiatives to raise public awareness is of crucial importance. However, an analysis of ski areas environmental communication strategies was beyond the scope (focus on measuring and monitoring)of this research, which explains the omitting of the education and outreach sampling form. To suit the requirements of this survey, the original sampling forms were rearranged to create a structure clearly focusing on the assessment of resource consumption (Figure 10). The content of the sampling forms was modified marginally. The modified "environmental assessment" part consisted of 16 sampling forms.

The structure of the Sustainable Slopes Assessment clearly reflects the main interest of this study (see Figure10 for an overview of the survey structure). The main part of the assessment – thirteen sampling forms - referred to resource consumption of ski field operation. This part of the assessment was structured into the three sections:*water resources*(5 sampling forms), *energy conservation and use* (4 sampling forms), and *waste management* (4 sampling forms). The remaining three sampling forms referred to general topics related to resource consumption, namely *planning, design, and construction*, *air quality*, and *transportation*. The structure of section four is different from the previous three. Each assessment form does not refer to the consumption of one resource in particular, but to three key business activities of ski areas with potentially high demand on resources. Planning, design, and construction, for example, is the most complex topic, because it potentially comprises energy consumption, water utilisation and consumption, and the production of solid wastes.

Furthermore, the important role of snowmaking in relation to resource consumption (water and energy) is reflected in the assessment tool. Two complete sampling forms (form number 2 and number 8) are solely dedicated to snowmaking, although it is only one of many services offered by ski fields in New Zealand.

Index of Evaluation Tool Forms

	Check here if applicable	Form
ENVIRONMENTAL ASSESSMENT		
I **Water Resources**		
Water Use for Snowmaking	☐	2
Water Use in Facilities		3
Water Use for Landscaping and Summer Activities	☐	4
Water Quality Management	☐	5
Wastewater Management	☐	6
II **Energy Conservation and Use**		
Energy Use for Facilities	☐	7
Energy Use for Snowmaking	☐	8
Energy Use for Lifts	☐	9
Energy Use for Vehicle Fleets	☐	10
III **Waste Management**		
Waste Reduction	☐	11
Product Re-use	☐	12
Recycling	☐	13
Potentially Hazardous Wastes	☐	14
IV **General Resource Consumption**		
Planning, Design, and Construction	☐	1
Air Quality	☐	18
Transportation	☐	20
BENCHMARKING		
I **Environmental Indicators**	**Required**	*22*
II **Resort Summary**	**Required**	23
III **Visitor Numbers**	**Voluntary**	24
Authorisation for Use of Data	Required	25

Figure 10: Sustainable Slopes Assessment 2001 – Index Sheet.

The three sampling forms *Environmental Indicators* (22), *Resort Summary* (23), and *Visitor Numbers* (24) refer to the benchmarking part of the ski field industry assessment and are explained in the section5.2.3.
Note: For the assessment of ski field managers' environmental awareness, the full, adapted survey instrument including all "environmental actions" sampling forms (1-21) was applied. The order of sampling forms in Figure10 has been changed to provide a clear structural overview at the writing stage. In the survey instrument sent out to ski field managers, the sampling forms were in numerical order as indicated by the form numbers (see Appendix 5). The information collected on sampling forms 15,16,17,19,21 were excluded from the analysis.

The structure of each sampling form is consistent throughout the instrument (Figure 11). In the first section of each form (*Environmental Actions*), a list of environmental actions is provided that support achieving the goals set out in the principles. Managers were asked to state for each action whether it was implemented, not implemented, or not applicable at their ski field. Additional space was provided to add environmental actions specific to single locations that were not included in the set options ("Section 1" in Figure 11). In the second section (*Implementation Levels*), managers were

asked to rate the degree of overall implementation of the environmental actions package as outlined in the first section. The non-continuous scale provided offered five different discrete degrees of implementation ("Section 2" in Figure 11).

Environmental Actions

What has your organisation done to support thisPrinciple? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organisation has undertaken to support this Principle, adding any additional practices in the spaces provided.

Section 1

		(Yes)	(No)	(N/A)
1	Conducting water use audits and investigating methods and alternative technologies to reduce water consumption?			
2	Installing water efficiency equipment in facilities, such as low-flow-faucets and toilets?			
3	Participating in existing water conservation and linen and towel re-use programmes, such as EPA"s WAVE and Project Planet programmes for lodging?			
4	Educating guests and employees about the benefits of efficient water use?			
5	<< Space for Additional Practices >>			
6	<< Space for Additional Practices >>			

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented.

Section 2

(1) (2) (3) (4) (5)

Priorities for Improvement (respond if you indicated a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

Section 3

	(Low)	(Med)	(High)
Increased Monetary Savings	(1)	(2)	(3)
Reduced Environmental Impacts	(1)	(2)	(3)
Reduced Regulatory Liability	(1)	(2)	(3)
Increased Positive Public image	(1)	(2)	(3)

Figure 11: Example of One Sampling Form: "Water Use in Facilities".
Corresponding Principle: "Conserve Water and Optimise Efficiency of Water Use in Ski Field Facilities".

The third section (*Perceived Potential Benefits*) asked those managers who rated the overall implementation status at three or lower to evaluate potential benefits (four specific benefits) if they were to fully implement the principles as outlined in section one ("Section 3" in Figure 11). Rating of the potential benefits was done on a three-point scale from "low" to "medium" to "high".

To verify the applicability of the marginally adapted Sustainable Slopes Assessment 2001, an interview with a ski field manager was undertaken prior to the sampling period. In the interview the questionnaire was completed together with the manager. While completing the assessment unclear wording of some environmental actions and the applicability to the New Zealand context was discussed. After this personal pre-test it was decided that the adapted questionnaire could be applied without further alterations in New Zealand[34]. The manager involved in the pre-test was able relate to all formulations specific to North America to the New Zealand context (e.g. "EPA's WAVE programme" a programme specific to North America, see action 3 in Figure11). Personal communication with other managers of commercial fields later in the research process reinforced that New Zealand's ski field professionals had a high degree of familiarity with operational practices at North America's ski fields. Additionally, it was found that some of them had worked at North American fields before, or used NSAA knowledge as input in the management of their field.

Limitations of Using the NSAA Survey Instrument

The NSAA "Sustainable Slopes Programme" has been criticised by several environmental groups (e.g. Ski Area Citizen's Coalition, Trout Unlimited, The Sierra Club, National Environmental Trust; Malkan, 2000). Most of the criticism is directed at NSAA condoning ski area expansions. Further criticism focuses on the charter condoning real estate speculation, the lack of monitoring and enforcement (e.g. enforcing compliance with clearly defined standards), and the lack of clear goals (e.g. definite targets for waste minimisation) (Colorado Wild, 2000). Therefore, the criticism did not primarily focus on the NSAA's data collection method, expect for the lack of monitoring. The benchmarking/monitoring part of the NSAA questionnaire was not applied in this study, but replaced by a sampling form, which is described later in this chapter. This author acknowledges that the actions outlined in the instrument will not satisfy strict environmentalist, but they represent a framework of feasible environmental actions that are considered a step into the right direction or an opportunity for environmental groups to work with the ski industry (Janofsky, 2000).

[34] The alteration made referred to re-structuring only, but not to change of content of questions or change of the survey methodology (e.g. application of different scales).

The structure of the assessment, only allowing "yes", "no", or "not applicable" responses, has, however, some clear shortcomings that are outlined here:

- The structure of the assessment suggests that a "yes"-response represents an environmentally positive aspect of ski area operation. However, most of the actions outlined in the charter may not be environmentally beneficial if only complied with gradually. For example, a "yes"-response to the question whether the ski area uses renewable energy sources can mean that one lodge is powered by hydroelectricity, while the rest of the ski area was operated by using fossil fuels (as was the case for one of the ski fields participating in this study).
- All responses are subject to managers' perception and interpretation. For example, a "yes"- response to the question whether the ski area operates its lifts with high efficiency motors is extremely subjective if not efficiency standard is given.
- The not applicable response category could be misused for strategic response behaviour. For example, a "not applicable"-response to the question whether the ski area purchases green power from energy providers can either mean that such power is not available or that the manager does not consider the purchase of green power as an alternative for whatever reason (he may even be not aware that green power is available on the market).

Despite these shortcomings the researcher decided not to change the assessment structure, since any alternative response structure would have made, the already comprehensive questionnaire, even longer. This would have had potentially decreased the response rate. Furthermore, the assessment of New Zealand's ski area manager's environmental awareness conducted in this research should not be misinterpreted as a clearly defined measure of manager's environmental awareness. As such it represents an attempt to provide a first snapshot how basic environmental actions (by North American standard of ski area management) are implemented in New Zealand. Following the results of this research, more specific indicators focusing on the most important areas of environmental management specific to New Zealand can be developed. Ideally, future industry assessment should be conducted by independent environmental certification agencies, such as Green Globe 21, and it is hoped that this research contributes to defining appropriate indicators for such future assessments.

Presentation of Results

Following the data collection, data were analysed with descriptive statistics. The three sections of each sampling form (*Environmental Actions*, *Implementation Levels*, *Perceived Potential Benefits*) were analysed separately for all valid responses.

The presentation of the results follows the structure of the survey instrument as presented in

Figure 10. Hence, four categories of environmental actions are presented, namely *Water Resources*, *Energy Conservation and Use*, *Waste Management*, and *General Resource Consumption*. Each category consists of several blocks of environmental actions (one block = one sampling form, e.g. *Water Use in Facilities*; compare Figure 11), which are called sub-categories in the remainder of this thesis. The number of environmental actions varies from sub-category to sub-category. The number of responses for each of the three response categories ("*yes*", "*no*", "*not applicable*") relative to the total number of valid responses is evaluated for each environmental action.

The results of the implementation ratings for each sub-category are compiled in one table to allow immediate comparison between different degrees of implementation for the 16 sub-categories. The aggregated information on the implementation levels complements the detailed analysis of the implementation of single environmental actions. The results are presented as relative share of the total valid responses for each response category.

The *priorities for improvement* are analysed and presented in two separate blocks. Block one comprises the two potential benefits referring to cost savings (*Increased Monetary Savings*) and the public image of ski fields (*Increased Positive Public Image*), whereas the second block comprised those benefits referring to regulatory responsibilities (*Reduced Regulatory Liability*) and the environmental impacts of ski areas (*Reduced Environmental Impacts*). This seemed a logical structure since both benefits of block one were potentially increased through the implementation of the proposed environmental actions and refer more to the economic side of operating ski areas. The benefits of block two are clearly linked to the ecological side of ski area operation and the proposed environmental actions should reduce environmental impact and regulatory liability. Again, the responses for each sub-category are evaluated relative to the total number of valid responses for the sub-category in per cent.

5.2.3 Benchmarking

One of the research objectives in this study was to estimate benchmarks of resource consumption associated with skiing/snowboarding in New Zealand. This study provides a single estimate of resource consumption benchmarks for ski field infrastructure (energy consumed, water used, and solid waste produced to operate base facilities, toilets, lifts, snow groomer, etc.).

The Survey Instrument

The data used to establish benchmarks were collected through part two of the "Sustainable Slopes Assessment 2001". The "resource consumption" part encompasses survey form 22 (*Environmental Indicators*). The sampling form does not stem from the original NSAA questionnaire (2001d), but was developed by the researcher. However, the original *Environmental Indicator* sampling form (form 22, NSAA, 2001d) served as a template to design the sampling form applied in this project.

It was essential to replace the original sampling form due to methodological incongruity of the NSAA approach to measure resource consumption indicators. For example, only information on electricity consumption is collected by the NSAA. In New Zealand, it seemed crucial to account for the full range of energy use, in particular for the use of fossil fuels for lift operation and remote electricity generation. In addition, ski fields usually operate large vehicle fleets (in particular in North America, but also in New Zealand). Snow groomers, for example, are part of the vehicle fleet and they guarantee the quality of a commercial ski field's core product– groomed trails. In order to provide a comprehensive assessment, it was important to account for the energy consumption of these core business fields. Moreover, the NSAA seemed to focus on evaluating the percentage of resources saved (in particular for solid waste) and not on the consumption itself.

In the following, the design of sampling form 22 *(Environmental Indicators)* on resource consumption is outlined. Data on three separate fields were collected: energy consumption, potable water use and solid waste diversion and production. Energy data were collected separately for snowmaking and other use. Managers were asked to supply information on electricity, diesel, petrol, LPG, wood and other fuel consumption. Water use data were also collected separately for snowmaking and general use. The experience of the NSAA (2001b, 2001d) with similar assessments in North America indicated that water use for snowmaking as well as solid waste production is not commonly metered and recorded at ski fields. Therefore, the questions referring to water use for snowmaking

and solid waste production were pre-structured. Managers were asked to estimate their consumption by ticking pre-manufactured response options[35]. The options were carefully constituted with assistance from one ski field manager during the consulting interview concerning the questionnaire's suitability for the New Zealand scenario. In contrast to water use for snowmaking, it was not possible to pre-manufacture response options for water use for facilities because of the different business sizes of the different ski fields in New Zealand. The questionnaire asked managers to supply their accurate consumption figures. However, only four managers supplied figures, the rest either indicated that the information was not available or left the space blank. Hence, accuracy is expected to be higher for the energy figures than for water and waste, which are considered estimates. Table 12 provides an overview of all data sampled through sampling form 22 (*Environmental Indicators*).

Table 12: Overview of All Resource Consumption Data Collected on the "*Environmental Indicator*" (Sampling Form 22)

Resource category	Consumption	Fuel Source	Units & Categories
Water	Snowmaking	----------	< 10 million Litres 10-50 million litres 50-100 million litres >100 million litres
Water	Other consumption[36]	----------	Litres
Energy	Snowmaking	Diesel	Litres
Energy	Snowmaking	Electricity	KWh
Energy	Other consumption	Wood	cubic-metre
Energy	Other consumption	LPG	Kilogram
Energy	Other consumption	Petrol	Litres
Energy	Other consumption	Diesel	Litres
Energy	Other consumption	Electricity	KWh
Energy	Other consumption	Other (Aviation Fuel)	Litres
Waste Reduction/Recycling	Total on-mountain diversion	----------	0% diversion[37] 1-5% diversion 5-10% diversion 10-20% diversion 20-50% diversion >50% diversion
Waste Disposal (to landfill)	Total on-mountain production	----------	< 20 tonnes/ annually 20–50 tonnes/ annually 50–100 tonnes/ annually 100–200 tonnes/ annually >200 tonnes/ annually

[35] An additional note asked managers to provide accurate data if available. None of the managers, however, provided accurate snowmaking water consumption figures.

[36] Other consumption encompasses, facility operation, landscaping, planting, toilets, etc.

[37] 0% diversion means: no recycling or waste reduction; all solid waste is disposed at the landfill.

In addition to resource use, information on the current infrastructure and vehicle fleet of each field and the total 2001 skier day numbers is required. For this purpose, sampling form 23 (*Resort Summary*) and 24 (*Visitor Numbers*) were developed. Information with relevance to resource consumption of facilities, vehicle fleets, and lifts (number, year built, engine types and sizes, heating systems) was collected in the Ski Field (Resort) Summary. This was considered important extra information to understand better the resource consumption figures and to be able to estimate missing data. The visitor numbers[38] are essential to calculate energy intensities (e.g. energy per skier day) in the results part.

Data Processing & Presentation of Results

Before the methods applied in data processing are explained, it is emphasised that the resource consumption data collected by this study refer to direct resource consumption only. This is in contrast to more comprehensive environmental assessment studies evaluating the total resource consumption associated with a service. These audits include the direct consumption and indirect consumption. Indirect consumption refers to the energy content embodied in equipment applied (e.g. water and energy used to produce a snow groomer), and services offered (e.g. the amount of waste created by advertising the ski field via brochures, flyers, etc.). The tool often applied to provide such comprehensive insight is input-output analysis (e.g. Lenzen, 1999). These comprehensive considerations are beyond the scope of this study. However, it would be interesting to conduct an input-output analysis for the snow sport industry in the future, since the high facility dependency of snow sport suggests that the indirect resource consumption could be significant.

A focus on direct resource consumption is only a first step in clarifying the definition of energy use. In Europe, studies commonly measure primary energy consumption. This measure includes energy input necessary to produce fuels, electricity (energy carrier), to transport them to the distribution centres and other energy loss factors[39]. Since the measurement of primary energy consumption is not commonly practiced in New Zealand, this study measures the secondary energy use only (energy equivalent of the consumed quantity of an energy source).

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[38] Skier days (per season) = the sum (over all open days) of the numbers of individuals that skied at the ski field on any open day with a valid lift ticket (includes learners tickets and half day tickets); in other words the total number of paying visits made to a ski field in one season.

[39] Compare RWEDP (1997) for a detailed explanation of energy losses in the energy chain. The energy chain describes all losses in the process from exploiting an energy source (e.g. crude oil), to the processing required (e.g. refining) until the end product (e.g. petrol) can be supply to the end user.

Furthermore, it is important to specify which elements of the compound ski product are included in the measurement of resource use benchmarks. In Figure 12 the boundaries are clarified exactly. The benchmarking data comprise the resource use of the base facility operation, all on-mountain infrastructure and services. The energy consumption associated with skiers and snowboarders' transport to and from the ski field is not included here.

The collected solid waste consumption and water consumption figures did not require further conversions or calculations. The data could be presented directly in the results as totals or normalised by skier days.

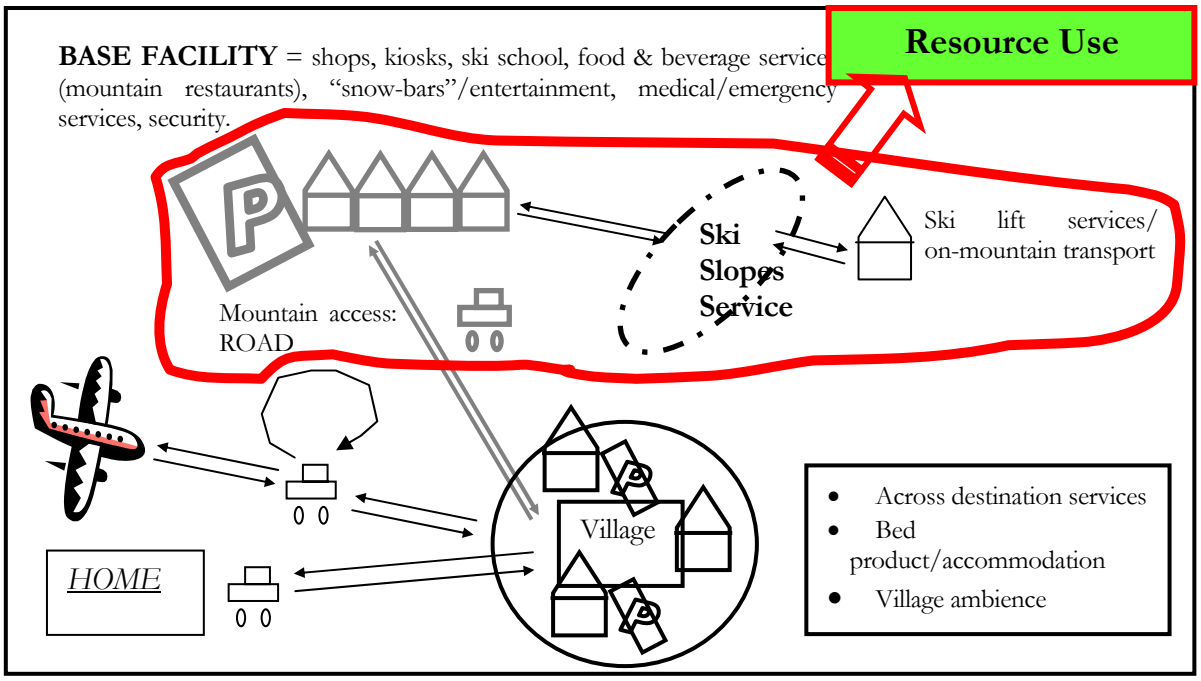

Figure 12: Resource Consumption Boundaries of the "New Zealand Mountain Experience".

The calculation of energy consumption from consumer fuel use figures required transformation into energy units. First, the fuel consumption figures, measured in physical standard units (e.g. litres), were converted into energy figures by using the gross calorific value (GCV) of each fuel source (see Appendix 1). The results are presented in megajoules (MJ) or terajoules (TJ). Hence, energy equivalents calculated here represent the ideal heat equivalent of the fuel source used to power a certain appliance. This method of calculating energy consumption does not account for different energy qualities of different fuel sources, and therefore might be misleading in some cases, but has been applied by comparable studies (Becken & Simmons, 2002; Stettler, 1997). The issue of

"energy quality" is briefly explained in the following section ("Brief Excurse on Energy Analysis"), but has been omitted for the presentation of results in this thesis. The overall energy input of the activity skiing is then derived from a simple addition of the mega-joule heat contents associated with the respective fuel consumption.

In addition to the energy consumption figures, the released amount of carbon dioxide (CO_2), as the main greenhouse gas resulting from energy use, was calculated from the fuel consumption data (Appendix 1). CO_2 emissions are a direct result of fossil fuel combustion. Electricity generated from renewable energy sources (e.g. hydro) does not produce CO_2 emissions, which applies to all electricity generated in New Zealand's South Island. However, energy demand on the North Island is met by additional thermal electricity production. Since this study aims to evaluate energy demand on a national level, it has been decided that the national CO_2 emission factor of 42 g/MJ (152 g/kWh) for electricity in New Zealand (Ministry for Economic Development, 2001) is applied. This emission factor is still relatively low compared with other western countries (between 500 and 740 g/kWh; Van den Vate, 1997), due to the large amount of hydro-generated electricity in New Zealand (approximately 70% of total electricity demand is hydro-generated).

Brief Excurse on Energy Analysis

Energy can, in a physical sense, not be "consumed", but only be converted from one form in another. The term energy efficiency in every day language refers mostly to using less of the fuel source in question to create the desired effect (e.g. diesel, electricity, etc.). The amount of fuel used depends on the type of energy converter (engine) and the desired output. The efficiency of an energy conversion process further depends on the fuel source. For example, the powering of the snowmaking system of a ski field via electricity is more efficient than powering generators with diesel to produce electricity, which is then used to run the pumps and compressors of the snowmaking system. This means that the energy quality of electricity is higher than the one of diesel in the above example. Apart from this often referred to "energy problem" (Patterson, 1993), the generation of electricity from the national grid requires primary energy input itself. The amount of primary energy input per unit of electricity generated depends on the relative contribution of each renewable energies and fossil fuels. Against this background (both different energy qualities and primary energy input to generate electricity), it is misleading to simply add up the heat content of different fuel sources, in particular electricity. It is possible to adjust for these inconsistencies, for example by applying "quality factors" and also by extending the scope from mere consumer energy

to primary energy. Both extensions go beyond the scope of this thesis. It is believed that adding up the heat content of consumer energy will provide a good first estimate of energy consumption of ski fields.

5.3 Skier & Snowboarder Survey

This part of the research project evaluated visitors' contribution to the overall environmental impact of skiing and snowboarding. Again, the focus is on resource consumption. This survey analysed the behaviour of skiers and snowboarders with regard to facilities, transport to the ski field, and disposal of waste.

5.3.1 The Survey Instrument

The questionnaire was designed specifically for this research project and was structured in three parts. A copy of the full questionnaire is provided in Appendix 6.

The objective of part one *General Attitudes* (six questions) is to find an answer to the question: "What do skiers and boarders value most at the visited field?" The survey evaluated the importance of several services and facilities provided to skiers and snowboarders by ski fields. The standard of facilities provided at ski fields clearly declines from the international commercial, to the national commercial to the club field. Sampling at locations that are in different ski field categories provides an opportunity to analyse if recreationists value the same things at the different locations (provided the facility exists at all locations). Apart from two introductory questions asking why skiers and snowboarders decided to come to the particular ski field, part one of the questionnaire focused on the infrastructure provided at the location (this part of the research is referred to as *Facility Dependency* in the remainder of the thesis). In order to account for both, the researcher's goals and the recreationists' perspective, questions related to ski field facilities and services were designed as both, multiple choice and open-ended.

One question asked respondents to rate the importance of 16 different facilities and services[40] at the sampling location using a seven point Likert-scale (1 being unimportant and 7 being very important). Some of the 16 facilities and services were not available at all sample locations and a

[40] The 16 facilities and services are compiled in the original questionnaire (Appendix 6, Question 3)

"not applicable option" was provided for that reason. The facilities and services were chosen based on personal experience of skier demands and after a review of customer satisfaction studies of ski field facilities and services (Flagstad & Hope, 2001; Hudson & Shephard, 1998). Additionally, a set of three questions was developed that asked skiers and snowboarders to state what they would like to have improved at the sampling ski field locations. The first question asked for any improvements, while the second and third question asked for improvements for which recreationists were prepared to pay.

The idea of researching snow sport recreationists' F*acility Dependency* was to find an indirect and un-biased measure of skiers' and snowboarders' attitudes toward the natural environment. It was hypothesised that the provision of high-quality facilities (in terms of international ski field standards: groomed trails, spacious and fully equipped base buildings including cafes, shops, ski rental, etc.) contributes to a high resource use, especially energy use and concomitant CO_2 emissions. This part of the questionnaire was designed to examine whether facilities are among the most highly valued elements of a ski field. The following assumption was tested (in an analytical rather than a statistical manner).
Assumption: The most highly valued elements of modern ski fields are those facilities and services that are characterised by a high resource demand (water or energy on the input side and waste on the output side).

The objective of part two *Characteristics and Demographics* (11 questions) was to collect demographics and some ski/snowboard specific characteristics so that respondents could be classified and compared to other studies on skiing conducted in New Zealand and elsewhere.

Objective one of part three *Today's Visit to this Ski Field* (nine questions) was intended to research the transport behaviour of snow sport recreationists and to check whether they were day visitors, weekend trippers or tourists. In the case of a multiple day trips, an outline of the tourist's itinerary was recorded on the sketch-map provided, collecting additional information on transport modes used for the single travel legs. Each respondent was asked separately about the actual transport mode used to travel from their overnight destination to the ski field on the day of the interview. The transport to the ski fields is hypothesised to be the main contributor to the overall direct resource use of skiing as a recreation / tourist activity (compare Stettler, 1997; Hellgreen, et al.,

1997). The resource use of each sampled recreationist for travelling to the ski field was calculated and used to test this assumption.

Objective two of Part three *Waste Disposal Behaviour* (five questions) was used to assess recreationists with regard to their behaviour of handling rubbish that they created on the field. This field of environmental behaviour is seen as one that can be changed most easily, since there are usually no additional financial costs involved for the recreationist.

Assumption: There is a potential to reduce solid waste production via the introduction of:

- (A) An environmental care code ("carry out what you carry in").
- (B) Recycling.

The questionnaire collected information on whether skiers and snowboarders would be prepared to "carry out what they carried in", a common behaviour displayed by recreationists in many other outdoor recreation activities. Additionally, information on the types of disposed rubbish was collected in order to complement the results obtained from the "Benchmarking" process during the "Ski Field Industry Assessment". These results provide a quantitative result on the volume/mass of solid waste disposed, whereas the data obtained in this part provide insight into what percentage of the created waste is avoidable, recyclable or biodegradable.

The design of the survey instrument guaranteed the anonymity and confidentiality of all participating recreationists. The questionnaire did not collect names or any personal details which might allow for any connection between participants and their completed questionnaires.

5.3.2 Sample Preparation

Six ski fields in the Canterbury Region (South Island, New Zealand) were selected for an on-site survey (Table 13). All selected fields are in close proximity to the South Island's main population centre Christchurch (app. 325,000 inhabitants[41]). The surveys were conducted during the second half of the 2001 snow season, namely from 8th August to 29th September. Ski fields were selected so that at least one of each category was sampled[42]. To represent club field visitors adequately, four

[41] Census 2001 count: 316,227 without undercount (estimated 7000) (Statistics New Zealand, 2002)

[42] Due to time and financial constraints heli/club fields were not included in this study. Special purpose commercial fields were not included due to methodological reasons. It seemed wrong to include a facility that provided for a different type of skiing (cross-country skiing) without providing that broad perspective in the literature review. A comparison of cross-country skiing to alpine skiing with regard to resource consumption, however, would be an interesting additional topic, since cross-country fields relies less on infrastructure than alpine fields. Additionally, it is acknowledged that the analysis of recreationists' attitudes and behaviours at the cross-country skiing location (Snow Farm) would have been a useful contribution to this study.

fields of this type were sampled. This was necessary since visitor numbers at club ski fields are usually small and it was assumed that the nature (and variety) of club ski fields could only be captured by sampling at different locations. In the end the targeted number of valid questionnaires for each category should approximately reflect the visitor volume at the six different sample locations. At the two commercial sample locations, sampling was conducted on a midweek day and a weekend to account for possible differences in visitor types. Club fields were only visited on weekends, since visitor numbers on weekdays are generally too low. Table 13 provides an overview of all selected sample locations.

Table 13: Sampling Locations in Overview

Sample Locations	**Distance from Christchurch**	**Ski Field Category**	**Number of sampling days**
Mt Hutt	125	International Commercial	2
Porter Heights	106	National Commercial	3[1]
Broken River	125	Club Field	1
Fox Peak	200	Club Field	1
Mt. Olympus	150	Club Field	1
Temple Basin	170	Club Field	2[1]
Total		----------	10

1) These fields had more sampling days, since the questionnaire was pre-tested at these locations.

Due to financial and time constraints, only Canterbury ski fields were selected for the on-mountain survey. Mt. Hutt (125 km) and Porter Heights (106 km) are the most popular commercial ski fields in Canterbury and are located close to Christchurch. Mt. Hutt receives by far the highest visitor volume of all Cantabrian fields (confidential information provided by ski field managers). Canterbury's two other commercial ski fields (Mt. Lyford and Mt. Dobson) are further away from Christchurch and less popular and were therefore not included in the research.

Similar reasoning guided the selection of the club field sample. With the exception of Fox Peak, all sampled fields are located relatively close to Christchurch (along State Highway 73 from Christchurch to Arthur's Pass). Fox Peak was included in the sample since it was expected to have a more rural visitor profile in comparison with the "Highway 73" ski fields, where these have traditionally developed as recreation sites for urban people from Christchurch. Craigieburn Valley Ski Club, the most popular club field among advanced skiers in Canterbury, has developed a cult status in recent years (personal observation). Therefore, the field was excluded from the sample,

since the researcher was unsure how to account for these recent developments. It is possible that the Craigieburn valley ski club is in a transition to a quasi-commercial operation.

A target of 150 - 200 completed questionnaires (approximately 100,000 – 150,000 skier days) at Mt. Hutt, 50 – 80 completed questionnaires (fewer than 70,000 skier days) at Porter Heights, and approximately 50 questionnaires at the Cantabrian club fields, was set. Detailed information on the six sampling locations is presented at the beginning of Chapter 7 – Results Part Two.

Skier and snowboarders were approached in and around the base facilities or in the on-mountain lodges of the ski fields. Outdoor sampling in alpine locations is weather dependent (wind, temperature and precipitation) and a decision on the actual sampling location on the field was made on the sampling day after consideration of weather conditions, visitor flows, and advice of the ski field staff. To account for the chance of missing out on some visitor groups not using the mentioned facilities, the car park field was also used as sample location at the end of the ski day.

Recreationists were approached by "convenience sampling", since setting up reliable and duplicative random sampling procedure at the different sampling locations seemed unfeasible. At some of the smaller club ski fields (Fox Peak or Mount Olympus) the researcher had a realistic chance to approach the majority of recreationists visiting the field on the day, since visitor numbers were low. In this case, a random selection process was unnecessary.

After agreeing to participate in the survey(see Appendix 6), the background of the study was briefly explained to participating recreationists. It was, however, avoided pointing out the environmental background since the researcher assumed that directly mentioning the environmental focus of the study would have potentially biased the subjects' responses to many questions. No written consent was obtained, because the information given to subjects was considered sufficient for them to decide whether or not they wished to participate in the survey. The survey instrument was a self-administered questionnaire to be completed by recreationists without the help of the researcher on-site. The researcher collected the questionnaires immediately after completion by participants.

Every visitor to the ski field (excluding full-time, part-time or even occasional employees) 15 years of age or older qualified as a subject. This definition included visitors who did not ski or

snowboard. Additionally, accurate day visitor numbers from ski field management and information on average visitor numbers to the field across the week/season (e.g. differences in visitation levels between weekend days and week days) were collected. Any special events having been staged on a sample day were recorded, because they could have biased the visitor mix. These data were used to assess the representativeness of selected sample days.

5.3.3 Data Processing & Presentation of Results

The various parts of the questionnaire require different data processing methods. The collected data had to be manipulated in several steps. In the following, each "data manipulation process" is briefly outlined. Details on data processing methods applied during the data analysis are compliled in Appendix 2. The data were analysed separately and compared for the different ski field categories. Hence, most results in Chapter 7 are split into the three different ski field categories (club field, national commercial field, commercial field). In the following four sections (Key Sample, Characteristics, Facility Dependency of Skiers and Snowboarders, Transport Behaviour and Waste Disposal Behaviour) the sampled variables are explained. Generally, three difference types of data processing techniques were applied:
(1) **CMM**: Calculation of means or medians from numerical data sampled (e.g. engine size).
(2) **CRF**: Calculation of relative frequency (in percent of total) of different response options.
(3) **OPEN**: Openly worded responses were coded into "summary categories".

Key Sample Characteristics

The "key characteristics" of the sampled population were presented in three separate parts: namely the "demographic profile of the sample population", the "skier and snowboarder profile of the sampled population", and the "reasons for visiting". Information on the structure of the sampled data, variables and units/categories used, and most important the data manipulation process, are presented in Table 14.

Table 14: Data Collection Methods for *"Demographic Profile"* and for *"Skier & Snowboarder Profile"*

Part	Variable	Unit / category	Analysis and Comments
Demographic Profile	Age groups	Years	Categorisation of results in age groups (based on Williams & Lattey, 1994; and Williams et al., 1994). => CRF
	Gender	Male/female	CRF
	Occupation	"Open" question	Categorisation in NZ Standard Classifications of Occupation (Statistics New Zealand, 2001a). => CRF.
	Qualification	Pre-manufactured response options	CRF. Response categories were based on NZ Census 2001 (Statistics New Zealand, 2001b).
	Country of Origin	"Open" question	CRF
Skier and Snowboarder Profile	Snow Sport	Ski/Snowboard/both/other	CRF
	Participation	Pre-manufactured response options	CRF. Response categories based on Williams & Lattey, (1994) and Williams et al. (1994)
	Field Pass	5 pre-manufactured response options	CRF
	Trip characteristic	Day tip / Weekend trip / Tourist	CRF. Definition by researcher based on WTO's tourist definition
	Purpose of trip	Snow Sport / Other	CRF
	Visit to other ski fields	Yes / No	CRF
	Days skied in 2001	Days	CMM
	Number of days skied per trip	Days	CMM
	Length of trip	Days	CMM
	Terrain preferences	Standard colour classification of ski trail	Evaluation of relative frequencies for three levels (*not liked/used/preferred*).
Reasons for Visiting		"Open" question	Responses were coded into "summary categories" (15). Details on the coding process are compiled in Appendix 2.

CRF = Calculation of relative frequency (in percent of total) for different response options.
CMM = Calculation of means or medians from numerical data sampled.

Facility Dependency of Skiers and Snowboarders

Facility dependency of snow sport recreationists is analysed in two separate parts. The first one comprises the "facility and service valuation" while the second one explored recreationists' "personal desired improvements". Information on the structure of the sampled data, variables and categories used, and most important the data manipulation process, are presented in Table 15.

Table 15: Data Collection Methods for *"Facility Dependency of Skiers & Snowboarders"*

Part	Variable	Unit / category	Manipulation required
Facility and Service Valuation	13 facilities and services	Importance is measured for each as mean rating on a 7-point Likert-scale.	CMM
	13 facilities and services	Response rate in percent for each	Calculation of response rate relative to the total number of sampled skiers
Desired Personal Improvement	"Open" question	5 response "summary categories"	Responses were coded into "summary categories" (4). Details on the coding process are compiled in Appendix 2.
Desired personal improvement + willingness to pay for it	"Open" Question	5 response "summary categories"	Same as above => resulted in same categories. Additionally, a cross tabulation of "summary categories" and "willingness to pay" ($-sum or unspecified) was necessary.

CMM = Calculation of means or medians from numerical data sampled.

Transport Behaviour

The analysis of transport behaviour was the most comprehensive aspect of the skier and snowboarder survey. Recreationists' transport behaviour was analysed in four separate dimensions. Each dimension examined different aspects of the travel component associated with visits to ski fields. The first dimension is a descriptive evaluation of "transport characteristic" (transport modes, vehicle occupancies, estimated travel costs). The transport characteristics are important prerequisites to the analysis performed in the three remaining parts. For example, transport modes and occupancy rates were essential to calculate transport energy use figures as described below.

The second dimension of transport behaviour comprised the calculation of energy consumption figures of recreationists' transport to the ski field. This measure is called "Ski Field Transport" and only includes the return transport from the last overnight location to the ski field. For day trippers it constituted the total transport energy consumption. For weekend trippers the return transport to the ski field location, as well as the return drive from the ski field to the overnight location was included. The weekend tripper commonly is a local ski recreationist, who is more similar in his/her transport behaviour to the day-tripper than to the ski tourist. The close similarity of weekend trippers' transport behaviour with the one of day-trippers is underpinned by the fact that weekend trippers commonly travel from their "home destination" directly to the ski field (as day trippers).

They stay one night before travelling home directly from the ski field, which means that an additional "ski field transport" leg is inserted into a day trip's transport component.

The fourth dimension of the transport behaviour analysis complements the quantitative examination of the other parts, and evaluates the reasons for choosing particular transport modes. Information on the structure of the sampled data, variables and units/categories used, and most important the data manipulation process, are presented in Table 16.

Table 16: Data Collection Methods for *"Transport Behaviour"*

Part	Variable	Unit / category	Manipulation required
Part I: Transport Characteristics	Transport modes	Multiple-choice response options (9 options)	CRF
	Vehicle Occupancy	Persons per vehicle by transport mode	CMM
	Estimated travel costs	NZ$ per person and kilometre by transport mode	CMM. Transformations were necessary when respondents did provide NZ$ per car. Per person kilometre were then used to calculate an average NZ$/ pkm.
Part II: Energy consumption for "Ski Area Transport"[1]	Energy use of transport types	Megajoule [MJ]	Secondary sources (see Appendix 1).
	Distance travelled to and from ski field	Kilometre [km] by ski field category	Respondents provided a sketch map of their trip, indicating the travel legs and transport modes. Using AA maps (AA, 1997) each recreationist's travel distance to the ski field was calculated.
	Energy use for transport 1	MJ per respondent by ski field categories	CMM: derived from the variables above (distance travelled and occupancy)
	Energy use for transport 2	MJ per transport type by ski field categories	CMM: derived from the variables above (distance travelled and occupancy)
	Energy Use for transport 3	MJ per passenger kilometre by ski field category	Calculated from average distance travelled to ski field and "energy use for transport 2".
Part III: Energy consumption for "Ski Trip Transport"[3]	Travel distance during trip	Kilometre [km] by trip characteristic	As above, but all recorded transport legs were included in the calculation.
	Energy Use for transport 4	MJ per respondent by trip characteristic[4]	CMM: derived from the variables above (total distance travelled and occupancy)
	Energy Use for transport 5	MJ per respondent by domestic visitors & international visitors	CMM: derived from the variables above (total distance travelled and occupancy)
Part IV: Reasons for transport choice		"Open" question	Responses were coded into "summary categories" (7) (Appendix 2).

CRF = Calculation of relative frequency (in percent of total) for different response options.
CMM = Calculation of means or medians from numerical data sampled
1) "Ski Area Transport": Transport leg from overnight location to ski field and back.
2) All energy data are normalised by length of trip
3) Ski Trip Transport: All transport used to travel from "home" to ski field location and back plus all intra-destinational travel.
4) Trip characteristic = day tripper / weekend tripper / tourist

Studies conducted in Europe (Hellgren, Heikkienen & Suomalainen, 1997; Stettler, 1997) included all travel during a "ski trip" in the calculation of energy consumption related to snow sport. Therefore, the third dimension of recreationists' transport behaviour features a calculation of total distance travelled for all recorded transport legs of each respondent's trip (e.g. total distance travelled split in land based travel and air travel). The "Ski Trip Transport" energy consumption was then calculated from these data and provides an internationally comparable measure of transport energy use associated with snow sport. In this measure, all transport between "home destination", ski field location and back was included.

Waste Disposal Behaviour

Although skiers and snowboarders generally leave solid waste on the mountain during most visits, ski field managers in New Zealand do not have an exact knowledge of the waste composition. This researcher considers knowledge of solid waste composition as an essential requirement for the design of waste minimisation programmes. Hence, the questions guiding the examination of the waste disposal behaviour were: first, what was the solid waste composition disposed at ski fields; and second, what measures could be taken to reduce the amount of solid waste disposed at ski fields. A set of survey questions asked for solid waste composition, and also the willingness to participate in two waste minimisation strategies. These were a "Carry out what you carry in" environmental care code and the participation in recycling programmes at the ski field (Table 17).

Table 17: Data Collection Methods for *"Waste Disposal Behaviour"*

Variable	Unit / category	Manipulation required
Opinion on no rubbish bins provided	"Open" question	Responses were coded into "summary categories" (4). Details on the coding process are compiled in Appendix 2.
"Carry out what you carried in": participation rates	Yes / No	CRF
"Carry out what you carried in": reasons for not participating	"Open" question	Responses were coded into "summary categories" (6). Appendix 2.
Rubbish bin use on survey day	Yes / No	CRF
Disposed rubbish	"Open" question	Responses were coded into "summary categories" (4). Appendix 2.
Recycling: participation rates	Yes / No	CRF
Recycling: reasons for not participating	"Open" question	Responses were coded into "summary categories" (5). Appendix 2.

CRF = Calculation of relative frequency (in percent of total) for different response options.

In the following chapter, the result of the ski area industry assessment are presented.

CHAPTER 6 – RESULTS PART ONE: SKI FIELD MANAGER ASSESSMENT

6.1 Implementation of Environmental Actions at Ski Fields

6.1.1 Introduction

This chapter presents the results obtained from the adapted NSAA mail-back survey, which was sent to all New Zealand ski field managers. As outlined in the methods chapter, the questionnaire had two different parts. The first part examined ski area managers' perception of the degree to which selected environmental actions are implemented at New Zealand's ski fields. Information on the data collection process and the organisation of these results is presented in the following two sections, while the results are presented in sections 6.2 to 6.7. The second part of the "Sustainable Slopes Assessment" researched resource consumption benchmarks of ski area operations, such as potable water use, energy use, and solid waste production. The results of this second part are presented under the heading "Benchmarking" in section 6.8.

The survey was posted out after the 2001 snow season (October 18th, 2001). Several follow up emails, letters, and phone calls were necessary to obtain a reasonable response rate[43]. Completed questionnaires of thirteen of New Zealand's 27 ski fields were received. The valid responses for the "environmental actions" part were higher (12) than for the "resource consumption" part (11). Ten ski fields returned questionnaires containing valid responses for both parts of the assessment (4 commercial and 6 club fields), two managers only completed the environmental actions part (one commercial and one club), and one ski field only returned the "resource consumption" part.

The response rate for commercial fields was lower (5 out of 14 = 36 %) than for the club fields (7 out of 11 = 64%), which may be explained by club ski field managers being more interested in environmental issues and less concerned about sensitivity of data. The higher response rate for club fields is, however, surprising considering that the contents of the assessment were better suited to commercial operators. The main reason for the low response rate of commercial ski fields may be the permanent staff structure of New Zealand's ski fields. Personal visits to several ski fields revealed that even the larger South Island ski fields only had one or two permanent employees (ski

[43] See Appendix 4 for further information including details of the sampling process.

field manager or the operations manager) with the knowledge to complete the questionnaire. These persons reported to be under permanent time pressure and they were not surprised that most of their colleagues could not find the time to complete the survey.

6.1.2 Data Collection Results of "Environmental Actions"

The response rate for the "environmental actions" part of the assessment was 44% (12 out of 27 ski field managers returned a completed questionnaire), however, not all managers completed the whole range of sample forms. The actual number of valid returned sample forms is indicated in Table 18 to Table 37 in the last column of each table. One reason for partially filled out questionnaires was that not all forms were applicable to all ski fields (e.g. "energy use of snowmaking" was inapplicable to club fields). This assumption was supported by the fact that the club ski field managers were more likely to omit survey forms, when compared to managers of commercial fields with a broader range of services on offer[44]. Since most New Zealand ski fields are not offering any summer recreation activities at the ski field location, most managers omitted the sampling form "water use for landscaping and summer activities" within "water resources". The response rate was significantly lower (19%) for this section compared with the overall response rate. Therefore, the section was excluded from the analysis.

6.1.3 Organisation of "Environmental Actions" Results

The structure of the "environmental actions" results part is outlined in Figure 13 to Figure 15 and the results are presented thereafter in three different sections. The first section, summarised in Figure 13, constitutes the most comprehensive part of the results. Here, detailed information on the implementation of 110 different environmental actions is presented. The actions are structured into four broad categories. Each category is sub-structured into four sub-categories and refers to a distinctive topic of resource efficiency (e.g. energy use of snowmaking). Each sample form exclusively refers to one sub-category.

[44] One commercial field does not rely on snowmaking and, consequently, did not fill in the two sample forms related to snowmaking.

Response Categories (1-4)	Sub-categories (=sample forms)	Number of actions	Results are compiled in[1]:
Water resources (4 sample forms)	Water use for snowmaking	7	Table 18 to Table 21
	Water use in facilities	4	
	Water quality management	7	
	Wastewater management	6	
Energy conservation (4 sample forms)	Energy use for facilities	16	Table 22 to Table 25
	Energy use for snowmaking	6	
	Energy use for lifts	4	
	Energy use for vehicle fleet	5	
Waste management (4 sample forms)	Waste reduction	5	Table 26 to Table 29
	Product re-use	4	
	Recycling	7	
	Potentially hazardous wastes	11	
General resource consumption (3 sample forms)	Planning, design, and construction	13	Table 30 to Table 32
	Air quality	8	
	Transportation	7	
	Total Number of Actions	110	
Summarising comments on "Environmental Actions"			

Figure 13: Organisation of Results I: **"Environmental Actions".**
1) Note: All results are presented in percent of valid responses for each single sub-category – NOT for the total sample.

