Diploma in Parks and Recreation

Proposal for Dissertation

Bruce Mason

Topic: The potential for skifield development in the Wakatipu district – an evaluation of the need for, the potential of, and constraints to skifield development at Coronet Peak and the Rastus Burn.

Background: Over recent years it has been advanced by development interests that Coronet Peak, whilst ranking as one of the top world skifields, is deficient in its capability to meet present and future demands. To overcome these deficiencies, skifield development has been advocated for other sites near Queenstown, notably in the Rastus Burn basin on the Remarkables. No quantitive measure of skifield potential exists to provide an objective assessment of development options.

Range of Investigation

Comparitive investigation of the following factors relevant to skifield operation, at Coronet Peak and Rastus Burn:-

* Reliability of snow cover } from historical records
* Length of ski season } and field investigation.
* Ski slope extent : field investigation
* Slope Carrying Capacity + Slope Analysis : from literature + field invest.
* Current utalisation (Coronet Peak only) : field investigation.
* (Skier Market Demand.?)
* Development Constraints and Design Capacities.
* Factors affecting snow accumulation (snowline, elevation, aspect, slope, irradiation) : from literature + field investigation.

Hopefull Outcome

A quantitive measure of skifield potential to provide the basis for long-term planning of skifield development in the Queenstown district.

Carrying Capacity ~~in~~ Land Use Planning: A Case study of Skifield Development in the Q'town District.

Stankie / ~~[illegible]~~ Neilson - 'wilderness Management'.

Don Poole = Canadian with skifield management experience.

Davy Lovell / Smith - Ch.

H. 623 ~~Planning~~ 4th

Dissertation Cost.

Typing	$45
Photo Xerox	5
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Agosto

DIPLOMA IN PARKS & RECREATION

A Dissertation "To hold forth in speech or writing"
A treatise; sermon; expository discourse".

"An original enlightening statement concerning a field of study".

Range and Status of Dissertation

The completed work should involve an input equivalent to that of a 3hr/week, single semester subject, i.e. about 6 hours/week through one semester. Students should bear in mind that it takes as long to write up the dissertation as it does to assemble the data. Time has been allocated in the week under "Special Topic" and in the new diploma under "Dissertation" in recognition of the time required.

Approval

For the Diploma in Parks & Recreation the dissertation must be on a subject approved by the Senior Lecturer and the Head of Department. Supervision by a qualified person is essential.

Subject

Students should consider a subject which has particular interest to them and one which may have future application in Parks & Recreation.

Content

Original research is not a requirement of a dissertation but original thought involving principles, process or suggested change add greatly to a dissertation. Inquiry, investigation, observation, the use of surveys, maps, charts, graphs, line drawings and quality photographs are important contributions to a dissertation.

Presentation

This can vary according to the writers desire. The topic itself may indicate a certain style or form of presentation. e.g. A topic based on wilderness protection or vandalism may rely heavily on photographic evidence while another based on changes to recreational activity may rely heavily on written statements and graphs. Where landscape considerations are involved then graphics will influence the style and lay-out work.

Physical requirements

Normally a dissertation is typed at 1½ spacing on A4 paper at single spacing and on one side only.

The work may be presented with either the short or the long margin to the left. It must be firmly stapled or bound and preferably have a firm cover. The presented dissertation remains the property of the College so it is recommended that a second copy is made to be retained by the student.

.../2

Margin widths: Left side, 3 cm, right side 2 to 3.5 cm. top 3 cm (to include page number) bottom, 2 cm.

The length of the dissertation should be no greater than 50 pages.

Completion Date

Must be handed in by February 28 for graduation in May. We strongly recommend students to complete the dissertation in the PR3 year and not to take an extra year over its preparation - the cost/benefit doesn't justify it.

Assessment and marking

A mark of 50% must be granted for a pass. The dissertation represents one paper.

Suggested layout

Short title. One line; one to ten words.

Sub title. One to three lines; ten to thirty words

Contents.

Acknowledgements. (if any)

Introduction. This may be about 200 words and it serves to introduce the subject by giving an outline of the work. An objective of the study may be included here.

Background, or historical reviews. If chapters are used to break the work into sections then they would begin here. Otherwise the work may be divided into parts (Part 1 etc.) or sections (Section 1 etc.)

The study. Titles begin each major section of the work such as problem areas, hypotheses (see example), description, reasons, methods, solutions.

Conclusion(s). The conclusions which you will have come to, regarding the study, will be your finite ideas about your investigations and observations. If you wish you may summarise before stating your conclusion(s).

Appendices. This may or may not be required. If supportive material is used, particularly in the form of maps, charts, graphs or tables then these are usually given as appendices. E.g. Appendix 1. The questionnaire.

Bibliography. This is a list of the literature cited. It should be written thus:

(a) Book or pamphlet cited as a whole:

OSBORN, A.D. 1955. *Serial publication, their place and treatment in libraries*. Chicago: American Library Association. 309p.

(b) Bulletin:

BRYANT, M.S. 1951. *Bibliography style: a manual for use in the Division of Bibliography of the library*. U.S. Dept. of Agr. Bibliographic Bull. 16. 30p.

(c) Paper published in a journal:

Kahan, J.C. 1966. The scientific literature of agriculture. *Farm Policy 6*: 84-89.

AN EXAMPLE

Developing a dissertation

1. The idea. You are interested in wilderness areas and passive recreation/sports grounds and active recreation.

2. Clarify the idea. Are you interested in people or the resource or both. Answer, both.

3. Interdisciplinary approach to identify problem. You need to have knowledge of the resource. (e.g. ecology or turf culture) as well as people (e.g. sociology).

4. Implication for future research and use. Wilderness areas are being isolated in many reserves etc. People want wilderness experience/new sports grounds are needed in new suburbs. Sports clubs are pressing for new grounds etc.

5. Specific subject. "Wilderness areas and how people relate to these areas."/"Sports grounds, the demand for active and passive recreational areas."

6. Develop definition of "Wilderness areas" and "Recreational areas" and give limits to your study. State how your subject is going to be studied.

7. Objectives. To find how people relate to wilderness areas and what factors affect peoples' experience of wilderness areas/to determine the need-demand for recreational areas in x locality.

8. Hypothesis. (A supposition made as a basis for reasoning without reference to its truth or a starting point for an investigation)
H1. The type of man-made objects in a wilderness area affect the return visits of wilderness trampers.
H2. Adequate flat land with high quality turf is a priority need in the neighbour-hood.

9. Problem statements or questions P1. What is the number of returning trampers to an area that has had an increase in huts, bridges, sign-posting etc. P2. What is the demand for sports grounds (actual) as against the demand for passive areas and the respective costs.

10. Conduct inquiry, survey, research.

11. Analyse

12. Prove findings; compare against other similar findings.

13. Summarise 10, 11, 12.

14. Make operative statements or recommendations.

The important part of the dissertation process is to define your problem, to form a concise defined hypothesis and to make clear problem statements.

SKIFIELD POTENTIAL IN THE WAKATIPU DISTRICT

An evaluation of the potential for, and the on-slope constraints to skifield development, principally at Coronet Peak and in the Rastus Burn basin of the Remarkables

B J MASON

In partial fulfilment for Diploma in Parks and Recreation,
Lincoln College, Canterbury

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INTRODUCTION

The Wakatipu District has long been known as a winter resort area. Since 1947 Coronet Peak has developed into one of the world's top ranking skifields[1].

New Zealand's principal tourist resort of Queenstown, which is primarily summer orientated, has become solely dependent on tourism generated from Coronet Peak, to reduce a winter trough in occupancy rates of hotels and motels, and a downturn in business activity generally. A rapid increase in the provision of tourist beds in recent years has led to demands for new skifields in close proximity to Queenstown. Such developments are seen as necessary to sustain continuing growth of summer-orientated facilities.

Skifield development in the Remarkables has been advocated in response to assumptions that Coronet Peak is deficient in its capacity to meet present and future demands. Conversely, the Rastus Burn Basin in the Remarkables has been promoted as the answer to future skiing requirements in the district.

To date, no quantitative measure of skifield slope potential within the Wakatipu District has been available as a basis for assessment of development options.

In a major OECD study in Switzerland[2] it was found that:

1. **"In general, the original development of a skiing area has been carried out on the best available slopes"**
2. **"It is the capacity of the skiing area which constitutes the limiting factors in the development of ski-tourism"**
3. **"In already developed ski areas, existing facilities are to be fully exploited. The transportation capacity should be co-ordinated to the carrying capacity of the slopes"**
4. **"The development of skiing areas already opened up should have priority over any development of still untouched areas"**

Although by comparison with Switzerland, the intensity of skifield development is light in New Zealand, the planning principles arrived at in the OECD study should have international application. This is due

to common origins for development pressures. It should be noted that the OECD conclusions were reached in spite of there being up to 40% of total skiable areas remaining undeveloped in Switzerland[2].

Only one comprehensive ski area assessment has been undertaken in New Zealand. The 1977 Whakapapa Skifield Survey[3], resulted in the Tongariro National Park Board determining that better slope utilisation could be achieved within the existing developed area by upgrading the lift capacity, rather than expanding the lift-serviced area.

The goal of this treatise is to assess physical carrying capacities and other factors relevant to skifield operation at three locations in the Wakatipu District.

It is the hypothesis of this paper that Coronet Peak plus the recently opened Mount Cardrona Skifield can satisfy skifield slope requirements in the district, without development of the Rastus Burn which is itself inherently unsuitable for skifield use.

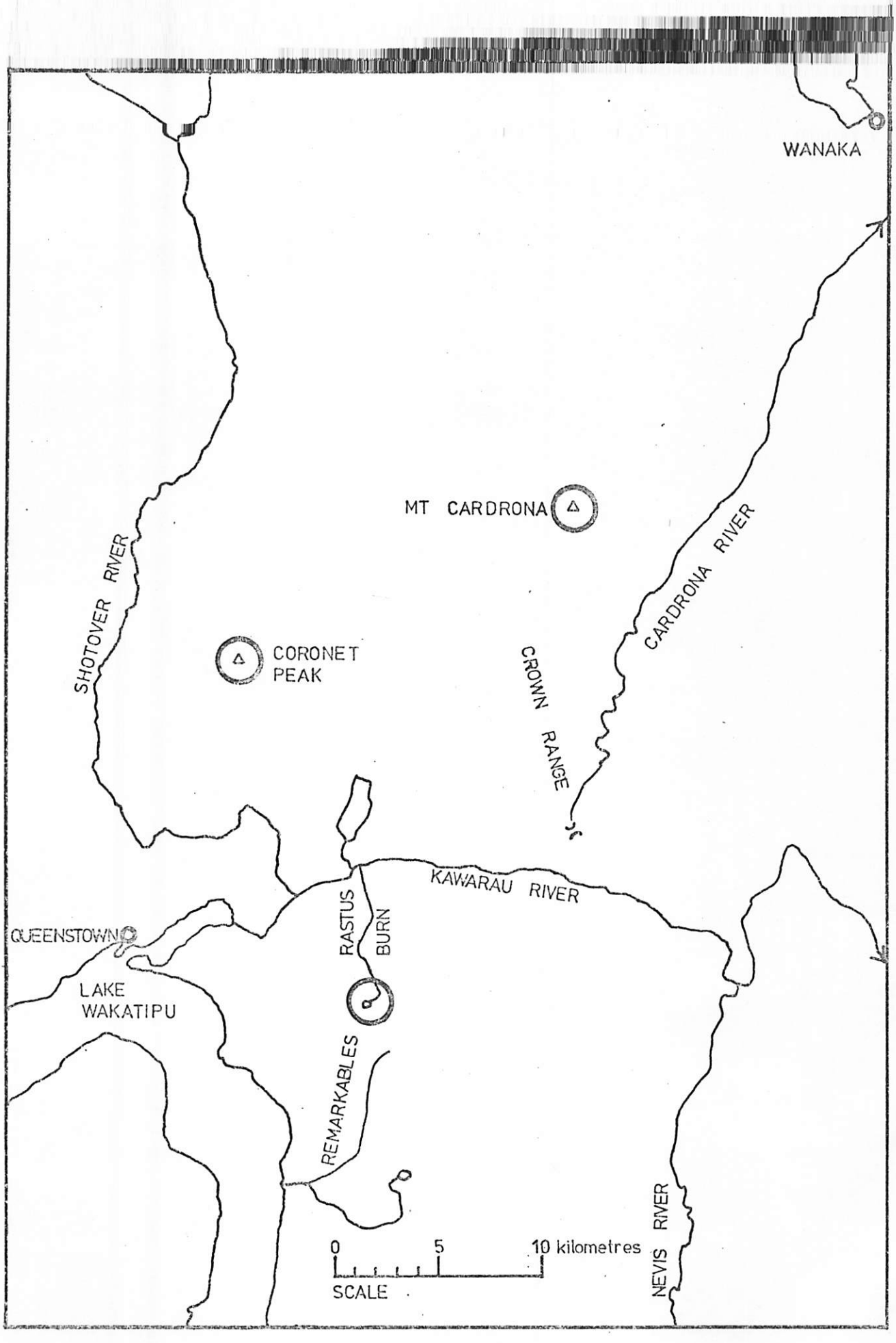


FIGURE 1 QUEENSTOWN DISTRICT

ONE

SECTION I

STATED PROBLEMS WITH CORONET PEAK

1.1 Unreliable Snow Season

Several witnesses for the Mount Cook Group before the Lake County Council in April 1979, stated that the **"vagaries of the weather result in unreliable snow seasons"** at Coronet Peak[4]. It was also stated that **"more particularly in recent years, there has been a disappointingly short season at the Coronet Peak skifields"**[5].

With intensive publicity, particularly since 1973, of 'unreliable snow' statements by the Mount Cook Group, an erroneous impression could be gained that this is a recent phenomenon. A review of recorded statements by the Mount Cook Company and Ski Clubs since 1938 show that skiing at Coronet Peak has always been subject to the vagaries of the weather (Appendix 1).

Coronet Peak was first promoted as a skifield in 1940 when the Mount Cook Company erected a ski hut not far above the Skippers Saddle (975m) and near the Skippers Road.