Figure 14 provides a self-perceived assessment by managers of the overall degree of implementation of a single "sub-category" (block of actions on one sample form).

Response Categories (1-4)		Results are compiled in:
Water resources	Separate implementation rating for all four sub-categories	Table 33
Energy conservation	Separate implementation rating for all four sub-categories	
Waste management	Separate implementation rating for all four sub-categories	
General resource consumption	Separate implementation rating for all three sub-categories	
	Number of separate ratings: 19	
Summarising comments on "Implementation Levels"		

Figure 14: Organisation of Results II: Implementation Levels of "Environmental Actions".

Implementation levels are measured on a five point scale ranging from "not yet started" to "principles implemented". The single environmental actions are not rated separately, but in aggregation for each single response sub-category (=sample form).

During the development stages, involving many different North American ski industry stakeholder groups, the NSAA suggested that the implementation of environmental actions would potentially result in benefits for ski areas. The third section (Figure 15) provides results on how managers rated four potential benefits for each sub-category (sample form) given the actions were fully implemented.

Potential Benefits	**Response Categories**	**Results are compiled in[1]:**
Increased Monetary Savings	Water resources	Table 34
	Energy conservation	
	Waste management	
	General resource consumption	
Increased positive public image	Water resources	Table 35
	Energy conservation	
	Waste management	
	General resource consumption	
Reduced environmental impact	Water resources	Table 36
	Energy conservation	
	Waste management	
	General resource consumption	
Reduced regulatory liability	Water resources	Table 37
	Energy conservation	
	Waste management	
	General resource consumption	
Summarising comments on "Perceived Potential Benefits"		

Figure 15: Organisation of Results III: Perceived Potential Benefits of Fully Implemented "Environmental Actions".

The perceived potential benefit for "Increased Monetary Savings" is measured on a three-point scale ranging from "low" over "medium" to "high". The single environmental actions are not rated separately, but in aggregation for each single response sub-category (=sample form).
1) Note: All results are presented in percent of valid responses for each single sub-category - NOT for the total sample.

6.2 Water Resources

6.2.1 Water Use for Snowmaking

The form "water use for snowmaking" was completed by all sampled ski fields where snowmaking facilities existed (N= 4). In 2001, only nine commercial ski fields offered snowmaking facilities in New Zealand (Upjohn, 2001). Hence, a response rate of 44% was obtained for this sub-category. Overall, managers showed a high awareness that water use for snowmaking needs to be limited as much as possible. All ski fields monitored their systems to reduce water loss and monitored stream

levels to not over exploit the water resource. Since snowmaking is responsible for most of the potable water use of commercial ski areas an additional interview[45] of staff in charge of the snowmaking system at one of the commercial ski areas was conducted to better understand the responses presented in Table 18[46]. The interview revealed that, in contrast to the application of modern computer optimised and monitored snowmaking systems in Europe and North America, in New Zealand optimising efficiency and monitoring is a main task of the operational staff. Apart from high investment cost, it is at present not possible to install computer-monitored systems at New Zealand's ski fields, due to the varying climatic conditions and high winds in many alpine areas. Co-operation with other local water users and suppliers did not seem important with only one ski field co-operating with other local water users. This is an interesting result with respect to the drought summer preceding the 2001 ski season, which caused snowmaking water shortages at some South Island ski fields.

Table 18: Results in Overview: Environmental Actions Reducing Water Use of Snowmaking

Actions	**NO %**	**YES %**	**N/A %**	**N**
Using appropriate technology and equipment to optimise efficiency?	25	75	0	4
Inspecting and monitoring water systems to reduce water loss?	0	100	0	4
Using reservoirs or ponds to store water for use during low-flow times of the year and to maximise efficiency in the snowmaking process?	0	100	0	4
Working with local water users and suppliers to promote in-basin storage projects to offset low flow times of the year?	25	25	50	4
Installing water storage facilities to recapture snowmelt runoff for re-use?	0	75	25	4
Inventorying water resources and monitoring seasonal variations in stream flows?	0	100	0	4
Supporting and participating in research to ecological impacts of snowmaking?	50	50	0	4

The key result of "water use for snowmaking" is that staff fulfilled the comprehensive monitoring duties necessary to produce artificial snow efficiently rather than technical equipment. It was of high priority to managers to maintain their snowmaking systems to the highest possible standard, since they were aware of the high costs involved in inefficient snowmaking operation.

[45] The interview was recorded and transcribed. An informal analysis of the transcript was conducted. The transcript is not included in this thesis, since it contains commercially sensitive data of the examined operation.

[46] After the interview the operations manager supplied the researcher with a study comparing two different snowmaking systems in New Zealand. This study provided important background information to understand systematic characteristics of different snowmaking solutions, along with technical information on power demand, and performance indicators of snowmaking systems (Clarkson, 1996).

6.2.2 Water Use in Facilities

This sub-category has a high response of ten (see Table 19). Two club field managers omitted the sampling forms. One reported that there were no water consuming facilities at the field, while the other one explained that the water was taken from a mountain stream and returned after use via a "grease trap". The latter manager suggested that water usage in this case was non-consumptive and therefore there was no need to reduce its use or record the utilisation volume. In New Zealand, water comes at no direct financial cost and is usually not metered. This is one explanation for the high percentage of negative responses in this section (Table 19) and, hence, little action that was taken to minimise water use. Another explanation is that there are generally not many on-mountain facilities compared with North America and therefore, water consumption is limited anyway. However, 50% of all managers stated that they installed equipment that increased the efficiency of water use in their facilities Table 19).

Table 19: Results in Overview: Environmental Actions Reducing Water Use in Facilities

Actions	**NO %**	**YES %**	**N/A %**	**N**
Conducting water use audits and investigating methods and alternative technology to reduce water consumption?	50	30	20	10
Installing water efficiency equipment in facilities, such as low-flow faucets and toilets?	40	50	10	10
Participating in existing water conservation and linen and towel re-use programmes?	70	10	20	10
Educating guests and employees about the benefits of efficient water use?	50	30	20	10

6.2.3 Water Quality Management

Water quality management was an important aspect of ski area management to all respondents. This finding was supported by the fact that the two club field managers who omitted the sampling forms on "water use" and "water quality management" provided extra information on their measures to preserve water quality.

The variety of New Zealand's different ski field types may explain the even distribution of responses over all actions in this sub-category (Table 20). Analysing the ski field categories separately revealed that commercial ski areas seemed more aware of their responsibility in terms of

preserving the water quality. They accounted for most of the "Yes-responses", whereas the club fields undertook little action. One commercial field stood out in responding "Not applicable" to all actions. This indicated that the manager did not consider water quality management to be amongst his responsibilities.

Table 20: Results in Overview: Environmental Actions Enhancing Water Quality Management

Actions	**NO %**	**YES %**	**N/A %**	**N**
Participating in watershed planning, monitoring, and restoration efforts?	40	40	20	10
Using appropriate erosion and sediment control practices, such as water bars, revegetation, and planting?	30	50	20	10
Maintaining stream vegetation buffers to improve natural filtration and protect habitat?	20	50	30	10
Applying state-of-the-art or other appropriate stormwater management techniques?	40	30	30	10
Using oil / water separators in maintenance areas and garages?	30	30	40	10
Using environmentally sensitive de-icing materials?	20	30	50	10
Encouraging guests to follow the "Leave no trace" principles of outdoor ethics?	40	50	10	10

6.2.4 Wastewater Management

Twelve managers provided answers to the wastewater treatment form, a response that indicated a high awareness of wastewater management issues. Two results stand out (see row 2 and 6, Table 21): 17% of all sampled ski fields did not have appropriate wastewater treatment technology in place; and 42% of all managers at the sampled locations did not monitor the wastewater quality. The lack of monitoring could be explained by the fact that there are many septic tanks in use at New Zealand's ski fields. These do not require wastewater monitoring unless the tank leaks or the size is inappropriate to visitor volumes.

Fifty percent of the managers are already planning wastewater treatment with the local community. Due to large distances between ski fields and nearest towns, a connection to the municipal wastewater system is often not possible (92% rated this option inappropriate). Therefore, it seems likely that in the future on-site treatment plants (58% of all managers are exploring this technology) will be developed or improved in cooperation with the local community.

Table 21: Results in Overview: Environmental Actions Enhancing Wastewater Management

Actions	NO %	YES %	N/A %	N
Planning for present and future wastewater needs with adjacent communities?	8	50	42	12
Using appropriate wastewater treatment technology or alternative systems where appropriate?	17	75	8	12
Connecting septic systems to municipal wastewater systems where appropriate?	8	0	92	12
Exploring the use of decentralised or on-site treatment technologies where appropriate?	17	58	25	12
Re-using treated grey water for non-potable uses and appropriate applications?	75	0	25	12
Monitoring wastewater quality?	42	42	17	12

6.2.5 Summary of "Water Resource":

Among ski field managers, water is not considered a scarce resource, but managers are aware that water has to be managed appropriately. This applies in particular for water use of snowmaking, stream monitoring and run-off, with the former being most important to ski field managers. Wastewater management is an area of importance to all sampled managers (Table 21). Finally, personal communication with several ski area managers showed that there is usually no monitoring or metering of water use, which explains the poor quantitative results obtained in the benchmarking part at the conclusion of this chapter.

6.3 Energy Conservation and Use

6.3.1 Energy Use for Facilities

All respondents completed this section of the assessment (Table 22). In general, it was found that energy management at New Zealand's ski field facilities was not innovative. Many services at ski areas depend on fossil fuels, despite, for example, the Canterbury CMS (concession framework, DoC, 2000a) clearly favouring electricity or other clean fuels over fossil fuels. In the case of some ski fields, there was a connection to the national grid (electricity); however, more remote lift systems were still powered by diesel engines. Furthermore, diesel backup power generation is in place at some sites to reduce demand on the national grid; in particular to meet peak demand of running snowmaking systems. It was generally found that actions, such as the introduction of

modern and highly energy efficient equipment (e.g. solar heating systems: 92% "No-response" and 8% "Not applicable"-responses or fuel cell power generation technology: 67% "No-response" and 33% "Not applicable"-responses) were not considered a realistic alternative to the existing fossil fuel dependent equipment. Notwithstanding the above, the installation of modern equipment has considerable advantages compared with conventional energy solutions in remote settings (e.g. cost of connection to the national grid). Hence, considering the relative remoteness of most ski areas, it is a noteworthy result that few alternative options have been explored in New Zealand to this stage.

While innovative energy measures that require initial investment and that have long-term pay-back benefits were not taken up by ski field managers, low cost energy saving alternatives are applied more commonly (e.g. use of timing systems, low watt bulbs). Moreover, 58% of all managers are investigating their current energy management indicating that actions may follow in the future.

Managers rarely collaborated with institutions to assist with energy audits or subscribe to energy efficiency programmes, nor did they invest in alternative or more efficient technology. Main energy providers advertise electricity generated on New Zealand's South Island as renewable "green power". Interestingly, even those managers relying on water-generated electricity from South Island providers did not rate this a "green purchase". Most ski area managers considered the collaboration with institutions or energy efficiency programmes as "not applicable", despite EECA's recently launched energy efficiency strategy (2001).

Table 22: Results in Overview: Environmental Actions Reducing Energy Use in Facilities

Actions	**NO %**	**YES %**	**N/A %**	**N**
Auditing current usage levels and targeting areas for improvement?	33	58	8	12
Developing and energy management plan that addresses short and long-term energy goals, staffing, and schedules for new and retrofit projects?	50	42	8	12
Orienting buildings and their windows to maximise natural light penetration, deuce the need for artificial lighting, and facilitate solar heating and photovoltaic electricity generation?	67	33	0	12
Using solar heating and geothermal heat pumps for heating air and water?	92	0	8	12
Using timing systems, light management systems and occupancy sensors?	42	50	8	12
Performing lighting retrofits to provide more energy efficient lamps, retrofitting exit signs to use low watt bulbs, calibrating thermostats, and finetuning heating systems?	50	50	0	12
Using peak demand mitigation, distributed on-site power generation and storage, and real time monitoring of electricity use?	67	33	0	12
Working with utilities to manage demand and take advantage of cost sharing plans to implement energy savings?	42	33	25	12
Entering into load sharing agreements with utilities for peak demand times?	42	8	50	12
Partnering with Institutions to assist with energy saving and transit programmes?	30	0	70	10
Partnering with energy efficiency programmes?	40	0	60	10
Educating employees, guests, and other stakeholders about energy efficient practices	25	58	17	12
Installing high efficiency windows, ensuring that all windows and doorways are properly sealed, and using insulation to prevent heating and cooling loss?	42	42	17	12
Minimising energy used to heat water by using low-flow showerheads, efficient laundry equipment, and linen and towel re-use programmes?	25	50	25	12
Investing in cleaner or more efficient technologies for power generation, including wind, geothermal, and solar power generation, fuel cells and natural gas turbines, and generation from biomass residues and wastes?	67	0	33	12
Purchasing green power, such as wind-generated power, from energy providers?	58	0	42	12

6.3.2 Energy Use for Snowmaking

All managers of fields offering snowmaking provided answers to this form (Table 23). As pointed out in the previous section, managers have rarely invested in energy efficient new technologies. However, due to the high costs of snowmaking, managers claimed to put much effort into using the existing equipment as efficiently as possible. Furthermore, all managers claimed to use high efficient snow guns and air compressors. This is possible, since many ski fields have introduced or upgraded snowmaking systems only recently. Nevertheless, managers' perceptions of applying highly efficient snowmaking equipment would need verification of an independent audit.

The previously mentioned interview (see Water Use for Snowmaking, p.88) conducted with snowmaking staff at a commercial ski field provided further insight into some of the environmental actions related to energy use of snowmaking. Most ski fields have on-mountain ponds, at the ski field base level or lower, from where they collect water before the start of the snowmaking season. The water is pumped to the storage ponds from stream levels, using cheaper 'night' (off peak) electricity tariffs, if the field is connected to main power. On-mountain ponds decrease total energy consumption significantly since the water is cooled down (to near optimal operational temperature required for snowmaking) during the storage time on the mountain by the low temperatures at ski field base altitude level. Otherwise, cooling is commonly achieved by pumping water out of the supply (e.g. stream), compressing it, and feeding it into the snowmaking system. This process requires the operation of energy intensive compressors. The option of building ponds above the ski area at higher altitudes that would be suitable for gravity feeding of snowmaking systems may be unsafe at most locations in New Zealand, as scree-slopes are not stable enough to hold large quantities of water. For this reason, significant energy input is required to pump water from the pond level up to the snow guns.

Table 23: Results in Overview: Environmental Actions Reducing Energy Use for Snowmaking

Actions	**NO %**	**YES %**	**N/A %**	**N**
Using high efficient snow guns and air compressors for snowmaking operations?	0	100	0	4
Upgrading diesel motors or converting them to clean energy generation sources?	75	0	25	4
Using real time controls, sensors, and monitoring systems to optimise the system and to reduce electrical demand?	25	75	0	4
Using on-mountain reservoirs and ponds to gravity feed snowmaking systems where possible?	25	50	25	4
Using distributed on-site power generation to avoid or reduce peak demands from the utility grid?	75	25	0	4
Purchasing green power from energy providers?	100	0	0	4

6.3.3 Energy Use for Lifts

All twelve managers completed this sample form (Table 24). Conversations with ski field managers suggested that, after snowmaking, lifts are the second single largest energy consumptive operational activity of ski areas, and their operation constitutes the core business of ski areas. Since no separate

quantitative consumption data for lift operation was collected in the benchmarking part, this section is particularly valuable for understanding lift operation practices.

One quarter of all managers indicated that lift engines were in the process of being upgraded to clean (i.e. renewable) energy sources. One manager stated that renewable[47] energy was used to power his lift engines. These results require further research and seem to be in contrast with information on the lift facilities collected on sample form 23 "Resort Summary" and via personal communication with managers (ski area inventory, see Appendix 3 – "Facilities at Ski Areas"). The inventory of New Zealand's ski areas indicated that ski lifts are mostly overseas second-hand purchases. It could therefore not be expected that the motors are modern or energy efficient. It is therefore surprising that 75% of all managers claim to use highly efficient motors, considering that the average:

- gripe tow engine was built in 1961;
- rope tow engine was built in 1973;
- platter engine was built in 1981;
- t-bar engine was built in 1973;
- chair lift engine was built in 1985.

A European study showed that the average life span of ski lift systems is approximately 20 years (Bieger & Rügger, 1991; cited in Michel, 2001, p. 55). This would suggest that many lift systems in New Zealand require overhauling, upgrading or replacement in the near future. If this were the case, managers would have the possibility to introduce more efficient lift systems.

Table 24: Results in Overview: Environmental Actions Reducing Energy Use for Lifts

Actions	**NO %**	**YES %**	**N/A %**	**N**
Using high efficiency motors?	25	75	0	12
Upgrading diesel motors or converting them to clean energy sources, such as fuel cells or micro turbines?	67	25	8	12
Using renewable energy sources?	75	8	17	12
Purchasing green power from energy providers?	58	0	42	12

[47] It is not clear whether this manager considered electricity from the national grid as renewable, not keeping in mind that actually one third of electricity in New Zealand is thermally generated and therefore associated with considerable pollution.

6.3.4 Energy Use for Vehicle Fleets

Forty-five percent of all managers claimed to have an energy efficient vehicle fleet (4WDs, company cars, vans for staff transport, graders, bulldozers, trucks, snowmobiles, quad-bikes, and snow groomers/cats). This statement, however, needs to be looked at in more detail, since a substantial proportion (62%) of ski field vehicles are 4WDs with relatively large engine sizes (on average 3250cc) and at an average six years of age. Furthermore, none of the responding managers has considered the purchase of vehicles using alternative fuels (Table 25).

Table 25: Results in Overview: Environmental Actions Reducing Energy Use for Vehicle Fleets

Actions	**NO %**	**YES %**	**N/A %**	**N**
Providing shuttles or transportation for employees?	11	67	22	9
Providing shuttles or transportation for guests?	13	63	25	8
Using energy efficient vehicles?	33	45	22	9
Using alternative fuel or hybrid electric engines in ski area fleet vehicles, including shuttles, trucks, snow cats, and snowmobiles?	78	0	22	9
Conducting regular maintenance on fleet vehicles?	22	78	0	9

Staff and guest transport management was oriented toward collective transport, which is potentially more energy efficient than individual transport solutions (Table 25). The provision of such transport options, however, is not a guarantee for use. Therefore further knowledge on occupancy rates of public staff transport vehicles and public guest transport vehicles would be required (see Chapter 7 for results on public guest transport).

6.3.5 Summary of "Energy Conservation and Use"

The high response rates for this sub-category suggest that energy use and conservation are of importance to ski field management. Overall, it was found, however, that managers did not consider investment in new technology for all four energy related sub-categories. This is despite lift equipment being relatively old and therefore probably not very efficient. In contrast, it appeared that ski field managers take maintenance of equipment and engines seriously. This benefits the environment, since the number of incidents such as spills caused by leakages in oil and fuel systems could be reduced (personal communication with several ski field managers). New Zealand's National Energy Efficiency and Conservation Strategy (EECA, 2001) has so far not been well communicated to ski area managers. Additionally, there seems to be little exchange of information between energy authorities, research institutions and the ski industry.

6.4 Waste Management

Waste management seems important to all ski fields regardless of size and the degree of commercialisation. However, handling solid waste is relatively straightforward, because DoC/the RMA has legally limited base facility development at New Zealand's ski fields (Kaspar, 1992; Pearce, 1975). Hence, the problem of on-mountain waste generation is minimised in the first place. Environmental actions, such as purchasing recycled products are rarely undertaken. A generally low level of recycling in New Zealand may explain this.

6.4.1 Waste Reduction

The high percentage of ski fields that implemented "guest education programmes" on waste reductions seemed surprising (see row 5, Table 26). Such programmes were not obvious to the researcher when visiting some of the ski areas during the fieldwork.

Table 26: Results in Overview: Environmental Actions Enhancing Waste Reduction

Actions	**NO %**	**YES %**	**N/A %**	**N**
Conducting and audit of waste production to establish a baseline and track progress toward reduction?	55	27	18	11
Purchasing recycled products?	64	18	18	11
Purchasing products in bulk to minimise unnecessary packaging?	18	64	18	11
Encouraging vendors to offer "take-backs" for used products?	55	27	18	11
Educating guests and employees about reducing wastes generated at the area and following the "Leave no trace" principles, such as "carry out what you carry in".	27	73	0	11

6.4.2 Product Re-Use

Product re-use appeared to be a common practice at all ski fields (see row 4, Table 27). As pointed out earlier, the re-use of overseas lift facilities is an example of cost effective and at the same time resource efficient management. Nevertheless, there are drawbacks of reusing lifts, as mentioned earlier in this chapter in the context of possibly energy inefficient, old lift engines. Research in how to upgrade second-hand equipment (re-use of the material) to become energy efficiency would be useful.

Table 27: Results in Overview: Environmental Actions Enhancing Product Re-use

Actions	NO %	YES %	N/A %	N
Using washable or compostable tableware/silverware in cafeterias and lodges?	27	64	9	11
Encouraging guests to re-use trail maps?	55	9	36	11
Composting food wastes, grass clippings, and woody debris for use in landscaping and revegetation areas?	73	9	18	11
Exploring opportunities for re-using products (e.g. building materials, lift parts and equipment, and office supplies)?	18	82	0	11

6.4.3 Recycling

Several managers indicated that they considered the introduction of on-mountain recycling. Against this background, the very low percentage of managers (18%) who collaborated with local governments to implement recycling programmes is striking (Table). Ski fields dispose the solid waste generated on the mountain at the nearest community landfill. Most ski fields are adjacent to relatively remote communities with no recycling (e.g. Springfield) or only relatively recently recycling programmes (e.g. Methven). This situation suggests that if the ski fields were interested in introducing recycling, the managers would have to collaborate with the community responsible for the landfill, before planning on-mountain activities.

Table 28: Results in Overview: Environmental Actions Enhancing Recycling

Actions	NO %	YES %	N/A %	N
Making recycling easy for guests by offering containers and displaying signage in facilities and lodges?	36	46	18	11
Recycling office paper, cardboard, newspaper, aluminium, glass, plastic, and food service waste?	45	36	18	11
Recycling building materials as an alternative to land filling?	27	64	9	11
Partnering with local governments on recycling in remote communities where recycling programmes are not readily available?	64	18	18	11
Encouraging vendors to offer recycled products for purchase?	55	9	36	11
Educating guests and training employees on recycling practices?	36	46	18	11
Setting purchasing specifications to favour recycled content and specify a portion of new construction to require recycled content?	64	9	27	11

6.4.4 Potentially Hazardous Wastes

Table shows that managers perceive that hazardous wastes are handled carefully and in an environmentally responsible way. Most actions were already implemented by over 80% of all fields. For example, environmentally friendly "fuel management" and "equipment maintenance" was a priority to all managers. As mentioned above, such efforts result in reduced environmental damage through accidental spills.

Table 29: Results in Overview: Environmental Actions Enhancing the Handling of Potentially Hazardous Wastes

Actions	**NO %**	**YES %**	**N/A %**	**N**
Safely storing and disposing of potentially hazardous material, such as solvents, cleaning materials, pesticides, and paints?	10	80	10	10
Recycling waste products, such as used motor oil, electric batteries, tires, and unused solvents?	18	82	0	11
Re-shelving and re-using partially used containers of paint, solvents, and other materials?	0	82	18	11
Purchasing non-hazardous products for use when effective?	9	82	9	11
Properly manage fuel storage and handling?	0	100	0	11
Maintaining or upgrading equipment to prevent leaks?	0	100	0	11
Initiating programmes to reduce the occurrence of accidental spills or releases?	9	91	0	11
Installing sedimentation traps in parking lots?	36	27	36	11
Educating employees on the requirements for properly handling hazardous wastes?	0	91	9	11
Reclaiming spent solvents?	46	9	46	11
Coordinating with local area emergency planning councils for response in case of a spill or release?	18	55	27	11

6.4.5 Summary of "Waste Management"

Waste management is important to all ski field operators, and managers indicated that they already comply with several actions suggested in the Sustainable Slopes Assessment. Despite this, no structured attempts to assess current practices or to develop a waste management strategy have been undertaken so far. Again, there appears to be a lack of communication between local government and ski area management. The handling of potentially hazardous waste shows that communication and coordination with local authorities can be forced upon operations with an appropriate legal framework (MfE, 2000).

6.5 General Resource Consumption

General resource consumption refers to three specific issues that are closely related to resource consumption associated with ski areas. First, careful planning and design of new constructions, or upgrades and extensions to existing facilities, is important for the protection of the alpine environment and for the preservation of resources. Second, the experience and enjoyment of fresh, clear air is a major feature of any alpine activity. Therefore, ski fields should be interested in preserving air quality at the highest possible standard. Third, several studies conducted in Switzerland (Meier, 2000; Müller, 1999; Stettler, 1997; Trösch & Messerli, 2000) showed that transportation of staff and guests to the base of the ski field constitutes an important environmental problem. Ski field managers can execute some influence on the transport behaviour of staff as well as guests, for example by promoting public transport.

6.5.1 Planning, Design and Construction

Managers generally showed high environmental awareness regarding "planning, design and construction". This may be explained by New Zealand's concession requirement for ski area operations (see CCMS Chapter 5.4.2.8, DoC, 2000a, pp. 236-238). Amongst other requirements, extensions and new construction require the conduction of an Environmental Impact Assessment (EIA) (MfE, 1999b), which includes similar actions as shown in Table 30. Therefore, the high degree of compliance with the environmental actions proposed by the Sustainable Slopes Assessment is not surprising.

Table 30: Results in Overview: Environmental Actions Enhancing Planning, Design and Construction of Ski Areas

Actions	**NO %**	**YES %**	**N/A %**	**N**
Engaging stakeholders collaboratively on the sitting of improvements and the analysis of alternatives?	0	58	42	12
Complementing local architectural styles, scales, and existing infrastructure to enhance the visual environment and to create a more authentic experience for guests?	8	67	25	12
Respecting outstanding natural resources and "physical carrying capacity" of the local ecology in planning new projects?	8	75	17	12
Using simulation or computer modelling, such as visual modelling or GIS, in planning to assist with analysing the effects of proposals on key natural resources and view sheds?	58	17	25	12
Designing trails with less tree removal and vegetation disturbance where feasible?	0	50	50	12
Incorporating green building principles, such as using energy, water, and material efficiency techniques and sustainable building practices?	42	42	17	12
Using long-life, low maintenance materials in building?	9	82	9	11
Including parks, open space, and native landscaping in base area developments?	25	17	58	12
Seeking opportunities for environmental enhancement and restoration?	8	58	33	12
Maximising alternate transport modes in and around the base area?	25	17	58	12
Minimising road building where practical?	0	67	33	12
Selecting best management practices (BMPs) for construction sites with stakeholder input?	8	33	58	12
Applying sound on-mountain practices, such as over-snow transport techniques, storm water control, or phasing of activities to minimise disturbance to natural habitats?	0	83	17	12

Only 75% of all managers (Table) considered "physical carrying capacities" in planning new projects. This result has to be treated with caution, since no carrying capacities are specifically defined for ski area locations in New Zealand. Therefore, the result most likely reflects managers' perception or interpretation of physical carrying capacities. More qualitative research (interviews with several managers) would be required to gain full understanding of managers' interpretation/perception of a ski area's carrying capacity.

Furthermore, it appears that ski fields in New Zealand do not take full advantage of the knowledge on sustainable building and planning available today. Only 17% have considered the application of computer modelling in the planning process, and less than half of all managers considered green building practices or best management practices for new constructions.

6.5.2 Air Quality

Some of the actions were clearly not applicable to New Zealand's ski fields (e.g. "sweeping paved parking lots" or "dust abatement for dirt roads during summer use", Table). Only 36% of all managers claimed to take actions to reduce air pollutants and greenhouse gas emissions, and only 18% worked with local communities to reduce air quality impacts. Only 46% of all ski field managers are actively reducing air pollution, 36% did not take any actions, and 18% considered such actions as not applicable for their operations. Considering that clear air is a major attraction of alpine resorts and taking into account the amount of CO_2 emitted by ski fields, it appears that managers underestimate their impact on air quality. However, it is also possible that managers are constraint in their actions (financially or through lack of knowledge) and, therefore, further research was required to understand why only little actions are taken in this area.

Table 31: Results in Overview: Environmental Actions Improving Air Quality

Actions	**NO %**	**YES %**	**N/A %**	**N**
Reducing air pollutants and greenhouse gas emissions from buildings, facilities, and vehicles through clean energy and transportation related measures identified in these Principles?	46	36	18	11
Using dust abatement methods for dirt roads during summer operations and construction?	46	9	46	11
Revegetating as appropriate to control dust?	36	27	36	11
Reducing the sanding and cindering of ski area roads by using alternative de-icing materials?	27	18	55	11
Sweeping paved parking lots periodically?	9	9	82	11
Reducing burning of slash through chipping or other beneficial use?	18	9	73	11
Limiting wood burning fireplaces or using cleaner burning woodstoves and fireplaces and installing gas fireplaces?	27	36	36	11
Working with local and regional communities to reduce air quality impacts?	55	18	27	11

6.5.3 Transportation

New Zealand's ski field managers' active role in the area of transport management is mostly restricted to the promotion of public or collective transport opportunities (Table). Overall it appears that managers do not consider the transport of ski area visitors among their responsibilities. Trösch and Messerli (2000) supported this finding for Swiss ski field managers. No incentives are offered to increase further the number of people per car, as for example in the Sundance ski resort

in the USA where a free day pass is offered to every forth person in a private car. Most commercial ski fields in New Zealand experience shortage of on-mountain parking space during peak times.

Table 32: Results in Overview: Transportation Actions Supporting the Environmental Quality of the Community/Region

Actions	**NO %**	**YES %**	**N/A %**	**N**
Providing employee transportation benefits, such as shuttles, bus passes or discounts, van pools, and ride-share incentives?	14	72	14	7
Providing and promoting ski area guest transport through shuttles or busses?	29	57	14	7
Offering and promoting carpooling or high occupancy vehicle incentives for guests, such as discounts or preferred parking in proximity to lodges?	57	14	29	7
Offering and promoting non-peak travel incentives for guests, such as Sunday night stay discounts?	29	14	57	7
Increasing density in base area development when appropriate to reduce the need for vehicle use?	43	14	43	7
Supporting and participating in transit initiatives in the community and region?	33	17	50	6
Working with travel agents to market and promote "car free" vacation packages?	43	14	43	7

Few managers had considered collaborating with the community or travel agents to improve traffic management to the ski area. For example, Tranz Rail (New Zealand's railway operator) now offers special fares from Auckland, Wellington, Hamilton and Palmerston North to the ski areas on Mt. Ruapehu (Tongariro National Park). On the flyer promoting this offer, however, the Mt. Ruapehu ski fields are not represented.

6.5.4 Summary of "General Resource Consumption"

The resource consumption results showed that some single actions are in place; however, these actions may have been implemented for regulatory reasons. In the "planning, design and construction" section, for example, the RMA, CA, and the resulting legal requirements, such as the CCMS (DoC, 2000a), were responsible for ski field managers complying with the environmental actions. Elsewhere, it appeared that managers believed air quality management and transport management are only partly their responsibility. In most cases they did recognise potential to influence travel behaviour, for example, through offering incentives to increase the use of public transport modes or to increase car-pooling. Additionally, there is little co-operation of ski field managers with authorities or travel agents to promote more sustainable products and practices.

6.6 Overall Implementation Levels of Environmental Actions at New Zealand's Ski Fields

This section summarises the analysis of single environmental actions implemented at New Zealand's ski fields. In general, the results reflect the detailed findings presented in the "environmental actions" part of this chapter. Table provides an overview of the degree to which the principles outlined by the NSAA (see Appendix 5) are already implemented at New Zealand's ski fields. The ratings were given for each single sub-category or sample form measuring the perception of the manager independently from the rating of each single action. The results may require different interpretation than responses of North American ski area managers and the different context in which the questionnaire was administered to New Zealand's ski field managers need to be accounted for. The North American ski area manager endorsing the "Sustainable Slopes Charter" was in a position to work deliberately toward the implementation of the principles. The New Zealand manager, who has not seen the charter before participating in this research project, could only compare current operational practices to the outlined principles.

Table 33: Overall Implementation Levels of "Sustainable Slopes Charter-Principles" at New Zealand's Ski Fields.

Implementation Level in percent of valid responses (=N)	**Not yet started**	**Investigating, but no actions implemented**	**Some actions implemented**	**Significant progress made[1]**	**Principles implemented[1]**	**N**
Water Use for Snowmaking	0	0	50	25	25	4
Water Use in Facilities	50	0	30	20	0	10
Water Quality Management	33	11	22	22	11	9
Wastewater Management	27	9	18	9	37	11
Energy Use for Facilities	36	9	36	18	0	11
Energy Use for Snowmaking	0	25	75	0	0	4
Energy Use for Lifts	25	25	33	17	0	12
Energy Use for Vehicle Fleets	22	11	56	11	0	9
Waste Reduction	18	18	36	27	0	11
Product Re-use	22	11	56	0	11	9
Recycling	22	33	22	11	11	9
Potentially Hazardous Wastes	0	20	20	50	10	10
Planning, Design and Construction	0	0	50	20	30	10
Air Quality	56	11	22	11	0	9
Transportation	29	0	43	29	0	7

1) The shaded areas symbolise strong evidence for environmentally motivated action

Overall, most ski fields have "some actions implemented", which was an expected result, considering the comments made above. Clearly, energy efficiency measures are less implemented than other measures. "Energy conservation and use" is the only category, which did not receive any "all principles implemented" rating. This indicates that, relative to the preservation of resources (such as water and land/habitat) energy saving seemed less important to ski field management. The relatively low energy prices in New Zealand may be one explanation. Another plausible reason could be the absence of a clear causal connection between energy use and environmental impact in managers' perceptions of environmental damages. Damage resulting from, for example, fossil fuel combustion is not locally confined and most often "invisible". The existence of these impacts is still debated by researchers, as for example in the case of global warming resulting from the release of greenhouse gases into the atmosphere. The high implementation levels of the more "visible" environmental action categories, such as "wastewater management" or "planning, design and construction", support this assumption.

Implementation levels for measures to increase efficiency of snowmaking were higher than for other measures. The eagerness to increase snowmaking efficiency was credited to the high financial costs associated with producing man-made snow. The handling practices of potentially hazardous wastes were ranked on a similar level than snowmaking. In this case the legal requirement in handling hazardous wastes are assumed to be responsible for the high implementation levels.

6.7 Perceived Potential Benefits from Implementing Environmental Actions

This section complements the examination of the implementation of environmental actions presented in the previous section of this chapter. Four possible potential benefits that ski field managers could expected from future (theoretical) full implementation of the principles are analysed. The benefits that ski field managers were asked to rate were: "increased monetary savings", "increased positive public image", "reduced environmental impact", and "reduced regulatory liability". The results of "increased monetary savings" and "increased positive public image" (Table 34 and Table 35) constitute a qualitative measure of how likely ski area managers would accept the principles to be endorsed for New Zealand's ski area industry. The results of "environmental improvement" and "reduced regulatory liability" (Table 36 and Table 37) reveal the areas of resource consumption on which managers perceived they had to concentrate in order to become more resource efficient.

6.7.1 "Increased Monetary Savings" & "Increased Positive Public Image"

In general, managers perceived that some actions related to resource efficiency of operation would be economically beneficial. This does not apply to the more general actions related to "planning, design, and construction", "air quality", and "transportation", which managers did not rate economically beneficial at all (Table 34). It is surprising that water conservation measures for snowmaking were considered most beneficial to ski areas expenses, although there is no charge for water use. It is therefore assumed that this response refers to an increased efficiency of snowmaking in general. This assumption is, however, not supported by the results referring to potential monetary savings resulting from actions of the category "energy use of snowmaking". Managers did not expect an "increased positive public image" from the full implementation of the principles, with the "waste reduction" being an exception. In fact, all waste related topics are ranked higher than other categories. In contrast, managers did not perceive that energy saving measures could increase their public image, despite this category receiving the highest response rates. Finally, they judged the public awareness for environmentally friendly planning and construction (green building) as medium to high (Table 35).

Table 34: Rating of Actions Regarding Their Potential to Save Money

Potential Benefit Rating (in percent of valid responses for "Increased Monetary Savings")	**LOW** %	**MEDIUM** %	**HIGH** %	**N**
Water Use for Snowmaking	0	0	100	4
Water Use in Facilities	56	11	33	9
Water Quality Management	50	25	25	8
Wastewater Management	63	13	25	8
Energy Use for Facilities	20	20	60	10
Energy Use for Snowmaking	50	25	25	4
Energy Use for Lifts	40	20	40	10
Energy Use for Vehicle Fleets	14	43	43	7
Waste Reduction	13	50	38	8
Product Re-use	14	0	86	7
Recycling	43	43	14	7
Potentially Hazardous Wastes	29	14	57	7
Planning, Design and Construction	50	25	25	8
Air Quality	86	0	14	7
Transportation	0	100	0	6

Table 35: Rating of Actions Regarding Their Potential to Increase Positive Public Image

Potential Benefit Rating (in percent of valid responses for "Increased Positive Public Image")	**LOW %**	**MEDIUM %**	**HIGH %**	**N**
Water Use for Snowmaking	50	25	25	4
Water Use in Facilities	56	22	22	9
Water Quality Management	13	63	25	8
Wastewater Management	50	25	25	8
Energy Use for Facilities	40	30	30	10
Energy Use for Snowmaking	50	25	25	4
Energy Use for Lifts	50	30	20	10
Energy Use for Vehicle Fleets	57	43	0	7
Waste Reduction	14	0	86	7
Product Re-use	0	88	12	8
Recycling	0	57	43	7
Potentially Hazardous Wastes	33	50	17	6
Planning, Design and Construction	13	50	38	8
Air Quality	57	43	0	7
Transportation	0	100	0	6

6.7.2 "Reduced Environmental Impact" & "Reduced Regulatory Liability"

Ski field managers perceived that actions undertaken across all categories would result in medium to high environmental benefits (Table 36). In particular, the category "water use for snowmaking" was ranked important in terms of environmental benefits; 75% of all managers thought that implementing the proposed environmental actions would "highly" benefit the environment (Table 36). Managing water use for snowmaking would also reduce regulatory liability. Half of all managers thought that the actions would "highly" reduce regulatory liabilities (Table 37). It may be that this result is influenced by the extremely dry summer preceding the 2001 winter season.

In general, it was found that many of the actions listed in Table 36 were ranked "high" (with exception of "energy conservation and use"). This means that ski field mangers were convinced that if the "Sustainable Slopes" Principles were fully implemented, the environmental impact of their operations could be reduced. In contrast, many responses concerning regulatory benefits in Table 37 tend toward the "low" end of the scale, indicating that a full implementation would raise the benchmark of environmental performance beyond legal compliance. Taken together, the results indicate that managers perceived the "Sustainable Slopes Charter" could be a suitable tool to increase the environmental standards of New Zealand's ski area industry.

Additionally, the results shown in Table 36 exposed again the misunderstanding of the environmental impacts of energy use. Clearly, managers perceived that energy efficiency measures would benefit the environment less than increased water efficiency (incl. wastewater management) and better waste management. This misperception is in strong contrast to the quantitative resource use figures measured by this study (see section 6.8), revealing that the consumption of energy is amongst the most important impacts of New Zealand's ski areas. This is especially true for snowmaking.

The responses of managers concerning their regulatory liability have to be treated with caution. Preliminary interviews with ski field managers revealed, that only limited information on the legal requirements of the ski field development could be obtained from current management. Many current managers have not been involved in past assessment processes during the years of initial development. However, they seem to be informed about current conflict issues with conservation groups, DoC, or the local community (e.g. water quality standards, minimum flow level of streams, etc.). Managers and staff were particularly aware of the legal regulations of handling hazardous wastes, such as used engine oil, and they knew about their responsibilities in case of conservation accidents, such as oil or fuel spills (Operations manager Mt Hutt ski field, personal communication, 8th November 2001).

Table 36: Rating of Actions Regarding Their Potential to Reduce Environmental Impacts

Potential Benefit Rating (in percent of valid responses for "Reduced Environmental Impact")	**LOW** %	**MEDIUM** %	**HIGH** %	**N**
Water Use for Snowmaking	0	25	75	4
Water Use in Facilities	44	44	11	9
Water Quality Management	25	25	50	8
Wastewater Management	38	25	38	8
Energy Use for Facilities	50	10	40	10
Energy Use for Snowmaking	25	50	25	4
Energy Use for Lifts	40	30	30	10
Energy Use for Vehicle Fleets	57	29	14	7
Waste Reduction	0	50	50	8
Product Re-use	13	50	38	8
Recycling	0	57	43	7
Potentially Hazardous Wastes	0	17	83	6
Planning, Design and Construction	13	14	50	8
Air Quality	14	71	14	7
Transportation	0	67	33	6

Table 37: Rating of Actions Regarding Their Potential to Reduce Regulatory Liability

Potential Benefit Rating (in percent of valid responses for "Reduced Regulatory Liability")	**LOW** %	**MEDIUM** %	**HIGH** %	**N**
Water Use for Snowmaking	0	50	50	4
Water Use in Facilities	67	22	11	9
Water Quality Management	50	38	13	8
Wastewater Management	50	25	25	8
Energy Use for Facilities	70	10	20	10
Energy Use for Snowmaking	50	25	25	4
Energy Use for Lifts	70	20	10	10
Energy Use for Vehicle Fleets	86	14	0	7
Waste Reduction	50	50	0	8
Product Re-use	63	38	0	8
Recycling	71	29	0	7
Potentially Hazardous Wastes	33	50	17	6
Planning, Design and Construction	50	25	25	8
Air Quality	100	0	0	7
Transportation	67	33	0	6

6.7.3 Summary of "Perceived Potential Benefits"

In summary, ski area managers perceived that a full implementation of the "Sustainable Slopes – Principles" could benefit the environment and save costs. The analysis also revealed that managers judge the increased positive public image from implementing better practice as low to medium. In other words, managers perceived that skiers and snowboarders would not attach importance to the ski fields becoming more environmentally sustainable. Therefore, the researcher concludes that managers believe that not much "competitive advantage" could be gained from communicating excellent environmental practice in the area of water and energy management to skiers and snowboarders. In the light of the low perceived public environmental awareness for these areas, it seems unlikely that the skiers and snowboarders will put pressure on ski field managers to improve their environmental management in the near future. Thus, environmental certification providers, such as GreenGlobe21, have to focus on convincing managers that competitive advantage can be gained from participation in certification schemes regardless of public recognition. Waste reduction, on the contrary, is considered a potential area of increasing the public image of ski fields. This suggests that recycling schemes and waste reduction strategies could be implemented in the near future at New Zealand's ski fields.

Ski field managers believe that fully implementing the "Sustainable Slopes – Principles" to decrease water use for snowmaking would save costs, reduce environmental impacts resulting from man made snow, and, to a lesser extent, would reduce their regulatory liabilities. It remains, however, unclear why managers rated the potential cost saving benefits of water use in snowmaking so highly. All managers operating snowmaking systems (100%) claimed that they could save money if snowmaking water efficiency was increased. Considering that the consumption of water is free of charge, the researcher assumes that potential cost savings from reduced water consumption are rather associated with other components of the snowmaking system. There are, for example, reduced energy costs for water pumps and water compression. Additionally, via the reduction of water losses the amount of snowmaking additives leaking from the system before arriving at the snow gun is reduced. Snowmaking additives are extremely costly, and losses are, therefore, important to avoid.

6.8 Benchmarking

This section presents the results gained from the benchmarking part of the Sustainable Slopes Assessment. Single point estimates are provided for water use, energy consumption and solid waste production of ski fields. It has to be emphasised that in a masterate thesis the benchmarking key characteristic of continuous resource consumption monitoring cannot be fulfilled. However, the researcher considers the results presented in this section as an important starting point for continuous benchmarking of ski field operations in New Zealand.

6.8.1 Data Collection Results

For the energy consumption assessment (form 22 – "Energy Consumption") eleven valid responses were returned (41% response rate), whereas thirteen valid responses (48% response rate) were obtained for the water and waste assessment (form 22 – "Water Use" and "Waste Management"). In addition, a brief inventory of each ski area's vehicle fleet, lift operations and on-mountain facilities was conducted via the "Resort Summary" (form 23). The collected information included relevant energy related technical details, such as engine size and type of lifts and vehicles. All thirteen managers completed this section of the survey.

The sampling form "Visitor Numbers" (form 24) collected information on the total number of skier days for the 2001 season. Due to the commercially sensitive nature of this information, the

required information on visitor numbers was provided to varying degrees of accuracy. Since the accuracy of the information was critical for the calculation of per capita consumptions, the results obtained were validated with published total skier days of the 2001 season (Tourism News, 2001) for all commercial ski areas in New Zealand. The comparison showed that the accuracy of the provided data on visitor numbers was sufficient for the purpose of this thesis. Data limitations unique to each resource consumption area are explained following the presentation of the results.

6.8.2 Energy Consumption and CO_2 Emissions of Ski Areas in New Zealand

Resort based skiing in New Zealand covers a wide range of ski area types ranging from the very basic club field to the well-developed commercial ski areas, such as Whakapapa or Coronet Peak. Club ski fields generally provide on-snow accommodation (lodge/backpacker style), whereas commercial fields offer energy consumptive services such as snowmaking. These different characteristics make comparisons of the energy consumption results difficult and these should be executed with care. For this reason, averages are only presented for the single ski area categories in Table 39 (commercial and club). Only one response of the national commercial field category was obtained. Therefore, the two commercial categories were collapsed into one. The "heli/cat" field category could not be collapsed with any other category due to the significantly different nature of such fields.