Despite assurances from some locals that heavy snow lay on the Saddle year after year from the beginning of June, the Company found that there was insufficient snow for skiing at that altitude in the 1940 winter. The higher, smoother slopes, one hours' walk from the Skippers Road were used instead[6]. Therefore, the snow cover proved to be 'unreliable' for the Company's purposes during the first year of operation as a skifield.

Sir Henry Wigley[6] recorded that in 1945 and 1946: **"The winter snowline settled down at nearer 1200 metres; they (the winters) also taught us that the slopes of the mountain were much more suitable above this altitude, and further to the north"**

In 1947 the Company installed the first rope tow with its lower terminal at 1067m. A determining influence on its location was ease of access, as at that stage there was no road access from the Skippers Road. **"There was no point in putting a rope tow on the best slopes of the mountain if the skiers could not reach it"**[6]. The 1947 winter confirmed the 1945 and 1946 observations, so in 1948 the tow was moved higher up the mountain.

The year 1949 was recorded as "a light snow year" with skiing not commencing until the first fall of snow on 26 June[7]. Also in that year, the Company shifted the tow again, this time close to the present alignment of the double chair lift, with its lower terminal at 1190m. Some of the extremes between ski seasons are worth quoting from the NZ Ski Year Books, as a reminder that the present climatic variability at Coronet Peak is not new:

1956 **"In October, two Otago Ski Club parties made an assult on Mount Kyeburn on Dansey's Pass near Naseby, prospecting for a new ski-field which would be usable before and after the short ski season at Coronet"**

1957 **"Recent seasons at Coronet Peak have been regrettably short and some (Otago Ski Club) members felt that new areas offering late-season skiing would be popular"**

1961 **"The Otago Ski Club reported that the snow season at Coronet Peak was the best for many years, giving members the largest number of man skidays ever"**

1967 **"Last season (1967) must have been one of the worst on record for skiing at Coronet, because of lack of snow"** (Report of the Wakatipu Ski Club)

1968 **"1968 was, of course, absolutely fabulous at Coronet Peak, with more snow than we knew what to do with"** (Report of the Southland Ski Club)

Trenberth[8] concluded that **"Special attempts should be directed at reducing the sensitivity of human activities to the fluctuations in climate that will surely continue to occur"**

Couple that statement to Sir Henry Wigley's acknowledgement that Coronet Peak has a **"comparitively low snowfall"**[6], which is a reflection of relatively low precipitation in the Queenstown district, and there is a clear warning against over-dependence by Queenstown on skiing to continue to sustain investment for peak summer tourist development.

The relative 'reliability' of the Rastus Burn for skiable snow is discussed further in Section III .

1.2 Short Ski Season

The Mount Cook Company has repeatedly stressed the need for 'extended' ski seasons, both earlier and later than that available at Coronet Peak. The need for, as well as the availability of suitable conditions are both factors which must be considered.

1.2.1 Beginning of Season:

From a review of Appendix 1, it can be concluded that the commencement of the ski season at Coronet Peak has been highly variable. This variability is due to the relatively low and variable frequency of cold fronts each winter. Owens states[9]: **"the frequency of cold front passage has an important influence on snowfall amounts recorded at Coronet Peak".**

The commencement date for skifield operation is highly variable throughout New Zealand and is not peculiar to Coronet Peak[10].

From my observations of Coronet Peak and other skifields throughout the South Island, the commencement of the ski season closely correlates to the first substantial snow falls, except in the case of some very early isolated falls.

The ability of the Rastus Burn to provide earlier ski seasons is discussed in Section III.

1.2.2 End of Season:

The end of the ski season does not necessarily indicate unsuitability for skiing. The Mount Cook Group has consistently closed operations at Coronet Peak near the last week of September since at least 1971, except in the case of 1975 (see Appendix 1). In the last decade, Company management decisions appear to be related to declining patronage and not to snow conditions.

Disinterest by skiers in spring skiing is not new. In 1958 Pairman[11] wrote **"the cry among our keener members has often been 'oh, for longer end-of-season skiing' and this season (1957), with its severely delayed start, should have seen the enthusiast off to every available patch of snow from August onwards, but what happened? Immediately after the August school holidays, Coronet was almost deserted although conditions were excellent for at least two weekends.**

PHOTOGRAPH 1

CORONET PEAK LIFT INFORMATION NOTICEBOARD
24 September 1979 B J Mason

Despite good snow conditions and cover, there is only sufficient skier patronage to run the Double Chair at half speed. Snow conditions are wet granular, not 'packed and powder'.

The fact seems to be that regardless of snow conditions, skiers in the south have either had a surfeit of skiing, run out of money or are looking towards the summer commitments after the end of August. Consequently the few remaining diehards are insufficient in numbers to warrant expenditure in promoting late-season skiing."

It appears that in most seasons there is the opportunity for extended spring skiing at Coronet Peak which remains unutilised due to disinterest by skiers.

1.3 Coronet Peak Near Capacity

Rogers[12] projects that within two years Coronet Peak will reach its peak capacity, without stating the nature of the capacity he refers to, or the basis for his statement. He records that growth in skier-days **"is now placing severe strains on the facilities at Coronet Peak, over-crowding of the base facilities and waits in the chairlift queues of 30-45 mins are not uncommon during the peak periods."** Messrs Robinson[4] and Grant[5] appear to have equated facility congestion with slope congestion.

It is not only growth in skier-days, but also Company management that is straining facilities. It is the Company's practice of catering for sightseers on the double chair lift during the peak August holiday period, that creates queues of 30-45 mins[10].

I have seen this lift running at half speed for foot passengers for up to 1-1 1/2 hours per day during the August holidays. At full speed, without interruptions to the ski cycle (i.e. queing, loading, transport by lift, and downhill skiing), queues are reduced to 15-20 mins during peak periods. This period is acceptable in my view, although naturally most skiers would prefer a shorter time.

Rogers[12] identified three components of 'Comfortable Carrying Capacity' as:

1. Extent of skiable terrain and acceptable skier densities on the slopes
2. Uphill lift capacity to service the slopes
3. Capacity of supporting facilities

He acknowledged that "the available attractive ski terrain is a major physical constraint to feasibility, since in general the ski area

developer designs to the physical capabilities of the site, the key measure of the ski areas ultimate capacity is the extent of attractive ski terrain available and the skier-density acceptable".

At no stage has the Mount Cook Group quantified these 'key measures' for either Coronet Peak or the Rastus Burn, and so provide a measurable basis for their claim that an additional skifield is needed in the Queenstown district, and that the Rastus Burn can meet such a need. Branch and Rowan[13] consider that **"the most critical factor in planning any facility is the establishment of the comfortable carrying capacity (CCC) of the recreation complex. The CCC is the maximum number of participants who can utilise the facility at any one time without excessive crowding and without damaging the quality of the environment. Once the CCC is established, the planner can bring into balance the uphill capabilities of the lifts, the downhill capabilities of the trails (by ability level), the size of the base lodge, utilities requirements, and access and parking requirements. The CCC is a key factor in the economic assessment of the facility, along with such other critical elements as the length of season and revenue per skier visit".**

Therefore, to make any valid judgements on the ability of Coronet Peak to meet future requirements, the key factors of 'ski-slope extent and the carrying capacity of the slopes must be determined'. These factors are determined in Section II.

1.4 Need for Better Slopes for Beginner and Intermediate Skiers

Forward and Robinson[4] state that the majority of skiers are in the beginner to intermediate category, and that beginners in particular are not particularly well catered for through shortage of suitable terrain.

From my own observations during the last 10 years, beginner-novice slopes that are being used tend to be congested during peak periods in August. However, intermediate slopes are generally underutilised. The extent of slopes and their capacities for all skier abilities are further discussed in Section II.

TWO

SECTION II

EVALUATION OF CORONET PEAK SKIFIELD

Sections II and III comprise of an evaluation and comparison of skifield characteristics at Coronet Peak and Rastus Burn. This is for two main reasons:

(a) The rationale behind the Rastus Burn proposal is that it will provide more favourable conditions for skiing than at Coronet Peak. Therefore, an assessment of relevant conditions at both sites is necessary for a valid evaluation of the Rastus Burn proposal.

(b) It is necessary to determine the degree to which Coronet Peak is currently utilised, and its potential for further use.

As a planning principle, the full utilisation of existing amenities in a district should take precedence over unnecessary new developments, in particular those which may infringe on existing users as well as providing risk of future public liability. The factors to be considered in this evaluation are:

(i) ski slope extent
(ii) reliability of snow cover and length of season
(iii) slope carrying capacity
(iv) present and potential slope utilisation
(v) skier market demand
(vi) design capacity

2.1 Ski Slope Extent

Branch and Rowan[13] have devised a system for classifying ski slopes to suit varying skier abilities. These I have used as the basis for determining slope availability for each ability level.

TABLE 1. SLOPE CLASSIFICATION BY SKIER ABILITY

SKILL CLASSIFICATION (Branch and Rowan)	ACCEPTABLE TERRAIN	
	Gradient	Pitch
Beginner	10-15%	6-8.5°
Novice	15-25%	8.5-14°
Low intermediate	25-35%	14-19°
Intermediate	30-40%	17-22°
Advanced intermediate	35-45%	19-24°
Advanced	45-50%	24-31°
Expert	60% plus	31° plus

Branch and Rowan's skill classifications and acceptable terrain gradients are identical to those recommended to Alex Harvey Industries as the preferred grade of ski runs for their Turoa development[14]. The gradients advocated by Rogers[12] are gently by comparison. For instance his 5% maximum gradient for beginner skiers is 6% gentler than the upper half of the Chalet beginners' slope, which the Mount Cook Company constructed specifically for beginners. Similarly, the upper part of the constructed Happy Valley novice run is 4% steeper than his maximum of 10%. In contrast to Rogers' figures, Forward[4] estimated that "5-10° or 12°" (9-17/21%) are suitable gradients for beginners, these being in the same order of Branch and Rowan.

Using the Branch/Rowan classification system during the 1979 ski season, I conducted a slope analysis of Coronet Peak, making approximately 90 measurements by 'Abney' level. At the same time I mapped the extent of skiable terrain using both my past experience of skiing at Coronet Peak during the last 12 years, and what I observed at the time of the survey. These areas can be regarded as reliably skiable, mid-season (August) most seasons.

For the sake of clarity on Plan 1, the skill classifications are broad-banded into 3 categories:

a) beginner-novice

b) low intermediate to intermediate

c) advanced intermediate to advanced to expert

The areas of the larger intermediate and advanced slopes were planimetered from Plan 1, and the beginner-novice slopes were measured on-site. These are tabulated on the left of Table 2.

TABLE 2. CORONET PEAK : SKI SLOPE EXTENT AND SLOPE CAPACITIES

Area Reference (Plan 1) Location	Area (ha)	Slope Density	Slope Capacity
BEGINNER (Green on Plan 1)			
a. Rocky Gully	0.38	125/ha	50
c. Chalet	0.18	125/ha	25
d. Halfway	0.66	190/ha	125
n. Lower Gullies	0.35	125/ha	45
	1.57		245
NOVICE (Green)			
b. Happy Valley	1.4	75/ha	105
LOW INTERMEDIATE to INTERMEDIATE (Brown)			
e. Greengates	30	20/ha	600
f. Main Slope	64	20/ha	1280
g. Rocky Gully	38	15/ha @ 30/ha; 23/ha @ 20/ha	901
	132		2790
ADVANCED INTERMEDIATE - ADVANCED - EXPERT (Blue)			
h. Top Half	42	10/ha	420
i. Above Rocky Gully	6	-	-
j. Halfway	1	15/ha	15
k. Lower Triple Chair	6	10/ha	60
l. Lower Gullies	19	-	-
m. Back Basin	32	-	-
	106		495
TOTAL AREA:	240 ha	TOTAL SLOPE CAPACITY:	3635

The total skiable area is 240 hectares, however, an area of 183 ha is obtained by deleting advanced slopes i, l and m on Plan 1 which are the least attractive for servicing by lifts.

2.2 Slope Carrying Capacity

Skier carrying capacity is a critical judgement of the density of skiers that can be accommodated on the slopes at one time and still maintain a satisfactory recreational experience. This is in addition to providing sufficient economic return for successful commercial operation. The concept of skier carrying capacity is relatively new in New Zealand with only one comprehensive attempt to date to define Carrying Capacity, at Whakapapa on Mount Ruapehu.

The Tongariro National Park Board initiated a survey in August 1977[3] to document existing skier distribution on the skifield, to record skier preferences, to investigate better utilisation of slopes that are already serviced by lifts, as well as determining the capacity of new slopes. The skier densities adopted by the Whakapapa planning team are considerably lower than those commonly accepted in North America. After consideration of snow and topographic conditions, and the National Park status of the skifield, a low density and hence high-quality skier experience was opted for.

To arrive at appropriate skier densitities for Coronet Peak, a comparison of various recommended densities, and an interpretation of such figures to suit the topographic and snow conditions is necessary.

TABLE 3. COMPARISON OF SKIER SLOPE DENSITIES

Skill Classification	Branch/Rowan per ha	Whakapapa per ha	Coronet Peak (Mason)
Beginner	125-250	100	125 and 190
Novice	100-150	50	75
Low Intermediate	75-125	15-20	30
Middle Intermediate	50- 85	12	20
Advanced Intermediate	40- 50	8-10	15
Advanced	25- 40	5- 8	10
Expert	25- 40		10

Whakapapa is characterised by extensive rock slopes, bluffs and extremes in gradients[10], this being quite unlike Coronet Peak. Sir Henry Wigley[6] described Coronet Peak as "not a high mountain, in fact it is only 1646 m above sea level, but it is ideally suited for skiing. The rock structure lies in such a way that it slopes away to the south in a series of gentle dips and hollows which make for fun skiing. There is an almost complete absense of rocky outcrops, so it is possible to ski over much of the area on a slope of one's own choosing. It's south-facing slopes are reasonably sheltered from the prevailing winds and the direct rays of the sun, with the result that the snow often remains dry and powdery for many days on end. It is also less subject to thaw than less favoured slopes in the area." Wigley[6] further states that "Coronet Peak is endowed with the natural features of good terrain, usually good snow conditions, and good weather .."