Total Energy Use and COs Emissions

Total energy use at the commercial ski fields averaged about 8 TJ per year (Table 39). The difference between the highest consumer and the lowest consumer was only about 4 TJ (50%), despite the significant differences in visitor numbers at these two different locations (the smallest commercial field received about 19% of the skier days of the largest). For the commercial fields the variations from the average total energy consumption per year (0.32 TJ) was also around 50% with similar variations in skier days. Due to the low number of responses no standard error of mean is provided for each category.

Table 38: Total Energy Consumption and CO_2 Emissions of all Sample Ski Areas

SKI AREAS	Beds in lodge	Total energy use [TJ]	Total CO_2 [tonnes]	Total energy use for snowmaking [TJ]	Total CO_2 for snowmaking [tonnes]
Commercial 1[1]	40	7.37	499	2.48	170
Commercial 2	0	11.2	581	3.34	140
Commercial 3[2]	32	6.50	367	0	0
Commercial 4[3]	0	7.00	450	2.66	173
Club 1[4]	120	0.267	18.3	----	----
Club 2[5]	68	1.07	49.4	----	----
Club 3[5]	42	0.166	11.3	----	----
Club 4[4]	40	0.694	2.62	----	----
Club 5[5]	60	0.295	16.0	----	----
Club 6[4]	?	0.267	1.83	----	----
Heli/Cat[6]	14	0.195	12.5	----	----
Mean com.	18	8.01	474	2.86	161
Mean club	55	0.316	17	------	-----

1) A lodge is operated separately from the ski area; consequently energy figures of the lodge were not included in the consumption totals.

2) Energy consumption of the lodge is included, but does not contribute significantly to total energy consumption. The on-snow overnight accommodation is not a main attraction of the ski field. If maximum occupancy of the lodge were assumed over the whole season, the number of bed nights would account for only 2-3% of the total skier days. The researcher estimated that the maximum total lodge energy consumptions would amount to less than 2% of total energy consumption of the field.

3) For this field the fuel consumption data for the vehicle fleet and lift operation (diesel and petrol) was missing. The missing data was estimated and is included in Table 39. For detail on the estimation process see Appendix 2.

4) Energy consumption of the lodge is not included in these figures.

5) Energy consumption of a lodge is included and contributes significantly to total energy use. The on-snow accommodation is a main feature of this ski field.

6) Energy consumption (non-renewable) of the lodge is included. The lodge is equipped with a renewable on-site hydro power plant.

Data Limitations

The total energy consumption rates and CO_2 emissions depend strongly on the nature of each single operation. Not only do fields within different categories differ, but there are differences also between the categories. The results in Table 38 (and consequently in Table 39), therefore, need some detailed explanation. Each issue mentioned here was briefly summarised in the footnotes of Table 38. The most important issues were:

- The analysis of the energy data of "Commercial 4" raised the assumption that the fuel consumption for groomers and vehicles was not included in the provided information. This assumption was based on a comparison of the inventory data (sample form 23) and the energy data. Despite many petrol and diesel powered engine types, the ski field manager only provided diesel consumption for snowmaking. The missing data was estimated by comparing the business to similar operations featuring comparable characteristics. A detailed description is compiled in Appendix 2 – "Estimating Missing Data".
- In the case of the club fields the energy consumption figures for accommodation are sometimes included in the data and sometimes not. Ideally, the sampling of resource consumption of club fields would have required one separate sample form for ski field operation and one for accommodation. Personal communication with managers during a meeting of Canterbury's ski club presidents prior to the sampling period, however, indicated that most club fields do not keep separate records for operations and accommodation.
- Not every recreationist visiting a club ski field uses the accommodation facilities. Arguably, it could be assumed that the equal share of responses including (3 fields) and excluding (3 fields) accommodation resource consumption may reflect the average energy use of club fields.

Due to the low visitor volume of club fields these considerations can be neglected for the calculation of the total energy impact of New Zealand's ski area industry (Table 40).

Per Capita Energy Consumption and CO_2 Emissions

While the total energy consumption is important for a comparison of skiing as an industry with other industries, the per capita consumption and emissions of CO_2 allow comparison of the efficiency between various ski areas or other recreational activities. Per capita energy use as shown in Table 40 can also be understood as an energy intensity of ski area use. In the remainder of this thesis this "energy intensity" will be used to discuss the environmental impacts of skiing.

The mean and the median per capita energy consumption for commercial, club fields and the total sample were compared[48], and it was found that the data were not normally distributed. Therefore, the median appeared to be a better measure of central tendency.

[48] Mean (commercial)=115 MJ, Median (commercial)=75 MJ; Mean (club)=140MJ, Median (club)=107MJ; Mean (total)=135MJ, Median (total)=82MJ

Table 39: Per Capita Energy Consumption and CO_2 Emission Figures of all Sampled Ski Areas*

SKI AREAS	Beds in lodge	Total energy use per skier day [MJ]	Total CO_2 per skier day [kg]	Energy use for snowmaking per skier day [MJ]	CO_2 for snow-making per skier day [kg]
Commercial 1	40	263	17.8	88	6.1
Commercial 2	0	75	3.87	22	0.9
Commercial 3	32	39	2.22	0	0
Commercial 4	0	82	5.29	31	2.0
Club 1	120	53	3.66	----	----
Club 2	68	286	13.2	----	----
Club 3	42	161	11.0	----	----
Club 4	40	28	1.05	----	----
Club 5	60	295	16.0	----	----
Club 6	0	15	1.05	----	----
Heli/Cat	14	191	12.3	----	----
Mean com.	18	115	7	47	1.8
Mean club	55	140	8	-----	-----

* All data limitations explained for the results presented in Table 38 are still valid here. The per capita figures are directly calculated from the each field's total energy figures divided by visitor numbers.

The most important findings are:

- Club field per capita energy consumption varies because half of the sample includes lodge energy consumption and the other half does not. A comparison with other research on energy consumption of accommodation helps to explain the results. Becken, Frampton and Simmons (2001) showed that campgrounds in New Zealand consumed on average 25 MJ per person night and backpackers 39 MJ per person night. Huts were integrated in the campground category. Given the generally small visitor numbers at on-mountain accommodation, Becken et al.'s results suggest a low contribution of accommodation to the ski field's energy bill. This would, on average, almost double the energy consumption of the club field that did not provide lodge energy data (e.g. a mean of 32 MJ would increase to an estimated 71 MJ). However, the estimate does not explain why the energy consumption of the three other fields that provided the energy consumption of the lodge is much higher (247 MJ on average). Personal observation at club fields has shown that these operations use substantial parts of their lodges to cater for day visitors as "base facilities". For example, the ticketing office and shelter from bad weather or lunch facilities are usually provided within the lodge building.
- Commercial fields without the snowmaking facilities that at the same time attract many visitors (Commercial 3) consume very little energy per person.

- In contrast, a large contribution of diesel combustion seems to be correlated with a high overall energy consumption.

Estimating the Total Energy Impact of New Zealand's Ski Area Industry

The total energy use of the ski area industry is estimated based on the energy consumption of an average ski field and visitor volumes. Since there was a great difference between commercial and club ski fields, each mean total energy use was weighted by the respective visitor numbers (as shown in Table 40). The same calculation was undertaken for CO_2 emissions.

Table 40: Aggregated Figures of Total Energy Consumption for New Zealand's 2001 Snow Season

Ski area category	N	Median per capita energy use [TJ]	Total skier days	Total energy use [TJ]	Total CO_2 emissions [t]
Commercial	14	8.01	1,254,000[2]	112	6,640
Club	11	0.316	28,000	3.48	187
Heli/cat	2[3]	0.195	2,000	0.39	25
TOTAL	27	90[1]	1,284,000	116	6,850

1) The figure is calculated from Table 40 by dividing "total energy use" by "total skier days". Note that this figure differs from the mean for the sample population, since it is weighted according to total visitor numbers for New Zealand.

2) Source: Tourism New Zealand (2001).

3) The 3rd heli/cat field is neglected since business size is too small (personal communication with owner).

During the 2001 snow season, ski areas consumed 116 TJ and released 6,850 tonnes of CO_2 in the atmosphere. This equated to 0.02% of New Zealand's total energy consumption of the year 2000 (MED, 2001). Commercial ski fields accounted for 97% of the ski areas industry's total energy consumption, as well as its total CO_2 emissions. Snowmaking, a service only offered by some commercial ski fields, accounted for 39.6 TJ (or an equivalent of 2,260 tonnes of CO_2 emissions). Therefore, commercial ski fields used on average 35% of their total energy consumption for running their snowmaking systems (34% of all CO_2 emissions). On a per skier day basis this means that one single snow sport recreationist consumes 90.4 MJ of energy and releases 5.33 kg CO_2 into the atmosphere. The consumption of 30.8 MJ (34%) for snowmaking on average per skier day highlights again the importance of this single largest contributor to total energy consumption (equalling 1.76 kg of CO_2 emissions per skier day).

In Figure 16 the results of the energy consumption assessment are presented in detail. For each sampled ski field the per skier day energy use is broken down by fuel type. The chart clearly shows that the majority of the sampled ski fields' energy requirements are met by the combustion of fossil fuels. More specifically, diesel was the main energy source.

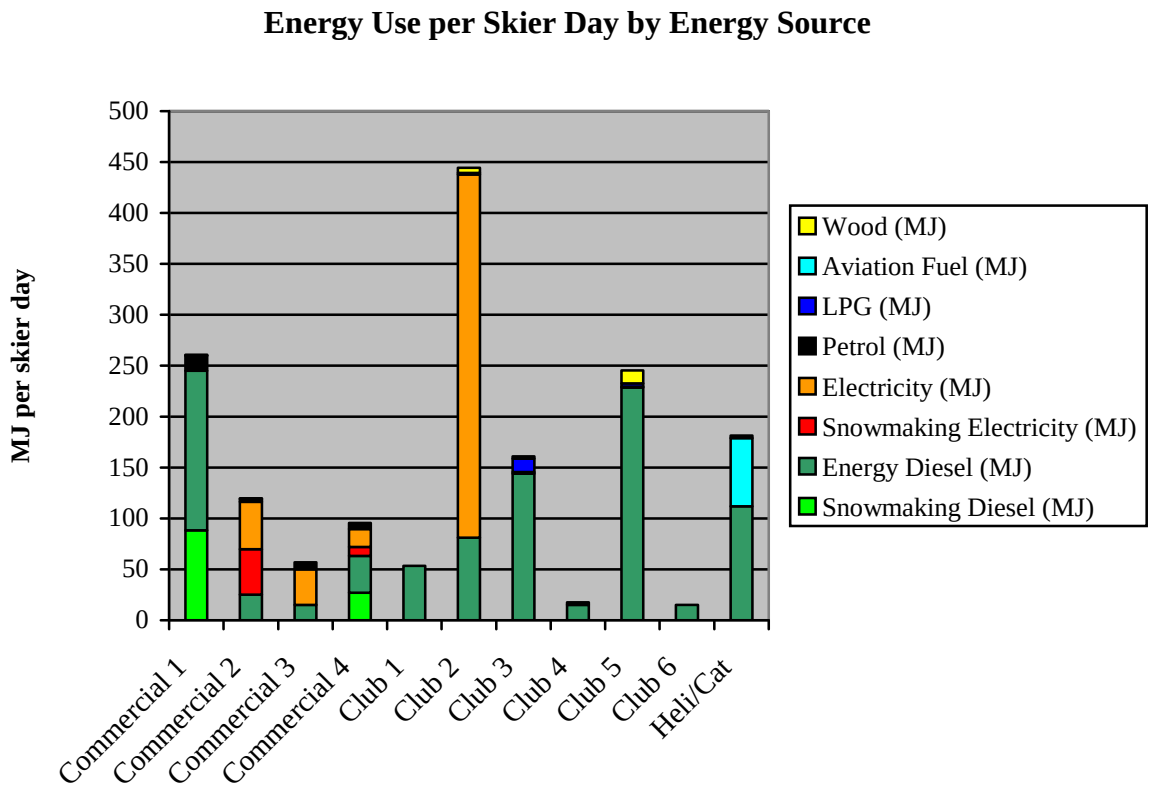

Figure 16: Summary Chart: Energy Use per Skier Day Broken Down by Fuel Sources in Megajoules.

6.8.3 Potable Water Use and Solid Waste Production

The results presented in Table 41 were collected through sample form 22 "Water Consumption" and "Waste Management". Metering water is uncommon for most New Zealand ski fields. Therefore, limited data on water use of facilities were available. In contrast, due to relatively accurate knowledge on volumes of water storage ponds and the energy demand of the snowmaking system, the figures on water use for snowmaking are commonly known to ski area managers.

However, none of the returned questionnaires included the exact water use figure. Also, the inclusion or exclusion of the accommodation facilities of club fields influenced the water consumption and waste production. This adds unknown inaccuracies to the following results.

Table 41 Potable Water Use, Solid Waste Production and Waste Recycling/Reduction

SKI AREAS	Beds in lodge	Water Snowmaking [10^6 litres/year]	Other Water Use Average [10^6 litres/year]	Waste Disposal [t/year]	Waste Reduction or Recycling
Commercial 1[1]	40	60 – 100	0.500	20-50	0% diversion
Commercial 2	0	60 – 100	?	20-50	0% diversion
Commercial 3[2]	32	0	4.50	20-50	6-10% diversion
Commercial 4	0	60 – 100	?	< 20	0% diversion
Commercial 5	0	> 100	5.20	51-100	0% diversion
Club 1[3]	120	0	?	20-50	6-10% diversion
Club 2[3]	68	0	?	20-50	21-50% diversion
Club 3[3]	42	0	?	< 20	1-5% diversion
Club 4[3]	40	0	?	< 20	11-20% diversion
Club 5[3]	60	0	?	< 20	5-10% diversion
Club 6[3]	0	0	0	< 20	0% diversion
Club 7[3]	75	0	0.200	< 20	21-50% diversion
Heli/Cat 1[3]	14	0	0	< 20	0% diversion

1) Lodge is operated separately. Therefore, no data on accommodation is included in these figures.

2) Size of lodge can be neglected in comparison to total business size.

3) Presumably, water use and waste production of lodge facilities are included in these data. It is unlikely that club fields keep separate record of water use and waste disposal for operation of ski field and lodge.

Assuming that the water and waste data encompass the whole business (clubs including accommodation) the following can be summarised: Commercial fields in New Zealand use around 100 million litres of water per season for snowmaking and another 3-4 million litres for the operation of other facilities. Additionally, they produce approximately 20-50 tonnes of solid waste per season, of which almost all is disposed in landfills. Recycling and waste reduction programmes have not yet been introduced at commercial ski fields.

Only one club field provided data on water use – not allowing any statement of average water consumption of ski clubs. Solid waste disposal is on average lower than 20 tonnes per year and clubs seem to recycle significantly more than commercial fields (at least 10% on average). This

means, that New Zealand's commercial ski fields used 950 million litres of water in the 2001 snow season. This quantity would fill a 1 m deep and 1000m x 950m wide pond.

Additionally, 300-700 tonnes of solid waste was produced on the mountain. The compacted solid waste mass would be equivalent to 0.12% - 0.28% of the total waste that was land filled in Christchurch in the year 1996[49]. Calculated on a per capita basis the average Christchurch resident produced 2.2 kg solid waste per day in 1996. In relation to this figure the 0.24 kg - 0.56 kg deposited on the mountain per the average skier or snowboarder visiting a commercial ski field in 2001 appears relatively high, given that the visitor will still produce some waste at home (e.g. breakfast and dinner).

[49] There are no more recent figures available on the Christchurch City Councils web site. The total land filled waste mass in 1996 was 254,293 tonnes. The population of Christchurch in 1996: 316,500 (Statistics New Zealand, 2002)

CHAPTER 7 – RESULTS PART TWO: SKIER AND SNOWBOARDER SURVEY

This chapter first describes the data collection illustrated at six Canterbury sampling ski fields. This is followed by the presentation of the results obtained by the skier and snowboarder survey. The results obtained from the fieldwork at these six ski areas are presented in four blocks. Firstly, "key characteristics" of the sampled population, such as demographics and trip specific statistics, are presented and analysed. The second block, named "facility dependency", analyses the importance of infrastructure and services provided by the ski area to the snow sport recreationist. In block three – "transport behaviour" – detailed results associated with ski area visitors' transport to the ski field are presented. This includes descriptive statistics of vehicle occupancy and choice of transport modes, and calculations of transport energy consumption. Results on "waste disposal behaviour" of skiers and snowboarders are presented in the fourth block. This part contains an evaluation of the waste composition at ski field location and details on possible waste minimisation strategies. This section complements the estimation of waste production presented in Chapter 6.

7.1 Data Collection

At Mt. Hutt, skiers and snowboarders were approached in and around the base facilities, including sun decks of the self-service restaurant and "brasserie". Towards the end of each sampling day the car park was also sampled to account for those visitor groups, who used the base facilities for short periods only (e.g. toilets, purchase of lift tickets, etc.). At Porter Heights sampling was mainly conducted in the car park area, due to limited restaurant facilities and the fact that many recreationists had a picnic lunch at their car. Randomly, throughout the day skiers and snowboarders were also approached in the restaurant to account for possibly different visitor types, i.e. increase representativeness. At the club ski fields, skiers and snowboarders were approached in the on-mountain lodges. In contrast to all other locations, surveys at Temple Basin were conducted in the evening after skiing or snowboarding, since generally recreationists stay over night due to the long walking access to the field. An overview of valid questionnaires obtained at each sample location is provided in Table 43.

Table 42: Sample Locations for Skier & Snowboarder Survey

Sample Locations	Ski Area Category	Valid Surveys [N]	Percent of total sample	Sampling dates	Snow conditions	Weather
Mt Hutt*	International Commercial	154	59.4%	26.09.2001 29.09.2001	Spring/ excellent Spring/ excellent	Sunny/warm Sunny/warm
Porter Heights*	National Commercial	61	23.6%	08.08.2001 16.09.2001 24.09.2001	Good Spring/good Spring/medium	Overcast Fine/some clouds Sunny/fresh
Broken River*	Club Field	7	2.7%	15.09.2001	Spring/ wet/ medium to poor	Rain/low clouds
Fox Peak*	Club Field	7	2.7%	25.08.2001	Spring/medium	Sunny/warm
Mt. Olympus*	Club Field	3	1.2%	24.08.2001	Good/wet snow	Overcast/low clouds
Temple Basin*	Club Field	27	10.4%	11.08.2001 01.09.2001	Powder/ excellent Spring/good/	Snow storm Sunny/warm
Total	----------	259	100.0%	[10 days]	----------	----------

*) See Appendix Three for a detailed description of all six sampling ski fields.

If recreationists consented to participate in the research, the questionnaire was briefly explained to them during distribution. The intention of surveying environmental attitudes was not discussed so as to prevent biases toward pro-environmental answers. If the respondents requested background information, they were told that ski area management was the general focus. The questionnaire was completed by the recreationists without guidance and was collected thereafter by the researcher. However, respondents were told to contact the researcher if problems answering the questions arose. Only five recreationists declined to participate, and another ten could not participate due to limited knowledge of English. All respondents refusing due to language problems were Japanese visitors at Mt. Hutt ski field. The assumption that the language barrier was the reason for their refusal was further supported by personal observation. It took up to 30 minutes for some Japanese ski tourists to complete the questionnaire, compared with most other respondents who required between 10-15 minutes for the same task. It is, therefore, likely that Japanese ski tourists were under sampled in this research[50]. Three more incomplete questionnaires had to be excluded from the data entry and analysis.

[50] Previous studies at Mt. Hutt ski field indicated that there was a significant share of Japanese visitors (24%, SAANZ Research Report, 2000).

Furthermore, there may be some limitations of the data since the sample days at Mt. Hutt ski field were relatively late in the season. This may, however, be outweighed by very favourable snow conditions in the 2001 season and the fact that the sampling period at the commercial fields fell in the Queensland school holidays, keeping the Australian visitor share at representative levels.

Two of the sample days coincided with the staging of special events attracting additional recreationists to the mountain:

- 29.09.2001 at Mt. Hutt: "Peak to Pub" multi-sport race (ski, mountain bike, run)
- 01.09.2001 at Temple Basin: Avalanche awareness course (not ski or snowboard specific).

It was assumed that these events did not substantially bias the results. The staging of special events is a common custom for recreation facilities to attract more customers. Thus, the sampled population, including the event visitors, can be considered representative for ski field visitors in general. Moreover, the percentage of people in the sample claiming to have visited the mountain specifically because of the event was relatively low compared with other reasons for both commercial fields (see Table 47).

Before the results are presented, a geographical description of the sampling ski fields illustrating the information on data collection is provided.

7.2 Key Sample Characteristics

Responses of the sample population are described from three different perspectives. First, general demographic data are provided. Second, information specific to skiing and snowboarding is analysed. Third, the reasons why people visited their ski field of choice are discussed. All results are analysed separately for the three sampled ski field categories to allow comparisons between them.

7.2.1 Demographic Profile of Sample Population

The visitors at the different sample locations did not differ significantly for "age" and "gender". The sampled populations differed, however, significantly for "qualification" and "occupation". It appears that club ski fields attracted a more even spread of all qualification and occupation groups. Professionals and visitors holding an undergraduate qualification were the largest visitor group at all fields, but the absolute percentages were significantly lower for club fields (compare Table 43).

The national commercial field (Porter Heights) was predominately used by New Zealanders, whereas the two other categories were also visited by international tourists. The high share of international visitors at the club fields (34%) is striking and may indicate that these locations were considered tourist attractions in the more common sense[51], worth visiting during a holiday. This assumption is supported by the analysis of "purpose of trip" (Table 44, p.127). Club fields received the highest number of visitors (36 %), who stated that skiing was not the main purpose of their trip. Therefore, it was concluded that club fields are seen as more than a pure ski location. It is possible that the opportunities for socialising (indicated in the "reasons to visit", Table 47, p.131) were more important at this location than skiing or boarding itself.

[51] This means, club fields are possibly visited as a New Zealand 'curiosity', comparable with, for example, jet boating.

Table 43: Demographic Profile

	Categories	Club Ski Fields	National Commercial Fields	International Commercial Fields	Total Sample	Test Pearson Chi-Square
Sample size		44	61	154	259	
Percentage		% within "club"	% within "nat. com."	% within "int. com."	% within all fields	
Age Groups	Not stated	2.3	0	1.3	1.2	F = 22.562 df = 14 p = 0.068
	<15	0	4.9	1.3	1.9	
	15-24	27.3	29.5	32.5	30.9	
	25-34	36.4	16.4	24.0	24.3	
	35-44	20.5	23.0	24.7	23.6	
	45-54	6.8	23.0	15.6	18.8	
	55-64	4.5	3.3	0.6	1.9	
	65-74	0	0	0	0	
	>74	2.3	0	0	0.4	
	TOTALS	100%	100%	100%	100%	
Gender	Not stated	0	0	1.3	0.8	F = 6.038 df = 4 p = 0.196
	Male	52.3	67.2	50.6	54.8	
	Female	47.7	32.8	48.1	44.4	
Occupation	Not stated	4.5	1.6	4.5	3.9	F = 26.424 df = 12 p = 0.009**
	Homemaker	2.3	6.6	5.2	5.0	
	Student	18.2	19.7	24.7	22.4	
	Professionals[1]	29.5	41.0	37.7	37.1	
	Service & Sales	9.1	0	13.0	9.3	
	Trades Worker	6.8	13.1	2.6	5.8	
	Other[2]	29.5	18.0	12.3	16.6	
	TOTALS	100%	100%	100%	100%	
Qualification	Not stated	4.5	4.9	2.6	3.5	F = 31.095 df = 12 p = 0.002**
	None	6.8	4.9	5.8	5.8	
	School	13.6	24.6	29.9	25.9	
	Diploma	13.6	4.9	7.8	8.1	
	Undergraduate	29.5	41.0	33.1	34.4	
	Postgraduate	15.9	13.1	20.8	18.1	
	Other	15.9	6.6	0	4.2	
	TOTALS	100%	100%	100%	100%	
Country of Origin	New Zealand	65.9	91.8	57.1	66.8	F = 35.927 df = 10 p < 0.001**
	Australia	9.1	3.3	27.9	18.9	
	United Kingdom	11.4	3.3	3.9	5.0	
	Japan	2.3	0	3.2	2.3	
	North America	9.1	1.6	4.5	4.6	
	Other	9.1	1.6	4.5	4.6	
	TOTALS	100%	100%	100%	100%	

*significant, **highly significant difference among types of ski field

1)Professionals comprise: Professionals and Technicians & Associate Professionals.

2)Other comprises: Unemployed, Clerks, Legislators & Administrators, Agriculture & Fishery Workers, Plant & machine operators & assemblers, Elementary Workers, Ski/snowboard professionals, Beneficiary, Retired.

The demographics of the sampled population at the international commercial field (Mt. Hutt) resemble those collected by the SAANZ (Ski Area Association of New Zealand) in 1999.

Compared with the more comprehensive data of the SAANZ study[52], the 25-34 age group was under sampled, while the 35-44 age group was over sampled by the survey presented here. Moreover, the Japanese visitor group has been substantially under sampled in this thesis. Japanese visitors made up only 2.3% of this sample population, whereas the ASSNZ study revealed a Japanese visitor share of 24% at Mt. Hutt ski field. Another study conducted by TNZ (2000) at five commercial South Island ski fields, however, only obtained a 13% share of Japanese visitors in 1999.

7.2.2 Skier & Snowboarder Profile of Sample Population

Ski Trip Key Statistics

The main ski trip characteristics of the sampled recreationists are presented in Table44 and Table45. The largest number of snowboarders in this sample was at the national commercial ski field. This is interesting because the location appeared least marketed for snowboarders[53]. The only plausible reason for the high snowboarder share, the author could think of (apart from random over sampling), is that teenagers of the visiting New Zealand families increasingly prefer snowboarding to skiing. If all sampling locations are considered, it can be assumed that snowboarders (24% of the total sample) are slightly under sampled, when compared with the 30% snowboarders reported by TNZ (2000).

Skiing and snowboarding participation levels were relatively high (25% claimed to ski or board between 7-14 days per year, while 31% claimed a participation of more than 15 days per year) compared with, for example, North American outdoor recreation participation trends showing a decline of people skiing more than 10 days per year between 1983 and 1995 (23% and 18%, respectively) (Cordell & Super, 2000). It was assumed that the results were biased by the recreationists' perception of how many days they would *like* to ski per year. This assumption was informed by the analysis of the number of days already skied in 2001 (Median = 5 days, compare Table45, p.128). Since the sample days were relatively late in the season, it was assumed that few further participation days would be possible in 2001.

[52] Due to a larger sample size and the more even spread of sample days over the whole season

[53] Informed personal observation: The author has worked as a ski instructor for the field in 2001 and had several casual communications on the marketing strategy of the field. Apart from that brochures and information material has also been reviewed during the preparation of the field work.

The introduction of cheap season passes[54] to the New Zealand market in 2001 was clearly reflected in the "field pass" result for Mt. Hutt. The season pass was by far the most popular field pass option, which is interesting considering the large proportion of overseas visitors to Mt. Hutt (23% of all international visitors at Mt Hutt skied with a season pass). Interestingly, multi-day passes at Mt. Hutt were as frequently purchased as day passes. Since such passes are mainly marketed in Australia, the result is likely to reflect the large number of Australian package tours to Mt. Hutt. Of the Australians 72% skied with a multi-day pass and 89% of all multi-day pass users of the sample population were Australians. At the other study locations day passes were the most used field pass.

The possibility that club fields are considered as tourist attractions by some visitors is further supported by an analysis of the "trip characteristic" (Table44). Not only were club fields often visited by weekend trippers (domestic), but they also attracted a large number of tourists (52%, Table44), many of them international. Additionally, a significant proportion of club field visitors (18%) also visited other ski areas on the sampled ski trip. A similar result was obtained for commercial fields (60% tourists, and 20% visiting another ski area), suggesting that the tourist population of club fields could potentially be similar to that of the international commercial field. In contrast, tourists did not visit national commercial fields as frequently as they visited the two other categories. Hence, the latter category was predominantly a day trip destination.

[54] Season passes were offered for NZ$ 299.

Table 44: Skier and Snowboarder Characteristics I

	Categories	Club Ski Fields	National Commercial Fields	International Commercial Fields	Total Sample	Test Chi-Square
Sample size		44	61	154	259	
Percentage		% within "club"	% within "nat. com."	% within "int. com."	% within all fields	
Snow Sport	Skier	61.4	55.7	63.6	61.4	F = 12.323 df = 6 p = 0.055
	Snowboarder	13.6	31.1	24.0	23.9	
	Both	4.5	8.2	3.9	5.0	
	Other	20.5	4.9	8.4	9.7	
	TOTAL	100%	100%	100%	100%	
Participation	< 3	15.9	24.6	16.9	18.5	F = 15.104 df = 8 p = 0.057
	3-6	15.9	27.9	23.4	23.2	
	7-14	29.5	31.1	20.8	24.7	
	15+	38.6	14.8	34.4	30.5	
	Not stated	0	1.6	4.5	3.1	
	TOTAL	100%	100%	100%	100%	
Field Pass	Day pass	40.5	59.0	23.5	34.8	F = 45.900 df = 10 p < 0.001**
	Season pass	7.1	24.6	37.9	29.7	
	Multi-day pass	31.0	1.6	22.9	19.1	
	Beginner pass	2.4	3.3	5.2	4.3	
	Other	19.0	9.8	9.2	10.9	
	None	0	1.6	1.3	1.2	
	TOTAL	100%	100%	100%	100%	
Trip characteristic	Day tripper	11.4	68.9	35.1	39.0	F = 66.773 df = 6 p < 0.001**
	Weekend trip	30.4	6.6	5.2	10.8	
	Tourists	52.2	24.6	59.7	50.2	
	TOTAL	100%	100%	100%	100%	
Purpose of Trip	Not stated	0	0	1.3	0.8	F = 8.325 df = 4 p = 0.080
	Snow Sports	63.6	83.6	79.2	77.6	
	Other	36.4	16.4	19.5	21.6	
	TOTAL	100%	100%	100%	100%	
Visit to other ski areas	No	81.8	88.5	78.6	81.5	F=15.104 df = 4 p= 0.057
	Yes	18.2	9.8	20.1	17.4	
	Not stated	0	1.6	1.3	1.2	
	TOTAL	100%	100%	100%	100%	

**** Significant …*** *****highly significant …*** ***difference among types of ski field***

Table45 reports trip length and the number of days skied during the trip. The sample population was further split into domestic and international skiers. The distribution shows that many international "ski tourists" have above average trip lengths (positively skewed), especially the

international club field visitors. It is possible that this result was biased by over sampling so-called ski bums[55] at Temple Basin ski field.

Table 45: Skier and Snowboarder Characteristics II

	Categories	Club Ski Fields	National Commercial Fields	International Commercial Fields	Total Sample	Test ANOVA (difference in means)
Sample size		44	61	154	259	
Not stated		1	1	11	14	
Days skied in 2001	Mean TOTAL SAMPLE	11	6	14	12	F = 3.423 df = 2 / 243 p = 0.034*
	Median	7	4	6	5	
No. of days skied per trip	Mean domestic visitors	2.14	1.36	1.79	1.71	
	Median domestic visitors	2	1	1	1	
	Mean International visitors	7.36	4.50	13.6	12.1	
	Median International visitors	7	4	6	6	F = 4.387 df = 2 / 243 p = 0.013*
	Mean TOTAL SAMPLE	4	2	7	5	
	Median Total Sample	2	1	3	2	
Length of Trip	Mean domestic visitors	2.93	1.96	2.97	2.62	
	Median domestic visitors	2	1	1	1	
	Mean International visitors	174	160	61	86.5	
	Median International visitors	96	15	11	14	F = 3.411 df = 2 p = 0.035*
	Mean TOTAL SAMPLE	61	15	28	30	
	Median Total Sample	3	1	6	3	

The results also demonstrated that in particular international visitors to New Zealand did not come for skiing only. International visitors to Mt. Hutt only skied for about half the days they stayed in New Zealand (based on the median as the appropriate statistic for positively skewed data). For the domestic market it was interesting to find that New Zealanders' mainly skied and boarded for one day only, except those visiting club fields, where visits were commonly for the weekend. This may have been due to the close proximity of the sampled ski fields to Christchurch.

[55] Devoted skier and snowboarder travelling the world in the search for snow, commonly on a very limited budget.

Recreationists' Terrain Preferences (Skill Levels)

Mill (2001) suggested that the distribution of skier abilities in an average North American ski area was 25% beginners, 50% intermediate skiers (comprising advanced beginners and good skiers), and 25% experts. Personal communication with various members of New Zealand's ski industry indicated that the same distribution could be assumed for commercial ski fields in New Zealand. The skill level of skiers and snowboarders could best be assessed by asking recreationists in what type of terrain they prefer to ski. In New Zealand, as in other countries, colours are used to classify the difficulty of ski runs. Green runs are considered suitable for beginners, blue runs for the intermediate skier, and black runs for the good to expert. The ungroomed terrain is for the expert only. Skiers are commonly familiar with this classification and usually rely on the designation when visiting new ski areas. Since every recreationist could specify as many preferences as wished, the percentages do not add up to 100%. Each nomination was considered in relation to the total sample population, for example, 80% of all 259 sampled recreationists did not like to ski on green runs; 20% regularly skied these runs, while less than 1% chose green trails as main runs (preferred).

Generally, no statistically significant differences were found for the terrain preferences among the three different ski area categories. Only the "off-trail" user percentage was significantly higher for the visitors of club fields. Considering that in the 2001 season none of the sampled club fields provided groomed terrain, the share of 37% of club field visitors, who did not prefer ungroomed terrain, was fairly high. In addition, only 12% stated that skiing or boarding the ungroomed snow was their most preferred terrain. This is even more surprising since most club fields advertise their "untracked powder" unavailable at commercial fields. Furthermore, 17% of the sampled skiers and snowboarders at all locations used or preferred terrain parks. Terrain parks are a relatively new "infrastructure service" and are commonly provided by commercial ski fields[56] (Table 48).

[56] The provision of a terrain park commonly requires expensive specialist grooming/shaping equipment, although it is possible to provide 'terrain park-like' facilities by manual work. This is often done at smaller NZ ski fields.

Table 46: Skier and Snowboarder Abilities Measured by Terrain Preferred

	Categories	Club Ski Fields	National Commercial Fields	International Commercial Fields	Total Sample	Test Chi-Square
Sample size		44	61	154	259	
Percentage		% within "club"	% within "nat. com."	% within "int. com."	% within all fields	
Green Slopes	Not liked	86.0	81.7	76.9	79.6	F = 7.518
	Used	11.6	28.3	23.1	20.0	df = 4
	Preferred	2.3	0	0	0.4	p = 0.111
Blue Slopes	Not liked	51.2	48.3	38.1	42.8	F = 4.043
	Used	44.2	43.3	51.0	48.0	df = 4
	Preferred	4.7	8.3	10.9	9.2	p = 0.400
Black Slopes	Not liked	55.8	46.7	51.0	50.8	F = 2.715
	Used	34.9	45.0	44.2	42.8	df = 4
	Preferred	9.3	8.3	4.8	6.4	p = 0.607
Off-Trail / Ungroomed	Not liked	37.2	58.3	68.7	60.8	F = 14.125
	Used	51.2	35.0	25.9	32.4	df = 4
	Preferred	11.6	6.7	5.4	6.8	p = 0.007**
Terrain Park	Not liked	95.3	75.0	82.3	82.8	F = 9.014
	Used	4.7	23.3	14.3	14.8	df = 4
	Preferred	0	1.7	3.4	2.4	p = 0.610

* significant …**highly significant … difference among types of ski field

7.2.3 Reasons for Visiting

The reasons why skiers and snowboarders visited their ski field of choice were considered important for this research. A Pearson Chi-Square Test between ski field categories (club, national commercial, international commercial) showed that there were significant differences between the field categories with regard to "reasons to come to the ski field" ($F = 106.934$, $df = 32$, $p < 0.001$) (Table47).

The key results from the analysis of the difference in motivations to come to the field among the three categories are summarised. The conditions were the most important pull factor for the total sample. Of all sampled ski field visitors, 19% claimed that the weather and good snow conditions were the main reason for visiting their field of choice. This was especially true for the international commercial field, which featured the best skiing conditions in the Canterbury region at the time of sampling. "Social" reasons (e.g. club work to meet other club members, family, or friends) were more important to club field users than for the visitors of the commercial fields. "Less crowded"

and "close" were more important to the visitors of the national commercial fields than to users of the other sampling fields. "Infra structure", "season pass" and "packages" were the most important reasons for the international commercial field visitors in total and in comparison with the other ski field users. "Price related" was very important for skiers and boarders at the national commercial field, important for club field users, and of little importance for the international commercial field visitors.

Table 47: Summary of Reasons to Come to the Ski Field by Ski Field Categories.

Summary categories	% within Club (N=60)	% within National Commercial (N=84)	% within International Commercial (N=199)	% within Total Sample (N=343)
n/s & n/a	3.3	2.4	0.5	1.2
less crowded	0.0	6.0	0.0	1.5
check out	1.7	0.0	2.5	1.7
professional visit	5.0	0.0	1.5	1.7
infra structure	0.0	2.4	4.5	3.2
favourite	5.0	6.0	2.0	3.5
fun/relax	5.0	2.4	4.0	3.8
environment	8.3	3.6	2.5	4.4
event	13.3	1.2	3.5	4.7
ski/board	8.3	4.8	4.0	4.9
price related	10.0	15.5	1.5	6.4
packages	1.7	3.6	9.5	6.7
season pass	0.0	10.7	12.1	9.6
social	25.0	10.7	9.0	12.2
close	0.0	27.4	15.1	15.4
conditions	13.3	3.6	27.6	19.2
TOTAL	100.0	100.0	100.0	100.0

The number of responses is larger than the sample size, because respondents named more than one reason for coming to the field.

7.3 Facility Dependency of Skiers and Snowboarders

7.3.1 Facility and Service Valuation

The survey instrument asked snow sport recreationists to rank the importance of 13 typical ski area facilities (and services) at the sample ski area. A "not applicable" option could be selected, in case the service or facility was not provided at the sampled ski area (e.g. chair lift at club field). During the analysis of the responses, it became obvious that some recreationists did actually rank the

general importance of a facility or service in question, independent of its existence at the sampling location. This means that these facilities and services (in the following charts marked with a frame) need to be treated with caution. For those recreationists who falsely ranked facilities and services, however, the answer can be interpreted as "wishful-thinking". This assumption was supported by a comparison with results obtained on "desired improvements" to the fields (Question 4-6), presented later in this chapter (compare Table49). Despite the uncertainty on recreationists' motivation to rank facilities and services that were not available, the collected information is considered valuable.

Figures Figure 17,Figure 18 and Figure 119 show the average valuation on a 7-point scale (1=unimportant, 7=very important) and the relative response rate for each single facility or service. The response rate is measured in relative frequency (0.00 – 1.00) of the total sample for each category. This means each facility or service has two bars, one indicating the average importance between zero and seven (light shaded), and another one presenting the response rate between zero and one (dark shaded). It was decided to discuss briefly those items ranking over five on average score, because these services were assumed to be important to skiers and snowboarders.

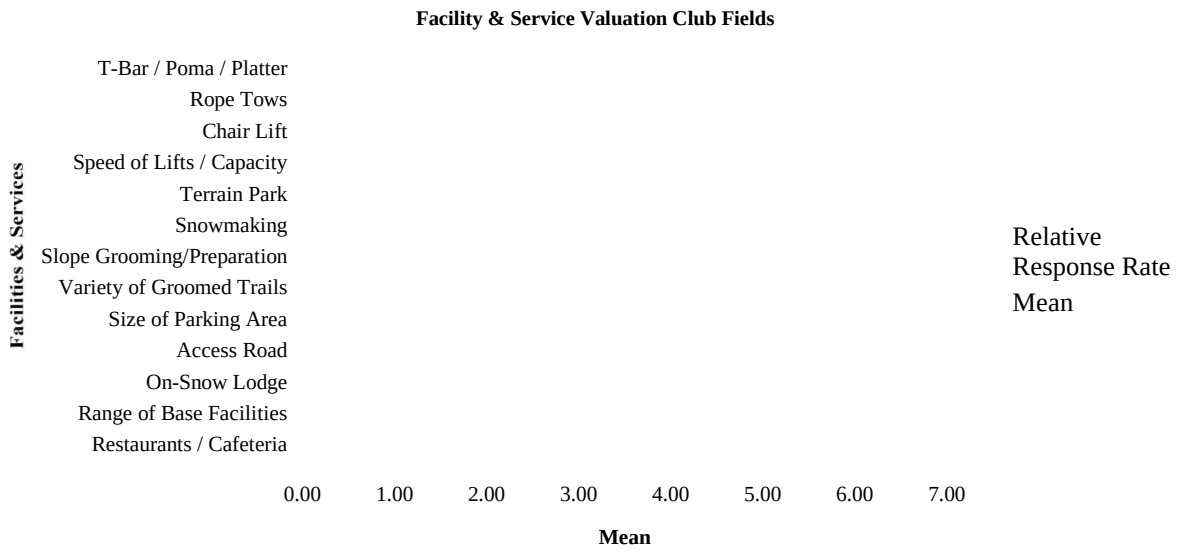

Figure 17: Importance of Facilities at Club Fields ($N_{(club\ fields)}$= 44).

The most important facilities and services to club field users were the on-snow lodge, speed of lifts, and the rope tow. The latter are a fast and efficient, but uncomfortable form of mountain transport (see Appendix 3 for more detail) common at club ski fields. The very high ranking of the on-snow

lodge emphasises the obvious need of club field users to socialise. It is probably justifiable to state that the existence of on-snow lodges is the most distinguishable characteristic of club fields compared with their commercial counterparts.

Some club field users wished that services available at commercial fields could also be offered at the club field. T-bar lifts were ranked relatively highly, although by fewer people than "trail services" (grooming & variety of groomed trails). Considering that club fields distinguish themselves from their bigger commercial counterparts on the basis of not providing trail preparation ("untracked powder"), these services were a latent demand ranking just over 3 on a seven-point scale. This confirms the results of the already presented terrain preferences of club field users (Table46).

For the national commercial field the number of items ranked over five was seven (see Figure 18). Since there is no chair lift provided at the sample location, it was concluded from the high ranking of this lift type (almost 5) that the customers would prefer this more comfortable mountain transport provided at the ski field. Despite the existence of an on-snow lodge, the importance of this facility at the "national commercial" location was low (under 3) compared with the club fields. The result is explained by the fact that almost 70% of all interviewed skiers at this location were day visitors. Overall, the response rates for most facilities and services were higher compared with the club fields, indicating the wider availability of facilities and services at the national commercial field. The most remarkable increase in importance could be found in the provision of typical ski infrastructure and services. Skiers' dependency on man made snow and groomed slopes is clearly visible in Figure 18, with all three related items ranked over 5. In summary, the analysis justifies the assumption that the sampled skiers valued the straightforward character of Porter Heights, being conveniently close to home and providing a cheap day trip skiing opportunity (Table47). It appears that they would value an upgrade of the skiing infrastructure rather than the more socially oriented facilities such as restaurants (only ranked at 3.5) and lodges.

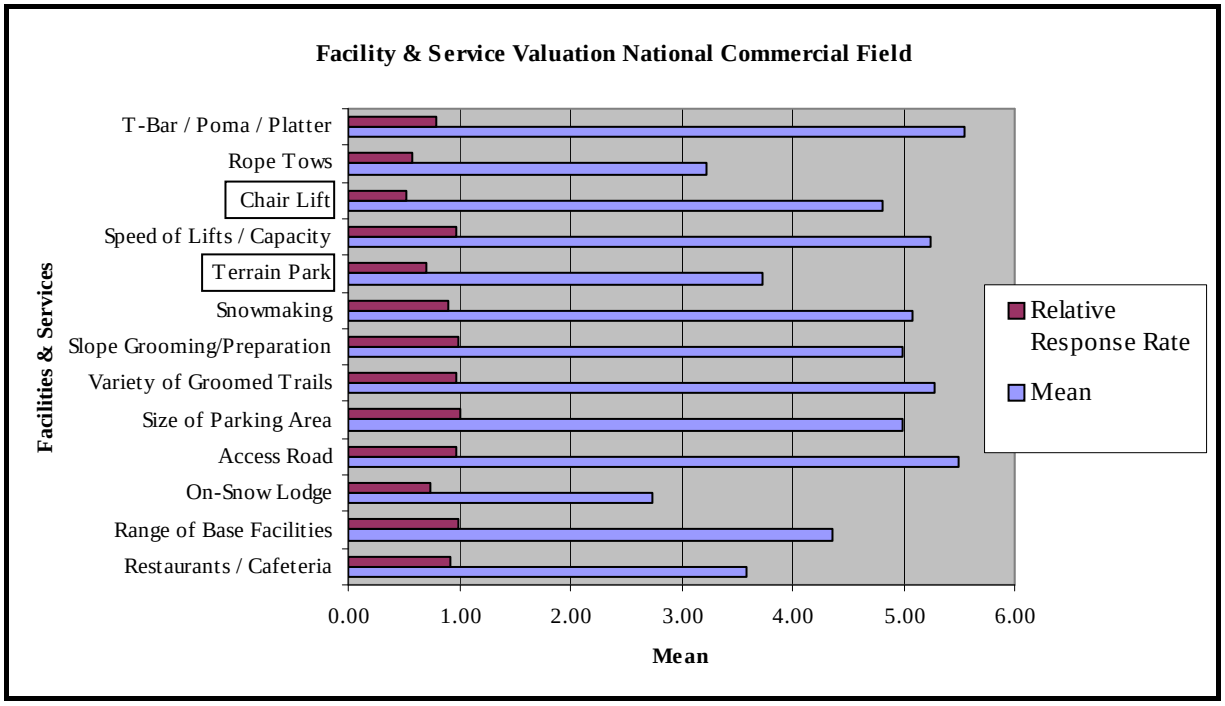

Figure 18: Importance of Facilities at the National Commercial Field ($N_{(national\ commercial\ fields)}$=61).