In terms of acceptable skier densities, terrain is only a minor constraint (hummocky slopes, compared to an ideal of smooth slopes which would allow more even distribution). The quality of skier experience, and sustainability of adequate snow cover under skier traffic, are the limiting constraints to attaining the high American densities of Branch and Rowan. Snow cover on Coronet Peak is light compared to that experienced in most areas of North America, and could not sustain similar usage.

The "Shirt Front" beside the double chair lift is the only area on Coronet Peak that I have observed to regularly exceed its physical carrying capacity mid-season. Future management options could be directed towards distributing usage more evenly, or by the use of modern snow-making techniques if practicable.

The other limiting constraint is the quality of recreational experience appropriate to Coronet Peak. It is currently designated Recreation Reserve, with recreation as its primary management objective. In a national park situation as in the case of Whakapapa, skiing is, or should be conditional on preserving the natural environment, as well as retaining a relatively low-density, high quality National Park experience. Therefore modification of the natural environment to attain heavier usage, is generally more acceptable in a non-national park setting if fragile ecological conditions do not exist. These considerations have influenced the densities I have adopted for Coronet Peak, as well as the high degree

of modification that has already occurred through skifield development.

2.2.1 Beginner Slopes:

The Chalet Beginners' Slope is the only area in continuous use by the Ski School and individuals. This is primarily due to its convenient location at the base of the skifield, immediately adjacent to the existing base facilities. Area 1800m^2.

Reference: Appendix 2

Rocky Gully has a short fixed grip beginners' lift below the bottom terminal of the Blue Gum Poma. This is very poorly located with the upper half of the slope too steep for beginners. The potential exists for the creation of two adjacent beginners' slopes at the base of the Rocky Gully and Blue Gum Pomas, with a total area of 3800m^2 or twice the existing Chalet beginners' area.

Reference: Appendix 3

Within an enclosed depression in the Lower Gullies area there is scope for the formation of a 3500m^2 beginners' slope. This would entail substantial earthworks, none of which would be visible from outside of the depression.

An access track suitable for a shuttle vehicle service commencing opposite the Otago University Ski Club hut, would need to be constructed for approximately 500m with a maximum grade of 1:8. As the area is separate from the existing facilities, it would probably only be necessary to develop it when other alternatives reached full capacity.

Half-way up the double chairlift, at 1434m is a small beginners' area (1100m^2) which has been formed and a fixed grip lift installed. This is infrequently used. Access to this slope involves running the chair lift at half-speed for the loading and unloading of beginners. The Company's stated reluctance[4] to utilise this slope due to disruption to other skiers, is at variance with the existing practice of running the lift at half speed for winter sight-seers. If the need for additional beginner slopes is all that pressing, and beginners are as lucrative as claimed[4], then it is merely a management decision as to who has priority - beginner or sightseer?

An additional 3700m² can be provided at the Halfway area with little or no earthworks, and with a protective fence to exclude other skiers. By filling in the depression known as the "Elephant Pit" a further 1800m² could be provided.

Full utilisation of this site would provide 6600m² of beginner slopes, or 3.5 times the Chalet slope. A further advantage of this site is its greater snow depth than the existing or potential beginners' areas on the lower slopes. I have not seen bare areas on this slope in mid-August during any of my skiing visits to Coronet Peak. Fitzharris[15] has recorded a "snow-wedge" of increasing snow depth with increasing elevation on Coronet Peak confirming a general observation that the upper half of the mountain is usually skiable in winter on those occasions when the lower slopes are unskiable.

Reference : Appendix 4 , Photograph 3

Beginner Slope Capacities. All beginner slopes are or could be formed into smooth, open slopes with no obstructions or hazards such as at Whakapapa. Therefore the beginner densities could be higher at Coronet Peak. I have adopted the lower Branch and Rowan figure of 125/ha which is 25% higher than at Whakapapa.

A total of 250 skiers could be accommodated on the slopes at one time, i.e. skiers actually skiing, and not those in queues or on lifts.

Reference : Table .2

Due to its greater snow depth, the Halfway beginners' area could sustain heavier usage than the lower slopes. At a factor of 50% greater density, this would allow a slope density of 190 skiers/ha which is still less than the maximum recommended figure of 250/ha of Branch and Rowan (Table 3). In comparison with the existing Chalet beginners' slope, with no or minimal earthworks, four times this area could be provided elsewhere on Coronet Peak. With more substantial earthworks, seven times the area could be provided.

2.2.2 Novice Slopes

So far there is only one slope specifically catering for novice skiers which is Happy Valley. It is a long, relatively narrow run with a total area of 1.4 ha. Due to some congestion because of narrowness near the top, a density of 75/ha, which is halfway between the lower Branch/Rowan figure and that for Whakapapa is considered appropriate.

PHOTOGRAPH 3

CORONET PEAK : HALFWAY ON DOUBLE CHAIR (1434 m) TO SUMMIT (1647 m)
9 October 1979 B J Mason

Adequate snow cover persists on upper half of mountain to provide potential for late season skiing. Halfway station could have been used to load skiers using only upper slopes. Access to these slopes available via chair from lower terminal. Skifield closed 9 days previously, but lift operating for sightseers. Halfway beginners' area, with fixed-grip tow on left. By filling the "Elephant's Pit" depression to the right of the tow, an area of 6600 m^2 or 6 times the existing tow serviced area could be made available for beginner skiers. Access could be as foot passengers on chair lift, or by oversnow vehicle. Upper terminal of triple chair on centre skyline.

At this density 100 novice skiers can be accommodated at one time exclusive of those que ing and on the poma lift. There is limited scope for further novice slopes but this would require major earth works. Limited improvement to the Happy Valley slope is feasible by widening the top narrow section.

2.2.3 Low Intermediate and Intermediate Slopes

Coronet Peak's predominant characteristic is its intermediate terrain; 2800 skiers could be distributed over the slopes at any one time, being 75% of the total slope capacity for the whole field. At the undeveloped eastern side of Rocky Gully some 30 ha are suitable for Low Intermediate skiers with a slope capacity of 450.

Overall the scope for Low Intermediate is relatively limited, compared to the vast scope for intermediate skiers. There is excellent lateral spread of intermediate slopes, occupying the full breadth of the lower slopes.

2.2.4 Advanced Slopes

The advanced intermediate to expert slopes generally occupy the upper slopes of the mountain, providing excellent separation from lower ability levels. By greater utilisation of slopes already in use, without expansion to the large Back Basin area, 500 advanced skiers could be accommodated on-slope.

2.3 Current Utilisation

Rogers[12] has recorded that the highest usage to have occurred at Coronet Peak was in 1977 with 121,000 skier days, with a mean of 1827/day during August. On the basis of one vehicle count in August 1976 Rogers estimated that the peak day for the month of August was twice the mean. This is a "persons at one time" (PAOT) measurement of the total number of visitors, both skiing and nonskiing at one time. On the peak day in August 1977, 3650 skiers may have visited Coronet Peak.