For the international commercial field, all the response rates were close to 100% (Figure 119). In contrast to the two other ski area categories, there are no single facilities or services that were rated as unimportant. All average ratings were over four (excluding the rope tow[57]), with ten out of thirteen having been ranked over five. Clearly, skiers and snowboarders valued most the two key components of the on-mountain product: Comfortable uphill transport (chair lift; ranked over 6) and good trail services (including grooming, snowmaking, and variety of groomed trails). As in the analysis of the terrain preferences (compare Table46), the terrain park was ranked as relatively important (over 4.5) by a large number of recreationists.

The access and the access road to the ski field was an important issue at all sample locations. Personal communication revealed that many visitors were not satisfied with current road conditions (including the absence of roads requiring walking access). The road was ranked fourth important at the club fields (although under 5), second important at the national commercial field and sixth important at the international commercial field (at both fields over 5).

[57] There are no rope tows installed at Mt. Hutt. It was assumed that many respondents confused this lift type with the handle tows provided in the learner area at Mt. Hutt.

The key components of ski fields in general are "ski slopes services" and "lift services" (Hudson & Shephard, 1998). The latter were always important at all categories of ski fields, whereas the importance of "ski slope services" increased from the club to the commercial setting. The facility and service dependence of skiers and snowboarders seemed to clearly increase from the club to the international commercial field. At club fields only three facilities and services were ranked important, whereas the number increased to seven and finally to ten for the national and the international commercial field. The high demand for well-prepared slopes suggests that skiing and snowboarding can probably no longer be considered a pure natural resource based outdoor recreation activity.

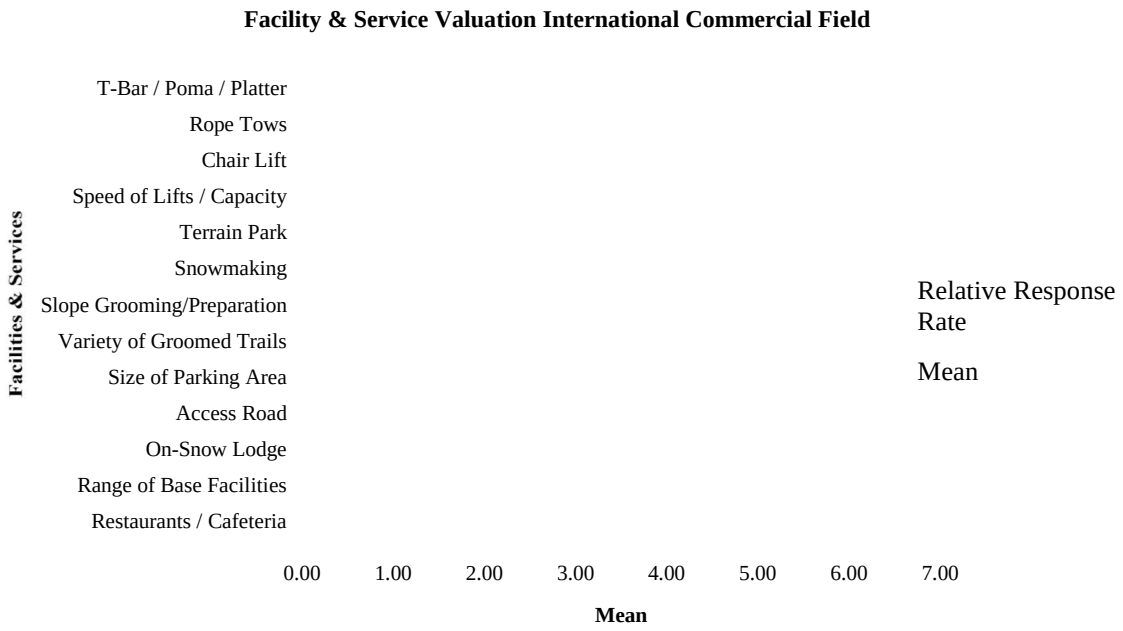

Figure 19: Importance of Facilities at the International Commercial Field ($N_{(international\ commercial)}$=154).

7.3.2 Desired Improvements of Skiers and Snowboarders

The analysis presented in the previous section suggests that through customer demand ski area providers may feel forced to offer either new or extended services. The provision of new services potentially increases the pressure on the alpine environment. To gain further insight into this threat, respondents were asked to name improvements that would make the ski area more valuable to them personally. In a second question they where asked if they would also be prepared to pay for specific improvements. It was necessary to code the initial responses (coding label) and categorise them into themes. Table48 compiles the final result of the coding and categorisation process.

It was decided to present the results for "desired improvements" for the total sample only, since differences between the three ski field categories were minor. Analysis of the responses revealed that 7% of all sampled ski area visitors were satisfied with the field and did not desire changes. Another 12% of visitors did not respond at all or their responses were considered not applicable (e.g. field needs more natural snow). Two single desired improvements stand out from the obtained valid responses. Of all responses, 10% referred to improving standard and safety of the access roads and another 10% of the responses referred to the desire that ski lift facilities were upgraded (compare bold print in Table48[58]). These results confirm that the infrastructure is amongst the most important features of a ski area. Further analysis of the remaining responses did confirm the importance of "ski slope services" and "ski lift services" (see italic print in Table48) found in the "Facility and Service Valuation" section prior to this analysis.

[58] 12% of all responses were either left blank or were classified as not applicable.

Table 48: "Desired Improvements" of Skiers and Snowboarders: Coding Labels and Themes

Themes	**Coding Label[1]**	**N**	**Percent[1]**
Price related	Season pass is to cheap	1	0.3%
	It is too expensive for what you get	8	2.2%
Access improvements	Improve access to learner facilities	1	0.3%
	Improve access to cafe	2	0.5%
	Improve access to the field = no walking access	10	2.7%
Environmental improvement	Improve sewage system	1	0.3%
Park & base	Improve parking facilities	13	3.6%
	Improve base facilities	15	4.1%
Road	**Improve access road (standard and safety)**	**36**	**9.9%**
Terrain & Ski Facility Management	Alter terrain to suit skiing.	6	1.6%
	Improve / offer terrain park	13	3.6%
	Improve learner facilities	14	3.8%
	Expand snowmaking	*6*	*1.6%*
	Increase uphill capacity	*23*	*6.3%*
	Expand ski area	*23*	*6.3%*
	Improve and increase grooming.	*23*	*6.3%*
	Upgrade lift facilities (etc. chair lifts)	**38**	**10.4%**
Food & accommodation	Build close and cheap accommodation	1	0.3%
	Build a café on top of the mountain (like Europe)	4	1.1%
	On-snow accommodation	5	1.4%
	Improve food and beverage services	10	2.7%
Service and products	Offer a pass for all Cantabrian ski fields	1	0.3%
	Improve the ski school	1	0.3%
	Improve the service provided by staff	1	0.3%
	Offer snow-playing facilities (tubing, etc.)	2	0.5%
	Improve on-mountain entertainment	3	0.8%
	Improve guest management (queuing, etc.)	5	1.4%
	Improve overall service	14	3.9%
	Provide more reliable information (snow report)	6	1.6%
	Improve toilet facilities	9	2.5%
	Offer shuttle transport up the mountain.	1	0.3%

1) Original responses were coded during data entry (=coding labels). The total number of coded responses (364=100%) exceeded the number of valid questionnaire (259), since respondents named more than one improvement.

The themes were then further classified into categories according to their potential resource use requirements. Table49 shows the three defined "Resource Use Requirement"-categories and specifies theme membership into the three categories. Resource consumption was defined as the increased use of energy, water, the increased production of solid waste, and increased pressure on

undeveloped land. It is acknowledged that the categorisation of snow sport recreationists' responses into broad resource consumption categories (Table49) was a subjective process. The results in Table49 show that the realisation of most proposed improvements would increase a ski area's resource consumption, unless more efficient technology was introduced.

The category "potentially increased resource consumption" comprises mostly improvements of the food and beverages services, and accommodation services. Especially, the demand for more on - snow accommodation and on-snow mountain cafes would require considerable resource input, unless the restaurants and accommodation units are managed more efficiently.

Table 49: "Desired Improvements" and Related Resource Consumption

Resource Use Requirements	**Themes**	**Percentage of Respondents**
Potentially increased resource use	Price related Food & accommodation	8.0%
Increased resource use	Access improvements Terrain & ski facility management	43.7%
Neutral / reduction	Service and products	11.8%
Special: potentially decreased resource use	Base & Parking Road	17.6%

It is interesting to note that while 81% of all respondents named some desired improvements, only 32% were prepared to pay for these improvements, and only 20% could specify how much more they would be willing to spend per day pass, if the specific improvement was realised. Some season pass holders (2%) could not specify a sum per day and provided a sum per season pass. The "per season pass" figures were scaled down to a "per day pass NZ$-sum", using information on the number of days skied in 2001. The average additional expenditure recreationists were willing to make for the different ski field categories are given in the bullet points below. The percentages refer to the 50 (=100%) respondents (20% of total sample) who specified a sum they were willing to pay for the identified improvements:

- Club fields: 32% of all respondents were willing to pay for improvements, namely on average NZ$ 7 more per day pass (Mean= $7.07 / Median=$5.0).
- National commercial field: 18% of all respondents were willing to pay for improvements, namely on average NZ$ 9 more per day pass (Mean= $8.56 / Median= $10.00).

- International commercial field: 7% of all respondents were willing to pay for improvements, namely on average NZ$ 11 more per day pass (Mean= $10.54 / Median = $7.18).

These results show that the less developed a field is, the higher the proportion of skiers and snowboarders who are willing to pay for specific improvements. However, the club field visitors were only willing to spend less than the average (average NZ$ 9, Table50), whereas the visitors to the international commercial field were willing to spend more than the total sample average. To analyse for which improvements ski field visitors were prepared to spend money, the NZ$ sums were cross-tabulated with the stated improvements. Table50 compiles the detailed results arranged according to "themes" and "resource use requirements".

Table 50: Cross-tabulation of "Sum Willing to Pay for Improvement" and the "Improved Item"

Resource Use Requirements	Themes	N	Percent of total sample (N=259)	NZ$ average per person and day pass
Increased resource use	Access improvements Terrain & ski facility management	34	13.1%	$7.33
Neutral / reduction	Service and products	11	4.2%	$14.1
Special: potentially decreased resource use	Road Base & Parking	6	2.3%	$8.10
TOTAL		50	20%	$9.16

In summary, about one third of all ski field visitors were prepared to pay more for an improvement in facilities to enhance their "mountain experience" (only 20%, however, specified a sum they were prepared to pay). This is significant proportion, and in combination with the indicated additional amount of NZ$9 visitors would be willing to pay, there seems to be some support for improvements at New Zealand's ski fields. However, visitors are not willing to pay per se for resource efficiency measures. Only one respondent was prepared to pay directly for an improved sewage system.

7.4 Transport Behaviour

7.4.1 Transport Modes

The results presented in Table51 show that the private car is the most important transport option for skiers and snowboarders. While this was expected, it was surprising to find that over 20% of all recreationists chose a public or other collective transport option. Although skiers and snowboarders at the different sample ski areas showed slightly different preferences in their

transport mode choices (Table51), the overall pattern of transport modes was similar for all locations. The most significant difference is the high proportion of skiers and snowboarders using the commercial coach at the international commercial field. This may be explained by the larger number of package trips, which include the public transport, at this location.

Table 51: Transport Modes Used

Ski Area Type →	**Club (N=44)**	**National commercial (N=61)**	**International commercial (N=154)**	**Total sample (N=259)**
Transport Modes ↓	% within club	%within nat. com.	% within int. com,	% of total sample
Private car	43.2	52.5	36.4	41.3
Rental car	2.3	3.3	9.7	6.9
Private 4WD/truck	34.1	34.4	16.2	23.6
Rental 4WD/truck	0	1.6	5.2	3.5
Rental campervan	0	0	3.9	2.3
Commercial minivan (max. 10 pass.)	4.5	1.6	5.2	4.2
Commercial coach (>10 pass.)	13.6	6.6	21.4	16.6
Hitch-hiking	2.3	0	1.3	1.2
TOTAL	100	100	99.4	99.6

Information on fuel types is provided for reference use in Appendix 2, and will be used for calculations later in the discussion chapter.

7.4.2 Vehicle Occupancies

The vehicle occupancy (persons per vehicle) is an important factor for the calculation of transport energy consumption. Moreover, it is important information for most New Zealand's commercial ski areas, as all have limited on-mountain parking space. Possible differences in the occupancy rate as a result of sample location have been tested using ANOVA[59]. No significant differences in the vehicle occupancies of the different transport modes could be found for different ski area types. Therefore, results are presented for the total sample in Figure 20. The "commercial coach" has to be treated with caution, because estimating the large number of people travelling on the same coach (up to 50) was expected to have been an unreliable and sometimes subjective measure. The coach occupancy was excluded in Figure 20, because it is much higher than the other occupancy rates. This would have resulted in a loss of detail in the chart.

[59] Private car (F=1.960, df=106, p=0.146), rental car (F=1.712, df=17, p=0.214), private 4WD (F=0.445, df=60, p=0.643), rental 4WD (F=0.368, df=8, p=0.563), commercial van (F=0.037, df=10, p=0.964), commercial coach (F=1.184, df=40, p=0.317).

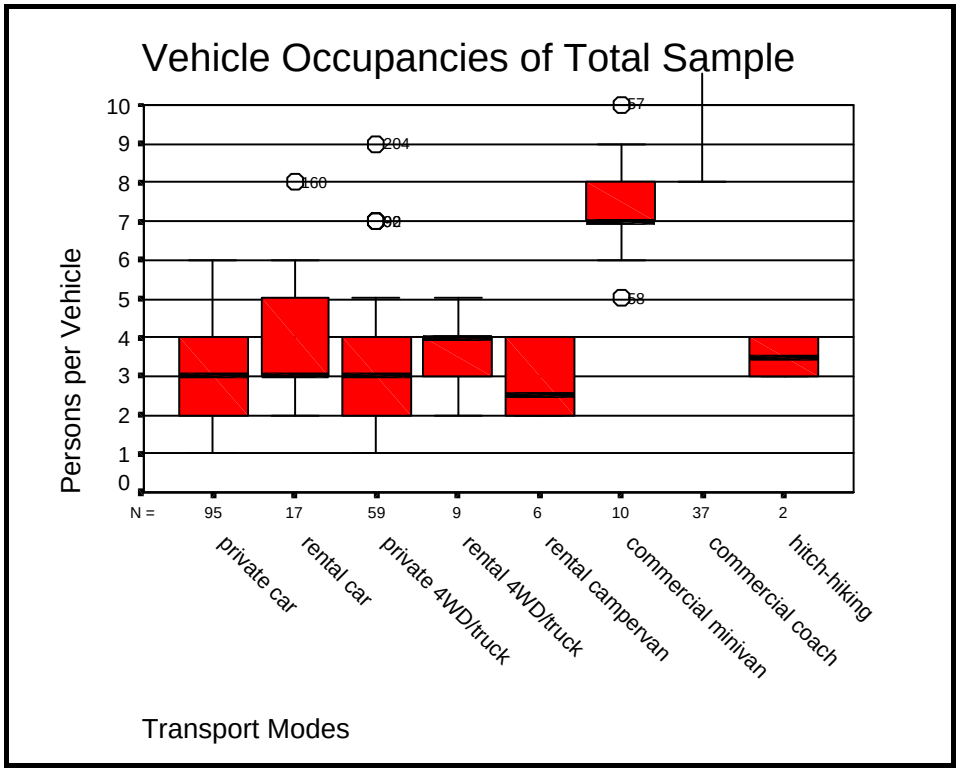

Figure 20: Vehicle Occupancies by Transport Modes.

The average occupancy of coaches in the sample was 29 persons per vehicle, ranging between a minimum of eight passengers to a maximum of 50.

7.4.3 Estimated Travel Costs

As for the occupancy, no significant differences for the estimated travel costs per passenger kilometre (costs/pkm) to the different sample locations could be found. However, due to different distances from villages and main population centres the total estimated travel costs per person and day vary for the different sample locations[60]. Figure 21 compiles the travel costs for each transport mode, as reported by ski field visitors. Additionally, the median distance (km) for per day "ski area transport"[61] is included for each transport mode.

[60] Club Fields: Mean=NZ$ 20 (Median=15); Nat. Com. Field: Mean= NZ$ 18 (Median= NZ$ 15); Int. Com. Field: Mean= NZ$ 16 (Median= NZ$ 12).

[61] 'Ski Area Transport' is defined in the Chapter 5 – Methods and should not be confused with "ski trip transport'.

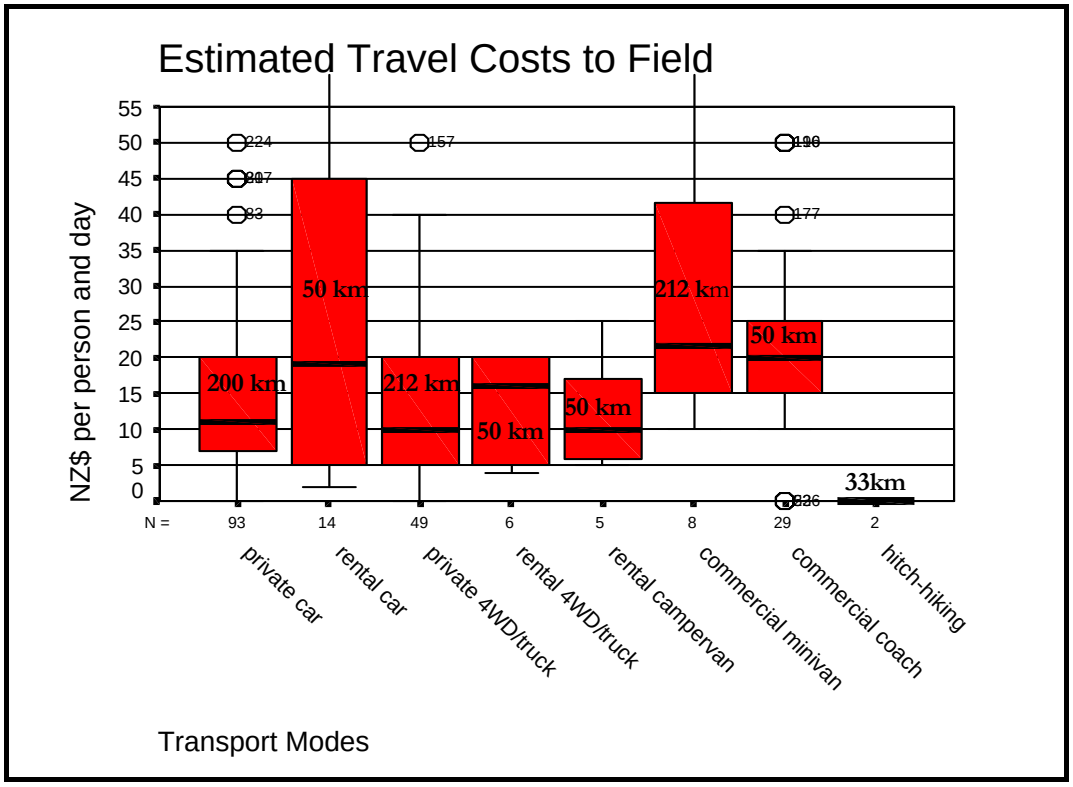

Figure 21: Travel Cost Per Person and Day Return Travel to the Ski Field by Transport Mode
The travel distances for the ski area transport given in the chart are medians. This in correspondence with the centre line of the box plots, which also represent a median.

The estimated transport costs per person divided by the distance travelled to the ski area provided the data for calculating the expenditures per passenger-kilometre (pkm) for "ski area transport". The calculations were separate for the different transport modes. Skiers and snowboarders perceived that they travelled at the following costs (mean and median in brackets):

- Private car: NZ$ 0.10 (0.06) per passenger-kilometre (pkm);
- Rental car: NZ$ 0.27 (0.38) per pkm;
- Private 4WD: NZ$ 0.09 (0.05) per pkm;
- Rental 4WD: NZ$ 0.48 (0.32) per pkm;
- Rental campervan: NZ$ 0.25 (0.20) per pkm;
- Commercial van: NZ$ 0.18 (0.10) per pkm;
- Commercial coach: NZ$ 0.33 (0.40) per pkm.

These estimated travel costs can be juxtaposed with real vehicle operating costs provided by the New Zealand Automobile Association (2002). The costs in the year 2001 for running a car with an

engine size over 2000 cc were 82.0c per kilometre. The costs comprised 19.7c running costs (fuel, maintenance, repairs) and 62.3c fixed costs (average value of vehicle, insurance, warrant of fitness, depreciation, capital costs). The average engine size of all private vehicles in the skier and snowboarder survey was 2246 cc, which may be explained by the above average number of 4WD vehicles used for travelling to ski fields. Considering the average occupancy of each transport mode (Figure 20) real vehicle operating costs per passenger kilometre can be calculated from the Automobile Association (AA) (2002) survey results. It is apparent that ski field visitors considerably underestimate real costs associated with their travel. The costs for public transport ("commercial costs", Table52) were calculated according to the transport prices of two typical ski field transport providers).

Table 52: Comparison of Estimated Costs with Real Travel Costs

Transport mode	Skier & Snowboarder Survey [cents/pkm]	AA survey "operating costs" [cents/pkm]	AA survey "running costs" [cents/pkm]
Private car	6c	27.3c (occupancy=3)	6.5c (occupancy=3)
Rental car:	38c	*Not reported*	*Not reported*
Private 4WD	5c	27.3c (occupancy=3)	6.5c (occupancy=3)
Rental 4WD	32c	20.5c (occupancy=4)	4.9c (occupancy=4)
Rental campervan	20c	41.0c (occupancy=2)	9.9c (occupancy=2)
		Commercial costs [cents/pkm]	
Commercial van[1)]	10c	16c (adult), 13c (child)	
Commercial coach[2)]	40c	44c (adult), 32c (child)	

1) This refers to "Snowman Shuttles" from Christchurch to Mt. Hutt return (250km at NZ$ 40 adult, NZ$ 32 child).

2) This refers to "Leopard Coachlines" from Methven to Mt. Hutt return (50km at NZ$ 22 adult, NZ$ 16 child).

The results suggest that recreationists have a good understanding what they paid directly for the transport to the field. In the case of private ownership, this reflects petrol costs only, whereas for the user of rental cars and public transport it appears to reflect the real costs. In summary, the results show that the short distance public transport solution (Methven - Mt. Hutt) is more expensive than the real private vehicle operating costs, which will prevent the switch of private vehicle users to public transport, as also concluded in a Swiss study by Trösch & Messerli (2000).

7.4.4 Calculating Energy Consumption

Analysis of energy consumption for travel to ski areas in this chapter focuses on the "ski area transport". Ski trip transport will be analysed in a separate section.

The energy consumption figures were calculated by multiplying the daily driving distances with the average energy consumption of each transport mode per vehicle kilometer (vkm) (Table53), divided by the occupancy rate for each valid response. The driving distances were taken from AA maps (1997). Since the sample ski field locations are not accurately marked on the AA maps, exact distances from the closest marked locations on the map to the ski area location was (a) measured personally on-site, (b) taken from the Brown Bear New Zealand Ski & Snowboard Guide 2001 (Upjohn, 2001) (c) measured from Topo Map Pro 2.0 (Map World New Zealand, 2002). The most direct distance along the "main route" as indicated by the AA road map was assumed[62].

Table 53: Energy Consumption of Various Transport Modes

Transport Mode I	Energy (MJ/km)	Transport Mode II	Energy (MJ/pass-km)
Private car	3.18	Cook Strait Ferry	2.4
Rental car	2.35	Train (pkm) (EECA, 1999)	1.44
4WD private & rental[1)]	4.48	Domestic air (EECA, 1999)	2.75
Campervan private & rental	4.54	International air (Lenzen, 1999)	1.75
Commercial van (max. 10 pass.)	3.22	Hitchhiking	1.03
Commercial coach (>10 pass.)	23.1		

(Source: Becken, 2002)
1) Own calculation; see Appendix 1 for details.

7.4.5 Energy Consumption Results of "Ski Area Transport"

Club Ski Fields

At the club field sample locations, each recreationists travelled per day

- Mean: 74 km (Median: 42 km), and consumed
- Mean: 116 MJ (Median: 53 MJ) diesel and petrol.

The energy use for "ski area transport" at the club ski fields is influenced by tourists visiting Temple Basin ski field. Most of these visitors stayed for several days on the mountain. Consequently, their "ski area transport" energy use was zero, since access to the field is on foot only. Overall, private cars and 4WDs were the most popular transport modes to travel to club ski fields. Energy use associated with the different transport modes is shown in Figure 28.

[62] An overview of all possible travel legs including distances is compiled in Appendix 1 – Calculating Transport Energy Consumption.

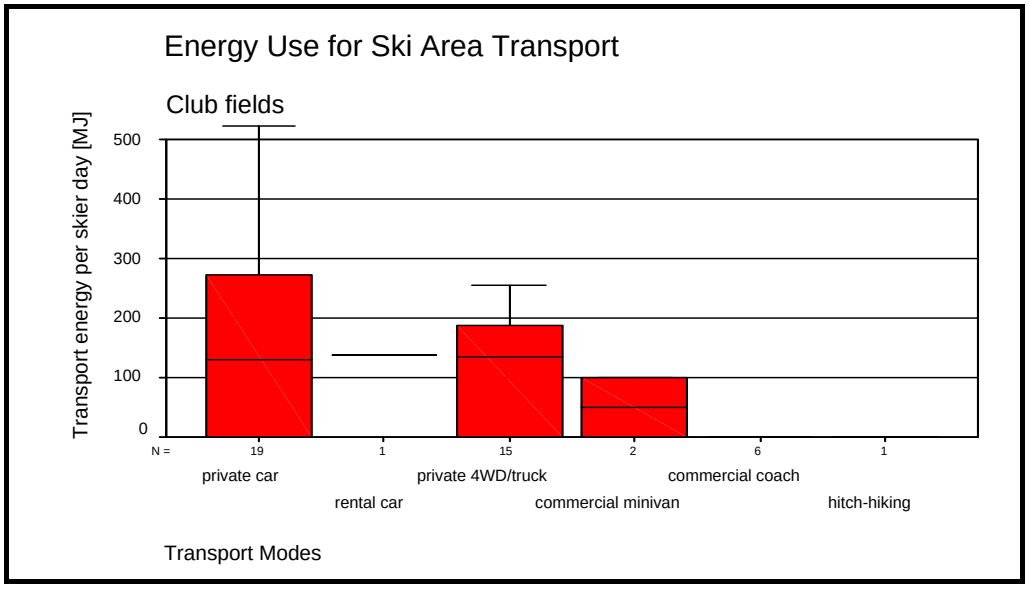

Figure 22: Energy Consumption for Transport Associated with Snow Sports at Club Fields (per person and transport mode).

Commercial Ski Fields

At the national commercial sample location, each recreationist travelled per day

- Mean: 182 km (Median: 212 km), and consumed
- Mean: 283 MJ (Median: 215 MJ) diesel and petrol.

At the international commercial sample location, each recreationist travelled per day

- Mean: 126 km (Median: 50 km), and consumed
- Mean: 168 MJ (Median: 84 MJ) diesel and petrol.

An average per passenger-kilometre energy use for the international commercial field was calculated from the above figures; the median energy use for travelling to Mt Hutt ski field is 1.06 MJ/pkm. Figures 29 and 30 show the distribution of energy use per skier day for the different transport modes. It can be seen from the boxplots that the data are not normally distributed.

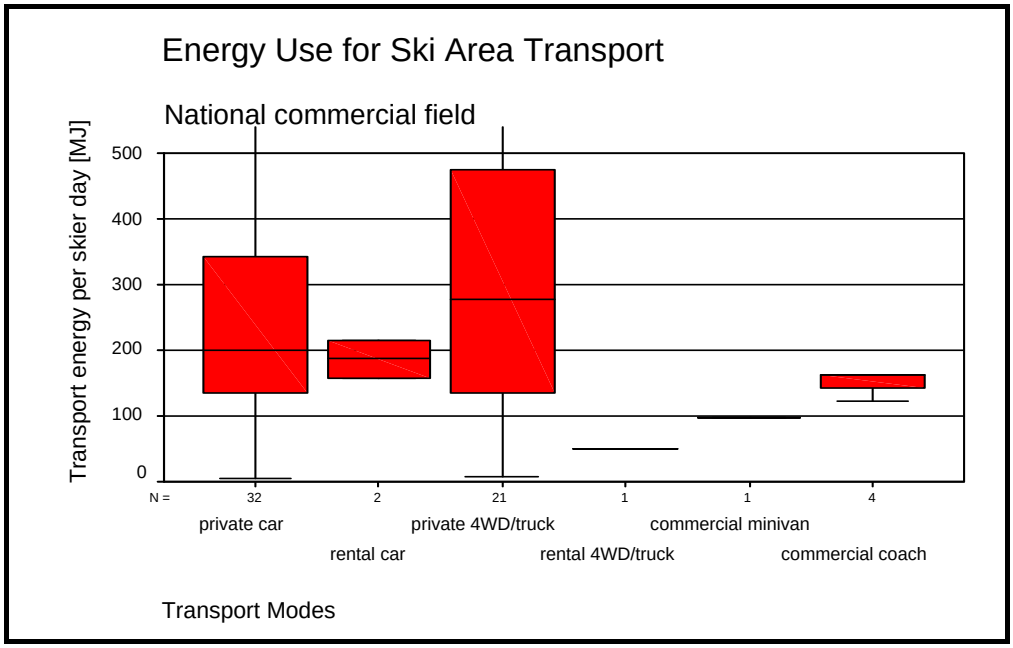

Figure 23: Energy Consumption for Transport Associated with Snow Sport at the National Commercial Field (per person by transport modes).

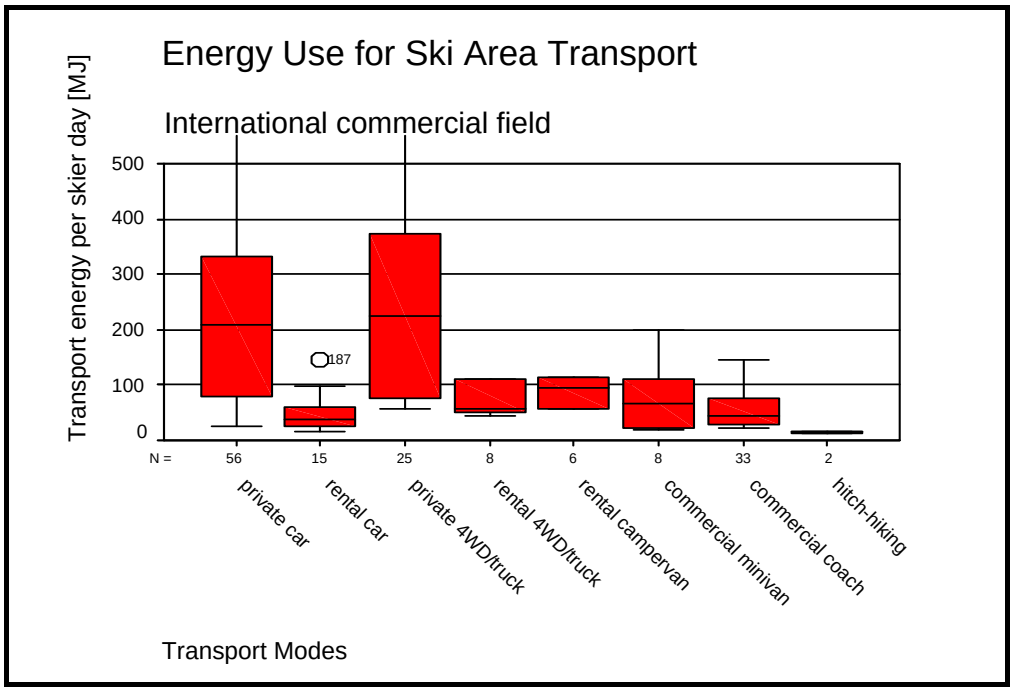

Figure 24: Energy Consumption for Transport Associated with Snow Sport at the International Commercial Field (per person by transport modes).

Of all skiers and snowboarders 87% came by private car or 4WD, and energy consumption was influenced by driving distance and occupancy rate. Christchurch was the main market for the

national commercial field, hence the typical driving distance was about 220 km per vehicle. It is noteworthy, that as a result of the high occupancy of rental cars, the average energy consumption per person for this transport mode almost equals that of an energy efficient coach.

In summary, skiers travel far to the ski fields and consume a considerable amount of energy. Driving up the 14 km long access road of Mt. Hutt ski field alone requires an energy input of 14.8 MJ on average. This energy consumption figure will be compared to alternative mountain transport options in Chapter 8.

Total Sample

Finally, an overall average distance and energy use for ski area transport was calculated from the collected information. The average snow sport recreationist in Canterbury travels per day and person:

- Mean: 143 km (Median: 124 km), and consumes
- Mean: 158 MJ (Median: 67 MJ) petrol and diesel[63]
- Per passenger kilometre energy use: Mean: 1.30 MJ/pkm (Median: 1.06 MJ/pkm)

CO_2 emissions were calculated based on the above figures for the total sample by using an average emission factor (67.4g/MJ) for a diesel and petrol mix as found in the skier and snowboarder survey. The average ski field visitor emitted 12.5 kg (median: 8.56 kg) of CO_2 per skier day. If this figure is projected to the New Zealand ski industry the CO_2 emissions amount to approximately 16,000 tonnes (11,000 tonnes) per year for "ski area transport". One important limitation of the above projection is that travel distances surveyed in Canterbury were assumed for other New Zealand ski regions (Queenstown and Ruapehu).

7.4.6 Energy Consumption Results "Ski Trip Transport"

The "ski trip transport" energy use was not analysed in the same detail as the "ski area transport", because it is less directly associated with the ski area itself. Other factors influenced the transport energy consumption of the whole trip, in particular for visitors whose main purpose was not skiing. The calculation of travel distances relied on a sketched itinerary outline on the back of the survey

[63] N (petrol) = 151; N(diesel) = 87.

form. Therefore, the "ski trip transport" energy consumption is understood as an estimate of the total transport energy consumption associated with snow sports. The measure is mainly interesting for the analysis of ski tourism. For this reason, the energy consumption for the "ski trip transport" was calculated for the three different trip types (day, weekend, tourist).

The "ski area transport" data were not normally distributed. This explains the significant difference between mean and median for the results (Table54). In the remainder of this thesis the median will be applied for further calculations and comparisons. If the international flight to New Zealand is excluded, the results show that the longer skiers stayed away from home, the more efficient their ski trip became. The day-tripper consumed 265 MJ for transport, while the weekend tripper consumed 189 MJ. The ski tourist usually staying close to the ski area only consumed 80 MJ per day. However, New Zealand's isolated location means that international tourists often travel long distances for their ski holiday. Hence, when the international flight is included in the calculation, energy use per ski trip day increases to 550 MJ. This also has a profound effect on the median of the total sample, which is increased to about 290 MJ transport energy consumption per day.

Table 54: "Ski Trip Transport" Energy Use Figures by Trip Characteristic

	"Ski Trip Transport" energy use per skier day (excl. international air) [MJ]	"Ski Trip Transport" energy use per skier day (incl. international air) [MJ]
Mean day	336	336
Median day	265	265
Mean weekend	207	207
Median weekend	189	189
Mean tourist	207	826
Median tourist	80	550
Mean total sample	258	571
Median total sample	180	293

It is not surprising that transport needs and, therefore, energy use differ for international and domestic ski field visitors. For this reason, these two key visitor groups are analysed in more detail.

7.4.7 Energy Consumption Comparison: International Visitors versus Domestic Visitors

Once in New Zealand, the international ski field visitor seemed to be energy efficient travellers as far as transport energy consumption was concerned. There is almost no difference between "ski area transport" and "ski trip transport" on a per day basis. This result is influenced by the length of

stay exceeding the number of ski days and consequently decreasing the per day "ski trip transport" energy consumption. However, the total distance travelled in New Zealand indicates that ski tourists travel less per day than domestic travellers. This results from a longer length of stay (1 day for domestic visitors and 14 days for international visitors, compare Table45). Generally, the drawn itineraries suggested that ski tourism seems to be confined to one or two regions of New Zealand. This is in contrast to most other forms of tourism in New Zealand.

Table 55: Comparison of Several Transport Statistics for International and Domestic Visitors

	Distance per skier day "Ski Area Transport" [km]	"Ski Area Transport" energy use per skier day [MJ]	Average total distance travelled in NZ (excl. domestic air) [km]	Average international air distance [km]	Average energy use for international air [MJ]	"Ski Trip Transport" energy use per skier day (excl. international air) [MJ]	"Ski Trip Transport" energy use per skier day (incl. international air) [MJ]
Mean domestic	165	245	399	0	0	354	354
Median domestic	212	199	250	0	0	265	265
Mean international	61	70	580	11,688	20,092	75	854
Median international	50	45	200	4,990	8,733	41	759

Regardless of travel within the skiing destination, the energy consumption per day of international ski tourists is always dominated by the international flight (Table 55). In this context, it should be remembered that Japanese tourists (refer to Table 43) might have been under-sampled by this study. Thus, the average "ski trip transport energy" could be even higher considering that the average flight to Japan is about 18,000 km or 32,000 MJ. This is well above the median for international air of the sample population (Table 55), which is dominated by Australian visitors.

After this excursion into broader analysis of tourists' transport energy consumption, the following more qualitative considerations will again focus on the "ski area transport" only. It is, for example, of interest why skiers chose different transport modes. This is important when transport behaviour is to be changed.

7.4.8 Reasons for Transport Choices

In general, private transport was found to be the most convenient solution for travelling to the field at all three different sampling field categories. Those skier or snowboarders using public transport alternatives did so mostly because they either did not have a feasible alternative or the transport was already pre-arranged (e.g. in a package). However, some users of public transport also stated that this was the most convenient option.

For a full discussion of transport alternatives, it is important to gain some insight into why recreationists used specific transport modes. To simplify the analysis, a distinction was only made between decisions for private transport options or public transport options. This can be justified by the main objective of this research, which was to find ways of minimising resource consumption of skiing. It is generally acknowledged that public transport options are more energy efficient than a comparable private transport option (provided the occupancy rates of the public transport are high). Moreover, public transport might be easier to manage than individual alternatives (parking space, etc.). The detailed results for each ski field category are presented in the following tables.

Table 56: Reasons Stated for Transport Mode Choice: Club Field Users

Club Fields: Transport choice reason	% within private transport (N=41)	% within public transport (N=10)	% within total (N=51)
fastest option	5	0	4
most convenient option	24	30	25
most flexible option	10	0	8
no other option feasible	10	10	10
ownership	7	0	6
pre-arranged transport	12	0	10
not stated	32	60	37
TOTAL	100	100	100

Table 57: Reasons Stated for Transport Mode Choice: National Commercial Field Users

National Commercial Fields: Transport choice reason	% within private transport (N=67)	% within public transport (N=5)	% within total (N=72)
fastest option	3	0	3
most convenient option	51	0	47
most flexible option	3	0	3
no other option feasible	4	20	6
ownership	12	0	11
pre-arranged transport	1	80	7
Not stated	25	0	24
TOTAL	100	100	100

Table 58: Reasons Stated for Transport Mode Choice: International Commercial Field Users

International Commercial Field: Transport choice reason:	% within private transport (N=134)	% within public transport (N=45)	% within total (N=180)
fastest option	4	0	3
most convenient option	41	18	35
most flexible option	16	4	13
no other option feasible	2	20	7
other	7	4	6
ownership	3	0	2
pre-arranged transport	1	33	9
Not stated	27	20	26
TOTAL	100	100	100

7.5 Waste Disposal Behaviour

The questionnaire included five questions concerning the disposal of rubbish at ski fields. Some skiers and snowboarders seem to take it for granted that services offered in urban environments are also available on the mountain. The provision of waste disposal facilities is among those services. The questions posed in the survey intended to explore whether skiers and snowboarders were prepared to take over some of the waste disposal responsibilities. This is, for example, common to tramping, since only few recreationists in New Zealand would expect rubbish bins along tramping tracks. Consequently, the first question asked what skiers and snowboarders would think about a ski field not providing rubbish bins. The results, analysed by the different sample locations, are compiled in Table 59. The results clearly showed that despite the majority of people being willing to carry their rubbish home, they were not convinced to do so by simply not providing any rubbish

bins. This is true across all ski field categories. Even users at the less developed club fields would interpret the non-availability of rubbish disposal opportunities as poor service. Overall, 90% of the sampled visitors found that it is the responsibility of ski area management to provide rubbish bins.

Table 59: Opinions on Ski Field Management Not Providing Rubbish Bins

Opinion on no rubbish bins provided	% within Club (N=44)	% within National Commercial (N=61)	% within International Commercial (N=154)	% of Total Sample (N=259)
"poor service"	59.1	75.4	74.4	72.2
"innovative management"	9.1	8.2	5.8	6.9
"management does not care"	18.2	13.1	13.0	13.9
"nothing"	9.1	3.3	3.2	4.2
not stated	4.5	0	3.2	2.7
Total	100	100	100	100.0

The New Zealand environmental care code published by DoC (2001) suggests for outdoor recreation activities that rubbish is not left in the natural environment at the recreation site. Trampers and other outdoor recreationists are encouraged to "carry out what they have carried in". The same principle could be applied to skiing and snowboarding. Respondents were asked if they would commit to the environmental care code when skiing or snowboarding at developed ski fields. The results showed that 21% of all respondents would not participate in "Carry out what you carried in", while 78% were willing to do so. The visitors of the club fields and the small national commercial fields showed more eagerness to take their rubbish home. 86% (club) and 85% (nat. com.) of the respondents would have participated at these locations, compared with only 72% at the commercial sample location. To gain further understanding, the "No-respondents"[64] were asked to provide a reason why they would not participate. The response rates for the categorised reasons are summarised in Table 60.

[64] Non participation rates: 14% of all club field users, 10% of all nat. com. field users, 25% of all int. com. field users.

Table 60: Overview of "No-Responses" by Ski Field Categories

Categories: Non participation, because it is …	Club: % within "No-responses"	National commercial: % within "No-responses"	International commercial % within "No-responses"	Total sample %within "No-responses"
… "paid for".	33	17	13	16
… "unfeasible".	0	0	11	8
… "inconvenient".	33	50	50	48
… "not necessary".	17	0	3	4
… "providers responsibility".	0	17	24	20
… my "service expectation".	17	17	0	4
N ("No-responses")	6	6	38	50

The fact that the potential non-participation rate was almost twice as high at the international commercial ski field than at the other locations was an expected result. However, it was interesting to find that the most common reason - for potential non-participation across all ski field categories except the club fields - stated by recreationists was "inconvenience". This suggested that club field users might realistically comply with the introduction of the "carry out what you carry in" environmental principle without much managerial or educational effort.

Table 61 shows that as long as rubbish bins are provided people are using them. Considering the results presented in Table 59, this suggests that if "carry out what you carry in" environmental principle were to be implemented at ski fields in New Zealand, an educational campaign would have to be launched to achieve it. Skiers and Snowboarders would probably not understand without further explanation that the non-provision of rubbish bins (see Table 59) is a transfer of responsibility to the individual creating the rubbish. Skiers and snowboarders were asked to state whether they used the rubbish bins provided on the sampling day (Table 61), and if yes, what rubbish they had disposed into the bins (Table 62). The question was open worded, i.e. the responses needed to be coded and summarised into categories.

Table 61: Rubbish Bin Use on Survey Day by Ski Field Categories

Rubbish bin use on survey day	% within Club	% within National Commercial	% within International Commercial	% within Total Sample
No	29.5	54.1	19.5	29.3
YES	70.5	44.3	77.3	68.3
Not stated	0	1.6	3.2	2.3

The results show the potential to successfully introduce (zero) waste management programmes at New Zealand's ski fields could be reasonably high. However, with only 46% of all "rubbish bin users" having provided information on the kind of disposed rubbish, there remains uncertainty over the real waste composition. It is likely that the share of "rest rubbish" in Table 62 was higher than measured here, as it was assumed that most of the missing statements could have referred to this waste category. In addition, almost all rest rubbish was created by "lunch wrappings" of picnic lunches brought from home. The proposed "carry out what you carry in" campaign would have to specifically target the avoidance of this waste source.

Table 62: Rubbish Disposed on Sample Day by Ski Field Categories

Summary categories of disposed rubbish	% within Club	% within National Commercial	% within International Commercial	% within Total Sample
Avoidable rubbish	5	0	21	13
Biodegradable rubbish	15	50	2	15
Rubbish that could be recycled	40	14	21	23
Rest rubbish (to landfill)	40	30	57	49
N (valid responses)	18	11	63	92

Finally, the survey results revealed that 93% of all sampled recreationists would have participated in recycling. Table 63 compiles comments why some recreationists objected to participate in recycling programmes. The results suggest that most of the 17% not willing to recycle simply were too "lazy" ("too much effort"). The successful implementation of recycling programmes at other locations has proved that it is feasible to overcome this barrier. Interestingly, 100% of club ski field visitors would obviously support the introduction of recycling programmes at their ski fields.

Table 63: Reasons for Non-Participation in Recycling

Reason for No categorised	N (Int. Com)	N (Nat. Com)	% within "No-responses"
No - no statement	0	4	25.0%
No - depends	2	0	12.5%
No - not practical	0	1	6.3%
No - too much effort	4	3	43.8%
No - not necessary	0	2	12.5%
N (No-responses)	6	10	16

CHAPTER 8 - DISCUSSION

8.1 Introduction

Skiing and snowboarding are important components of the New Zealand recreation and tourism industry. The visitor volumes at New Zealand ski fields range from 1,000 skier days at the smallest club fields to up to 200,000 skier days at the large commercial fields, which compare to large New Zealand tourist attractions in terms of visitation level (The Tourism and Leisure Consulting Group, 2001). A comparison of visitor volumes at New Zealand's ski fields with the visitation levels of New Zealand's "Great Walks" further demonstrates the relative importance of the commercial fields for the tourism industry (New Zealand Tourism Board & DoC, 1993).

The New Zealand Ski Council (2001) estimated that "snow" tourism earns about NZ$100 million annually for New Zealand. The financial injection into the rural communities adjacent to ski areas is a major benefit (SAANZ Research Report, 2000; TIANZ, 2002). The SAANZ regularly initiates research on economic impacts of ski fields, ensuring that current market information is available to the ski industry (SAANZ, 2000; TIANZ, 2002). No such initiatives are known concerning environmental impacts. It appears that information in this field is only provided by the Department of Conservation, as in the case of studies on vegetation damage undertaken in Otago (Fahey & Wardle, 1998 and 1999).

Against the background of the importance of skiing in New Zealand, this discussion integrates and discusses the results of this research with particular emphasis on a summary description of resource consumption patterns of ski fields, the question "Who triggers facility development – skiers or ski fields?", and a hypothetical analysis of options to decrease the energy consumption of transportation associated with visits to ski fields. Furthermore, the resource consumption benchmarks obtained in this study are compared internationally, with snowmaking being discussed separately. The chapter is concluded with some research implications and a brief summary of the main findings.

8.2 Resource Consumption - Experiences and Key Results

In New Zealand, information on resource use at ski fields is scarce and difficult to collect. During the data collection in the current study, many ski field managers expressed time constraints as a reason for not providing information on resource use, and they were reluctant to provide commercially sensitive data (e.g. visitor numbers). In the case of club ski fields it was often difficult to determine who the person responsible for keeping records on resource use was. Given that about 44% of all ski New Zealand ski field managers participated in this research, it is believed that some interest in environmental issues on the part of managers exists.

Managers' awareness of the environmental consequences of energy consumption was lower than their awareness of the importance of environmentally sound water, wastewater, and solid waste management. The commercial ski field managers' eagerness to maximise the "water-efficiency" (for economic, environmental, and liability benefits) of their snowmaking systems additionally supported this finding. Present water consumption amounts to approximately 750 litres per skier day, mainly for snowmaking. This water consumption appears high considering that on-mountain development limits the number of water consumptive activities. Personal communication with ski field managers indicated a belief that water is not a limiting factor in the New Zealand context and not of environmental concern. These statements, in combination with knowledge gained from the benchmarking analysis, indicate that the consumption of energy is currently the biggest environmental issue at ski fields. Personal communication with several managers revealed that energy costs are among the highest operational costs. Energy consumption per skier day is 90 MJ, which is relatively high compared with other recreation activities (e.g. commercial rafting = 36 MJ; commercial mountaineering = 88 MJ; Becken & Simmons, 2001). The survey results showed that managers do not yet take concerted action to improve the energy efficiency of ski field operations. In this light, the low awareness of energy conservation issues is not surprising.

This study suggests that ski field managers should address energy conservation for several reasons:

- cost savings;
- the ongoing public discussion on global warming puts pressure on ski field managers (public image);
- ratification of the Kyoto Protocol (government pressure);
- impacts of climate change, such as signs of a higher snow line observed by some ski area managers over the last decade (personal communication).

Resource use varied considerably for the different ski fields surveyed. One factor that determines resource use is size, which explains why commercial ski fields consume more resources (950 million litres of water and 8,010 GJ energy) per year than smaller club ski fields (316 GJ energy). In terms of energy use, the 14 commercial ski fields are responsible for 97% of total annual consumption (116,000 GJ) in New Zealand. Variation remains when resource use is normalised by visitor numbers, however, on a per capita basis, club ski fields appeared to be more energy intensive. The niche market of heli/cat ski fields was most energy intensive per skier visit. There is still variation within the categories, which indicates that factors other than visitor volumes influence energy efficiency, for example buildings, technical standard of the equipment, snowmaking systems, grooming equipment, power generation, and general management style.

Waste production is another important issue that was addressed in this research. The importance of waste management in New Zealand is manifested by the release of the Waste Management Strategy (MfE, 2002). In this strategy great emphasis is put on waste avoidance and recycling. The recycling scheme introduced in Christchurch further demonstrates an increasing public awareness and willingness to participate in waste reduction. The survey of snow sport recreationists conducted in this research showed that 78% of skiers and snowboarders were willing to "carry out what you carry in", if this environmental care code was introduced to ski fields. The potential participation rate for an introduction of recycling schemes was even higher (93%). This trend has been recognised by managers, who stated that solid waste management would improve their public image. Managers also indicated that recycling programmes were likely to be introduced in the near future. This may help to reduce the current production of about 570 grams of solid waste per person per day. An introduction of waste separation and recycling seems possible, when considering that 13% of rubbish was "avoidable", 15% was biodegradable, and 23% of rubbish could be recycled. According to these results, the remaining rubbish that has to be land filled could be reduced by about 50%. While the reduction of waste to half of the present volume is correct from an "end of the line" perspective, it is important to keep in mind, that the separated waste still needs to be transported from the ski field to a landfill site, the compost plant or the recycling firm. This would impede efforts to decrease transport energy use.

This study addressed sewage only peripherally, because it was difficult to obtain accurate information. Moreover, managers did not believe that improved wastewater management actions as proposed by the Sustainable Slopes Assessment would result in a decrease of regulatory liabilities;

nor did managers assume any environmental benefits resulting from wastewater management. Notwithstanding, managers seemed generally aware of issues associated with wastewater. Additionally, this research found that several managers are currently reviewing their wastewater systems with the plan to switch to on-site treatment technology. It is surprising, however, that only 42% of all ski fields monitor wastewater quality, despite DoC regulations clearly prescribing regular monitoring of ski area operations (Point 6 CCMS; Doc, 2000a, p. 237).

8.3 Meeting Visitor Expectations or "What comes first, the chicken or the egg?"

The leisure and tourism industry is generally characterised by a trend toward increasing commodification (Buckley, 2000). The question arises whether this trend is fostered by the industry seeking to develop new products and markets, or by the consumer who demands increasing diversification of leisure. These considerations also apply to the skiing industry, where more and more on-mountain facilities are provided (Best, 1998 and 2000; Bieger, 1999). The facility dependency of skiers has been analysed in this study.

While it was found that skiers did not differ in their demographic characteristics and their skiing behaviour for the three different ski field categories studied, visitors differed clearly in their facility expectations. Skiers and snowboarders at commercial fields ranked a greater number of facilities (10 out of 13) as important than club field visitors (3 out of 13), which means that they were generally more demanding customers. For example, commercial ski field visitors considered lift facilities, grooming, and snowmaking as very important. In contrast, club ski field visitors ranked the on-snow lodge to be the most important facility, followed by the lift facilities. The facilities that were ranked highest correspond well with what the respective ski field category has to offer. It appears that visitors to commercial fields appreciated the level of service and comfort provided (this might be the very reason why they chose this category), whereas club ski visitors appear to be satisfied with the basic facilities provided. At both locations upgrading lift facilities was more important than the introduction of more on-mountain entertainment facilities. Provided that, first, snow sport recreationists go to different ski fields with different expectations, and, second, the total number of skiers in the market remains stable, there is theoretically no need to further develop the level of facilities offered (other than upgrading to more efficient equipment and refurbishment). The observed development pattern of the ski market is, however, such that ski field managers have to (or perceive the need to) continuously increase their level of service or facilities to maintain or

increase their visitation levels. Increased visitor numbers can only be achieved by general growth of the ski market or (in a mature market) by luring visitors from other fields, for example through offering special attractions, such as the "magic carpet" beginners lift first offered at Cardrona ski field. If the attraction is successful it is, however, introduced at other ski fields and soon becomes a standard feature of ski field operations. Visitors ultimately expect these services or facilities, which in turn puts managers under pressure to provide new services or facilities. As a result of the increasing globalisation of the snow market this circular development is occurring faster. A good example of such facility development is the introduction of snowmaking systems, which are today installed by even small ski fields. For ski fields to become more environmentally sustainable it is critical to interrupt this self-enforcing circuit. In New Zealand there is potential to keep development at present levels and only invest in new technology when it helps to decrease resource consumption.

Lift facilities are important to skiers and snowboarders. Many recreationists (17% of all sampled skiers and snowboarders) further stated that they wished the lift facilities to be upgraded across all ski field categories, and they were also prepared to pay more for improvements. Here lies some potential to modernise current lift equipment. This might benefit energy conservation, since it was found that most lift equipment in New Zealand is relatively old and could potentially be energy inefficient. However, only few lift systems have been upgraded or modernised to date. In contrast, most ski fields in New Zealand have recently introduced or upgraded their snowmaking systems, although snowmaking was less important to skiers and snowboarders than upgrading lift facilities. It appears that managers do not recognise present wants of their customers.

The results of this research indicate that skiers generally appreciate facility development and do not consider the environment (and impacts resulting from continuous development) as an important factor. Only one respondent specifically made reference to an environmental improvement referring to sewage treatment. Although it is acknowledged that the applied questionnaire did not make special reference to environmental issues, the researcher of this study is surprised that only one response referring to environmental improvements was obtained.

The results of the Sustainable Slopes Assessment suggest that ski field managers seemed aware of at least some environmental impacts of ski fields than their clients. The assessment also shows that managers did not perceive that environmentally improved management practices would

significantly increase the ski fields' positive public image. Certification schemes, such as Green Globe 21 (GG 21), emphasise that environmental certification can create a competitive market advantage and therefore not only increase the environmental, but also the economic performance of the tourism operations that are certified. For the ski market in New Zealand this argument needs a closer examination. If both the skier and snowboarder survey result and managers perception are considered, it seems unlikely that the New Zealand skier and snowboarder will demand better environmental management of ski fields in the future. This, in turn, means that an environmentally certified ski field in New Zealand will most likely not gain competitive marketing advantage over uncertified competitors through the use of an eco-label. However, the emphasis of, for example, the "Sustainable Slopes Programme" on improved resource management will most definitely create an competitive advantage for participating ski fields. The analysis of the manager survey supports this assumption. Most managers anticipated economic benefits from implementing the "Sustainable Slopes" principles. Therefore, this researcher assumes that an independent certification scheme, such as the GG21 programme scrutinizing the organisations more rigidly, would obtain even better environmental performance. This could result in more monetary savings, more environmental creditability amongst environmentally committed stakeholders and therefore in an even higher competitive advantage.

To make schemes such as GG 21 more attractive, it appears necessary to initiate public discussion on environmental impacts of skiing and also to provide information on this topic. With the help of strategic environmental marketing, ski fields could eventually create a market advantage from environmental best practice. The researcher believes that there could be a potential to interrupt the self-enforcing circle of increased on-mountain facility development by substituting the introduction of new facilities with the introduction of environmentally smart business solutions. These solutions can be technological as well as organisational in nature. To really turn best practice into a business advantage, further global research in environmental marketing would be required. Knowledge on how to communicate environmentally sound business practices to the wider public is crucial in this context. Finally, it is imperative to emphasise, that even if improved, environmental management at ski fields does not return a market advantage in the near future in New Zealand, such approaches are likely to be financially beneficial to the operations through increased resource efficiency.

8.4 Transportation Issues

Transportation to the ski field is a key issue for the total energy consumption of snow sports. To understand the underlying reasons for transport, and hence environmental impacts resulting from travel, the behaviour of recreationists was examined. This may help in identifying and developing programmes to reduce energy use associated with transportation to ski fields. International air travel (e.g. Gössling, 2000) as part of an international tourist's of transport to ski areas is only discussed briefly.

8.4.1 Travel Distance to the Ski Field

Travel distance has been measured as "ski area transport", which is transport from the site of overnight accommodation to the ski field, and "ski trip transport", which measures energy use involved in transporting visitors from home to the ski field and back. Travel behaviour for "ski area transport" differed substantially for the three different categories of ski fields; transport to the national commercial field (Porter Heights) was furthest (212 km per skier day) and therefore associated with the largest energy use of 215 MJ per skier day. Transport energy use to club fields is significantly lower than other fields, due to a high proportion of weekend travellers, who stay the night and therefore travel less per day (42 km and 53 MJ per skier day).

Obviously, ski area transport is only a small part of travel undertaken by snow sport recreationists, more travel both within New Zealand and internationally is involved in snow sports. To account for the full energy use associated with transport, the ski trip transport energy use within New Zealand and worldwide was analysed. This study found that an average skier consumed 400 MJ for the whole trip and 180 MJ per day within New Zealand. The range of energy use was large, which may be explained by the very different types of skiers travelling to ski fields, namely, day-trippers, weekend trippers, and tourists. Day-trippers account for a relatively large energy use (265 MJ/day), whereas tourists commonly use less transport energy while in New Zealand, because they stay close to the ski field (about 80 MJ per skier day). Weekend visitors consume more energy (about 189 MJ per skier day) than tourists per day, but less than day visitors. When the international flight is included in the calculation of "ski trip transport" energy use, the total energy use of tourists' "ski

trip transport" is much higher (550 MJ per skier day). Consequently, the median[65] energy use of 293 MJ per skier day for the total sample for the ski trip transport resembles European figures (Figure 25). The comparison in Figure 25 shows that New Zealand is special in that including the international travel considerably alters energy use figures.

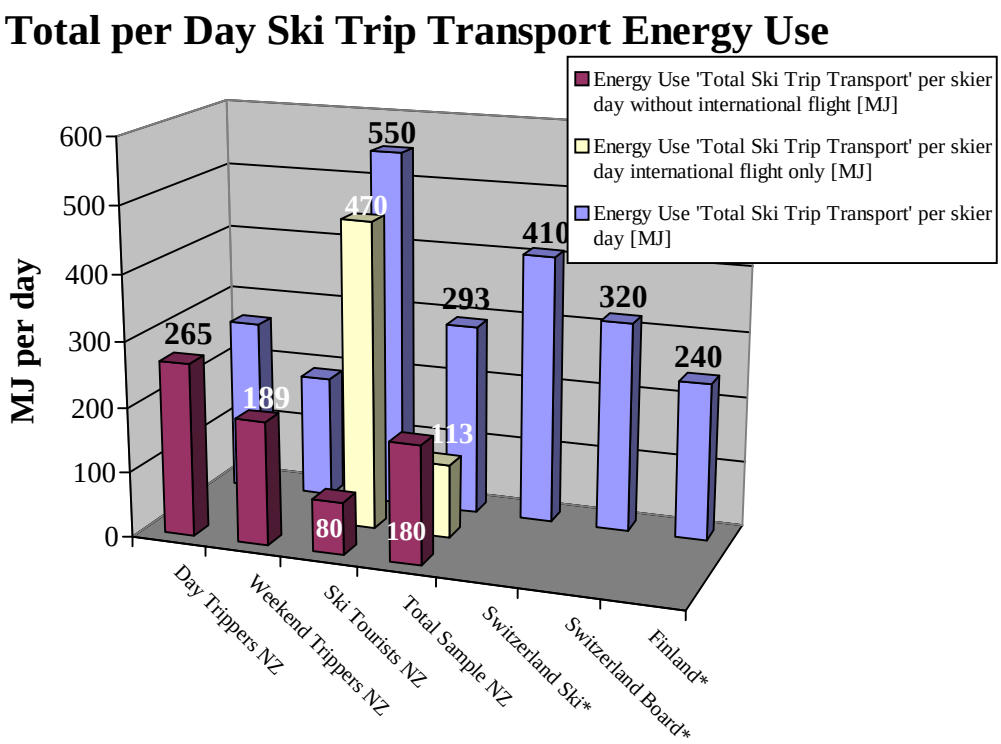

Figure 25: Comparison of Total Transport Energy Consumption Associated with Snow Sport per Ski Trip Day. *These figure were calculated in primary energy, i.e. energy used for production processes (refining, transport to distribution centres, such as filling stations) is included. The Enquête Kommission "Schutz der Erdatmosphäre" des Deutschen Bundestages (ed.) (1994) proposed to secondary direct energy use by 10% to account for primary consumption.

The energy use of 293 MJ per day for "ski trip transport" results in CO_2 emissions of about 19.7 kg. If the 5.33 kg (90.4 MJ) per skier day for ski field infrastructure energy use are added the average skier day in New Zealand releases 25.0 kg CO_2 (383 MJ) into the atmosphere. Projected to the total visitor number to New Zealand ski fields (1,284,000 skier days), snow sport is estimated to be responsible for 32,100 tonnes (including international flights) of CO_2 emission. Transport is

[65] The data distribution is positively skewed for this statistic (mean=571 MJ, median=293). This can be explained by the small number of European/American tourists with an extremely large energy use. It has already been pointed out that Japanese visitors are under represented in study. Consequently, it could be expected that the real average per ski trip day transport energy use was even higher.

responsible for the main share (24,200 tonnes) compared with the estimated 6,850 tonnes of CO_2 emitted by the ski fields. Hence, transport CO_2 emissions are 3.5 times higher than those associated with the ski field infrastructure.

8.4.2 Reducing Energy Use of Ski Area Transport

It has been discussed above that total transport energy use is much larger than "ski area transport", especially when international air travel is included. However, it is believed that ski area managers have little influence on these (more significant) transport components. For this reason, the discussion of reducing transport energy use focuses on the aspects under the control of ski fields, namely the access roads.

The lowest energy use theoretically possible on the access road would be obtained, if all transport was by fully occupied coaches. For example, assuming that all visitors would be transported by fully occupied 45-seater coaches, the total transport energy consumption on the Mt. Hutt ski field road would amount to 2.1 TJ (147 tonnes CO_2 emission). This is a reduction of 52% in on-site transport energy consumption. It can be concluded that there is considerable potential to decrease transport energy consumption. Energy use could be reduced by the promotion of collective transport, as already practiced at some fields through shuttle bus operators, the encouragement of car-pooling, and the discouragement of day trips. This latter option could be achieved through the development of attractive multi-day passes. Another option of developing "car-free" resorts (Holding, 2001) is not discussed further, because a broader transport management strategy at community or regional level would be required.

Gondolas have been proposed as reliable and efficient transport modes in alpine areas. Schmoll, Seddon, and Coburn (2001), for example, outlined the pros and cons of ropeways[66] in mountain areas, and found that construction and maintenance costs for ropeways was lower than for railways and roads, and that they were less vulnerable to landslides, avalanches, flooding, and other mountain hazards. Additionally, ropeways consume less space than roads and create less air pollution and therefore, are considered "environmentally friendly". However, ropeways have the

[66] Ropeway is a general term for all forms of mountain transport relying on suspended ropes, such as funiculairs, gondolas or chairlifts.

potential to develop inaccessible areas and threaten fragile mountain areas, especially if related to mass tourism.

In the following, the option of replacing the Mt. Hutt ski field access road by a gondola is hypothetically explored. The access road at Mt. Hutt is approximately 14 km long with an altitude gain of about 900 m. The energy use for driving up (i.e. one way) the access road is 14.8 MJ per skier, when based on an average per passenger kilometre energy use of 1.17 MJ[67]. The calculations in the following section are based on the average transport energy intensity (estimated for Mt. Hutt by this study) plus additional 10%[67] to account for primary energy use. This addition is undertaken to make the survey results of this study comparable with the European ropeway and railway energy consumption figures. Data on alternative mountain transports are, for example, available from Geisel (1997) for two gondolas and a mountain rack railway to the Mount Pilatus above Luzern in Switzerland. Brunner (2001) provided information on energy consumption figures and passenger load statistics of typical "tourist mountain railway icons" in Switzerland. The gondolas and rack railway line in Luzern, and the railway from Brigg to Zermatt were chosen for the comparison. The latter is suitable in this context because of its importance for tourism and a comparable topography with the Methven to Mt Hutt road connection. The comparison of energy use associated with mountain transport for the Pilatus gondola, the Pilatus rack railway, the Brigg-Zermatt train, and the vehicle access to Mt. Hutt are summarised in Table 64. Two parameters were calculated to fully explore the different uphill energy consumptions, namely energy use per passenger kilometre and energy use per one-thousand (1000) metres of altitude gained.

When comparing the energy use of the different transport options presented in Table 64, it can be seen that the energy consumption of vehicle transport along the Mt Hutt access road compares poorly with all other mountain transport modes. Gondola I on the Pilatus requires only 8% the energy use consumed to drive the Mt Hutt road. This is only partly explained by the shorter travel distance of about five kilometres when compared with the 14 km of Mt. Hutt. The railway from Brigg to Zermatt is also more energy efficient considering the travel distance of 44 km; in fact this option in the case of Mt Hutt would make all other transport from Methven redundant.

[67] Estimated primary energy use = survey result (1.06 MJ/pkm) plus 10% (Enquête Kommission "Schutz der Erdatmosphäre" des Deutschen Bundestages, 1994).

Table 64: Gondola and Mountain Railway Energy Consumption Figures

Mountain Transport	Pilatus Gondola I (Kriens - Fräkmühlegg)	Pilatus Gondola II (Fräkmühleg - Pilatus)	Pilatus rack railway	Zermatt train[1]	Mt. Hutt road access
Altitude difference [m]	899	717	1629	955	900
Distance [km]	4.900	1.389	4.618	44	14
Energy use per (one way) trip [MJ]	1.3	0.83	6.40	33.0	16.4
Energy per passenger kilometre [MJ/pass km]	0.27	0.60	1.39	0.76	1.17
Energy per passenger-kilometre per 1000 metre altitude gain [MJ/pkm/km altitude]	0.3	0.84	0.85	0.80	1.05

(Source: own calculations based on: Brunner, 2001; and Geisel, 1997)

1) These figures have to be treated with some caution, because energy consumption figures include both passengers and freight.

The option of a gondola along Pudding Hill Stream (see location map in Chapter 5 - Methodology) has already been explored (Operations manager Mt Hutt ski field, personal communication, 8th November 2001). The distance between the road end and the ski field car park would be 9 km, because of a more direct line compared with the current road. The technical problems associated with a gondola construction at Mt. Hutt (e.g. wind exposure) are not explored any further here, as they would require more knowledge on the engineering side of mountain ropeway construction and design. Similar arguments apply for the analysis of the economic feasibility of such a large-scale project. However, two simple scenarios on the energy saving potential are calculated to provide an idea of potential benefits. Currently total annual energy consumption on Mt. Hutt ski field road (14 km) equals approximately 4.9 TJ (330 tonnes of CO_2 emissions[68]). An energy use scenario is calculated for a ropeway system featuring the same technical details as "Pilatus I". Total annual energy consumption of transport on the access road in this scenario would decrease to 0.73 TJ[69] (38% of the energy consumption with current access road transport). Assuming that the theoretical gondola would be powered by electricity, the CO_2 emissions released by the hypothetical gondola at

[68] Calculated with a petrol diesel mix CO_2 conversion factor of 67.4 g/MJ (petrol diesel mix according to sample of this study).

[69] Energy consumption figures used here are primary energy figures for Switzerland. They would be different for New Zealand, because the electricity mix is different. However, as Switzerland also relies heavily on hydro electricity production it could be assumed conversion factors were relatively similar in New Zealand.

Mt. Hutt would be 31 tonnes[70] annually (about 9.4% of the energy consumption with current access road transport).

It should finally be acknowledged that the current vehicle occupancy rates found by this study are already high. This has to be rated as positive, however, the scenario above indicated that the creation of incentives to further increase occupancy and a shift to collective transport modes was desirable regarding transport energy efficiency. At current price levels, the public transport options are not competitive, in particular on the short distance between Methven and Mt. Hutt ski field. Consequently, a shift to more commercial collective transport seems unlikely. The findings of the ski field manager assessment suggested that, while providing public transport options, ski field managers did not offer incentives for their use. Nor did managers work together with the community or travel agents to promote further use of public transport. Coupled with managers' low awareness of the need to reduce energy consumption it is unlikely that there will be any action taken in the near future to decrease transport energy associated with snow sports in New Zealand.

8.5 International Comparison and Standards

If the energy consumption figures for ski trip transport (322 MJ/21.7 kg CO_2) and for ski area infrastructure (99 MJ/5.86 kg CO_2) are combined, the average ski day in New Zealand accounts for approximately 421MJ[71]. This amounts to 27.6 kg CO_2 emissions per skier day. Taking into consideration the isolated location of New Zealand and that all international ski tourists require air transport, these results are relatively low compared with Stettler's (1997) energy consumption figures provided for Switzerland. Stettler juxtaposed per skier day energy use of snow sport activities (alpine skiing, snowboarding, ski touring, cross-country skiing) with 25 other sports. All snow sport activities are above the average energy use per sport session (125 MJ). Of the snow sports, alpine skiing is most energy intensive, ranked 7th (610 MJ), while snowboarding is ranked 8th (520 MJ), followed by ski touring 9th (410 MJ), and cross-country-skiing 10th (290 MJ). It is important to note that Stettler's results include 50 MJ per session energy consumption for equipment use. If it is assumed that this finding would also apply to New Zealand, the energy consumption results obtained for skiing in this study (including international travel to New

[70] The conversion factor for this calculation is 42 g/MJ. This factor was applied in other CO_2 emission calculations for electricity use in New Zealand (see Appendix 1).

[71] Again, 10% has been added to the original results of the study findings to account for primary energy consumption (Enquête Kommission "Schutz der Erdatmosphäre" des Deutschen Bundestages, 1994).

Zealand) are approximately 21% lower than the results of Stettler's analysis of the Swiss "ski market" (Figure 26) and 9% lower than the Swiss "snowboard market". The ski area infrastructure component of New Zealand ski fields (99 MJ primary energy use) also appears low compared with the average energy consumption of Aspen Ski Company (2000) in North America (230 MJ primary energy consumption). Aspen's four resorts include 15 on-mountain restaurants, three hotels (260 rooms), 3500 winter employees (1000 in summer), 90 vehicles, and receives about the same visitor volume as the total New Zealand ski market. All these facts make Aspen a useful comparison with the total New Zealand ski area market.

In conclusion, it can be said that snow sports are energy intensive recreation activities. This is particularly true in the European Alps and North America, but also in New Zealand.

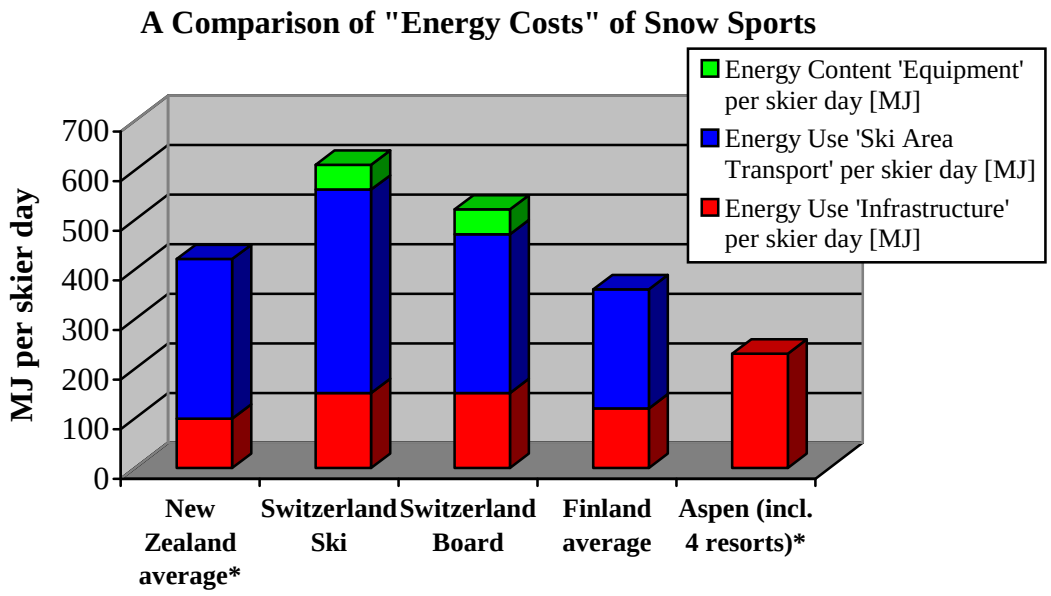

Figure 26: International Comparison of Energy Consumption Associated with Snow Sport
(Source: Hellgrenet al., 1997; Stettler, 1997; Aspen Ski Company, 2000). * 10% have been added to the original figures of this current study to account for primary energy consumption.

Considering the degree of entertainment and accommodation development at North American ski fields, it is surprising that the average per skier day water consumption is almost equal for Aspen and the average New Zealand ski field. Water consumption for facilities (on-mountain base facilities, accommodation, entertainment complexes, restaurants, etc.) only is, in fact, lower in New Zealand (32 litres per skier day) compared with Aspen (232 litres per skier day). Therefore, it can be

concluded that snowmaking, the main water consumption activity of ski areas, in New Zealand is higher than in Aspen. Snowmaking is analysed in more detail later in this discussion.

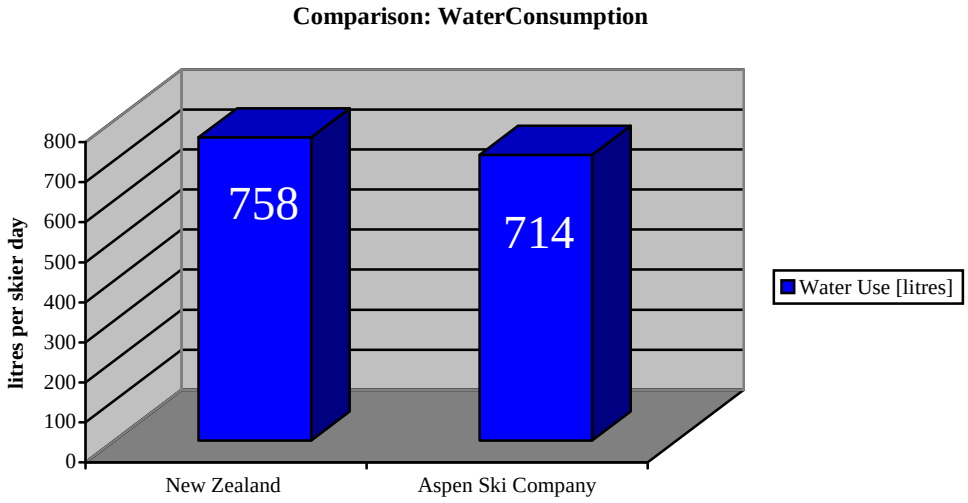

Figure 27: International Comparison of Ski Area Water Utilisation (Source: Aspen Ski Company, 2000).

Compared with waste monitoring results from Aspen (North America), solid waste production at New Zealand's ski fields appears relatively low. Per skier day, the North American resort produced 3.7 kg of solid waste (Aspen Ski Company, 2000) compared with 0.6 kg produced at New Zealand's ski fields, and 2.2 kg per citizen of Christchurch. The difference is explained by the generally lower degree of additional entertainment development in New Zealand. The comparison indicates that limiting further entertainment development pays off in terms of waste reduction.

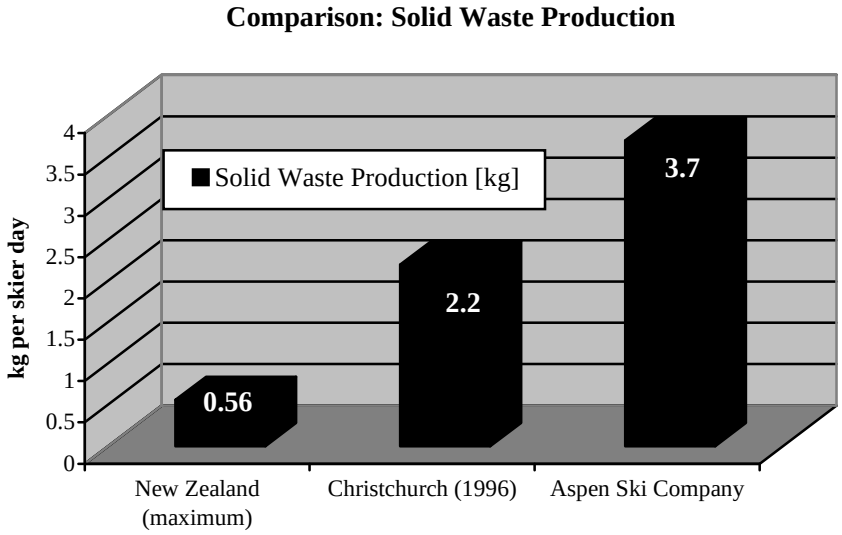

Figure 28: International Comparison of Ski Area Solid Waste Production
(Source: Aspen Ski Company, 2000).

8.6 Snowmaking – A Special Consideration

8.6.1 Snowmaking Data Comparisons

Snowmaking has been discussed as water and energy intensive service offered at most commercial ski fields in New Zealand. The issue of energy use is discussed first. A Swiss study (Skilifte Thusis-Tschappina-Urmen, 2001) suggested that to cover and maintain an area of 43 hectares with an artificial snow layer of 40 cm depth, 500,000 kWh (= 1.8 TJ) are required annually. The average area of snowmaking systems researched in this study was 38 ha, with the systems consuming on average 2.86 TJ per annum (or 75.3 GJ per hectare). The Aspen Ski Company (2000) consumed 25 TJ for a snowmaking area of 244 ha (or 102 GJ per ha), which is higher than the New Zealand results. Aspen is considered one of the most environmentally advanced ski areas in the world and applies much technology for the optimising of snowmaking efficiency (Figure 29).

Compared with the per capita snowmaking energy consumptions of Aspen, New Zealand's on average per skier day energy consumption of 47MJ is 88% higher. There are four possible explanations for this comparatively poor per capita result of New Zealand's snowmaking:

- The slow response times to changes in snowmaking conditions of typically human instead of computer monitoring of snowmaking operations at New Zealand's fields makes snowmaking inefficient.
- Snowmaking technology is not (yet) suited to New Zealand's climatically unfavourable conditions (high winds, high humidity) and therefore inefficient.
- Snowmaking systems at New Zealand's commercial ski fields cover a too large surface area in relation to the visitor volumes received and are therefore inefficient.
- The maintenance of trails with artificial snow in New Zealand is conducted inefficiently (too much snowmaking, when not required).

As far as the monitoring is concerned, a recent North American analysis of snowmaking systems clearly states that the human response time on changing conditions is too slow to be most efficient (Colorado Department of Public Health and Environment, 2002). Detailed analysis of the operational practices would be required to get further understanding how the energy efficiency of snowmaking could be improved. Conclusions based on the data presented here are not reliable enough to be translated into concrete recommendations.

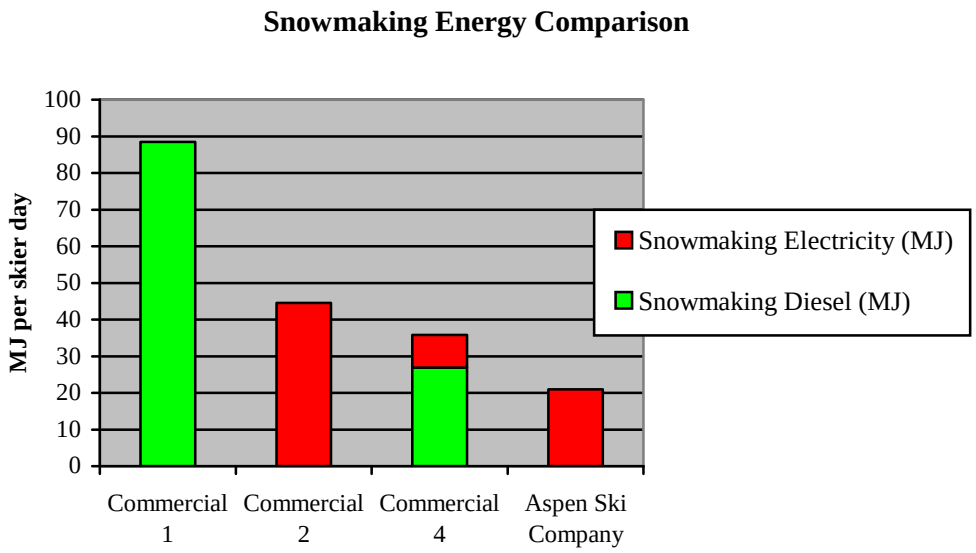

Figure 29: International Energy Consumption Comparison of Snowmaking Systems
(Source: Aspen Ski Company, 2000).

The second indicator for assessing environmental performance of snowmaking systems is water consumption. Again, the Aspen ski company is more efficient with 482 litres per skier day compared with New Zealand's performance of almost 900 litres per skier day. Once again, this figure is 88% higher than the North American results (Figure 30).

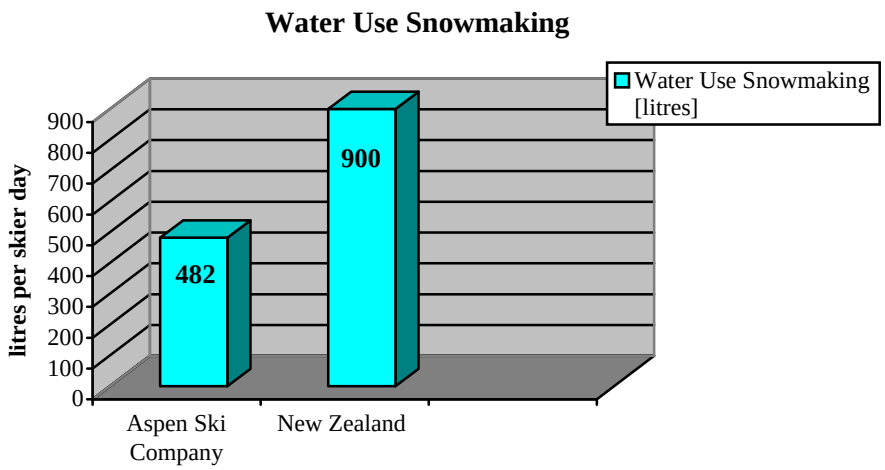

Figure 30: International Comparison of Water Consumption for Snowmaking
(Source: Aspen Ski Company, 2000).

Generally, comparisons of resource consumption data of snowmaking systems operating under significantly different climatic conditions have to be executed very carefully. In Figure 29, as well as in Figure 30, no further information on the snowmaking systems and the climatic operational conditions is supplied. However, even if all influencing factors (named above) are considered in favour of the New Zealand water consumption figures, it appears that New Zealand's snowmaking efficiency is not yet maximised. The extreme difference in the per person water consumption shows that there might be some systematic improvement potential. If the researcher is wrong with his assumption that New Zealand's snowmaking efficiency can be improved, economic scrutinising of the viability of snowmaking in New Zealand's climatic conditions should be conducted instead.

From an economic perspective the investment in a snowmaking system is efficient if the number of visitors attracted due to the improved (artificial) snow conditions is large enough to justify additional financial costs. Research in Austria showed that snowmaking systems are economically efficient if they generate 10% of the total seasonal revenue over ten years (Breiling, 2001).

8.6.2 Efficient Snowmaking?

The production of snow is dependent on many factors. Important factors are temperature, wind speed and direction, constant change in wind direction (swirls), humidity, natural occurrence of condensation kernels in water resource (e.g. minerals such as Ca), and the system itself (high pressure system vs. compressor guns). Notwithstanding the variety of influences, snowmaking can be made more efficient by using modern technology. The Colorado Department of Health (2002) provide a very detailed and comprehensive discussion of diverse snowmaking systems. The authors include specific tips on how to increase the efficiency of existing systems (e.g. heat transfer between water cooling and base facility heating). Information of this kind could be used more often by New Zealand snowmaking experts and would also offer a new field of research for engineers in New Zealand.

Traditional ways of reducing energy use and water consumption of snowmaking focus on technological and operational measures only. It is rarely questioned whether snowmaking systems are a necessary requirement of modern ski areas or whether there are other ways of reducing resource consumption of snowmaking. Personal observation of the ski markets in Europe and New

Zealand stimulated the researcher to challenge ski area operations with an alternative proposal for snowmaking management in New Zealand.

Some ski field managers in New Zealand put much effort into opening their fields as early in the season as possible, preferably at "Queen's Birthday" weekend in early June. Managers also try to stimulate demand through heavy advertising at this time of the year. The marketing in the early season is, in particular, supported by the equipment industry trying to boost its sales. However, the snow cover at this time of the year is usually insufficient and, at most, only suitable for beginners to intermediate skiers. Opening the field at this time is only possible due to artificial snowmaking. Once the field has opened it is necessary to continuously maintain the trail conditions by further snowmaking. Hence more energy and water is required, until natural snow does arrive.

While it appears that the ski season starts artificially early, it does not extend to a maximum possible length. At the end of the season, New Zealand's commercial ski fields often experience good snow cover and conditions, although the snow quality is commonly wet. The wet and difficult to ski snow may play a role in dropping visitor numbers, and some ski fields close with still sufficient snow cover. In many cases, the snow cover at closing date is much better than at opening date.

The author believes that current practice is strongly influenced by the marketing of skiing as winter sport. If skiing was marketed as a spring sport the snow business would be better adapted to natural snow conditions. Notwithstanding the more preferable snow conditions in spring, the ski industry, in New Zealand and elsewhere, favours the earliest possible start to the latest possible finish of the season. While such behaviour is understandable in Europe, where the Christmas holidays set a "must start" to the season, no such fixed event ties the start of the New Zealand ski season to a the "Queen's Birthday" weekend date. It would be useful to further explore the resource savings that lie in a shift of the snow season from early winter into spring. It is, however, realistic that commercial ski areas of international standards rely to some extend on snowmaking systems, not at least to hold international snow sport competitions (e.g. the FIS requires snowmaking coverage of race venues from start to finish).

8.7 Research Implications

8.8 Research Recommendation

The researcher suggests that the key recommendation presented below follows directly from the results of this research. However, the link between the recommendation and the research results is not obvious and requires some explanation:

- "Recommendation": Low density of development and use appears to be a key characteristic, which keeps environmental impacts of skiing at "acceptable" levels[72] in New Zealand. This key characteristic needs to be communicated to the industry and the recreationists and this researcher believes it needs to be preserved as such.

The discussion in the following section will briefly outline and emphasis the importance of limited on-mountain entertainment development. The drawback of commercial fields being more resource efficient than the smaller club fields is that they receive higher use levels per hectare. This can cause damage to the biophysical environment if the use level is above the areas' physical carrying capacity. One hectare within the borders of a commercial ski field supports approximately 17 times more skiers and snowboarders than one hectare at club field locations, and 400 times more than at heli/cat fields. In comparison with North America, New Zealand's commercial fields are sparsely populated with only one third of the US skier numbers per hectare (average of five selected North American fields; see Table 65). These figures are important with regard to potential environmental impacts that have not been measured in this study, such as vegetation damage and environmental impacts through waste disposal or sewage spills.

Table 65: Intensity of Area Use by Ski Field Categories

Ski Area Category	Skiable Area [ha]	Annual Area Intensity [people/ha]
Commercial Average NZ	333	270
Club Average NZ	174	16
Heli/Cat Average NZ	1,460	0.68
Aspen (4 resorts) & Araphahoe Basin[1]	1,076	921

1) (Source: Colorado Ministry of Health and Environment, 2002, page 1-2.)

[72] This researcher concludes that the current overall environmental impact of New Zealand's ski areas is "acceptable" based on Wardle & Fahey's (1998 and 1999) studies and his own judgment following the resource consumption analysis presented in this thesis. The researcher acknowledges that this conclusion is, however, debatable and studies with a more rigid environmental focus might come to different conclusions.

With regard to environmental impacts on soil and vegetation, club ski fields are often seen as basic and, therefore, low impact recreation facilities. In this context, it is interesting to imagine the hypothetical situation of New Zealand's ski market being completely served by club fields. A total surface area of 80,250 ha or 461 single club ski fields would be necessary to accommodate all skier visits of the 2001 season[73]. The environmental impact of access road building alone would be immense for this scenario.

The fact that base facility development and the construction of on-mountain facilities at commercial ski fields are restricted by the RMA, CA, and CMS (DoC, 2000a; Kaspar, 1992; Pearce, 1977) keeps the total environmental impact of skiing low compared with large scale on-mountain developments as found in Europe and North America. Therefore, it is believed that New Zealand's commercial ski fields could be operated at slightly higher visitation rates than at present, without compromising environmental performance. Environmental damages as experienced in some alpine locations of Europe and North America could be avoided, under the prerequisite of careful on-mountain management and preservation of the current low level of on-mountain entertainment development.

8.8.1 Research Implications

Several implications from this research can be formulated:

- "Implication I": A public discussion on environmental issues of snow sports (outdoor recreation in general) needs to be initiated to increase environmental awareness of skiers and snowboarders.

- "Implication II": This research analysed managers' perceptions of environmental management at New Zealand's ski fields measured by standards developed in North America. While this method provided valuable first insights, it would be necessary to conduct in-depth interviews with managers to further understand actual environmental management practices. Additionally it would be desirable to conduct a detailed resource consumption audit at a representative New Zealand ski field to fully understand consumption patterns.

- "Implication III": Further development of benchmarking guidelines for recreation facilities, including ski fields would be desirable to ensure high standards and international comparability.

[73] This compares to the existing 14 commercial fields, 11 club fields, and 2 heli/cat fields.

- "Implication IV": The role of skiers and snowboarders and their customer behaviour needs to be explored further. In particular, the potential for environmental education needs to be investigated.

Finally, it should be emphasised that in relation to its economic importance to some regions, snow sport has received not much academic attention in recent years. It is hoped that the implications outlined above show some valuable areas of future research in the interface of tourism and recreation studies and the field of resource management.

8.9 Conclusion

Previous research in New Zealand indicated that vegetation damage and erosion damage resulting from ski area construction and operation is of minor concern. Hence, this research focused on resource consumption associated with skiing and snowboarding. The analysis of both ski fields and ski field visitors suggested that snow sports (skiing and snowboarding) are resource intensive recreation activities, in particular, due to considerable resource requirements for snowmaking (water and energy) and transport (energy). The reliance of New Zealand ski field management on fossil fuels is a major problem, mainly because of the emission of greenhouse gases. This research also assumes that sewage and wastewater management might be a local environmental issue that requires further research. Since on-mountain accommodation and entertainment development is limited the overall environmental impact at New Zealand's ski fields is relatively low compared with other international skiing destinations. While it appeared that skiers' and snowboarders' environmental awareness was rather low, ski field managers were more aware of their environmental responsibility. This is possibly explained by the legal requirements that most ski field managers have to meet on conservation land.