The mean for August 1979 was 2620. The relatively late start to the season, caused a disproportionately high figure (83% of total skier days per season, compared to an average of 52% for 1973-78). In the absence of a survey to determine actual visitation, it may be unrealistic to apply the x2 factor. However, if applied, a total of 5200 may have visited on the peak day during the 1979 winter.

2.4 Skier Market Demand

Ideally the balance of slopes available in a district should suit the full range of skier ability levels. Rogers[12] has provided "Apparent Skier Market Proportions" which provide the only available basis for measuring Coronet Peak's potential to meet market demands.

TABLE 4 Coronet Peak : Potential to Meet Skier Market Demand

Skill Classification	'Apparent Skier Market Proportions' %		Slope Capacity Available	Slope Capacity Requirement*	% Availability
Beginner	5		245	182	135
Novice	15		105	545	19
Low Intermediate	27		450	981	46
Intermediate	30		2340	1090	215
Advanced Intermediate	13	)			
Advanced	5	) 23	495	836	59
Expert	5	)			
			3635		

* in relation to total capacity available

Coronet Peak can supply beginners' requirements by full use of the Halfway, Chalet and Rocky Gully slopes without construction of the lower gullies area. Major imbalances occur with novice and low intermediate slopes, with one fifth of novice and one half low intermediate requirements. There are twice the requirements of intermediate and 60% of advanced requirements. This latter deficiency could be overcome by development of the Back Basin area.

This analysis has identified deficiencies in novice and low intermediate terrain at Coronet Peak. However there are few individual skifields which I have visited which provide a balanced range of slopes to suit all ability levels. There are invariably readily apparent imbalances. For example, I have always regarded Coronet Peak predominently as an intermediate

field, Tekapo as novice/low intermediate, Mount Hutt as low intermediate for the area developed to date, and Craigieburn Valley as advanced.

Short of finding or constructing the ideal mountain designed to suit market specifications, the only alternative is to plan towards a regional balance between ski fields so that market demands can, if possible, be satisfied on a regional basis.

The ability of other alternatives in conjunction with Coronet Peak, to meet market requirements is discussed in Sections 3 and 4.

2.5 Design Capacity

The Whakapapa study[3] determined the relationship between the numbers actually skiing the slopes, those on the lifts or in queues, and in carparks or other facilities. It was determined that the "skiers at one time" (SAOT) being those on the slopes, lifts or in queues, is three times those on the slopes.

It has further been found that the PAOT being the total number of people on the mountain either skiing or not skiing is twice the SAOT. A significant factor in public visition to Mount Ruapehu is the large number of nonskiing snow players. This usage is almost nonexistant at Coronet Peak, so the two times factor for calculating the PAOT is too high. A factor of 1.5 is probably closer to the Coronet situation. The SAOT and PAOT are calculated in Table 5.

Table 5 Calculation of Design Capacity: Skiers and People At One Time

Slope Capacity	x3 = SAOT	x1.5 = PAOT
3600	10,800	16,200

The constraints to achievement of full slope utilisation are lift capacity, and supporting facilities such as car parking and service buildings. The present maximum uphill lift capacity of the two chairlifts and three pomas is 4580 skiers per hour. Due to mechanical breakdowns, and misloading, lifts operate at less than their design capacity under peak conditions[3,10]. Also the practice of running the double chair at half speed for winter sightseers reduces Coronet Peak's uphill capacity to approximately 3700 skiers per hour in peak periods.

Discontinuation of this practice and the provision of an over-snow passenger vehicle to transport beginners to and from the Halfway slopes, would substantially increase the chairlifts capacity.

To attain maximum slope utilisation would require approximately a four times increase in lift capacity. In practice this could probably not be achieved. Due to constraints of lift alignment and terrain, it may not be economically attractive to service all available slopes with sufficient uphill capacity to allow optimal skier distribution. However I estimate that Coronet Peak could accommodate more than twice the present lift capacity. Options for increasing lift capacity include:

1. Installation of additional lifts in areas g and f (Plan 1) between the existing lifts
2. Extension of lift development to east of the Blue Gum Poma utilising existing base facilities in Rocky Gully (area g)
3. Development of the extensive "Greengates" slopes above Dirty Four Creek (area e). These slopes are a very uniform gradient (35-40%) and are suitable for one or more surface lifts such as T-bars with 245-305m vertical lift.

Existing car parking is available over an area of approximately 7500m^2. At an allowance of 25m^2 per car, the four car parks at Coronet Peak can accommodate 300 cars with another 50 or more parked on road-sides. At present use levels, the existing car parks appear to be adequate on most occasions.

Field inspections to locate further parking areas, being areas with gradients of less than 1:5 that could be developed down to 1:10 have shown three main areas which could comfortably accommodate all the cars that would result from a PAOT of 2-3 times the 1977 peak.