It is believed that there is potential to improve the overall environmental performance (resource efficiency) of snow sport in New Zealand. Ski field managers have a range of options to increase resource efficiency, for example, to modernise their equipment, while recreationists can contribute through participating in environmental initiatives (e.g. recycling) and through their general consumer behaviour by demanding greener products. Ski fields have the opportunity to encourage this trend through environmental marketing and eco-labels. For both groups, managers and recreationists, information and education will be necessary. The results of this study provide a good starting point to disseminate knowledge about current resource consumption to the industry and the consumer. Future research is now required to investigate the reasons for current practices and constraints of environmental best practice. In-depth interviews with managers and focus group meetings with recreationists could be undertaken.

A key observation of this research was that little co-operation between managers and institutions or other stakeholder groups is in place. EECA for example, could be a partner in energy management and also contributes financially to energy audits. Also co-operation between local governments, transport providers, accommodation providers and ski field management could be beneficial in

many ways, for example, the promotion of "car free" destinations and the promotion of public transport.

The growth of New Zealand's tourism industry in recent years has mainly been attributed to increased international visitor numbers, with further increases predicted for the years to come. Similar reasons have also been cited to explain the growth of the ski market, which has experienced a boom since 2000. In a country as isolated as New Zealand that intends to commit itself to reduce greenhouse gas emissions by ratifying the Kyoto protocol in 2002, a reliance on international long – distance flights and concomitant fuel consumptions seems highly controversial. Clearly, if New Zealand's ski industry intends to base future growth on international visitors, this issue should be addressed. Destination planners should think of strategies to increase the length of stay of international visitors rather than their numbers.

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APPENDICIS

The Appendicis I – VI follow a logical order and not the first mention in the main body of the text.

APPENDIX – ONE: CALCULATIONS

Deriving Carbon Dioxide (CO_2) Emission Factors and Calculating CO_2 Emissions

The basis of all CO_2 emission calculations are the New Zealand specific conversion factors provided by Baines (1993) (Table 66). The GCV of wood depends on the type of wood and was not readily available. It was calculated as an average of several wood types provided by Baines (1993) (see Table 66).

Table 66: Energy Content and CO_2 Emission Factors

Fuel type	**Energy content**	**CO_2 emission**
GCV[1] Petrol	34.5 MJ/l	66.6 g/MJ
GCV Diesel	38.1 MJ/l	68.7 g/MJ
GCV Dual Purpose Kerosene	36.8 MJ/l	68.7 g/MJ
GCV Wood[2]	8940 MJ/m^3	No net emissions
GCV LPG	50.0 MJ/kg	60.4 g/MJ
Electricity	3.6 MJ/kWh	42 g/MJ[3]

(Source: Baines, 1993)
1) GCV: Gross calorific value
2) GCV for wood was calculated as an average over appropriate NCVs (net calorific values) of wood types listed in Baines (1993). The average NCV was then converted into GCV via the formula (GCV = NCV + 10%) provided in Baines (1993, p. 44).
3) Energy Data File 2001 (Ministry of Economic Development [MED], 2001).

The conversion factors for different fuel types were directly applied to energy intensities of different transport modes. For the calculation of ski areas' CO_2 emissions it was necessary, first, to identify the "fuel mix" and, second, to apply the conversion factors proportionally to the energy consumptions for different fuel types (see Table 67 and Table 68). The fuel mixes are subject to the same limitations as the original energy data. It is important to notice that blank spaces in Table 67 and Table 68 do not represent missing data, but a share of "zero per cent" of the respective fuel source.

Table 67: Fuel Mix for All Aki Areas

Ski Fields	Electricity	Diesel	Petrol	Aviation Fuel	Wood	LPG	Energy use per skier day (MJ)
Commercial 1		93.0%	5.62%		1.12%	0.17%	263
Commercial 2	61.1%	33.8%	4.00%		0.45%	0.6%0	75
Commercial 3	44.3%	38.1%	17.5%				39
Commercial 4[1]	16.2%	76.6%	7.23%				82
Club 1		100%					53
Club 2	62.3%	28.4%			8.74%	0.56%	286
Club 3		89.3%	0.93%	1.55%		8.18%	161
Club 4		54.9%			45.1%		28
Club 5		77.4%	0.35%		21.2%	1.02%	295
Club 6		100%					15
Heli/Cat		58.9%		35.0%	6.41%		191

1) For this field the fuel consumption data for the vehicle fleet and lift operation (diesel and petrol) was not provided. The missing data was estimated and is included in the fuel mix of Table 67 and Table 68. For detail on the estimation process see Appendix TWO.

Since snowmaking is the single biggest contributor to energy consumption and CO_2 emissions of all ski area activities, the fuel mix for the three sample location with snow making facilities are listed in Table 68. It has to be noted that due to the estimation process for "Commercial 4" the snowmaking share might be too large. It is possible that the researcher underestimated the missing fuel consumptions for diesel and petrol (see 0 Estimating Missing Data).

Table 68: Fuel Mix for Snowmaking

Ski Area	Electricity		Diesel		Energy use per skier day	
	% of total	% of snowmaking	% of total	% of snowmaking	[MJ]	% of total energy consumption
Commercial 1	0%	0%	33.6%	100%	88	33.5%
Commercial 2	29.9%	100%	0%	0%	22	29.3%
Commercial 4	5.4%	14.2%	32.6%	85.8%	31	37.8%

Estimating Energy Consumption of Transport Modes

4WD Energy Consumption

Energy consumptions figures for different transport modes were in general adopted from literature. However, this researcher decided to distinguish between 4WDs and private 2WD cars. The rational for this decision was, firstly, the micro level of the analysis and, secondly, the distinct higher average fuel consumption of 4WD vehicles. Thus, the energy consumption of 4WD was estimated.

Step 1: The average engine size and ratio of petrol to diesel vehicles was evaluated.

- The petrol/diesel ratio was 6/5.
- The average engine size was 2700cc.

Using the information on fuel consumption of 4WDs provided by the Australian Government (1999) and the UK based Vehicle Certification Agency (2002) an average fuel consumption of petrol and diesel powered 4WDs was calculated. The fuel consumptions were averaged over 19 different models, which are also common in New Zealand. The average engine size of the selected 19 models was adapted to the average engine size of sampled 4WDs (2700cc). The following figures were derived:

- Petrol 4WDs: 14.4 litres per 100 kilometres
- Diesel 4WDs: 10.0 litres per 100 kilometres
- In average: 12.4 litres per 100 kilometres (0.124 l/km)[74]

Using gross calorific value (GCV) for diesel (38.1 MJ/l) and petrol (34.5 MJ/l) (Baines, 1993) and the petrol/diesel ratio stated above an average energy consumption of 4.48 MJ/km was calculated.

Helicopter Energy Consumption

Using the data sheet on fuel consumption of several helicopter models provided by the United States Department of Agriculture (USDA) Forest Service (2002) an average hourly fuel consumption rate of five different helicopter models was calculated. The selection criterion for the models was a "load calculation" of over 400kg. This load was considered suitable to transport skiers or fly out septic tanks.

- Average hourly fuel consumption rate estimated for helicopters: 277 litres per hour.

Using GCV of Dual Purpose Kerosene (36.8 MJ/l) an energy consumption of 10 GJ/h was calculated for helicopters.

[74] Weighted with the petrol/diesel ratio stated above

APPENDIX – TWO: DATA ANALYSIS DETAILS

Data Manipulations of "Skier & Snowboarder Survey"

Recoding Question 2: "Why did you choose to come to this field today? Please state your most important reason."

Table 69: Coding Process and Frequency of Naming in Survey

Themes	Coding label[1]	Frequency	Percent	club	Nat.	Int.
price related	two4one = Two for one day lift pass	5	1.4%	6	13	3
	$$$ = … because it is cheaper.	17	4.7%			
check out	Check = check out the ski area / new facilities	3	0.8%	1	0	5
	Recom = the ski field was recommended	3	0.8%			
close	Conv = conveniently located	2	0.6%	0	23	30
	Enroute = travelling by	3	0.8%			
	Pubease = easily accessible with public transport	1	0.3%			
	Close = field is close to home	47	13.1%			
conditions	Weather = good weather	12	3.3%	8	3	55
	Snow = good snow cover	54	15.0%			
environment	scenic	4	1.1%	5	3	5
	Terrain = "terrain that I like"	9	4.2%			
event	event	16	7.2%	8	1	7
favourite	Return = "I keep coming back, because I like it".	5	1.4%	3	5	4
	Favourite = it is my favourite field	7	1.9%			
fun/relax	To chill out	13	3.6%	3	2	8
infra	Infra = the infrastructure offered is excellent	11	3.1%	0	2	9
less crowded	nopark hutt = not enough parking at Mt. Hutt	1	0.3%	0	5	0
	Less = less people here	4	1.1%			
n/s & n/a	n/a = not applicable	3	0.8%	2	2	1
	not stated	2	0.6%			
packages	Pack = packaged ski trip	11	3.1%	1	3	19
	School = school ski trip	12	3.3%			
season pass	Season pass	33	9.2%	0	9	24
professional	Professional reason to visit	6	1.7%	3	0	3
ski/board	Experience skiing or snowboarding	6	1.7%	5	4	8
	To play the sport (skiing/snowboarding)	11	3.1%			
social	Friendly = … because staff is friendly	1	0.3%	15	9	18
	Clubwork = voluntary club maintenance work	4	1.1%			
	Club = … to meet the other member …	8	2.2%			
	Fam = to have a family expereince	14	3.9%			
	Friend = to experience something with friends	15	4.2%			
TOTAL	----------	**343**	**100.0%**	**60**	**84**	**199**

1) Original responses were coded during data entry (=coding labels). The total number of coded responses exceeds the number of valid questionnaire (259) since people named more than one reason.

Recoding Question 4 - Step I: "What needs to be improved at this field to make it more valuable to you personally?"

Table 70: Response Differences Between Ski Field Categories with Regard to "Desired Improvement"*

Themes for Desired Improvement	Club Fields	International Commercial Fields	National Commercial Fields	Total Sample
access improvements	10		2	12
env. improvement		1		1
food & acc		10	3	13
n/s & n/a	12	17	13	42
nothing	4	13	8	25
park & base	2	15	7	24
price related		7	1	8
road		15	2	17
service & products	1	12	5	18
terrain & facility management	15	64	20	99
TOTAL	**44**	**154**	**61**	**259**

*In the presentation of the results it has been pointed out that the number of responses exceeded the number of valid questionnaire. However, to perform the Pearson Chi-Square test only one response per person was allowed (first response).

Pearson Chi Square test showed a significant difference between ski area categories with regard to responses of "desired improvements" ($F = 63.174$, $df = 18$, $p < 0.001$). A closer analysis could, however, not determine the exact response, which was responsible for the significant difference. The international commercial field received more different responses compared with the club field (Table 70). This could be explained by the larger sample size. It was assumed that ski field categories might differ of that reason alone. Therefore, it was decided to continue the analysis for "desired improvement" for the total sample only.

Recoding Question 4 - Step II:

Table 71: Categorisation According to Resource Consumption Requirements

Resource Requirements	Theme	Frequency		Percentage	
Neutral / reduction	service and products		43		11.8%
Increased resource use	access improvements	13	159	3.6%	43.7%
	terrain & ski facility management	146		40.1%	
Potentially increased resource use	price related	9	29	2.5%	8.0%
	food & accommodation	20		5.5%	
Special: Road & base & park	park & base	28	64	7.7%	17.6%
	road	36		9.9%	
Environmental Improvement	env. improvement		1		0.3%
Nothing	Nothing		25		6.9%
n/a & n/s	n/a & n/s		43		11.8%
TOTAL			**364**		**100.0%**

The next to pages explore a cross-tabulation of question 5 and 6, in order to explore for what specific improvement recreationists would be willing to pay for and how much they would be willing to spent exactly for that improvement.

Cross-tabulation of Question 5 and 6 - Step I & Step II: "Is there a specific improvement you would be willing to pay more for skiing and snowboarding?"

Table 72: Individual responses and corresponding categories (Note: table stretches over two pages)

Resource Requirements	Themes	Question 5: Coding - Label	%	N	Ratio[1]	$ per person and day pass		
Increased resource use	terrain & ski facility management	Increase uphill capacity	0.8%	2	2-0-0			
		Build chair lift	1.5%	4	2-2-0	$10	$10	
		Build chair lift and expand field	0.4%	1	0-1-0	$5		
		Build detachable chair	1.2%	3	1-1-1	$10	$70 for season pass	
		Expand field	2.3%	6	4-2-0	$5	$5	
		Expand field and build chair lift	0.4%	1	0-0-1	$250 for season pass		
		Expand field and build more lifts	0.8%	2	1-1-0	$5		
		Build a gondola to base	0.4%	1	0-1-0	$20		
		More grooming	0.8%	2	2-0-0			
		Build a half pipe	0.8%	2	2-0-0			
		Improve learn facilities	1.2%	3	2-0-1	$100 for season pass		
		Improve learner facilities and lifts	0.4%	1	0-1-0	$10		
		Improve lift	1.5%	4	1-2-1	$8	$10	$100 for season pass
		Improve lift and expand field	0.4%	1	1-0-0			
		Build more lifts	0.4%	1	0-0-1	$100 for season pass		
		Expand snowmaking	0.4%	1	0-1-0	$2		
		Expand snowmaking and groom	0.4%	1	0-1-0	$4		
		Build a t-bar lift	0.8%	2	1-1-0	$10		
		Build a terrain park	1.2%	3	1-2-0	$2	$5	
		Install a tow besides pipe	0.4%	1	0-1-0	$12		
		Install s tow to summit	0.4%	1	0-1-0	$10		
		Upgrade tows to t-bars	0.8%	2	0-2-0	$8	$14	
	access improvements	Improve access	2.3%	6	3-3-0	$7	$5	$10
		No walking field access	0.8%	2	0-2-0	$5	$5	

Resource Requirements	Themes	Question 5: Coding - Label	%	N	Ratio[1]	$ per person and day pass		
Neutral / reduction	service and products	Fast queuing opportunity	0.4%	1	0-1-0	$10		
		Improve on-mountain entertainment	0.4%	1	0-1-0	$5		
		Improve information services	0.4%	1	0-1-0	$1		
		Improve phone info service	0.4%	1	0-1-0	$1		
		Season pass	0.4%	1	0-0-1		$600 for season pass	
		Improve overall service	1.2%	3	0-3-0	$3	$10	$20
		Offer shuttle from CHCH	0.4%	1	1-0-0			
		Improve ski school	1.6%	4	1-3-0	$10	$25	$10
		Improve toilets facilities	0.4%	1	1-0-0			
Potentially increased resource use	food & accommodation	Improve f&b	0.8%	2	2-0-0			
		Build on-snow accommodation	0.8%	2	2-0-0			
	price related	$-	0.8%	2	2-0-0			
Special: road & base & park	road & base & park	Improve base facility and road	0.4%	1	0-1-0	$5		
		Improve parking to field access	0.8%	2	0-2-0	$5	$10	
		Improve access road	0.8%	2	0-2-0	$2	$5	
		Improve access road and entertainment	0.4%	1	1-0-0			
		Improve access road and lifts	0.4%	1	0-1-0	$10		
		Improve access road and parking	0.4%	1	0-0-1		$100 for season pass	
		Improve safety of road and parking	0.4%	1	0-1-0	$25		
n/a	n/a	Make it less crowded	0.4%	1	1-0-0			
		Not applicable	1.5%	4	4-0-0			
		Improve snow	0.4%	1	1-0-0			
TOTAL			**44.0%**	**88**				

1) "Ratio" (a-b-c) means: a= number of respondents who are willing to pay, but did not specify a $-sum; b= number of respondents, who specified a $-sum per day pass; c= number of respondents, who specified a $-sum per season pass

Calculating Day Averages from Season Pass $-Totals

Table 73: Question 6: Transforming $ Per Season Pass in $ Per Day Pass

Themes	Coding Label	N	No. of days skied in 2001	$ per season pass	$ per person & day pass	$ ave. per person & day pass
Service and products	Season pass	1	10	600	60	$60
Road & base & park	Road + park	1	15	100	6.67	$6.67
Terrain & facility management	Expand + chair	1	8	250	31.2	$8.10
	More lifts	1	60	100	1.67	
	Expand	1	13	100	7.69	
	Lift	1	30	100	3.33	
	Learn	1	30	100	3.33	
	Det-chair	1	50	70	1.40	

Cross tabulation of Question 5 and 6: Summary

Table 74: Summary of Cross tabulation of Question 5 and 6: Including Unspecified Willingness to Pay

Resource Requirements	Themes	%	N	$ average per person and day pass	
Increased resource use	access improvements	3.9%	10	$6.43*	$7.33*
	terrain & ski facility management	17.8%	46	$8.23*	
Potentially increased resource use	food & accommodation	1.5%	4		
	price related	0.8%	2		
Neutral / reduction	service and products	5.0%	13		$14.1*
Special topic	road & base & park	2.7%	7		$8.10*
n/a	n/a	2.3%	6		
No	No	66.0%	171		
TOTAL		**100.0%**	**259**		**$9.16***

* For the calculation of averages only those responses were considered that stated a NZ$-sum. Compare Table 75 for an exact summary. Each average is calculated over all single responses.

Table 75: "Dollars Per Summary Category" (only including valid NZ$-sums)

Resource Requirements	Themes	N	% of total sample (N=259)	$ average per person and day pass	
Increased resource use	access improvements	7	2.7%	$6.43	$7.33
	terrain & ski facility management	27	10.4%	$8.23	
Neutral / reduction	service and products	11	4.2%		$14.1
Special topic	road & base & park	6	2.3%		$8.10
TOTAL		**50**	**20%**		**$9.16**

Recoding Question 25: Transport Mode Choices

Results are analysed sperate for private (private and rental car, private and rental 4WD, private and rental campervan) and public transport (commercial minivan and coach) options.

In total 302 reasons were stated. This is more than the number of valid survey responses (259), since recreationists often stated more than one reason. Each single reason is listed here.

Table 76: Reason Stated for Use of Private Transport Option

Summary categories	Reason for Transport Mode - Private	Frequency	Percentage	
Private ownership of transport	I own a 4WD	4	1.65%	6.20%
	I have my own car	11	4.55%	
Cheapest transport option	cheap	28		11.57%
Most convenient transport option	convenient	73	30.17%	40.9%
	Ease of use	23	9.50%	
	Too much gear to carry	2	0.83%	
	No chains are required	1	0.41%	
Fastest transport option	fast	9		3.72%
Most flexible transport option	flexibility	24	9.92%	11.2%
	free	3	1.24%	
Prearranged transport	We came as a group	4	1.65%	6.61%
	package	3	1.24%	
	We have a rented car	7	2.89%	
	touring	2	0.83%	
No other transport option feasible	I have no other transport option	7	2.90%	4.13%
	No public transport available	1	0.41%	
	Organisation of public transport is too complicated	1	0.41%	
	I am solo.	1	0.41%	
Not stated		38		15.70%
TOTAL		**242**		**100.00%**

Table 77: Reason Stated for Use of Private Transport Option

Summary categories	Reason for Transport Mode - Public	Frequency	Percentage	
Cheapest transport option	cheap	9		15.0%
Most convenient transport option	convenient	6	10.00%	18.3%
	Ease of use	5	8.33%	
Most flexible transport option	flexibility	1	1.67%	3.34%
	free	1	1.67%	
Prearranged transport	We came as a group	1	1.67%	31.7%
	package	17	28.33%	
	I have a coach pass	1	1.67%	
No other transport option feasible	No other access possible	2	3.33%	21.7%
	I have no other transport option	4	6.67%	
	No private transport	6	10.00%	
	I am solo.	1	1.67%	
Other reasons	It is safer.	1	1.67%	3.34%
	Because of work.	1	1.67%	
Not stated		4		6.67%
TOTAL		**60**		**100.00%**

Summary Results Question 23:

In Part C the fuel sources were examined. The following results were obtained.

Table 78: Fuels Source by Transport Mode

Fuel Source →	**Petrol**	**Diesel**	**Not stated**	**Total sample**
Transport Modes ↓	% within transport mode	%within transport mode	% within transport mode	N in total sample
Private car	86.0	13.1	0.9	107
Rental car	100	0	0	18
Private 4WD/truck	47.5	50.8	1.6	61
Rental 4WD/truck	88.9	0	11.1	9
Rental campervan	33.3	66.7	0	6
commercial minivan (max. 10 pass.)	18.2	72.7	9.1	11
commercial coach (>10 pass.)	0	69.8	30.2	43
hitch-hiking	0	0	100	3
% TOTAL Sample	**58.3**	**33.6**	**8.1**	**258**

Recoding Question 27: "Would you be willing to 'carry out what you carry in'?"

Table 79: Categorisation and Overview of all "No-responses"

Category: Non participation, because it is …	**Reason for No (Carry out what you carry in)**	**N**	**Stated at**
… "paid for".	because it should be included in the lift pass	1	Int. com
	I pay - you serve!	1	Int. com
	I pay for the service	1	Int. com
	I payed for my boarding	1	Club
	only if you paid to ski at the facility	1	Club
	pay lot of money => I want no hassle	1	Int. com
	we pay for disposal opportunity	1	Int. com
	we pay for service	1	Nat. com.
… "unfeasible".	=> litter everywhere	1	Int. com
	but others would litter	1	Int. com
	it wouldn't happen	1	Int. com
	unrealistic - litter would be everywhere	1	Int. com
… "inconvenient".	because I should not have to	1	Int. com
	bins should be provided	1	Int. com
	carrying too much already	1	Int. com
	do not want to carry rubbish	1	Int. com
	got too much stuff already	1	Club
	hassle	4	Int. com
	I don't like rubbish in car	1	Int. com
	I prefer not to	1	Nat. com
	inconvenient	3	Int(1)/Nat(2)
	lazy	1	Int. com
	too hard	1	Int. com
	too hard to carry things	1	Int. com
	too hard to carry whilst skiing	1	Int. com
	too much rubish	1	Int. com
	we don't have room	1	Int. com
	bins are easier	1	Int. com
	but I would rather not like to do it	1	Int. com
	maybe	1	club
	recreation should be carefree	*1*	Int. com

Table 79: Categorisation and Overview of all "No-responses"

Category: Non participation, because it is …	**Reason for No (Carry out what you carry in)**	**N**	**Stated at**
… "not necessary".	no point when there are bins	1	Int. com
	only because there are rubbish bins available	1	Club
… the "providers responsibility".	but not bins from cafeteria	1	Int. com.
	but not restaurant rubbish	1	Int. com
	commercial field should provide service	1	Int. com
	depends on who creates the rubbish	1	Int. com
	it is the role of a modern & rich country	1	Int. com
	most rubbish comes from cafe	1	Int. com
	not on a commercial field	1	Int. com
	responsibility of resort	1	Nat. com
	too much packaging in the cafeteria	1	Int. com
	too much rubbish created by cafeteria	1	Int. com
… my "service expectation".	I feel that ski fields need to do that for their customers	1	Club
	I would be unhappy with the service	1	Nat. com
No statement	Total N=44 => response rate=14%	38	Club
No statement	Total N=61 => response rate=10%	55	Nat. com.
No statement	Total N=154 => response rate=25%	116	Int. com.
TOTAL		**259**	

Recoding Question 29:Use of Rubbish Bins and Rubbish Disposed

First, the summary of question 29 is presented:

Table 80: Summary of Table 81: Disposed Rubbish by Categories

Rubbish Category	**Frequency**	**Percent**
Avoidable rubbish	13	12%
Biodegradable rubbish	15	14%
Rubbish that could be recycled	25	24%
Rest rubbish (to landfill)	52	50%
TOTAL	**105**	**100%**

If respondents named more than one disposed item, these items were counted separately. Therefore, the results contain more disposed rubbish items than responses (N=92). See Table 81 for more detail

Table 81 is the compilation of the original responses and an overview of the coding process used to derive Table 80.

Table 81: Rubbish Disposed at Ski Field

Category	Disposed rubbish on survey day	Frequency	Percent	Stated at (N)		
				club	Nat. com.	Int. com.
avoid	restaurant / lodge rubbish	12	4.6%	1	0	11
bio & avoid	food rests & restaurant rubbish	1	0.4%	0	0	1
bio	food rests	13	5.0%	2	1	10
bio & recycle	food rests & cans	1	0.4%	1	0	0
recycle	bottles & cans	1	0.4%	1	0	0
	cake can	1	0.4%	1	0	0
	paper & bottles	1	0.4%	0	0	1
	paper & cans	1	0.4%	1	0	0
	lift pass backing	2	0.8%	1	1	0
	paper	2	0.8%	2	0	0
	plastic	2	0.8%	0	1	1
	bottles	3	1.2%	0	0	3
rest & recycle	food rests & bottles	2	0.8%	0	0	1
	plastic bottles	2	0.8%	1	0	1
	lunch wrapping & bottles	7	2.7%	1	1	5
rest	allsorts	1	0.4%	0	1	
	cigarettes	1	0.4%	0	0	1
	plastic bags	2	0.8%	0	0	1
	tissues	2	0.8%	0	0	1
	lunch wrapping	35	13.5%	6	6	23
No statement		167	64.5%	26	50	91
TOTAL		**259**	**100%**	**44**	**61**	**154**

Estimating Missing Data

Energy Consumption Figures of Ski Areas

(This section refers to "Sustainable Slopes Assessment 2001" sample form 22.)

From the comparison of the resource use data and the "resort summary" data provided by "Commercial 4", it became evident that at least petrol and diesel consumption figures were not included in the information. Only diesel consumption for snowmaking was provided, although the resort has a considerable vehicle fleet (diesel and petrol) and three lifts are operated by diesel engines. The manager of Commercial 4, however, supplied exact data on vehicles and lift equipment operated by the field including the fuel sources for vehicles and lift equipment.

The figures provided in Table 82 were estimated using comparable figures provided by ski field managers of the other ski fields:

Table 82: Energy Consumption Estimates for Commercial 4

Energy Consumer	**Energy Consumption Estimate [per year]**
4 groomer	58,000 litres diesel
6 vans	4000 litres diesel
2 x t-bar lifts and 1 x 2-seater-chair lift	18,750 litres of diesel
3 snowmobiles, 2 quad bikes	12,900 litres of petrol
2 4WDs	1748 litres of petrol
TOTAL DIESEL:	**80,750 litres**
TOTAL PETROL:	**14,648 litres**

APPENDIX – THREE: INFORMATION ON NEW ZEALAND'S SKI FIELDS

Ski Areas of New Zealand

Ski Field Locations

All New Zealand ski fields, operational in the 2001 snow season are listed in the "Brown Bear New Zealand Ski & Snowboard Guide 2001" (Upjohn, 2001). The ski areas are sorted from north to south:

Table 83: New Zealand's Ski Areas

North Island:

1. Mt Ruapehu - Whakapapa Ski Area
2. Mt Ruapehu - Turoa Ski Area
3. Tukino Ski Field
4. Mt. Taranaki - Maunganui Ski Field

South Island:

5. Rainbow Ski Field
6. Mt. Robert Ski Field
7. Hanmer Springs Ski Field
8. Mt. Lyford Ski Field
9. Temple Basin Ski Field
10. Broken River Ski Field
11. Mt. Olympus Ski Field
12. Mt. Cheeseman Ski Field
13. Craigieburn Valley Ski Field
14. Porter Heights Ski Field
15. Mt. Hutt Ski Field
16. Mt. Potts Ski Field: Cat skiing with heli access
17. Alpure Cat Ski: Cat skiing with four-wheel drive access
18. Mt. Dobson Ski Field
19. Fox Peak Ski Field
20. Round Hill Ski Field
21. Awakino Ski Field
22. Ohau Ski Field
23. Cardrona Ski Field
24. Waiorau Nordic Ski Field
25. Treble Cone Ski Field
26. The Remarkables Ski Field
27. Coronet Peak Ski Field
28. Invincible Snowfields, Rees Valley: Rope tow with heli access

Ski Area Categories

New Zealand's ski fields can be categorised in to five different classes of ski fields. In the following each field is listed under the corresponding category:

Table 84: Ski Area Categories

(I) INTERNATIONAL COMMERCIAL SKI FIELDS:

1. Mt Ruapehu – Whakapapa skim field (snowmaking)
2. Mt Ruapehu - Turoa Ski Field (snowmaking)
3. Mt. Hutt Ski Field (snowmaking)
4. Cardrona Ski Field
5. Treble Cone Ski Field (snowmaking)
6. The Remakables Ski Field (snowmaking)
7. Coronet Peak Ski Field (snowmaking)

(II) NATIONAL COMMERCIAL SKI FIELDS:

1. Rainbow Ski Field (snowmaking)
2. Mt. Lyford Ski Field
3. Porter Heights Ski Field (snowmaking)
4. Mt. Dobson Ski Field
5. Round Hill Ski Field (snowmaking)
6. Ohau Ski Field

(III) *SPECIAL PURPOSE COMMERCIAL SKI FIELDS:*

1. *Waiorau Nordic Ski Field*[75] *(cross-country)*
2. *Snow Park (terrain park, half pipes). This area only opens in 2002. Note: The new field –Snow Park - was not considered in this research.*

(IV) CLUB SKI FIELDS:

1. Tukino Ski Field
2. Mt. Taranaki - Maunganui Ski Field
3. Mt. Robert Ski Field
4. Hanmer Springs Ski Field
5. Temple Basin Ski Field
6. Broken River Ski Field
7. Mt. Olympus Ski Field
8. Mt. Cheeseman Ski Field
9. Craigieburn Valley Ski Field
10. Fox Peak Ski Field
11. Awakino Ski Field

(V) CAT & HELI SKI FIELDS:

1. Alpure Cat Ski (Cat skiing with four-wheel drive access)
2. Mt. Potts Ski Field (Cat skiing with Heli access)
3. *Invincible Snowfields, Rees Valley (Rope tow with heli access). Not considered for this research, since business size is very small.*

[75] The ski area is also know as the "Snow Farm' and is commonly included in the visitor statistics of commercial ski areas.

Facilities at Ski Areas

Statistics:

Table 85: All Uphill Lift Facilities of New Zealand in Overview

Lift Type	Number
Handle Tow	19
Rope Tow	31
Platter	16
T-Bar	23
Chair 2	9
Chair 3	4
Chair 4	10
Chair 6	1
Magic Carpet	5
TOTAL	**118**

(Source: Brown Bear Ski &Snowboard Guide 2001, Upjohn, 2001; 27 operating ski areas excluding the Invincible ski field)

Explanations:

To the non-skiing expert the handle tow and the rope tow lift types are brief explained. The rope tow is a unique New Zealand lift facility and should not be confused with the beginner lift facility of a handle tow common in ski areas world wide:

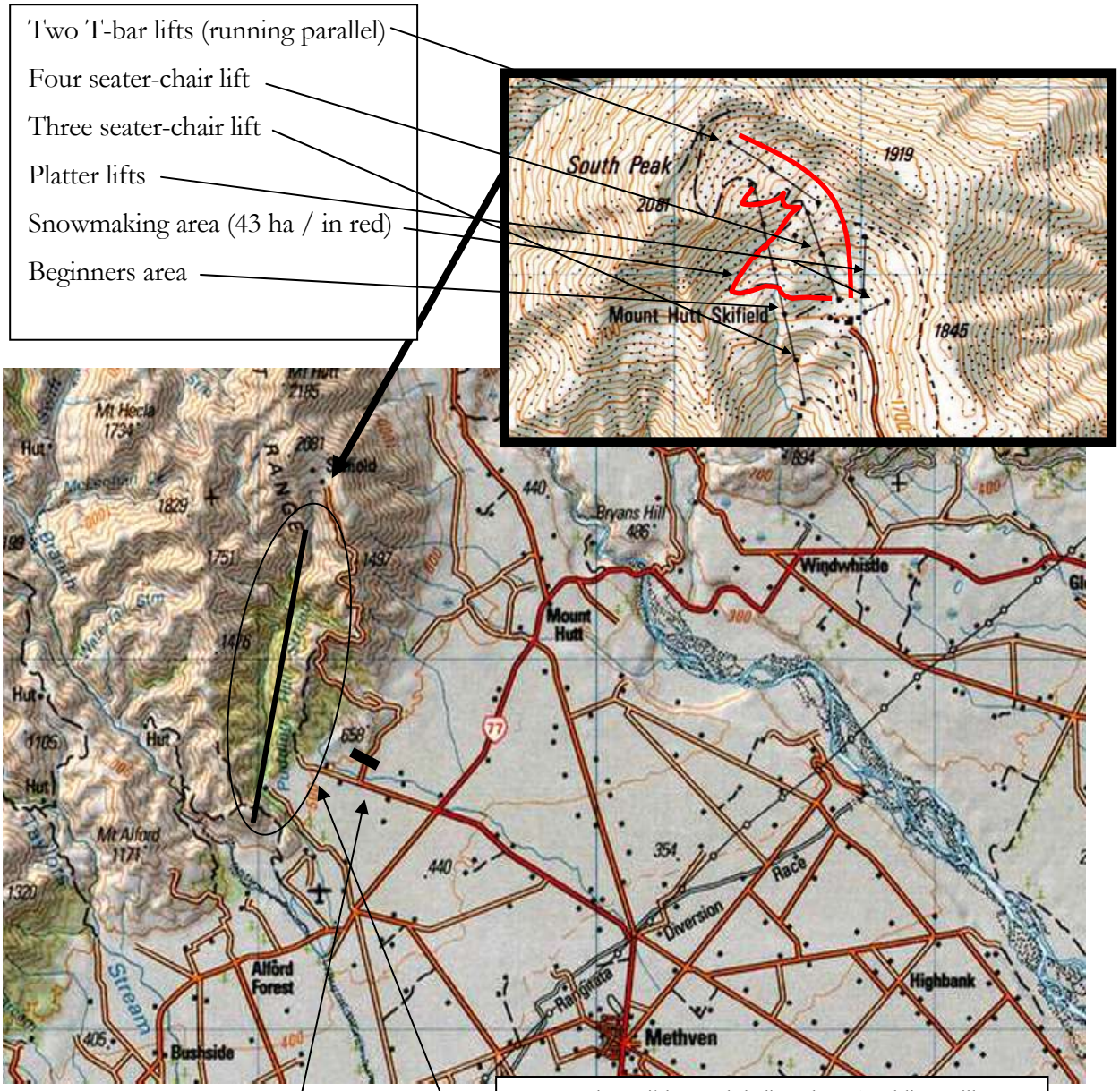
- Handle Tow: A lift type commonly used for beginners to cover short up-hill distances on very flat slopes. The rope is fitted with devices (handle bars) to hold on to, while travelling uphill.
- Rope Tow: A typical New Zealand club field lift type. The lift is used to cover all sort of terrain and consists of a running rope fixed to basic towers. The pullies guiding the rope require adjustment to the actual snow height. The skier hooks onto the rope by using a "nut-cracker" that is fitted to a belt or harness. The nutcracker is a metal ???, which is used to grab the rope. The rope does not stop for the recreationist in order to hook onto it and commonly run at relatively high speed. This speed made the lift type popular amongst some expert skiers.

Description of The Six Sampling Ski Fields

All six sampling ski fields were located in Canterbury. The map provided earlier (Figure 8) shows that Canterbury is one of three main ski regions in New Zealand. The sampling fields are all in the proximity of Christchurch, the South Island's main population centre. In the following sections, the main features of each single sampling ski field are presented. The geographical location is highlighted through the provision of topographical maps for each location. Being located above the bush line is a general characteristic of all New Zealand ski fields. Skiing is (provided sufficient snow cover) is commonly possible limitless across the whole basin. This is explains the relatively large sikable area figures (compare Table 86) despite the spatially confined ski area infrastructure. The infrastructure of some overseas ski areas that are located with in forested areas (e.g. Aspen Highlands ski area in North America with 280 ha of sikable area) is spatially more wide spread than, for example at Mt Hutt despite featuring less sikable area.

Mount Hutt

Mount Hutt is Canterbury's largest commercial ski area receiving over 100,000 skier days annually and was classified as an international commercial field. Mount Hutt is the highest South Island ski field, which makes it one of the most snow reliable ski field's in New Zealand. The location requires a relatively long and steep access road climbing up from the plains to the main car park (14 km unsealed). The road is exposed in places making it susceptible to high winds and is perceived as potentially dangerous by some ski field visitors (personal communication during field work). The field offers extensive snowmaking facilities and a range of other on-mountain recreation opportunities during the winter season (bungee, restaurant, café, scenic flights). Figure 31 (see over page) provides a detailed map of the area and the ski field.



Altitude start ski field road:
500 m
Altitude car park: 1403 m

Length of ski field road:
approximately 14 km.

Vertical climb of ski field road: 900m

Proposed possible gondola line along 'Pudding Hill Stream' (approximately 9 km). The 'gondola-scenario' will be discussed in Chapter 8.
(The line is hypothetical only and was added to the map by the author.)

Figure 31: Location Map of Mount Hutt Ski Field.
(Source: Topo Map Pro 2.0, Map World New Zealand, 2002)

Porter Heights

Porter Heights is the closest ski area to Christchurch. The field receives fewer than 70,000 skier days annually and was classified as a national commercial field. This former club field is set in a relatively steep, southeast-facing bowl of the Craigieburn Range. Two avalanche paths are limiting the possibility of further base facility development. The field is equipped with a snowmaking system along the first of its three T-bars. The access road (9 km) is a relatively comfortable ski field road by New Zealand's South Island standards and suitable for 2WD cars (see blue enlargement in Figure 32 for a detailed map).

Broken River

Broken River is a 50 year old club field (around 2,000 skier days annually) set in the Craigieburn Range about 1.5 hours west of Christchurch on SH 73. The access road (6 km) is suitable for 2WD cars, but untypical for New Zealand ski fields, since it is located in native beech forest. From the car park a goods-lift transports equipment up to the lodges at the bush line, while recreationists have to walk 15-30 min up to the field. The club developed three different basins and offers a connection to the neighbouring Craigieburn Valley Ski Club field (see green enlargement in Figure 32 for a detailed map).

Mount Olympus

Mount Olympus is a club field (around 1,500 skier days per season) set in a wide south-facing basin of the Craigieburn range. Access to the field is via a long rough dirt road (35 km) from Windwhistle near the Rakaia Gorge (Canterbury). The last climb of the road (4 km) is only accessible by 4WD. The long, uncomfortable access makes the field a relatively remote recreation facility and excludes some visitor groups (see red enlargement in Figure 32 for a detailed map).

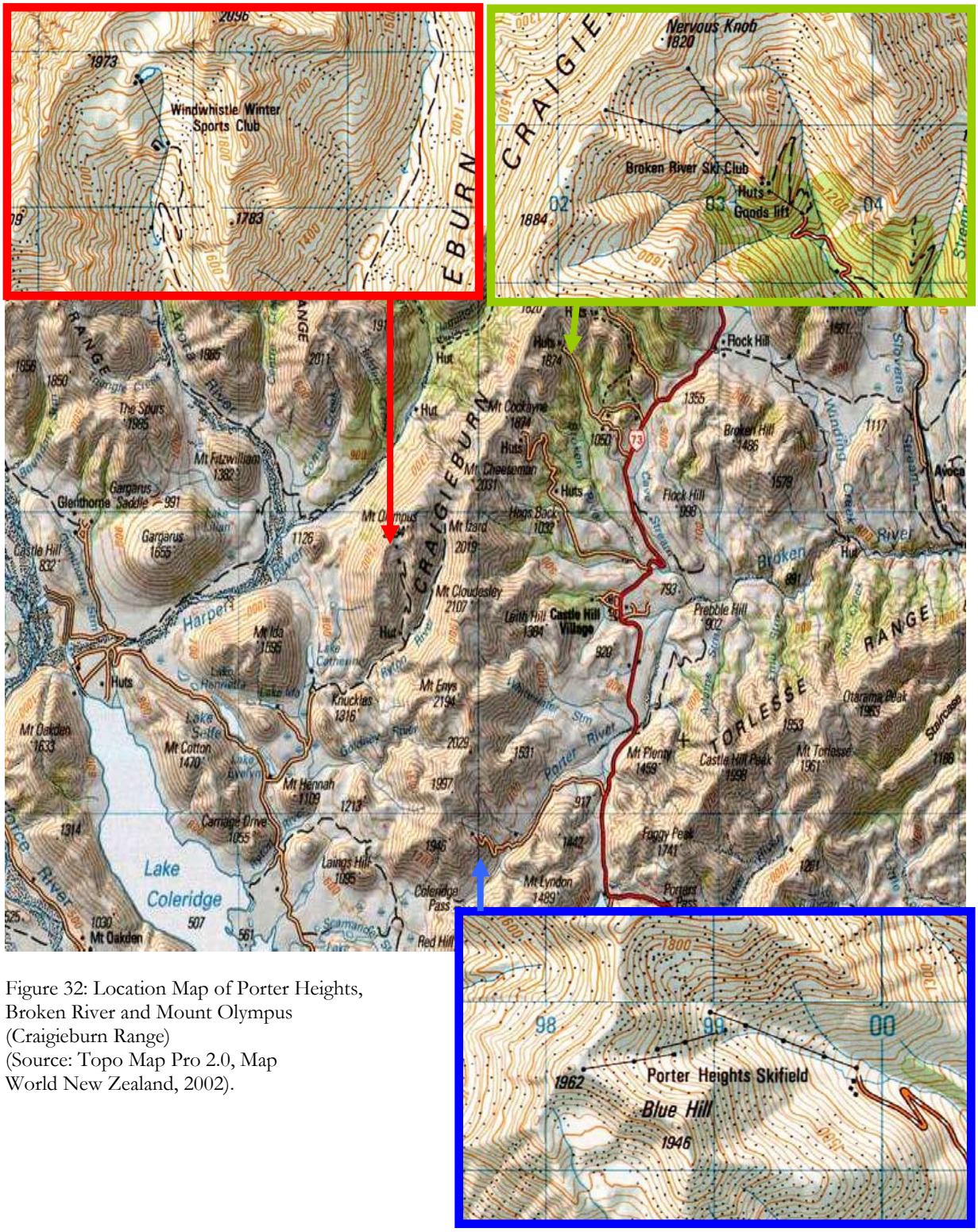


Figure 32: Location Map of Porter Heights, Broken River and Mount Olympus (Craigieburn Range)
(Source: Topo Map Pro 2.0, Map World New Zealand, 2002).

Temple Basin

Temple Basin is one of the oldest club ski fields in New Zealand and was founded by the Christchurch Ski Club. The club operates the venue (lodge and goods lift) all year round. In summer, Temple Basin is an environmental education centre, while in winter it caters for the adventurous snow sporter, and in recent years to snowboarders. Temple Basin is estimated to receive around 5,000 skier days annually. It is located within the boundaries of Arthur's Pass National Park at New Zealand's main divide. The field can only be accessed by a 40-60 minutes walk from the car park, which is located at SH 73 four kilometres west of Arthur's Pass Village (see Figure33). Equipment is transported to the field via a goods lift.

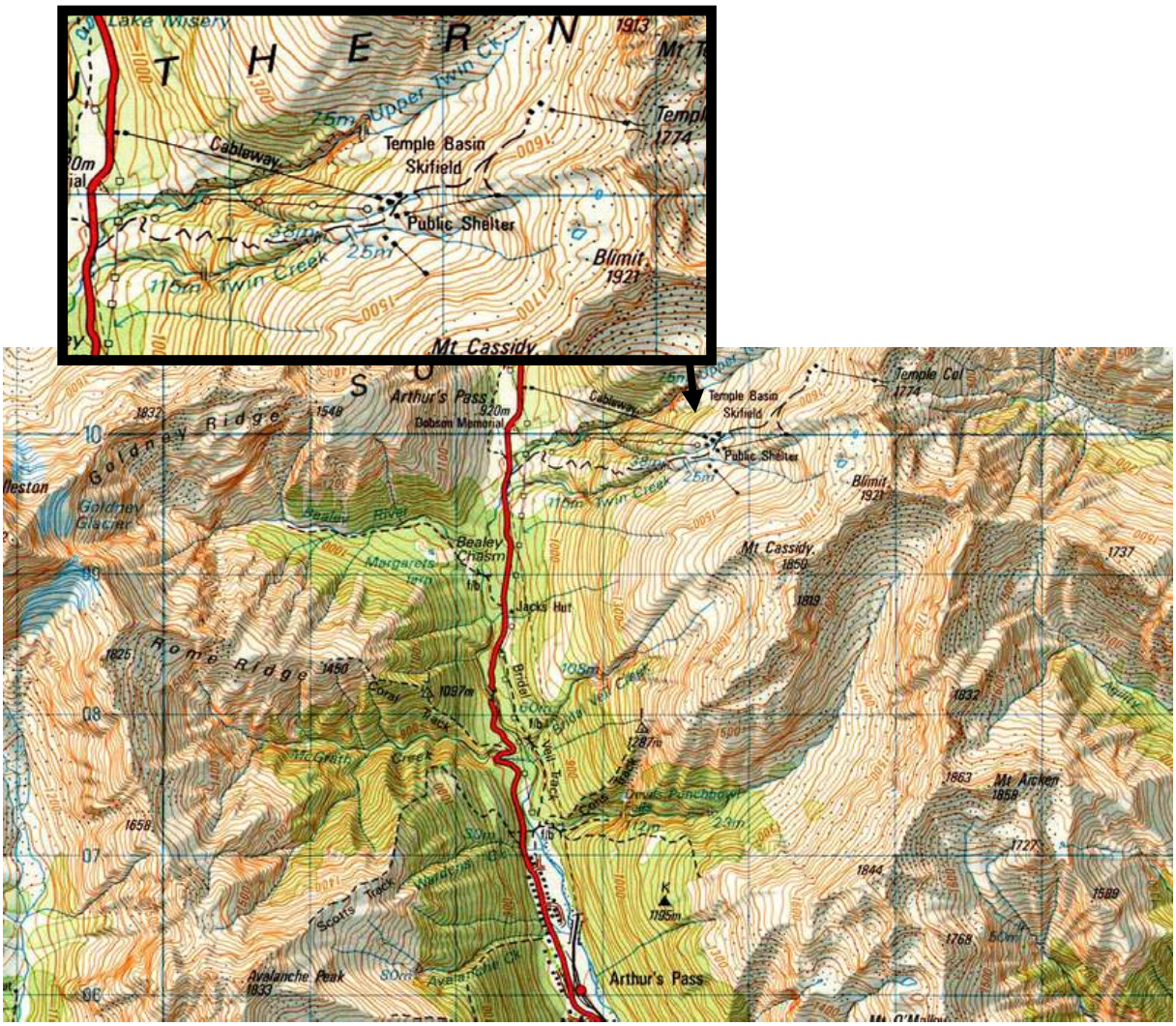


Figure 33: Location Map of Temple Basin (Source: Topo Map Pro 2.0, Map World New Zealand, 2002).

Fox Peak

Fox Peak is a small and traditional, rural club field (around 1,000 skier days per season), which is relatively far away from major population centres (Christchurch 200 km). The field is set on wide-open, southeast-facing slopes in the Sherwood Range between Fairlie (36 km) and Geraldine (82 km). The access road is suitable for two wheel drive cars and leads across private farmland to the (approximately 16 km unsealed). Fox Peak field is located on private land (see Figure 34).

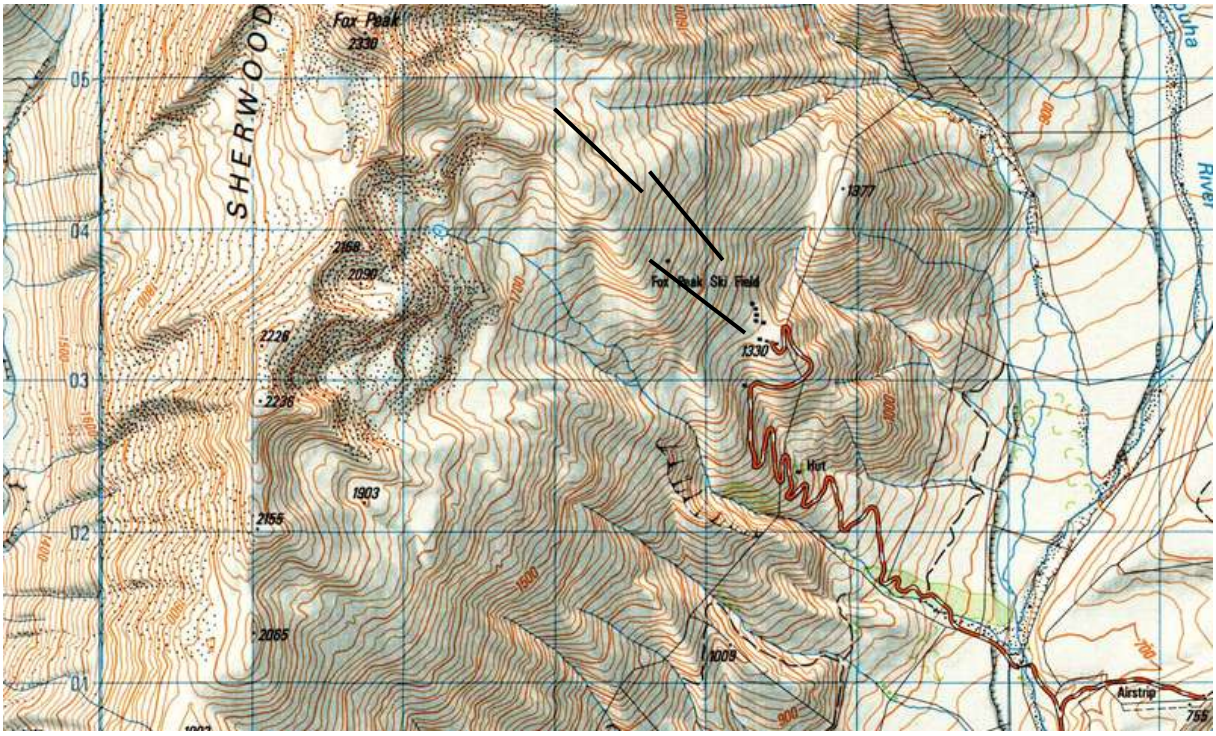


Figure 34: Location Map of Fox Peak (Source: Topo Map Pro 2.0, Map World New Zealand, 2002).

Sample Ski Fields in Overview

Table 86 provides a brief overview of basic geographic data and information on facilities and services available at the sampling locations.

Table 86 Overview of the Key Features of the Case Study Areas

Ski Area	**Mount Hutt**	**Porter Heights**	**Temple Basin**	**Broken River**	**Mount Olympus**	**Fox Peak**
Nearest Town	Methven	Springfield	Arthur's Pass	Springfield	Methven	Fairlie
Distance (km)	25	35	8	53	58	36
Nearest Airport	Christchurch	Christchurch	Christchurch	Christchurch	Christchurch	Christchurch
Distance (km)	125	106	163	123	125	195
Season Opens	End May	Mid June	Late June	Mid/late June	Mid July	Mid July
Season Closes	Late October	Mid October	October	October	October	October
Skiable Area (hectares)	365	230	320	150	60	385
Total Number of Lifts	10	5	4	4	4	4
Base Altitude (m)	1403	1340	1326	1313	1434	1330
Highest Altitude (m)	2075	1950	1753	1730	2097	1910
Vertical (m)	672	610	427	417	663	580
Beginner	25%	20%	25%	20%	10%	15%
Intermediate	50%	40%	50%	50%	55%	60%
Advanced	25%	40%	25%	30%	35%	25%
Chairlfts	2	0	0	0	0	0
T-Bars	3	3	0	0	0	0
Platters	2	1	0	0	0	0
Rope Tows	3(handle tows)	1	4	4	4	4
Ski School	Yes	Yes	Yes	Yes	Yes	Yes
Ski Hire	Yes	Yes	Yes	No	No	No
Chain Hire	Yes	Yes	No	No	No	No
Groomers	Yes (4)	Yes (2)	No	Yes[1] (1)	No	Yes [1]
Half Pipe	Yes	sometimes	No	No	No	No
Terrain Park	Yes	No	No	No	No	No
Cafe	Yes	Yes	Yes	----------Canteen selling----------		
Bar	Yes	Yes	Yes	----------snacks & drinks----------		
Accommodation on Ski Area	No	Yes	Yes	Yes	Yes	Yes

1) Not operational in the 2001 ski season.

APPENDIX – FOUR: SKI FIELD ASSESSMENT SAMPLING DETAILS

The questionnaire and a covering letter explaining the research project (see **Appendix – Five: Sustainable Slopes**) had been sent out to all managers of the ski fields listed in Table 83 on October 18th, 2001. On the same days an email was sent to all ski field mangers with known email contact to announce the arrival of the questionnaire.
One completed questionnaire was received back on October 22nd, 2001 (Ski field: Commercial 3).

Between November 5th, 2001 and November 9th, 2001 telephone follow-up calls to all twenty-eight managers were made. It was asked whether the questionnaire had arrived and if management considered taking part in the research. Most ski field managers replied positively, although pointing out that they were still busy after the end of the season. Some managers were unavailable and could not be contacted personally. In these cases a message was left with either the secretaries (commercial fields) or on the answering machine (club fields) reminding managers to consider taking part in the research project. The telephone follow-up resulted in several returned questionnaires (cub fields: four returned[76]; commercial fields: one returned). None of the managers refused to take part at this stage.

On the 27th November, 2001 a reminding letter was sent out to all operation that had not respond (positive and negative) to previous contacts. The letter encouraged mangers to return the questionnaires before the end of the year. The letter did not result in responses, but several mangers (all with one exception of commercial fields) refused to participate, all claiming time constraints as the reason for refusal.

[76] Initially one club field refused to participate, since the manger thought the club was to small to be relevant. After clarifying the research interest in any ski operation the manager returned the completed questionnaire.

During January 2002 several telephone calls were made and emails were exchanged with various managers. This resulted in two returned questionnaires (all commercial field) and some more refusals. On March 5th, 2001 a final email-reminder was sent out. This resulted in three more returned questionnaire (all club fields). In total the following response rates could be obtained. The last five valid responses could only be obtained after sending out another questionnaire since the original one had been displaced[77].

Table 87: Response Rate of "Sustainable Slopes Assessment 2001" in Overview

Ski Area Category	**Total no. of fields in 2001**	**Response Rate "Environmental Actions"**		**Response Rate "Resource Consumption"**	
	Equals 100%	N	%	N	%
International commercial fields*	7	4	57%	3	43%
National commercial fields*	6	1	17%	1	17%
Special purpose commercial fields	1	0	0%	0	0%
Club fields	11	7	64%	6	55%
Heli & cat fields	2	0	0%	1	50%
TOTAL	**27**	**12**	**44%**	**11**	**41%**

* As can be seen from Table 87, only one valid response of the national commercial ski field category could be obtained. Since the data collected is confidential and must only be presented in aggregated manner, international and national commercial fields were combined to commercial fields in the analysis of the thesis.

[77] Initially six new questionnaires have been sent out, of which two are still not returned despite reassurance of management to complete the survey.

APPENDIX – FIVE: SUSTAINABLE SLOPES CHARTER AND ASSESSMENT

Two documents of the NSAA were applied for this research; the "Environmental Charter" (NSAA, 2001c) and the "Sustainable Slopes Assessment 2001 (ESA)" (NSAA, 2001d). The latter consists of two parts:

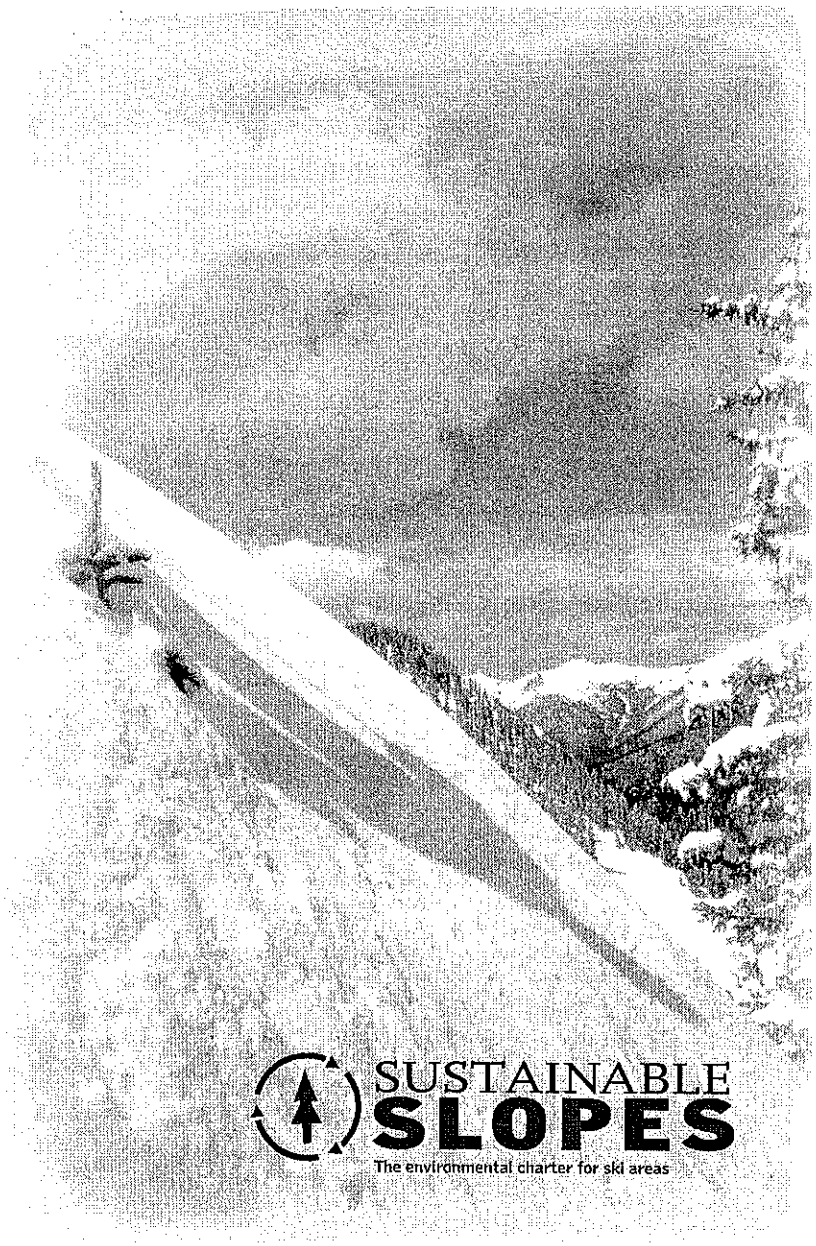
- Part One: "Environmental Actions" assessment
- Part Two: "Benchmarking" assessment

The "Environmental Charter" was included in the covering letter to provide the ski field managers with the essential background information. The charter outlines the principles, which were further specified by the "Environmental Actions" within the questionnaire. Additionally, the charter was considered valuable information and it was hoped that this would increase the response rate.

ESA Part One: The assessment forms 1-21 were directly copied from the original as published on the NSAA internet domain. Since no electronic copy of the assessment could be obtained from the NSAA, the sheets were not edited and some USA specific actions remained in the version used for New Zealand. For the analysis presented in this thesis all information that does not directly relate to resource consumption of ski areas was not considered. Respectively, data collected in sample forms 15,16,17,19, and 21 were not used.

ESA Part Two: The assessment forms 22-25 were purposely designed for this study to obtain resource consumption benchmarks for the ski area industry.

Both documents are attached on the following pages.



INTRODUCTION

The environment is a ski area's number one asset. The founders of the ski industry recognized that fact 60 years ago in choosing some of the most spectacular terrain for establishing ski areas. The natural surroundings are awe inspiring and provide a backdrop unmatched in any other sport. The premier alpine recreation sites we have today were made possible through the vision, pioneering spirit and hard work of our industry's founders. The value of those efforts holds today, as resorts are showcases of quality recreation opportunities for skiers, snowboarders, and countless summer guests as well. Although many forces may draw us to the slopes—the thrill and excitement of sliding down a mountain, the chance to reconnect with family and friends—we can never underestimate the value of the natural surroundings in renewing the human spirit.

As a society, we now find ourselves needing more than ever to escape every day pressures by heading for the outdoors. With that increasing demand comes impacts and a number of emerging environmental concerns that must be addressed proactively. As an industry, we need to apply the same vision and pioneering spirit of our founders to this new set of challenges. It is not enough to simply provide opportunities for fun and recreation; we must also be part of the solution.

We are taking this collective step of adopting our Environmental Charter to demonstrate our commitment to good environmental stewardship. We do so for a number of reasons. We respect the natural settings that we call home and want the same experience to be available for future generations. We are also keenly aware that our guests take the environment seriously and want us to be the most sustainable operations we can be. This means making efforts in all facets of our operations to use natural resources wisely and ensure that similar opportunities are available for future generations. Individual resorts have made great strides on this front in areas such as water and energy conservation, water quality protection, waste reduction, habitat protection, forest and vegetative management, and air and visual quality protection. This Charter will provide guidance for doing so collectively in the years to come.

This document represents a great deal of input, hard work, and energy from people inside and outside our industry. The National Ski Areas Association's (NSAA) Environmental Committee was instrumental in guiding the development of the Charter over the past year. NSAA's Board of Directors adopted the Mission and Vision statements in October of 1999. The Preamble was developed to convey the context of this Charter, provide background on our industry, and identify the purpose, goals, and limits of the Principles. The industry hosted four regional meetings on the Principles during the

1999/2000 season in Colorado, Oregon, Utah, and Vermont to gain input from stakeholders, including federal, state and local government officials, environmental groups, resorts, other recreation groups and academia. The Keystone Center, an independent non-profit public policy and education organization based in Colorado, facilitated these meetings. Our process was inclusive. In total, we invited more than a thousand individuals to participate, of which 200 provided us input over a nine-month period. A sampling of the Participating Organizations is provided on page 5. The Charter reflects this input, and is a much-improved document because of it.

The Principles are the heart of this Environmental Charter. They provide a framework for resorts across the country to implement best practices, assess environmental performance, and set goals for improvement in the future. Undoubtedly the implementation of these Principles may be more difficult for some resorts than others, as resorts vary greatly in their technical expertise and financial resources. Although we have chosen to use the term "ski area" throughout the Principles, the term encompasses a variety of winter and summer resort operations, from large destination resorts to small, local ski hills. Some of the smaller ski areas, in particular, may need more time to fully implement the Principles. Although there are many differences among ski areas, each shares in common a commitment to improved environmental performance and sound environmental stewardship.

We are fortunate to have a solid group of Partnering Organizations—those organizations that support the development of the Principles and are committed to working with us in the future—on board with this Charter. The Partnering Organizations are listed on page 4. In addition to participating in the stakeholder meetings, the Partnering Organizations attended a meeting in Washington, D.C. in March to provide final input on the Principles. They helped make this process a successful one, and we look forward to working with them in their areas of interest in the future.

The Charter also includes an Environmental Code of the Slopes in recognition of the high priority that our guests place on environmental concerns. The Code was developed with input from the stakeholder process to provide snowsports participants and other guests a role in this Charter. We are committed to heightening their awareness of the industry's efforts and educating them on what they can do to help us make sustainable use of natural resources. An outreach campaign on the Code will be developed and implemented at ski areas beginning next season.

The ski industry has an opportunity to be leaders among outdoor recreation providers and other businesses in promoting environmental awareness and striving to be a model of sustainable development. It is our hope that all ski areas will take advantage of that opportunity by endorsing this Charter, committing to implementing it, and helping us provide information to the public on our collective progress under it.

On behalf of NSAA, we are grateful to all of the individuals, organizations and agencies outside the industry that provided input, and the Keystone Center for their superb facilitation of this process. This is truly a beginning, and we look forward to working with all of you in the years to come.

—Michael Berry, National Ski Areas Association President
June 14, 2000

ENVIRONMENTAL VISION STATEMENT

To be leaders among outdoor recreation providers through managing our businesses in a way that demonstrates our commitment to environmental protection and stewardship while meeting the expectations of the public.

ENVIRONMENTAL MISSION STATEMENT

Ski areas across North America provide a quality outdoor recreation experience in a manner that complements the natural and aesthetic qualities that draw all of us to the mountains. We cherish the outdoors and respect the alpine environment in which we live and work. We are committed to improving environmental performance in all aspects of our operations and managing our areas to allow for their continued enjoyment by future generations.

PARTNERING ORGANIZATIONS

The Principles were developed through a stakeholder process facilitated by the Keystone Center. Input was sought from a wide variety of interests, including federal, state and local governmental agencies, environmental and conservation groups, other outdoor recreation groups, and academia. The "Partnering Organizations" listed below support the ski industry's development of the Principles and are committed to working with the industry on their particular areas of expertise and interest as the industry moves forward to implement the Principles.

Colorado Department of Public Health & Environment
Conservation Law Foundation
U.S. Department of Energy
U.S. Environmental Protection Agency
USDA Forest Service
Leave No Trace Inc.
The Mountain Institute
National Fish & Wildlife Foundation
National Park Service Concession Program
2002 Olympics Salt Lake City Organizing Committee
Teton County, Wyoming
Trust For Public Land

This list will be revised periodically. Please check www.nsaa.org for updates.

The Mountain Institute

CLF Conservation Law Foundation

PARTICIPATING ORGANIZATIONS

Individuals from the following organizations and agencies provided input on the Principles through the stakeholder process. Participation does not imply that these individuals or organizations support the Principles.

The Alford Design Group, Inc.	(Peter Alford, Jr., Peter Alford Sr.)
Cirrus Ecological Solutions	(Neal Artz, Scott Evans)
Citizens Allied for Responsible Growth	(Dana Williams)
Colorado Department of Public Health & Environment	
Colorado Mountain College – Ski Area Operations	(Curtis Bender, Paul Rauschke)
Colorado Ski Country USA	(Melanie Mills)
Conservation Law Foundation	(Mark Sinclair)
Economics Research Associates	(Greg Cory)
Environmental Defense	(Jennifer Pitt)
Green Mountain Club	(Ben Rose)
Innovation Works	(Mary Lou Krambeer)
Jack Johnson Company	(Brooke Hontz, Lauren Loberg)
Kimley-Horn & Associates, Inc.	(Jim Fletcher)
Leave No Trace Inc.	(Amy Mentuck)
Lyndon State College	(Catherine DeLeo, Ph.D.)
National Environmental Trust	(Jan Pendlebury, Kevin Curtis, Laura Culberson, Paul Blackburn, Susan Sargent)
National Fish and Wildlife Foundation	(Cinda Jones)
National Park Service	(Wendy Berhman)
The Nature Conservancy	(Liz Schulte, Angela Koloszar)
Normandeau Associates	(Al Larson, P.G.)
North Fork Preservation Alliance/Sundance Resort	(Mary Morrison)
Northwest Colorado Council of Governments Q/Q Committee	(Lane Wyatt)
ORCA – Trade Association of the Outdoor Industry	(Myrna Johnson)
Pacific Northwest Ski Areas Association	(Doug Campbell)
Park City Municipal Corporation	(Richard Lewis, Myles Rademan)
Pioneer Environmental Services, Inc.	(Roy Hugie)
Outward Bound USA	(Craig Mackey)
Salt Lake Organizing Committee for the Olympic Winter Games of 2002	(Diane Conrad, David Workman)
s.e. group	(Ted Beeler)
Sierra Club – Utah	(Jock Glidden)
Sierra Club – West Virginia	(Paul Wilson)
Ski Areas of New York	(Rob Megnin)
SKI Magazine	(Andy Bigford)
Ski Maine Association	(Greg Sweetser)
The Citizens Committee to Save Our Canyons	(Gavin Noyes)
Surfrider Foundation/Snowrider	(Jen Ader, Darryl Hatheway)
Teton County, Wyoming	(Ann Stephenson)
The Groswold Ski Company	(Jerry Groswold)
The Mountain Institute	(Jane Pratt)
Town of Mammoth Lakes	(Bill Taylor, Mike Vance)
Trout Unlimited – Colorado Chapter	(Melinda Kassen)
Trout Unlimited – Oregon Chapter	(Jeff Curtis)
Trout Unlimited – Utah Chapter	(Paul Dremann)
Trust for Public Land	(Doug Robotham)
University of Colorado – Center for Sustainable Tourism	(Charles Goeldner)
U.S. Department of Energy	
U.S. Environmental Protection Agency	
U.S. Forest Service	
Vermont Natural Resources Council	(Stephen Holmes)
Vermont Ski Areas Association	(Bill Scheer)

PREAMBLE

OUR VALUES

- Like their guests, ski area operators and employees enjoy the outdoors, appreciate the alpine environment and consider it their home. A strong environmental ethic underlies our operations, makes us stewards of the natural surroundings, and is the basis for our commitment to constant improvement in environmental conditions.

- The recreation opportunities that ski areas provide contribute to improving the quality of life for millions of people each year, and the natural surroundings greatly enhance those experiences. In providing quality, outdoor recreation opportunities, we strive to balance human needs with ecosystem protection.

- Ski areas are well suited to accommodate large numbers of visitors because of their infrastructure and expertise in managing the impacts associated with those visits. By providing facilities for concentrated outdoor recreation in limited geographic areas, ski areas help limit dispersed impacts in more remote, wild areas.

- Ski areas operate within and are dependent on natural systems including ecological, climatic and hydrological systems. These dynamic systems can affect our operations, just as we have effects on them. We are committed to working with stakeholders to help understand and sustain the diversity of functions and processes these systems support.

- In addition, ski areas operate within rural and wild landscapes that are valued for their scenic, cultural and economic characteristics. We are committed to working with stakeholders to understand and help maintain those characteristics which make these landscapes unique.

- Given the ski industry's dependence on weather, climate changes that produce weather patterns of warmer temperatures or decreased snowfall could significantly impact the industry. Accordingly, the industry is committed to better understanding the actual and potential impacts of climate change, reducing its own, albeit limited, emission of greenhouse gases, and educating its customers and other stakeholders about this issue.

- Along with environmental concerns, ski area operators are deeply concerned with the safety of our guests. We take safety into account in the design and operation of ski areas, and in some situations need to place the highest priority on safety.

BACKGROUND ON THE PRINCIPLES

- The ski industry is composed of a diverse group of companies, varying in size, complexity, accessibility to resources, and geographic location. These Principles are meant to be a useful tool for all ski areas, from local ski hills to four season destination resorts, whether on public or private land. Our vision is to have all ski areas endorse these Principles eventually and make a commitment to implementing them. Some smaller areas that endorse these Principles may be limited in their ability to make progress in all of the areas addressed.

- The Principles are voluntary and are meant to provide overall guidance for ski areas in achieving good environmental stewardship, not a list of requirements that must be applied in every situation. Recognition must be made that each ski area operates in a unique local environment or ecosystem and that development and operations may reflect these regional and operational differences. Each ski area must make its own decisions on achieving sustainable use of natural resources. While ski areas have the same goals, they can choose different options for getting there.

- The Principles are meant to go "beyond compliance" in those areas where improvements make environmental sense and are economically feasible. Ski areas should already be meeting all applicable federal, state, and local environmental requirements. Through these Principles, we are striving to improve overall environmental performance, whether it be in the form of achieving efficiencies, sustaining resources or enhancing the public's awareness of our special environment.

- The Principles encourage ski areas to adopt the "avoid, minimize, mitigate" approach to natural resource management. Avoidance should be the first consideration when outstanding natural resources or settings are at stake.

- The Principles recognize that ski areas have some unavoidable impacts. At the same time, ski areas strive to maintain the integrity of the environments in which they operate, by contributing to the sense of place in mountain communities and being good stewards of natural resources.

- The Principles are aimed at improving environmental performance at existing ski areas, and can serve as helpful guidance for planning new developments. The Principles cannot fully address when and where new ski area development should occur, as that issue should be addressed on the merits of each individual project and in consideration of the specific characteristics of a particular location. What might be beneficial development in one location could be inappropriate in another.

- Ski areas are concerned about the larger issues of growth and sustainable development in mountain communities. Key issues of community planning, such as protecting viewsheds, quality of life, and open space, are inherently linked to our business and the quality of experience of our guests. While the Principles cannot address fully some of the larger issues of growth in mountain communities, the ski industry is committed to working with stakeholders to make progress on these issues of concern to mountain communities. Many of the concepts in these Principles can provide leadership in confronting those issues.

- The Principles were developed through a collaborative dialogue process where input and awareness, not necessarily consensus on every issue or by every group, was the goal. The Principles represent the major areas of agreement for ski areas and Partnering Organizations.

- These Principles are a first, collective step in demonstrating our commitment to environmental responsibility. We hope that this initiative will help us better engage our stakeholders in programs and projects to improve the environment.

ENVIRONMENTAL PRINCIPLES

VOLUNTARY ENVIRONMENTAL PRINCIPLES FOR SKI AREA PLANNING OPERATIONS AND OUTREACH

I. Planning, Design and Construction

In planning and designing trails, base areas and associated facilities, ski areas have the opportunity to explore ways of integrating our operations into natural systems and addressing short and long-term environmental impacts to natural resources. There may also be opportunities to address past disturbances from historical uses that have occurred in the area and mitigate the unavoidable impacts from future ones.

Principles:

- Engage local communities, environmental groups, government agencies and other stakeholders in up front and continuing dialogue on development plans and their implementation
- Assess environmental concerns and potential restoration opportunities at local and regional levels
- Plan, site and design trails, on-mountain facilities and base area developments in a manner that respects the natural setting and avoids, to the extent practical, outstanding natural resources
- Emphasize nature in the built environment of the ski area
- Make water, energy, and materials efficiency and clean energy use priorities in the design of new facilities and the upgrading of existing facilities
- Use high-density development or clustering to reduce sprawl, provide a sense of place, reduce the need for cars and enhance the pedestrian environment
- Meet or exceed requirements to minimize impacts associated with ski area construction

Options for getting there:

✓ Engaging stakeholders collaboratively on the siting of improvements and the analysis of alternatives
✓ Complementing local architectural styles, scale, and existing infrastructure to enhance the visual environment and create a more authentic experience for guests
✓ Respecting outstanding natural resources and physical "carrying capacity" of the local ecology in planning new projects
✓ Using simulation or computer modeling in planning to assist with analyzing the effects of proposals on key natural resources and viewsheds such as visual modeling or GIS
✓ Designing trails with less tree removal and vegetation disturbance where feasible
✓ Incorporating green building principles, such as using energy, water and material efficiency techniques and sustainable building practices
✓ Using long-life, low maintenance materials in building
✓ Including parks, open space and native landscaping in base area developments
✓ Seeking opportunities for environmental enhancement and restoration
✓ Maximizing alternate transportation modes in and around the base area
✓ Minimizing road building where practical
✓ Selecting best management practices (BMPs) for construction sites with stakeholder input
✓ Applying sound on-mountain construction practices such as over-snow transport techniques, stormwater control or phasing of activities to minimize disturbances to natural habitats

** These Principles are voluntary and are not intended to create new legal liabilities, expand existing rights or obligations, waive legal defenses, or otherwise affect the legal position of any endorsing company, and are not intended to be used against an endorser in any legal proceeding for any purpose.*

II. Operations

In the day-to-day operation of ski areas and associated facilities, there are many opportunities for stewardship, conserving natural resources, and achieving efficiencies. Taking advantage of these opportunities will not only benefit the environment, but can also result in long-term cost savings.

Water Resources

Water is an important resource for ski areas as well as the surrounding natural environments and communities, and should be used as efficiently and effectively as possible.

Water Use for Snowmaking

Principles:

- Optimize efficiency and effectiveness of water use in snowmaking operations
- Conduct snowmaking operations in a manner that protects minimum stream flows and is sensitive to fish and wildlife resources (see Fish & Wildlife Principles on page 14).

Options for getting there:

✓ Using appropriate technology and equipment to optimize efficiency
✓ Inspecting and monitoring systems to reduce water loss
✓ Using reservoirs or ponds to store water for use during low flow times of the year and to maximize efficiency in the snowmaking process
✓ Working with local water users and suppliers to promote in-basin storage projects to offset low flow times of the year
✓ Installing water storage facilities to recapture snowmelt runoff for reuse
✓ Inventorying water resources and monitoring seasonal variations in stream flows
✓ Supporting and participating in research on the ecological impacts of snowmaking

Water Use in Facilities

Principle:

- Conserve water and optimize efficiency of water use in ski area facilities

Options for getting there:

✓ Conducting water use audits and investigating methods and alternative technologies to reduce water consumption
✓ Installing water efficient equipment in facilities such as low-flow faucets and toilets
✓ Participating in existing water conservation and linen and towel re-use programs such as EPA's WAVE® and Project Planet® programs for lodging
✓ Educating guests and employees about the benefits of efficient water use

Water Use For Landscaping and Summer Activities

Principle:

- Maximize efficiency in water use for landscaping and summer activities

Options for getting there:

- ✓ Incorporating water efficiency BMPs in planning and design phases
- ✓ Planning summer uses in conjunction with winter uses to maximize the efficiency of necessary infrastructure
- ✓ Using drought-tolerant plants in landscaped areas
- ✓ Using native plant species where appropriate
- ✓ Using water efficient irrigation and recycling/reuse technologies
- ✓ Using compost in soil to increase water retention and reduce watering requirements
- ✓ Inspecting and monitoring systems to reduce water loss
- ✓ Watering at appropriate times to minimize evaporation
- ✓ Educating employees about efficient water use

Water Quality Management

Principle:

- ◆ Meet or exceed water quality-related requirements governing ski area operations

Options for getting there:

- ✓ Participating in watershed planning, monitoring and restoration efforts
- ✓ Using appropriate erosion and sediment control practices such as water bars, revegetation and replanting
- ✓ Maintaining stream vegetative buffers to improve natural filtration and protect habitat
- ✓ Applying state-of-the-art or other appropriate stormwater management techniques
- ✓ Utilizing oil/water separators in maintenance areas and garages
- ✓ Using environmentally sensitive deicing materials
- ✓ Encouraging guests to follow the Leave No Trace™ principles of outdoor ethics

Wastewater Management

Principle:

- ◆ Manage wastewater in a responsible manner

Options for getting there:

- ✓ Planning for present and future wastewater needs with adjacent communities
- ✓ Using appropriate wastewater treatment technology or alternative systems to protect water quality
- ✓ Connecting septic systems to municipal wastewater systems where appropriate
- ✓ Exploring the use of decentralized or on-site treatment technologies where appropriate
- ✓ Re-using treated wastewater/greywater for non-potable uses and appropriate applications
- ✓ Monitoring wastewater quality

Energy Conservation and Use

Ski areas can be leaders in implementing energy efficiency techniques and increasing the use of renewable energy sources within their operations to conserve natural resources, reduce pollution and greenhouse gases and reduce the potential impacts of climate change.

Energy Use for Facilities

Principles:

- ◆ Reduce overall energy use in ski area facilities
- ◆ Use cleaner or renewable energy in ski area facilities where possible
- ◆ Meet or exceed energy standards in new or retrofit projects

Options for getting there:

- ✓ Auditing current usage levels, and targeting areas for improvement
- ✓ Developing an energy management plan that addresses short and long term energy goals, staffing, and schedules for new and retrofit projects
- ✓ Orienting buildings and their windows to maximize natural light penetration, reduce the need for artificial lighting and facilitate solar heating and photovoltaic electricity generation
- ✓ Using solar heating or geothermal heat pumps for heating air and water
- ✓ Using timing systems, light management systems and occupancy sensors
- ✓ Performing lighting retrofits to provide more energy efficient lamps, retrofitting exit signs to use low watt bulbs, calibrating thermostats, and fine tuning heating systems
- ✓ Using peak demand mitigation, distributed, on-site power generation and storage, and real time monitoring of electricity use
- ✓ Working with utilities to manage demand and take advantage of cost sharing plans to implement energy savings
- ✓ Entering into load sharing agreements with utilities for peak demand times
- ✓ Partnering with the U.S. Department of Energy and state energy and transportation departments to assist with energy savings and transit programs
- ✓ Participating in energy efficiency programs such as EPA/DOE's Energy Star™
- ✓ Educating employees, guests and other stakeholders about energy efficient practices
- ✓ Installing high efficiency windows, ensuring that all windows and doorways are properly sealed and using insulation to prevent heating and cooling loss
- ✓ Minimizing energy used to heat water by using low-flow showerheads, efficient laundry equipment, and linen and towel re-use programs
- ✓ Investing in cleaner or more efficient technologies for power generation, including wind, geothermal, and solar power generation, fuel cells and natural gas turbines and generation from biomass residues and wastes
- ✓ Purchasing green power, such as wind-generated power, from energy providers

Energy Use for Snowmaking

Principles:

- ◆ Reduce energy use in snowmaking operations
- ◆ Use cleaner energy in snowmaking operations where possible

Options for getting there:

- ✓ Using high efficiency snow guns and air compressors for snowmaking operations
- ✓ Upgrading diesel motors or converting them to alternative clean energy generation sources
- ✓ Using real time controls, sensors and monitoring systems to optimize the system and reduce electrical demand

✓ Using on mountain reservoirs and ponds to gravity feed snowmaking systems where possible
✓ Using distributed, on-site power generation to avoid or reduce peak demands from the utility grid
✓ Purchasing green power from energy providers

Energy Use for Lifts

Principles:
- Reduce energy use in lift operations
- Use cleaner energy in lift operations where possible

Options for getting there:
✓ Using high efficiency motors
✓ Upgrading diesel motors or converting them to alternative clean energy sources, such as fuel cells or microturbines
✓ Using renewable energy sources
✓ Purchasing green power from energy providers

Energy Use for Vehicle Fleets

Principles:
- Reduce fuel use in vehicles used for ski area operations
- Use cleaner fuel where possible

Options for getting there:
✓ Providing shuttles or transportation for guests and employees
✓ Using energy efficient vehicles
✓ Using alternative fuel or hybrid electric engines in ski area fleet vehicles including shuttles, trucks, snowcats and snowmobiles
✓ Conducting regular maintenance on fleet vehicles

Waste Management

The Principles below incorporate the "REDUCE, REUSE, RECYCLE" philosophy of waste management to help ensure materials are being used efficiently and disposed of only after consideration is given to reusing or recycling them. Reducing waste helps protect natural resources, reduce pollution, greenhouse gases and energy use by decreasing the need to produce new materials, and minimizes disposal costs.

Waste Reduction

Principle:
- Reduce waste produced at ski area facilities

Options for getting there:
✓ Conducting an audit of waste production to establish a baseline and track progress toward reduction
✓ Purchasing recycled products
✓ Purchasing products in bulk to minimize unnecessary packaging
✓ Encouraging vendors to offer "take-backs" for used products
✓ Educating guests and employees about reducing wastes generated at the area and following the Leave No Trace™ Principles such as "pack it in, pack it out"

Product Reuse

Principle:
- Reuse products and materials where possible

Options for getting there:
✓ Using washable or compostable tableware/silverware in cafeterias and lodges
✓ Encouraging guests to reuse trail maps
✓ Composting food wastes, grass clippings, and woody debris for use in landscaping and revegetation areas
✓ Exploring opportunities for reusing products (e.g., building materials, lift parts and equipment, and office supplies)
✓ Joining EPA's WasteWise® program

Recycling

Principle:
- Increase the amount of materials recycled at ski areas where possible

Options for getting there:
✓ Making recycling easy for guests by offering containers and displaying signage in facilities and lodges
✓ Recycling office paper, cardboard, newspaper, aluminum, glass, plastic and food service waste
✓ Recycling building materials as an alternative to landfilling
✓ Partnering with local governments on recycling in remote communities where recycling programs are not readily available
✓ Encouraging vendors to offer recycled products for purchase
✓ Educating guests and training employees on recycling practices
✓ Setting purchasing specifications to favor recycled content and specifying a portion of new construction to require recycled content

Potentially Hazardous Wastes

Principle:
- Minimize the use of potentially hazardous materials, the generation of potentially hazardous wastes and the risk of them entering the environment

Options for getting there:
✓ Safely storing and disposing of potentially hazardous materials such as solvents, cleaning materials, pesticides and paints

- ✓ Recycling waste products such as used motor oil, electric batteries, tires and unused solvents
- ✓ Restelving and reusing partially used containers of paint, solvents, and other materials
- ✓ Purchasing non-hazardous products for use when effective
- ✓ Properly managing fuel storage and handling
- ✓ Maintaining or upgrading equipment to prevent leaks
- ✓ Initiating programs to reduce the occurrence of accidental spills or releases
- ✓ Installing sedimentation traps in parking lots
- ✓ Educating employees on the requirements for properly handling hazardous wastes
- ✓ Reclaiming spent solvents
- ✓ Coordinating with local area emergency planning councils for response in case of a spill or release

Fish and Wildlife

Ski areas operate within larger ecosystems and strive to be stewards of fish and wildlife habitats. They need the cooperation of other landowners, managers, local communities and other stakeholders for an effective ecosystem management approach. There are measures ski areas can take to better understand, minimize, and mitigate impacts to fish and wildlife, and in some cases, enhance habitat, particularly for species of concern. The benefits of these measures include promoting biodiversity and the natural systems that attract guests to the mountain landscape.

Principle:

- Minimize impacts to fish and wildlife and their habitat and maintain or improve habitat where possible

Options for getting there:

- ✓ Supporting and participating in research of fish and wildlife populations and their interactions with ski areas
- ✓ Inventorying and monitoring fish and wildlife and their habitat, particularly protected species
- ✓ Using snowmaking storage ponds or reservoirs to store water for use during times of low stream flows to help protect aquatic habitat
- ✓ Conducting activities and construction with sensitivity to seasonal wildlife patterns and behavior
- ✓ Siting and designing trails and facilities to include gladed skiing areas, linkage of ungladed areas to maintain blocks of forested corridors and inter-trail islands to reduce fragmentation where appropriate
- ✓ Limiting access to, or setting aside, certain wildlife habitat areas
- ✓ Using wildlife-proof dumpsters or trash containers
- ✓ Creating or restoring habitat where appropriate, either on- or off-site
- ✓ Using land conservation techniques such as land exchanges and conservation easements as vehicles for consolidating or protecting important wildlife habitat
- ✓ Participating in ecosystem-wide approaches to wildlife management
- ✓ Providing wildlife education programs for employees, guests, and the local community such as Skecology® and the Leave No Trace™ Principles of respecting wildlife

Forest and Vegetative Management

Ski areas recognize the importance of stewardship in managing the forests and vegetation that support ecosystems and allow for public recreation opportunities. Sound forest and vegetative management can benefit fish and wildlife habitat, water quality and viewsheds and reduce erosion, pollution, and greenhouse gases.

Principle:

- Manage effects on forests and vegetation to allow for healthy forests and other mountain environments

Options for getting there:

- ✓ Inventorying and monitoring forest and vegetative resources
- ✓ Adopting vegetative management plans
- ✓ Minimizing the removal of trees through the careful siting and design of trails
- ✓ Using over-snow skidding to remove logs for new runs during times of sufficient snow cover
- ✓ Using aerial logging where economically feasible
- ✓ Removing dead and diseased trees, with consideration to habitat value, to promote healthy forests and public safety
- ✓ Revegetating roads that are no longer used
- ✓ Revegetating disturbed areas with native plant species and grasses, recognizing that faster growing, non-native species may be needed to address erosion
- ✓ Revegetating disturbed areas as quickly as possible following disturbance
- ✓ Limiting disturbance to vegetation during summer activities
- ✓ Assessing the role of forest stands in reducing greenhouse gases
- ✓ Providing signage informing guests of sensitive vegetation areas
- ✓ Using traffic control measures, such as rope fences, on areas with limited snow coverage to protect sensitive vegetation and alpine tundra
- ✓ Reducing or eliminating snowcat and snowmobile access to sensitive areas with limited snow coverage
- ✓ Planting at appropriate times to minimize water use while optimizing growth
- ✓ Employing practices to control invasive or noxious weeds

Wetlands & Riparian Areas

Ski areas recognize that wetlands and riparian areas are crucial components of the alpine ecosystems in which they operate.

Principle:

- Avoid or minimize impacts to wetlands and riparian areas, and offset unavoidable impacts with restoration, creation or other mitigation techniques

Options for getting there:

- ✓ Inventorying and monitoring wetland and riparian areas
- ✓ Limiting snowmaking and grooming equipment access to wetlands and riparian areas if snow cover is inadequate to protect them

- ✓ Limiting guest access to wetlands and riparian areas and vernal pools if snow cover is inadequate to protect them
- ✓ Engaging in restoration, remediation and protection projects
- ✓ Establishing buffers and setbacks from wetland and riparian areas in summer
- ✓ Managing snow removal and storage to avoid impacting wetlands and riparian areas as feasible
- ✓ Supporting or participating in research on functions of wetland habitats and riparian areas
- ✓ Using trench boxes to minimize impacts to forested wetlands from construction of utility lines

Air Quality

Ski area guests and operators value fresh air as an integral part of the skiing experience. Although there are many sources in and around the community that, combined, may compromise air quality, ski areas can do their share to help minimize impacts. Some of the many benefits of cleaner air and reduced air pollution include enhanced visibility and lessening human influences on climate change, which is of particular concern to ski areas given their location.

Principles:

- Minimize ski area impacts to air quality
- Reduce air pollution and greenhouse gas emissions as feasible

Options for getting there:

- ✓ Reducing air pollutants and greenhouse gas emissions from buildings, facilities and vehicles through clean energy and transportation-related measures identified in these Principles
- ✓ Using dust abatement methods for dirt roads during summer operations and construction
- ✓ Revegetating as appropriate to control dust
- ✓ Reducing the sanding and cindering of ski area roads by using alternative deicing materials
- ✓ Sweeping paved parking lots periodically
- ✓ Reducing burning of slash through chipping or other beneficial uses
- ✓ Limiting wood burning fireplaces or using cleaner burning woodstoves and fireplaces and installing gas fireplaces
- ✓ Working with local and regional communities to reduce potential air quality impacts

Visual Quality

Scenic values are critical to surrounding communities and the experience of guests. Although ski area development is a part of the visual landscape in many mountain areas, it can be designed and maintained in a manner that complements the natural setting and makes the natural setting more accessible to guests. Where opportunities for collaboration exist, ski areas should also consider working with appropriate partners in the protection of open lands that help define the visual landscape in which their guests recreate.

Principles:

- Create built environments that complement the natural surroundings
- Explore partnerships with land conservation organizations and other stakeholders that can help protect open lands and their role in the visual landscape

Options for getting there:

- ✓ Planning with landscape scenic values in mind
- ✓ Minimizing ridgeline development where feasible
- ✓ Promoting protection of open space elsewhere in the community to enhance regional viewsheds
- ✓ Applying local architectural styles and highlighting natural features to minimize disruption of the visual environment and create a more authentic experience
- ✓ Using visual simulation modeling in siting, planning and design to assist in demonstrating visual effects of projects
- ✓ Designing lifts and buildings to blend into the natural backdrop or complement the natural surroundings
- ✓ Constructing trails to appear as natural openings
- ✓ Using non-reflective building products and earth tone colors on structures
- ✓ Planting trees or other vegetation to improve visual quality
- ✓ Incorporating low level lighting or directional lighting to reduce impacts of lights on the night sky while recognizing safety, security, and maintenance needs
- ✓ Keeping parking areas free of debris and garbage
- ✓ Placing existing and new utility lines underground to reduce visual impacts

Transportation

Travel to and within ski areas has unavoidable impacts. Through transportation initiatives, ski areas can do their part to help ease congestion and impacts to air quality and improve the ski area experience. (See related topic of ski area vehicle fleets under Energy Principles.)