THREE

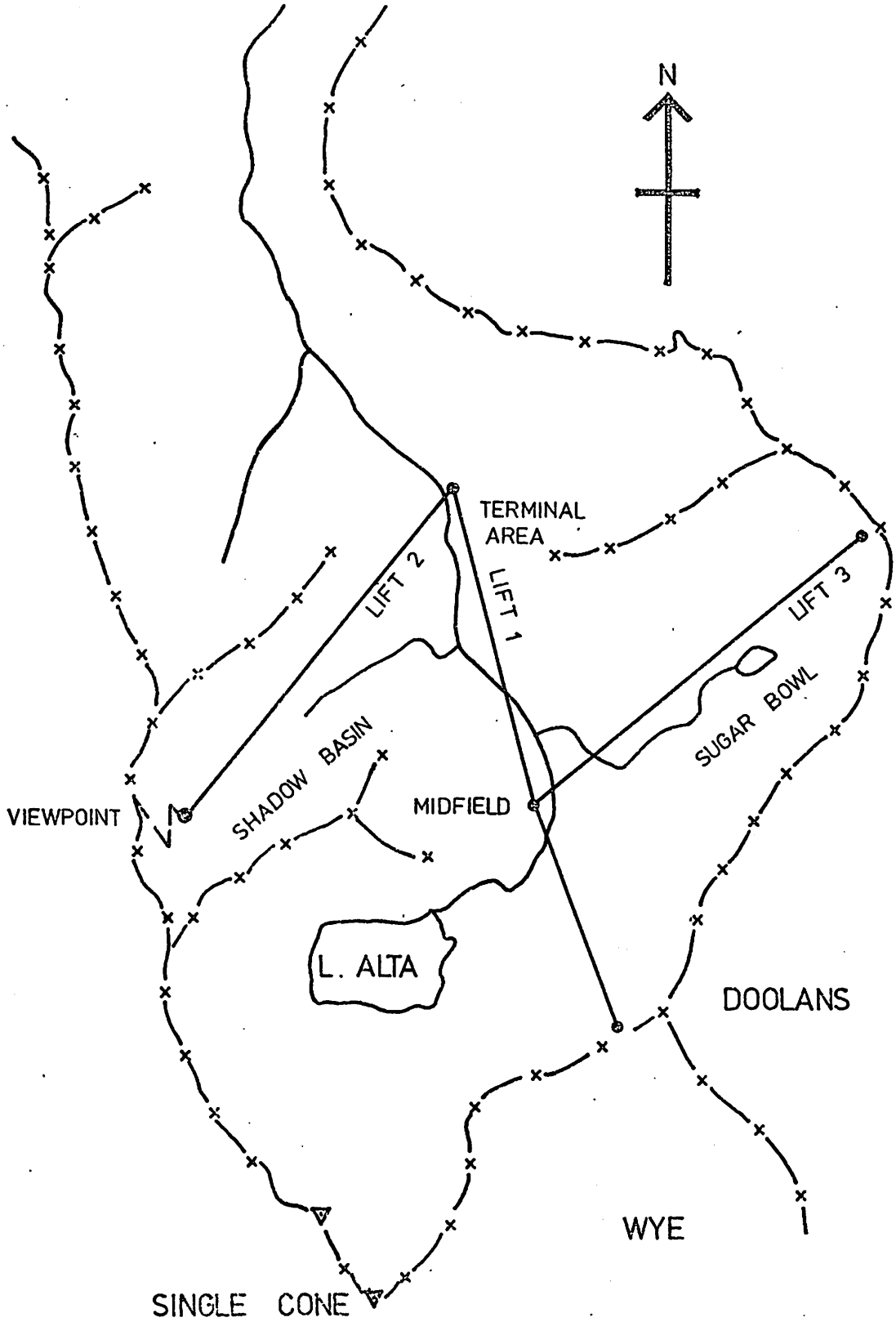


FIGURE 2 : Proposed Lift Alignment in RASTUS BURN (July 1978)

SECTION III

EVALUATION OF RASTUS BURN SKIFIELD PROPOSAL

3.1 Extent of Skiable Terrain

On visits to the Rastus Burn in the winter of 1975 and 1979, I observed the extent of terrain which, in mid to late August can usually be relied upon to be skiable. This is mid-season, and at the period of maximum snow accumulation.

My definition of "skiable" is that which I have been able to ski without impediment from scree, rocks, boulder fields or vegetation due to absence of snow cover. The ability of these "skiable" areas to sustain high density skier traffic and its suitability for skifield development are separate considerations. The total "skiable" area is approximately 80 ha.

Reference : Plan 2

3.2 Length and Reliability of Ski Season

I have found no basis for numerous claims that both an earlier and later season is available in the Rastus Burn in comparison to Coronet Peak. Rogers[12] stated "that the month of June and October will experience greater patronage in the proposed ski area due to the certainty of snow in these months in the Rastus Burn". Forward[4] stated that the Rastus Burn satisfied his Company's requirement of "a reliable ski season extending from June through October". Robinson[4] went further than Forward in his claims, that "with grooming there would be ideal conditions for skiing in the Rastus Burn from early June until November each year".

Sir Henry Wigley surpasses all his Company's employees' claims by stating in the Mount Cook Group's Annual Report 1979[20]

> "It is noteworthy that while Coronet Peak at this date (25 July) has only just become skiable, the Rastus Burn Basin has had enough snow to have been in full operation and catering for a large number of skiers for over two months" (i.e. prior to 25 May 1979).

Reference : Photographs 4, 5, 7, 9

3.3 Factors Affecting Snow Accumulation

It appears that the basic assumption behind the Company's claims is that due to its higher elevation, the Rastus Burn receives and retains more

PHOTOGRAPH 4

RASTUS BURN VALLEY
18 June 1979 D G Jardine

Development proposals as at 4 July 1978

Chair Lift 1: Bottom terminal : centre bottom
Top terminal on Wye Saddle : left skyline

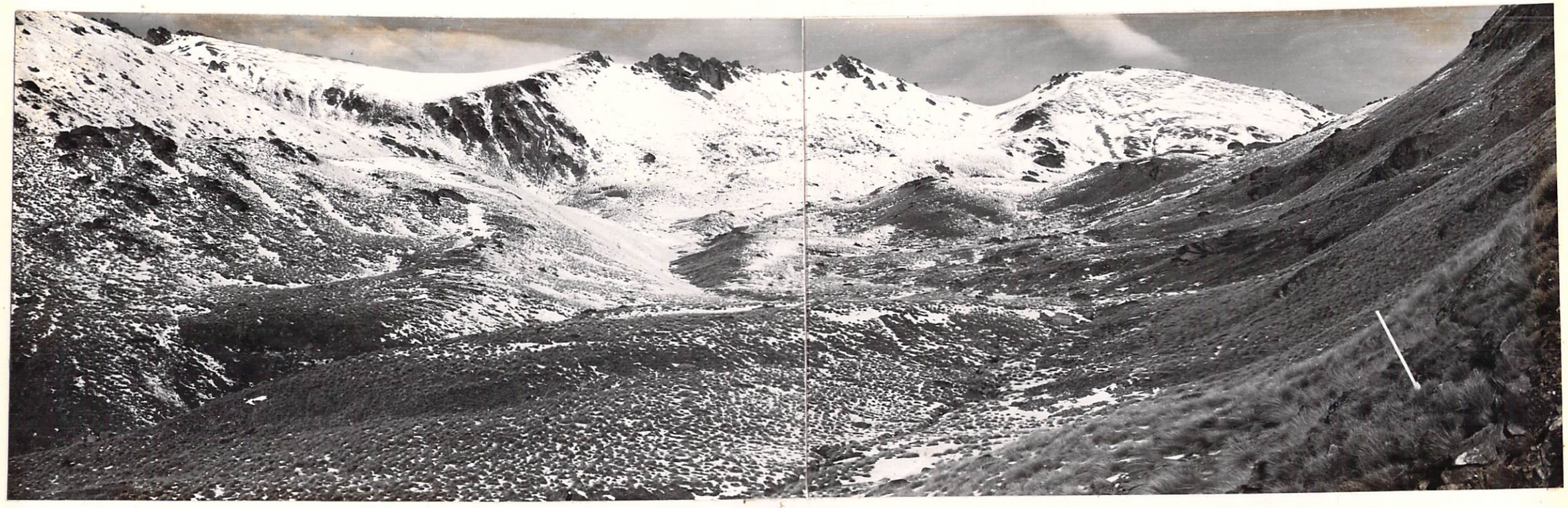
Chair Lift 2: Shadow Basin
Bottom Terminal : centre bottom
Top terminal below ridge and proposed tourist lookout on extreme right skyline

Chair Lift 3: Sugar Bowl out of sight on left
Bottom terminal at base of Wye Saddle face

All proposed ski runs unskiable one month before the opening of the Coronet Peak skifield

Single and Double Cones (2502 m) : right of centre

PHOTOGRAPH 5



RASTUS BURN BASE AREA
8 July 1979

K D Mason

Nine days before the opening of the Coronet Peak skifield, the Rastus Burn remains unskiable. This is despite the claim by Sir Henry Wigley that the Rastus Burn could have been in full operation as a skifield prior to 25 May, until the time of Sir Henry's statement on 25 July 1979.
The Sugar Bowl is out of sight below Doolans Saddle (left skyline). Wye Saddle (right of centre). Lower slopes of Shadow Basin run on right foreground; with survey marker for No. 2 chair lift.

snow than Coronet Peak. Fitzharris[15] identifies four scales for the purposes of considering snow accumulation. On the macro scale (i.e. group of mountains), variations are controlled by synoptic scale weather patterns, that is passage of frontal systems. This can be partially monitored by the mapping of snowlines during storms. Fitzharris defines a continuous snowline as the **"elevation above which 90% of the area is covered by snow".** A discontinuous snowline is the **"lowest elevation at which substantial snow occurred".**

From my photographic records of Coronet Peak and the floor of the Rastus Burn during five periods of the 1979 winter, comparitive snowlines are tabulated in Table 6.