Principle:

- Ease congestion and transportation concerns

Options for getting there:

- ✓ Providing employee transportation benefits, including shuttles, bus passes or discounts, van pools, and ride-share incentives
- ✓ Providing and promoting ski area guest transportation through shuttles or buses
- ✓ Offering and promoting carpooling or HOV incentives for guests such as discounts or preferred parking in proximity to lodges
- ✓ Offering and promoting non-peak travel incentives for guests such as Sunday night stay discounts
- ✓ Increasing density in base area development when appropriate to reduce the need for vehicle use
- ✓ Supporting and participating in transit initiatives in the community and region
- ✓ Working with travel agents to market and promote "car free" vacation packages

III. Education and Outreach

Because of their setting in an outdoor, natural environment and the clear connection between that natural environment and the guest experience, ski areas have an excellent opportunity to take a leadership role in environmental education and in enhancing the environmental awareness of their guests, surrounding communities, and employees.

Principles:

- Use the natural surroundings as a forum for promoting environmental education and increasing environmental sensitivity and awareness
- Develop outreach that enhances the relationship between the ski area and stakeholders and ultimately benefits the environment

Options for getting there:

✓ Training employees and informing guests of all ages about the surrounding environment
✓ Promoting the Environmental Code of the Slopes®
✓ Educating stakeholders about these Principles and the Environmental Charter for Ski Areas
✓ Providing leadership on environmental concerns with particular importance to the alpine or mountain environment, such as climate change
✓ Dedicating personnel to environmental concerns and incorporating environmental performance measures and expectations into departmental goals
✓ Dedicating a portion of the ski area's website to environmental excellence and the Environmental Charter
✓ Offering Skecology® or other environmental education and awareness programs that provide on-mountain instruction and offer classroom information for use in schools
✓ Partnering with local school systems, businesses and the public on initiatives and opportunities for protecting and enhancing the environment
✓ Displaying interpretive signs on forest resources, vegetative management and fish and wildlife
✓ Publicly demonstrating a commitment to operating in an environmentally sensitive manner by adopting these Principles or addressing environmental considerations in company policies or mission statements
✓ Creating funding mechanisms for environmental outreach projects
✓ Promoting the ski area's environmental success stories or specific measures taken to address water, energy, waste, habitat, vegetation, air quality, visual quality or transportation concerns
✓ Encouraging employees to participate in community environmental initiatives
✓ Supporting initiatives to reduce snowmobile noise and emissions
✓ Asking guests their opinions about ski area environmental programs and initiatives and using their feedback to improve programs and the guests' experiences.

NEXT STEPS FOR SKI AREAS

- Endorsing the Environmental Charter and making a commitment to implement the Principles over time.
- Adopting environmental mission statements, policies or programs that reflect or expand upon the Environmental Charter and demonstrate your commitment to environmental protection and stewardship.
- Designating an "Environmental Charter contact" at your resort.
- Conducting audits and gathering data to measure, document, and report your progress toward implementing the Principles.
- Using the Principles as a framework, targeting areas for improved environmental performance.
- Supporting research on, exploring, and applying technologies that conserve natural resources.
- Developing comprehensive programs for waste reduction, product reuse and recycling.
- Participating in existing programs that help foster effective environmental management and policies or measure environmental improvements.
- Developing Environmental Management Systems over time which are tailored to your operations.
- Sharing data and innovative environmental solutions with other resorts and the industry as possible.
- Taking active steps to educate employees, guests, and the general public about the Environmental Charter and the ski area's environmental policies and practices.

ENVIRONMENTAL CODE OF THE SLOPES®

WHAT SKIERS, SNOWBOARDERS AND SKI AREA GUESTS CAN DO TO HELP

- Follow the Leave No Trace™ Principles of outdoor ethics when visiting ski areas:
  - **Plan ahead and prepare:** Know the regulations and special concerns for the area you'll visit, prepare for winter weather, and consider off-peak visits when scheduling your trip.
  - **Dispose of waste properly:** Recycle your glass, plastics, aluminum and paper at resorts. Reuse trail maps on your next visit or recycle them rather than throwing them away. Never throw trash, cigarette butts or other items from the lifts.
  - **Respect wildlife:** Observe trail closures, seasonal closures, and ski area boundaries. These closures are in place not only for your safety, but the well being of plants and animals located in sensitive areas. In summer, stick to designated trails when hiking and biking to avoid disturbances to vegetation and wildlife.
  - **Be considerate of other guests:** Respect other guests, protect the quality of their experience, and let nature's sounds prevail.
- Carpool with friends and family or use transit to avoid traffic when travelling to and within the ski area.
- Turn off the lights when leaving your room and reuse bath towels and linens to help conserve energy and water.
- Use washable tableware and silverware in cafeterias and lodges instead of paper or plastics to help us reduce waste.
- Take advantage of environmental or alpine education programs offered at ski areas to learn more about the surrounding environment and how to help protect it.
- If you have kids, get them involved in environmental and alpine education programs at a young age.
- Support "clean up days" or other environmental programs at your local ski area.
- Provide feedback and let ski areas know how they can improve their environmental performance.

ENDORSING SKI AREAS

THE FOLLOWING SKI AREAS HAVE ENDORSED THE ENVIRONMENTAL CHARTER AND ARE COMMITTED TO IMPLEMENTING THE PRINCIPLES.

Alpine Meadows Ski Resort (CA)
Alta Ski Area (UT)
Alyeska Resort (AK)
Anthony Lakes Mountain Resort (OR)
Arapahoe Basin (CO)
Arizona Snowbowl (AZ)
Aspen Highlands (CO)
Aspen Mountain (CO)
Aspen Skiing Company (CO)
Attitash Bear Peak (NH)
Balsams Wilderness (NH)
Bear Creek Ski & Recreation Area (PA)
Beaver Creek Resort (CO)
Berthoud Pass Ski Area (CO)
Big Bear Mountain Resort (CA)
Big Mountain Ski & Summer Resort (MT)
Black Mountain Ski Area (NH)
Blacktail Mountain Ski Area (MT)
Blue Mountain Resorts Limited (Canada)
Bogus Basin Resort (ID)
Bolton Valley Resort (VT)
Boreal Mountain Resort (CA)
Boston Mills/Brandywine Ski Resort (OH)
Breckenridge Ski Resort (CO)
Bridger Bowl Ski Area (MT)
Bristol Mountain Ski Resort (NY)
Brodie Mt. Ski Resort (MA)
Bromley Mountain Ski Resort (CVT)
Brundage Mountain Resort (ID)
Buttermilk Mountain (CO)
Camelback Ski Area (PA)
Cannon Mountain (NH)
The Canyons (UT)
Cataloochee Ski Area (NC)
Copper Mountain Resort (CO)
Cranmore Mountain Resort (NH)
Crested Butte Mountain Resort (CO)
Crystal Mountain, Inc. (WA)
Crystal Mountain Resort (MI)
Discovery Ski Area (MT)
Denton Hill Family & Ski Resort (Ski Denton) (PA)
Devil's Head Resort (WI)
Dodge Ridge Ski Area (CA)
Dyer Mountain Associates, LLC (CA)
Eagle Crest Ski Area (AK)
49 Degrees North Ski Area (WA)
Gore Mountain Ski Area (NY)
Grand Targhee Ski & Summer Resort (WY)
Greek Peak Ski Resort (NY)
Gunstock Area (NH)
Heavenly Ski Resort (CA)
Hidden Valley Ski Area (MO)
Holiday Valley Resort (NY)
HooDoo Ski Area (OR)
Hunter Mountain (NY)
Hyland Ski & Snowboard Area (MN)
Jackson Hole Mountain Resort (WY)
Jiminy Peak – The Mountain Resort (MA)
Keystone Resort (CO)
Killington Resort (VT)
Kirkwood Mountain Resort (CA)
Lookout Pass Ski & Recreation Area (ID)
Loon Mountain Recreation Corp. (NH)
Lost Trail Ski Area (MT)
Loveland Ski Area (CO)
Mammoth Mountain Ski Area (CA)
Massanutten Ski Resort (VA)
Mission Ridge (WA)
Mohawk Mountain Ski Area (CT)
Monarch Ski & Snowboard Area (CO)
Mont Ste. Marie (Canada)
Montana Snow Bowl (MT)
Mount Shasta Board & Ski Park (CA)
Mount Snow Resort (VT)
Mount Sunapee Resort (NH)
Mountain Creek (NJ)
Mountain High Resort (CA)
Mt. Ashland Ski Area (OR)
Mt. Bachelor Inc. (OR)
Mt. Hood Meadows Ski Resort (OR)
Mt. La Crosse, Inc. (WI)
Mt. Rose - Ski Tahoe (NV)

Northstar-at-Tahoe (CA)
Nub's Nob Ski Area (MI)
Okemo Mountain Resort (VT)
Otis Ridge (MA)
Panorama Resort (Canada)
Paoli Peaks (IN)
Park City Mountain Resort (UT)
Pat's Peak Ski Area (NH)
Pebble Creek Ski Area (ID)
Peek 'n Peak Resort (NY)
Pelican Butte Corporation (OR)
Pomerelle Mountain Resort (ID)
Powderhorn Resort (CO)
Powder Ridge Ski Area (CT)
Purgatory Resort (CO)
Red Lodge Mountain (MT)
Red River Ski Area (NM)
Seven Springs Mtn Resort (PA)
Shawnee Peak Ski Area (ME)
Sierra Summit Mt. Resort (CA)
Sierra-at-Tahoe Ski Resort (CA)
Silver Creek Ski Resort (CO)
Ski Bluewood (WA)
Ski Cooper (CO)
Ski Liberty (PA)
Ski Plattekill (NY)
Ski Roundtop (PA)
Ski Snowstar Winter Sports Park (IL)
Ski Windham (NY)
Sleepy Hollow Sports Park Inc. (IA)
Smuggler's Notch Resort (VT)
Snowbasin Ski Area (UT)
Snow Creek Ski Area (MO)
Snow Summit Mt. Resort (CA)
Snowbird Ski & Summer Resort (UT)
Snowmass Ski Area (CO)
Snowshoe Mountain (WV)
Soda Springs Ski Area (CA)
Solitude Mountain Resort (UT)
Spirit Mountain (MN)
Squaw Valley Ski Corp. (CA)
Steamboat Ski & Resort Corp. (CO)
Stevens Pass (WA)
Stowe Mt. Resort (VT)
Stratton Mountain (VT)
Sugar Bowl Ski Resort (CA)
Sugarbush Resort (VT)
Sugarloaf USA (ME)
The Summit at Snoqualmie (WA)
Sunburst Ski Area (WI)
Sundance (UT)
Sunday River Ski Resort (ME)
Sunlight Mountain Resort (CO)
Swain Ski & Snowboard Center (NY)
Taos Ski Valley (NM)
Telluride Ski & Golf Company (CO)
The Temple Mountain Ski Area (NH)
Tenney Mountain Ski Area (NH)
Timberline Four Seasons Resort (WV)
Timberline (OR)
Tremblant Resort Inc. (Canada)
Triple M-Mystical Mountain Magic (NM)
Vail Mountain (CO)
Vail Resorts, Inc. (CO)
Wachusett Mountain Ski Area (MA)
Welch Village Ski Area (MN)
Whistler & Blackcomb Resorts (Canada)
White Pass Ski Area (WA)
Whiteface Mt. Ski Center (NY)
Whitetail Resort (PA)
Wildcat Mountain Ski Area (CT)
Willamette Pass Ski Corp. (OR)
Williams Ski Area (AZ)
Winter Park Resort (CO)
Wintergreen Resort (VA)
Wolf Creek Ski Area (CO)

ENDORSING ASSOCIATIONS AND AFFILIATES

American Association of Snowboard Instructors
Colorado Mountain College - Ski Area Operations
Colorado Ski Country USA
National Ski Patrol
Pacific Northwest Ski Areas Association
Professional Ski Instructors of America
Ski Areas of New York
Ski Maine Association
Ski New Hampshire
Ski Utah
University of Colorado Center for Sustainable Tourism
Vermont Ski Areas Association

(Please see www.nsaa.org for updates and revisions to this list.)

NATIONAL SKI AREAS ASSOCIATION

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Sustainable Slopes Assessment - 2001

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Form 1. Planning, Design, and Construction

Principles

- Engage local communities, environmental groups, government agencies, and other stakeholders in up front and continuing dialogue on development plans and their implementation.
- Assess environmental concerns and potential restoration opportunities at local and regional levels.
- Plan, site, and design trails, on-mountain facilities, and base area developments in a manner that respects the natural setting and avoids, to the extent practical, outstanding natural resources.
- Emphasize nature in the built environment of the ski area.
- Make water, energy, and materials efficiency, and clean energy use priorities in the design of new facilities and the upgrading of existing facilities.
- Use high-density development or clustering to reduce sprawl, provide a sense of place, reduce the need for cars, and enhance the pedestrian environment.
- Meet or exceed requirements to minimize impacts associated with ski area construction.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Engaging stakeholders collaboratively on the siting of improvements and the analysis of alternatives?*	O	O	O
2	*Complementing local architectural styles, scale, and existing infrastructure to enhance the visual environment and to create a more authentic experience for guests?*	O	O	O
3	*Respecting outstanding natural resources and physical "carrying capacity" of the local ecology in planning new projects?*	O	O	O
4	*Using simulation or computer modeling, such as visual modeling or GIS, in planning to assist with analyzing the effects of proposals on key natural resources and viewsheds?*	O	O	O
5	*Designing trails with less tree removal and vegetation disturbance where feasible?*	O	O	O
6	*Incorporating green building principles, such as using energy, water, and material efficiency techniques and sustainable building practices?*	O	O	O
7	*Using long-life, low maintenance materials in building?*	O	O	O
8	*Including parks, open space, and native landscaping in base area developments?*	O	O	O
9	*Seeking opportunities for environmental enhancement and restoration?*	O	O	O
10	*Maximizing alternate transportation modes in and around the base area?*	O	O	O
11	*Minimizing road building where practical?*	O	O	O
12	*Selecting best management practices (BMPs) for construction sites with stakeholder input?*	O	O	O
13	*Applying sound on-mountain construction practices, such as over-snow transport techniques, stormwater control, or phasing of activities to minimize disturbances to natural habitats?*	O	O	O
14	<< Space for Additional Practices>>	O	O	O
15	<< Space for Additional Practices>>	O	O	O
16	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, (5) Principles implemented.

O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 2. Water Use for Snowmaking

Principles

- Optimize efficiency and effectiveness of water use in snowmaking operations.
- Conduct snowmaking operations in a manner that protects minimum stream flows and is sensitive to fish and wildlife resources.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Using appropriate technology and equipment to optimize efficiency?*	O	O	O
2	*Inspecting and monitoring water systems to reduce water loss?*	O	O	O
3	*Using reservoirs or ponds to store water for use during low flow times of the year and to maximize efficiency in the snowmaking process?*	O	O	O
4	*Working with local water users and suppliers to promote in-basin storage projects to offset low flow times of the year?*	O	O	O
5	*Installing water storage facilities to recapture snowmelt runoff for re-use?*	O	O	O
6	*Inventorying water resources and monitoring seasonal variations in stream flows?*	O	O	O
7	*Supporting and participating in research on the ecological impacts of snowmaking?*	O	O	O
8	<< Space for Additional Practices>>	O	O	O
9	<< Space for Additional Practices>>	O	O	O
10	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 3. Water Use in Facilities

Principle

\+ Conserve water and optimize efficiency of water use in ski area facilities.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Conducting water use audits and investigating methods and alternative technologies to reduce water consumption?*	O	O	O
2	*Installing water efficient equipment in facilities, such as low-flow faucets and toilets?*	O	O	O
3	*Participating in existing water conservation and linen and towel re-use programs, such as EPA's WAVE and Project Planet programs for lodging?*	O	O	O
4	*Educating guests and employees about the benefits of efficient water use?*	O	O	O
5	<< Space for Additional Practices>>	O	O	O
6	<< Space for Additional Practices>>	O	O	O
7	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 4. Water Use for Landscaping and Summer Activities

Principle

+ Maximize efficiency in water use for landscaping and summer activities.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Incorporating water efficiency best management practices (BMPs) in planning and design phases?*	O	O	O
2	*Planning summer uses in conjunction with winter uses to maximize the efficiency of necessary infrastructure?*	O	O	O
3	*Using drought-tolerant plants in landscaped areas?*	O	O	O
4	*Using native plant species where appropriate?*	O	O	O
5	*Using water efficient irrigation and recycling/re-use technologies?*	O	O	O
6	*Using compost in soil to increase water retention and reduce watering requirements?*	O	O	O
7	*Inspecting and monitoring systems to reduce water loss?*	O	O	O
8	*Watering at appropriate times to minimize evaporation?*	O	O	O
9	*Educating employees about efficient water use?*	O	O	O
10	<< Space for Additional Practices>>	O	O	O
11	<< Space for Additional Practices>>	O	O	O
12	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented.

O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 5. Water Quality Management

Principle

+ Meet or exceed water quality-related requirements governing ski area operations.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Participating in watershed planning, monitoring, and restoration efforts?*	O	O	O
2	*Using appropriate erosion and sediment control practices, such as water bars, revegetation, and replanting?*	O	O	O
3	*Maintaining stream vegetative buffers to improve natural filtration and protect habitat?*	O	O	O
4	*Applying state-of-the-art or other appropriate stormwater management techniques?*	O	O	O
5	*Using oilwater separators in maintenance areas and garages?*	O	O	O
6	*Using environmentally sensitive de-icing materials?*	O	O	O
7	*Encouraging guests to follow the "Leave No Trace" principles of outdoor ethics?*	O	O	O
8	<< Space for Additional Practices>>	O	O	O
9	<< Space for Additional Practices>>	O	O	O
10.	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 6. Wastewater Management

Principle

+	Manage wastewater in a responsible manner.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Planning for present and future wastewater needs with adjacent communities?*	O	O	O
2	*Using appropriate wastewater treatment technology or alternative systems to protect water quality?*	O	O	O
3	*Connecting septic systems to municipal wastewater systems where appropriate?*	O	O	O
4	*Exploring the use of decentralized or on-site treatment technologies where appropriate?*	O	O	O
5	*Re-using treated wastewater/greywater for non-potable uses and appropriate applications?*	O	O	O
6	*Monitoring wastewater quality?*	O	O	O
7	<< Space for Additional Practices>>	O	O	O
8	<< Space for Additional Practices>>	O	O	O
9	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented.	O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 7. Energy Use for Facilities

Principles

+ Reduce overall energy use in ski area facilities.

+ Use cleaner or renewable energy in ski area facilities where possible.

+ Meet or exceed energy standards in new or retrofit projects.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any addional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Auditing current usage levels and targeting areas for improvement?*	O	O	O
2	*Developing an energy management plan that addresses short and long term energy goals, staffing, and schedules for new and retrofit projects?*	O	O	O
3	*Orienting buildings and their windows to maximize natural light penetration, reduce the need for artificial lighting, and facilitate solar heating and photovoltaic electricity generation?*	O	O	O
4	*Using solar heating or geothermal heat pumps for heating air and water?*	O	O	O
5	*Using timing systems, light management systems, and occupancy sensors?*	O	O	O
6	*Performing lighting retrofits to provide more energy efficient lamps, retrofitting exit signs to use low watt bulbs, calibrating thermostats, and fine tuning heating systems?*	O	O	O
7	*Using peak demand mitigation, distributed on-site power generation and storage, and real time monitoring of electricity use?*	O	O	O
8	*Working with utilities to manage demand and take advantage of cost sharing plans to implement energy savings?*	O	O	O
9	*Entering into load sharing agreements with utilities for peak demand times?*	O	O	O
10	*Partnering with the U.S. Department of Energy (DOE) and state energy and transportation departments to assist with energy savings and transit programs?*	O	O	O
11	*Participating in energy efficiency programs, such as the U.S. Environmental Protection Agency's (EPA'a)/DOE's Energy Star?*	O	O	O
12	*Educating employees, guests, and other stakeholders about energy efficient practices?*	O	O	O
13	*Installing high efficiency windows, ensuring that all windows and doorways are properly sealed, and using insulation to prevent heating and cooling loss?*	O	O	O
14	*Minimizing energy used to heat water by using low-flow showerheads, efficient laundry equipment, and linen and towel re-use programs?*	O	O	O
15	*Investing in cleaner or more efficient technologies for power generation, including wind, geothermal, and solar power generation, fuel cells and natural gas turbines, and generation from biomass residues and wastes?*	O	O	O
16	*Purchasing green power, such as wind-generated power, from energy providers?*	O	O	O
17	<< Space for Additional Practices>>	O	O	O
18	<< Space for Additional Practices>>	O	O	O
19	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 8. Energy Use for Snowmaking

Principles

+ Reduce energy use in snowmaking operations..

+ Use cleaner energy in snowmaking operations where possible.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Using high efficiency snow guns and air compressors for snowmaking operations?*	O	O	O
2	*Upgrading diesel motors or converting them to clean energy generation sources?*	O	O	O
3	*Using real time controls, sensors, and monitoring systems to optimize the system and reduce electrical demand?*	O	O	O
4	*Using on-mountain reservoirs and ponds to gravity feed snowmaking systems where possible?*	O	O	O
5	*Using distributed, on-site power generation to avoid or reduce peak demands from the utility grid?*	O	O	O
6	*Purchasing green power from energy providers?*	O	O	O
7	<< Space for Additional Practices>>	O	O	O
8	<< Space for Additional Practices>>	O	O	O
9	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) Investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented.

O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 9. Energy Use for Lifts

Principles

+ Reduce energy use in lift operations.

+ Use cleaner energy in lift operations where possible.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Using high efficiency motors?*	O	O	O
2	*Upgrading diesel motors or converting them to alternative clean energy sources, such as fuel cells or microturbines?*	O	O	O
3	*Using renewable energy sources?*	O	O	O
4	*Purchasing green power from energy providers?*	O	O	O
5	<< Space for Additional Practices>>	O	O	O
6	<< Space for Additional Practices>>	O	O	O
7	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 10. Energy Use for Vehicle Fleets

Principles

+ Reduce fuel use in vehicles used for ski area operations.

+ Use cleaner fuel where possible.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Providing shuttles or transportation for guests and employees?*	O	O	O
2	*Using energy efficient vehicles?*	O	O	O
3	*Using alternative fuel or hybrid electric engines in ski area fleet vehicles, including shuttles, trucks, snowcats, and snowmobiles?*	O	O	O
4	*Conducting regular maintenance on fleet vehicles?*	O	O	O
5	<< Space for Additional Practices>>	O	O	O
6	<< Space for Additional Practices>>	O	O	O
7	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented.

O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 11. Waste Reduction

Principle

+ Reduce waste produced at ski area facilities.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Conducting an audit of waste production to establish a baseline and track progress toward reduction?*	O	O	O
2	*Purchasing recycled products?*	O	O	O
3	*Purchasing products in bulk to minimize unnecessary packaging?*	O	O	O
4	*Encouraging vendors to offer "take-backs" for used products?*	O	O	O
5	*Educating guests and employees about reducing wastes generated at the area and following the "Leave No Trace" principles, such as "pack it in, pack it out?"*	O	O	O
6	<< Space for Additional Practices>>	O	O	O
7	<< Space for Additional Practices>>	O	O	O
8	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 12. Product Re-use

Principle

\+ Re-use products and materials where possible.

Actions

What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.

		(Yes)	(No)	(N/A)
1	*Using washable or compostable tableware/silverware in cafeterias and lodges?*	O	O	O
2	*Encouraging guests to re-use trail maps?*	O	O	O
3	*Composting food wastes, grass clippings, and woody debris for use in landscaping and revegetation areas?*	O	O	O
4	*Exploring opportunities for re-using products (e.g., building materials, lift parts and equipment, and office supplies)?*	O	O	O
5	*Joining the U.S. Environmental Protection Agency's (EPA's) WasteWise program?*	O	O	O
6	<< Space for Additional Practices>>	O	O	O
7	<< Space for Additional Practices>>	O	O	O
8	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 13. Recycling

Principle

+ Increase the amount of materials recycled at ski areas where possible.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Making recycling easy for guests by offering containers and displaying signage in facilities and lodges?*	O	O	O
2	*Recycling office paper, cardboard, newspaper, aluminum, glass, plastic, and food service waste?*	O	O	O
3	*Recycling building materials as an alternative to landfilling?*	O	O	O
4	*Partnering with local governments on recycling in remote communities where recycling programs are not readily available?*	O	O	O
5	*Encouraging vendors to offer recycled products for purchase?*	O	O	O
6	*Educating guests and training employees on recycling practices?*	O	O	O
7	*Setting purchasing specifications to favor recycled content and specifying a portion of new construction to require recycled content?*	O	O	O
8	<< Space for Additional Practices>>	O	O	O
9	<< Space for Additional Practices>>	O	O	O
10	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 14. Potentially Hazardous Wastes

Principle

+ Minimize the use of potentially hazardous materials, the generation of potentially hazardous wastes, and the risk of them entering the environment.

Actions

What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.

		(Yes)	(No)	(N/A)
1	*Safely storing and disposing of potentially hazardous materials, such as solvents, cleaning materials, pesticides, and paints?*	O	O	O
2	*Recycling waste products, such as used motor oil, electric batteries, tires, and unused solvents?*	O	O	O
3	*Reshelving and re-using partially used containers of paint, solvents, and other materials?*	O	O	O
4	*Purchasing non-hazardous products for use when effective?*	O	O	O
5	*Properly managing fuel storage and handling?*	O	O	O
6	*Maintaining or upgrading equipment to prevent leaks?*	O	O	O
7	*Initiating programs to reduce the occurrence of accidental spills or releases?*	O	O	O
8	*Installing sedimentation traps in parking lots?*	O	O	O
9	*Educating employees on the requirements for properly handling hazardous wastes?*	O	O	O
10	*Reclaiming spent solvents?*	O	O	O
11	*Coordinating with local area emergency planning councils for response in case of a spill or release?*	O	O	O
12	<< Space for Additional Practices>>	O	O	O
13	<< Space for Additional Practices>>	O	O	O
14	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 18. Air Quality

Principles

+ Minimize ski area impacts to air quality.

+ Reduce air pollution and greenhouse gas emissions as feasible.

Actions

	What has your organization done to support these Principles? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support these Principles, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Reducing air pollutants and greenhouse gas emissions from buildings, facilities, and vehicles through clean energy and transportation-related measures identified in these Principles?*	O	O	O
2	*Using dust abatement methods for dirt roads during summer operations and construction?*	O	O	O
3	*Revegetating as appropriate to control dust?*	O	O	O
4	*Reducing the sanding and cindering of ski area roads by using alternative de-icing materials?*	O	O	O
5	*Sweeping paved parking lots periodically?*	O	O	O
6	*Reducing burning of slash through chipping or other beneficial uses?*	O	O	O
7	*Limiting wood burning fireplaces or using cleaner burning woodstoves and fireplaces and installing gas fireplaces?*	O	O	O
8	*Working with local and regional communities to reduce potential air quality impacts?*	O	O	O
9	<< Space for Additional Practices>>	O	O	O
10	<< Space for Additional Practices>>	O	O	O
11	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of these Principles: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principles implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principles above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 20: Transportation

Principle

+	Ease congestion and transportation concerns.

Actions

	What has your organization done to support this Principle? Listed below are the suggested "options for getting there" provided in the Charter. Please indicate which option(s) your organization has undertaken to support this Principle, adding any additional practices in the spaces provided.	(Yes)	(No)	(N/A)
1	*Providing employee transportation benefits, including shuttles, bus passes or discounts, van pools, and ride-share incentives?*	O	O	O
2	*Providing and promoting ski area guest transportation through shuttles or buses?*	O	O	O
3	*Offering and promoting carpooling or high-occupancy vehicle (HOV) incentives for guests, such as discounts or preferred parking in proximity to lodges?*	O	O	O
4	*Offering and promoting non-peak travel incentives for guests, such as Sunday night stay discounts?*	O	O	O
5	*Increasing density in base area development when appropriate to reduce the need for vehicle use?*	O	O	O
6	*Supporting and participating in transit initiatives in the community and region?*	O	O	O
7	*Working with travel agents to market and promote "car free" vacation packages?*	O	O	O
8	<< Space for Additional Practices>>	O	O	O
9	<< Space for Additional Practices>>	O	O	O
10	<< Space for Additional Practices>>	O	O	O

Overall Status

Given your indications of progress above, please estimate your overall level of implementation in meeting the intent of this Principle: 1) not yet started, 2) investigating, but no actions implemented, 3) some actions implemented, 4) significant progress made, 5) Principle implemented. O (1) O (2) O (3) O (4) O (5)

Priorities for Improvement (respond if you indicate a 3 or less on the previous question)

Using a scale of 1 to 3 (1 being the lowest positive outcome, 3 being the highest), rate the following potential benefits if you were to fully implement the Principle above.

	(Low)	(Med)	(High)
Increased Monetary Savings	O (1)	O (2)	O (3)
Reduced Environmental Impacts	O (1)	O (2)	O (3)
Reduced Regulatory Liability	O (1)	O (2)	O (3)
Increased Positive Public Image	O (1)	O (2)	O (3)

Form 22. Environmental Indicators

Purpose

In the coming years, it may become a common protocol to report quantitative results of key environmental indicators for the industry. In the "next steps for ski areas", the Charter recommends that ski fields gather data to measure, document, and report their progress toward implementing the Principles. The following questions are intended to help gather quantitative data currently available, while encouraging ski fields to begin preparing their tracking methods for quantitative reporting in future years.

Water Consumption

Estimate the (or if possible give exact) number of litres of water your field consumed in the 2001 season. If possible distinguish water consumption for snowmaking from other water consumption *(if you should have accurate figure, please provide these).*

A: Water Consumption for Snowmaking

- O <10 million litres / season
- O 10 – 50 million litres / season
- O 60 – 100 million litres / season
- O > 100 million litres / season

B: Other Water Consumption

_____ litres annually

Energy Consumption

Estimate (or if possible give exact) amount of energy your field consumed in the 2001 season. If possible distinguish energy consumption for snowmaking from other water consumption *(if you should have accurate figure, please provide these).*

A: Energy Consumption for Snowmaking

_____ litres diesel
_____ kWh electricity
_____ (other)

B: Other Energy Consumption

_____ m^3 wood
_____ kilogrammes LPG
_____ litres petrol
_____ litres diesel
_____ kWh electricity
_____ (other)

Waste Management

Estimate the percent of total waste your ski field diverts from the landfill on an annual basis through recycling efforts. Also indicate the total amount of waste going to the landfill.

A: Waste Reduction and Recycling

- O 0% diversion (no recycling or waste reduction)
- O 1-5% diversion
- O 5-10% diversion
- O 10-20% diversion
- O 20-50% diversion
- O >50% diversion

B: Waste Disposal

- O < 20 tonnes / annually
- O 20 – 50 tonnes / annually
- O 50 – 100 tonnes / annually
- O 100 – 200 tonnes / annually
- O >200 tonnes / annually

Form 23. Resort Summary[1]

Vehicle Fleet

Please tick the vehicle types operating on your field, specify the number for each type, name the engine for each type (eg. Petrol, Diesel, ...), engine size and the year the vehicle was built.

Vehicle Fleet Information[1]

O	Groomers	How many? _____	Engine: _____	Size?_____cc built:____
O	Snowmobiles	How many? _____	Engine: _____	Size?_____cc built:____
O	Quad-Bikes	How many? _____	Engine: _____	Size?_____cc built:____
O	4WD	How many? _____	Engine: _____	Size?_____cc built:____
O	Vans	How many? _____	Engine: _____	Size?_____cc built:____
O	Graders	How many? _____	Engine: _____	Size?_____cc built:____
O	Bulldozers	How many? _____	Engine: _____	Size?_____cc built:____
O	_____	How many? _____	Engine: _____	Size?_____cc built:____
O	_____	How many? _____	Engine: _____	Size?_____cc built:____
O	_____	How many? _____	Engine: _____	Size?_____cc built:____

Lift Facilities

Please tick the lift types operating at your field, specify the number for each type, name the engine for each type (eg. Electric, Diesel, ...), and the year the engine was built.

Lift Information[1]

O	Grip tows		How many? _____	Engine:_____built:____
O	Rope tows		How many? _____	Engine: _____built:____
O	Platter lift		How many? _____	Engine:_____built:____
O	T-bar lift		How many? _____	Engine: _____built:____
O	Double chairlift	O detachable	How many? _____	Engine: _____built:____
O	Triple chairlift	O detachable	How many? _____	Engine: _____built:____
O	Quad chairlift	O detachable	How many? _____	Engine: _____built:____
O	Six-seater chairlift	O detachable	How many? _____	Engine: _____built:____
O	Magic carpet		How many? _____	Engine: _____built:____
O	Helicopter Service		How many flights/year? _____	Av. flight time_____

On-Mountain Facilities

Please tick the facilities operating at your field, name the type of heating system (eg. Electric, Wood), specify the size of the facility in m^2, and the year the facility was built.

Facility Information[1]

O	Kiosk	Heating? _____	Size in m^2?_____built:_____
O	Cafeteria	Heating? _____	Size? _____built:_____
O	Restaurant	Heating? _____	Size? _____built:_____
O	Ski/Snowboard Hire	Heating? _____	Size? _____built:_____
O	Office Building	Heating? _____	Size? _____built:_____
O	Lodge number of beds?_____	Heating? _____	Size? _____built:_____
O	Staff Quarter beds?_____	Heating? _____	Size? _____built:_____
O	Day Lodge / Shelter	Heating? _____	Size? _____built:_____
O	Other:_____	Heating? _____	Size? _____built:_____
O	Other:_____	Heating? _____	Size? _____built:_____

[1] If there is not enough space for your information, please write on the back of this side. Thank you.

Sustainable Slopes Assessment 2001

Form 24. Visitor Numbers

Box I: Skier / Snowboarder Visits

A Skier / Snowboarder Visit is any single visit to your ski field at each open day in the 2001 season by a person, who paid for a valid ticket on the day of visit.

Skier / Snowboarder Visits Information

- O Skier/Snowboarder Visits How many? _____ (annually)
- O **Non**-Skiers/Snowboarders Visits How many? _____ (annually)
- O We do not count Skier/Snowboarder Visits at all
- O We count: _____ How many? _____ (annually)

Box II: Tickets sold in 2001

Please tick the lift tickets sold in 2001 and indicate the number sold.

Pass Sales Information

- O Season Passes How many? _____
- O Multi-day Passes How many? _____
- O Day Passes How many? _____
- O Beginners Passes / Package How many? _____
- O Ski Express Pass How many? _____
- O Frequent Card How many? _____
- O Group Arrangements How many? _____ Please specify: _____
- O _____ How many? _____
- O _____ How many? _____

Visitor Number Estimate

It would be desirable to collect the data as outlined above (Box I and Box II). However, the researcher is aware of the commercial sensitivity of the figures demanded. If you cannot provide us with the figures as required by this form, please indicate the average skier / snowboarder visitor volume your ski field attracts per annum:

- O < 2,500 Skier/Snowboarder Visits per annum
- O 2,500 – 5.000 Skier/Snowboarder Visits per annum
- O 5,000 – 10.000 Skier/Snowboarder Visits per annum
- O 10,000 – 30,000 Skier/Snowboarder Visits per annum
- O 30,000 – 50,000 Skier/Snowboarder Visits per annum
- O 50,000 – 100,000 Skier/Snowboarder Visits per annum
- O > 100,000 Skier/Snowboarder Visits per annum

Please describe briefly the procedure of collecting visitor numbers at your field:

_____

_____

_____

_____

Form 25. Authorization for Use of Data

Confidentiality Declaration

Assessment of Environmental Performance of Ski Fields in New Zealand

Only aggregated data will be published! The researcher asks the ski field managers to state any confidentiality issues special to this ski field that need to be respected in published work:

_____

_____

_____

_____

_____

_____

I declare that I will respect the confidentiality issues stated above.

Axel Reiser

Axel Reiser (Researcher)

Consent Form

Consent

I have read and understood the description of the above-named project. On this basis I agree to participate as a business in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. I understand also that I may at any time withdraw from the project, including withdrawal of any information I have provided.

Signed: _____ Date: _____

Position: (_____)

Ski Field: _____

APPENDIX – SIX: THE CANTERBURY SKIER & SNOWBOARDER SURVEY

The questionnaire was purposely designed to research the four aspects outlined under research objective IV:

- What is the demographic profile (general and snow sport related) of the recreationists and tourists?
- What man-made facilities do skiers and snowboarders value most? (Degree of Facility Dependency)
- What is the transport behaviour of snow sport recreationists?
- What is the waste disposal behaviour of snow sport recreationists?

The three parts of the questionnaire do not reflect these questions. They are structured in a way that respondents could fluently answer the questions. The first part referring to off site general attitudes, the second part asking for demographic and snow sport detail, and the third part referring to the visit on the sampling day. Part I answers the questions concerning facilities, the demographics and snow sport characteristics are dispersed over all three parts. The blocks for transport (Question 23-25 and Question 31[78]) and waste disposal behaviour (Questions 26-30) are located under part III.

Note that the questionnaire presented on the next page was folded into B5 format (booklet style).

[78] The map was located at the back of the questionnaire since only ski tourists needed it to outline their itinerary.

Field:______________________ Date:__________________(office use only)

The Canterbury Ski and Snowboard Survey

Welcome to the snow sport study!

You are invited to participate in a project entitled *Canterbury Ski & Snowboard Survey* by completing the following questionnaire. The aim of this project is to research your skiing and snowboarding experience at Canterbury's ski fields. We are interested some general attitudes but mainly in today's visit to this ski field. We would like to know how you travelled to the ski field and what you do besides skiing or snowboarding. The questionnaire is anonymous, and you will not be identified as a respondent without your consent. You may at any time withdraw your participation, including withdrawal of any information you have provided. If you complete the questionnaire, however, it will be understood that you have consented to participate in the project and consent to publication of the results of the project with the understanding that anonymity will be preserved.

If you see a box like this, ☐ please tick ✓ your choice, if there is a line like this, ________please write on it.

➢ **Screening Question:** **Why did you visit this ski area today?**

SKIING ☐ SNOW BOARDING ☐ OTHER: ______________________

PART 1: GENERAL ATTITUDES

Question 1: **Are you member of a ski / snowboard club?**

NO ☐ YES ☐ Club: ______________________

Question 2: **Why did you choose to come to this field today? Please state your most important reason:**

____

____

____

Question 3: **How do you value the following facilities at this field?**

Ranking Key: 1 = unimportant -------------------------7 = very important

na = not applicable

	1	2	3	4	5	6	7	na		1	2	3	4	5	6	7	na
1: Restaurant / Cafeteria									2: Ski Rental Facilities								
3: Access Road									4: Size of Parking Area								
5: Range of Base Facilities									6: On-Snow Lodge								
7: Variety of Groomed Trails									8: Terrain Park								
9: Slope Grooming/Preparation									10: Chair Lift								
11: Speed of Lifts / Capacity									12: Rope Tows								
13: T-Bar / Poma / Platter									14: Learner Area								
15: Ski School									16: Snowmaking								

Question 4: **What needs to be improved at this field to make it more valuable to you personally?**

____

____

Question 5: **Is there a specific improvement you would be willing to pay more for your skiing / snowboarding experience?**

____

____

Question 6: **Could you specify how much more you would be willing to pay?**

(This questions refers to what you have stated above: Question 5)

1: NO ☐ 2: YES ☐ How much? $ ________ per ____________

PART 2: CHARACTERISTICS AND DEMOGRAPHICS

Question 7: **Where do you prefer to ski/board?**

(If multiple preferences, please tick all and underline main one)

1: Green Slopes (Beginners) ☐ 3: Black Slopes (Advanced) ☐ 5: Terrain Park / Half-Pipe ☐

2: Blue Slopes (Intermediate) ☐ 4: Off-Trail (Ungroomed) ☐ 6: Other: ______________

Question 8: **How many days per season do you ski/board?** (Refer to your last season.)

Please, try to be honest and do **not** tell "How many days you would like to ski/board"

1: Fewer than 3 days ☐ 3: 7-14 days ☐

2: 3-6 days ☐ 4: 15 days or more ☐

Question 9: **How many overnight trips do you take per season?** ______________

(This question does not ask for the number of nights you spent away skiing, but for the number of overnight trips)

Question 10: **How many days have you skied already this season?** ____________ **days**

Question 11: **How many winter seasons did you ski or board actively in your life?**

____________________seasons

Question 12: **How old are you?** **I am** ________ **years.**

Question 13: **Are you?** **1: Female** ☐ **2: Male** ☐

Question 14: **What is your current occupation** (main source of income)?

____

Question 15: **Are you still enrolled in a secondary** ☐ **... or tertiary** ☐ **... education institute?** **Not applicable** ☐

(Please tick the one applicable)

Question 16: **Do you have (A) a secondary** ☐ **(B) a tertiary** ☐ **school qualification?**

☐ (C) NONE Other: ______________

Question 17: **What is your highest qualification?**

Part A: *Please print the name of your highest qualification*

____

Please turn over, more questions other side!

PART 3: TODAY'S VISIT TO THIS SKI FIELD

Question 18: How long are you away from home on this trip? _____

Question 19: What is your hometown? _____

Question 20: What is your country of residence? _____

Question 21: On this trip, you visited this ski field for ... One Day ☐

More than one day ☐ How many days? _____

How many days did you ski already _____ / do you plan to ski in total _____ on this trip?

Will / Did you visit other ski areas in New Zealand on this trip? YES ☐ NO ☐

Is skiing the main purpose of your trip? YES ☐ NO ☐

Question 22: What field pass did you use today?

1: Day: ☐ 2: Season: ☐ 3: Multi-Day: ☐ 4: Beginners: ☐ 5: Other: _____

Question 23: What transport did you use today to come to the ski field?

1: Private Car ☐ 2: Rental Car I ☐

5: Private 4WD or Truck: ☐ 6: Rental 4WD or Truck ☐

7: Private Campervan ☐ 8: Rental Campervan ☐

9: Commercial Minivan (max. 10 passengers) ☐

10: Commercial Coach (more than10 passengers ☐

11: Other: _____ (please specify)

Part A: *Engine Size:* _____ *cc* ☐ *own:*

Part B: *Fuel Source of vehi* ☐ Petrol ☐ Diesel ☐ LPG Other: _____

Part C: How many passengers were in the vehicle you came to the ski field today? _____

Question 24: What are your estimated costs for travelling to the ski field today?

$ _____ per _____

Question 25: Why did you choose to come by [redacted] rather than by another type of transport? (eg. public transport if you came by private transport)

_____

_____

Question 26: What would you think about a ski field that does not provide rubbish bins?

1: Poor service ☐ 2: Innovative Management: ☐ 3: Management does not care: ☐ 4: Nothing: ☐

Question 27: Would you be willing to "carry out what you carry in"?

YES ☐ NO ☐ Reason for NO? _____

Question 28: Do you think that it is amongst the responsibilities of ski fields to provide waste disposal opportunities? YES ☐ NO ☐

Question 29: Did you use the bins at the ski field today to dump your rubbish?

YES ☐ NO ☐ What kind of rubbish? _____

Question 30: Would you participate in recycling if different bins were provided to separate your rubbish?

YES ☐ NO ☐ Reason for NO? _____

Question 31: Please briefly outline your entire trip on the map provided:

I am interested in:

- Your travel legs & number of nights spent at each location
- Type of transport used for each travel leg & number of persons in vehicle
- Type of accommodation used
- Main purpose of your trip (if not skiing)? _____

I would like you to mark this information on the map provided as outlined below:

Motel

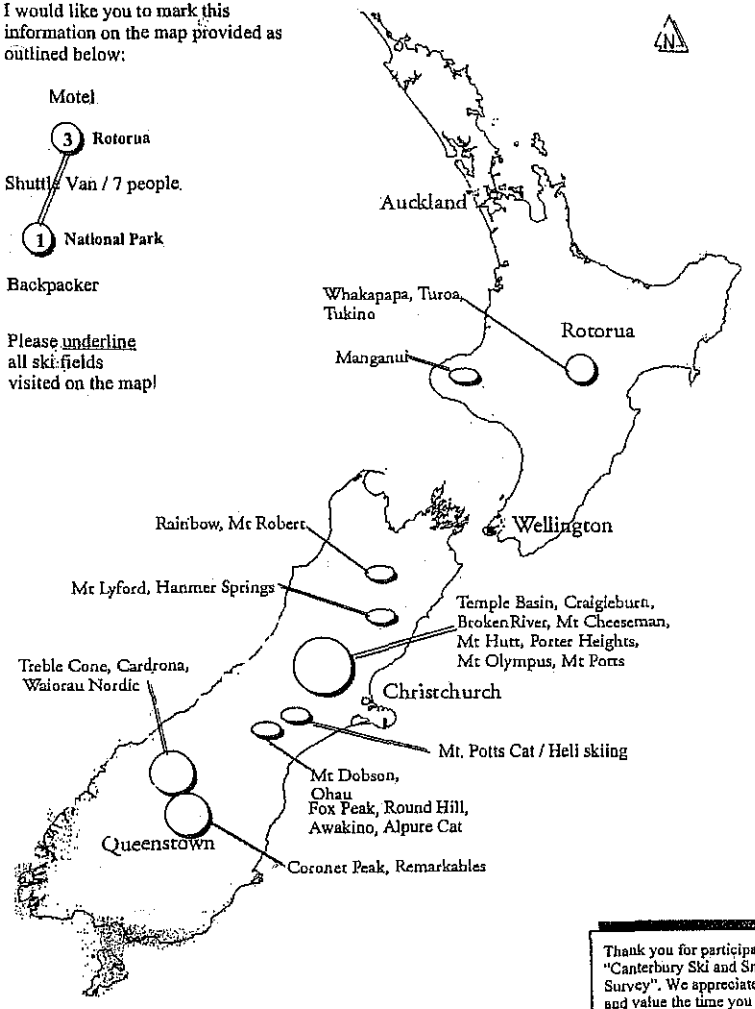
(3) Rotorua

Shuttle Van / 7 people

(1) National Park

Backpacker

Please underline all ski fields visited on the map!



Thank you for participating in the "Canterbury Ski and Snowboard Survey". We appreciate your effort and value the time you spent completing the questionnaire.

Please turn over, more questions other side!