Table 6 COMPARISON OF SNOWLINE : RASTUS BURN AND CORONET PEAK WINTER 1979

	2 June (fresh fall)	8 July	25 September (fresh fall)	9 October	15 October
Discontinuous Snowline					
South face Coronet	855 m		1130 m		1280 m
Valley floor Rastus	1340 ± 45 m		1495 m		1555 m
Continuous Snowline					
South face Coronet		1495 m		1310 m	
Valley floor Rastus		1738 m		1617 m	

Mean snowline	Rastus Burn	1550 m
	Coronet Peak	1215 m

During the period of the 1979 Coronet ski season (17 July to 30 September) the continuous snowline was lower than 1190 m (lower terminal elevation). In view of my observations on my August 1975 visit to the Rastus Burn, I would expect the continuous snowline in the valley floor to be approximately 1585 m during mid-August to early September.

Variations of slope affect snow retention due to snow creep or avalanching, as well as the amount of incident solar radiation, and hence melt[15].

Appendix 6 is a calculation of the maximum potential radiation received on the three lift lines proposed for the Rastus Burn, as well as for Coronet Peak. This calculation allows for both slope and aspect, and assumes no atmospheric interference.

The incident radiation or actual radiation received by a slope depends also on altitude, atmospheric conditions and shading. From figures presented by Greenland[16], the higher altitude of the Rastus Burn over Coronet Peak (about 300 m) would allow as much as 10 langleys per day more, but this is small compared to the daily totals (Appendix 6). Greenland[16] recorded that during the period June-August the actual radiation received in the Chilton Valley near Cass was 65% of the maximum possible for that altitude at latitude 45° south. This percentage includes the effects of atmospheric conditions and shading by other hills and mountains.

A "Sun Path Diagram for Helicopter Ridge", Rastus Burn[9] by Owens shows that this site in the Sugar Bowl receives a maximum of 6 hours mid-winter sunshine per day, compared to a mean of 1.75 hours per day in the Chilton Valley[16]. From my knowledge of the terrain proposed for development in the Rastus Burn, I would assume Owens' site to be fairly representative of the whole.

By comparison, Coronet Peak is shaded mid-winter (Figure 3), other than the crests of some promontories, and the southwest Greengates face. Owens[9] has concluded that during the months July-September, the Rastus Burn has a similar proportion of clear days to Coronet Peak. Therefore there is unlikely to be a significant atmospheric difference that would affect comparitive radiation receipts. Pollock[17] recorded only a 10% difference in actual radiation receipts between Mount Brewster on the Main Divide, and the Old Man Range in Central Otago. Considering that Cass is in a similar climate district to the Wakatipu district[18], extrapolation of Greenland's results provides a fair indication of radiation receipts on Coronet Peak and in the Rastus Burn. Without actual measurement of solar radiation receipts at these sites, I assume that they are similar to that recorded in the Chilton Valley. The higher altitudes of Coronet Peak and Rastus Burn could allow a slightly larger radiation receipts than the

MIDDAY SUN ANGLE — CORONET PEAK and RASTUS BURN

MID WINTER'S DAY to EQUINOX

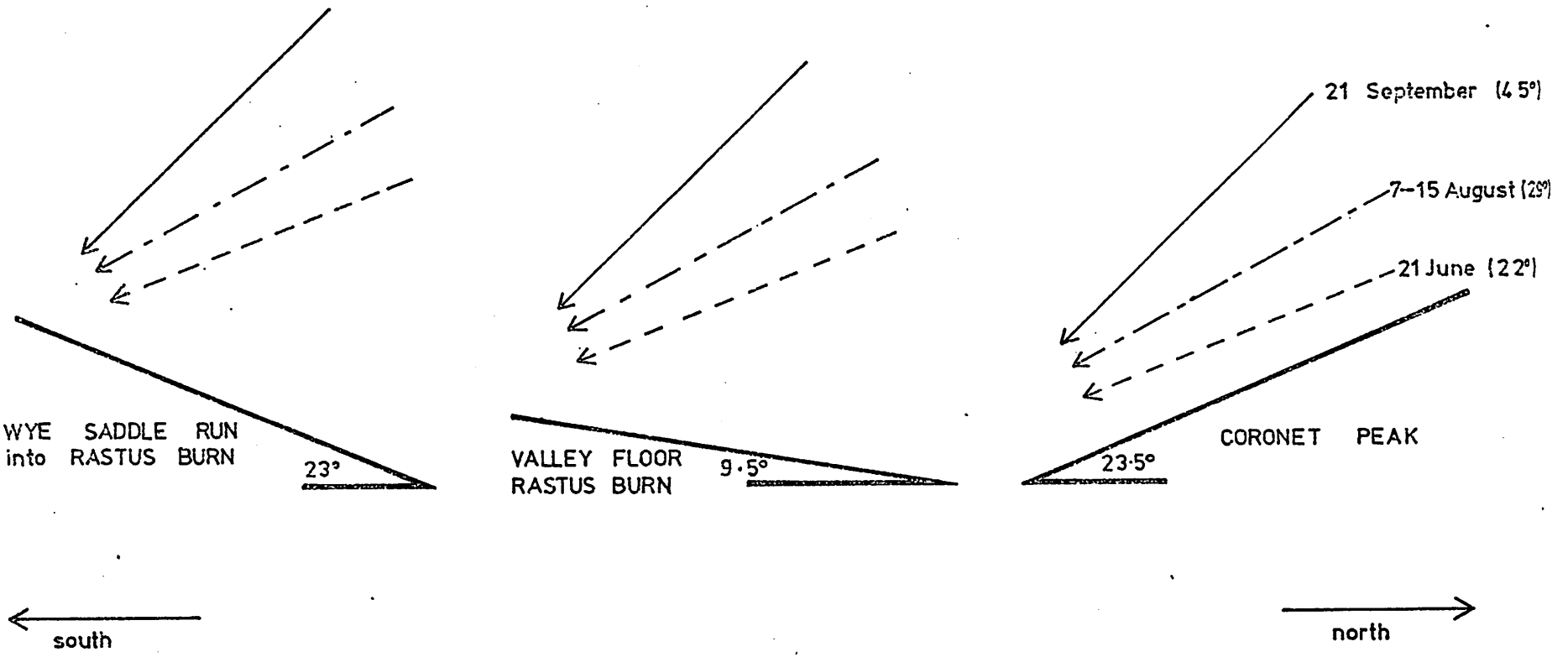
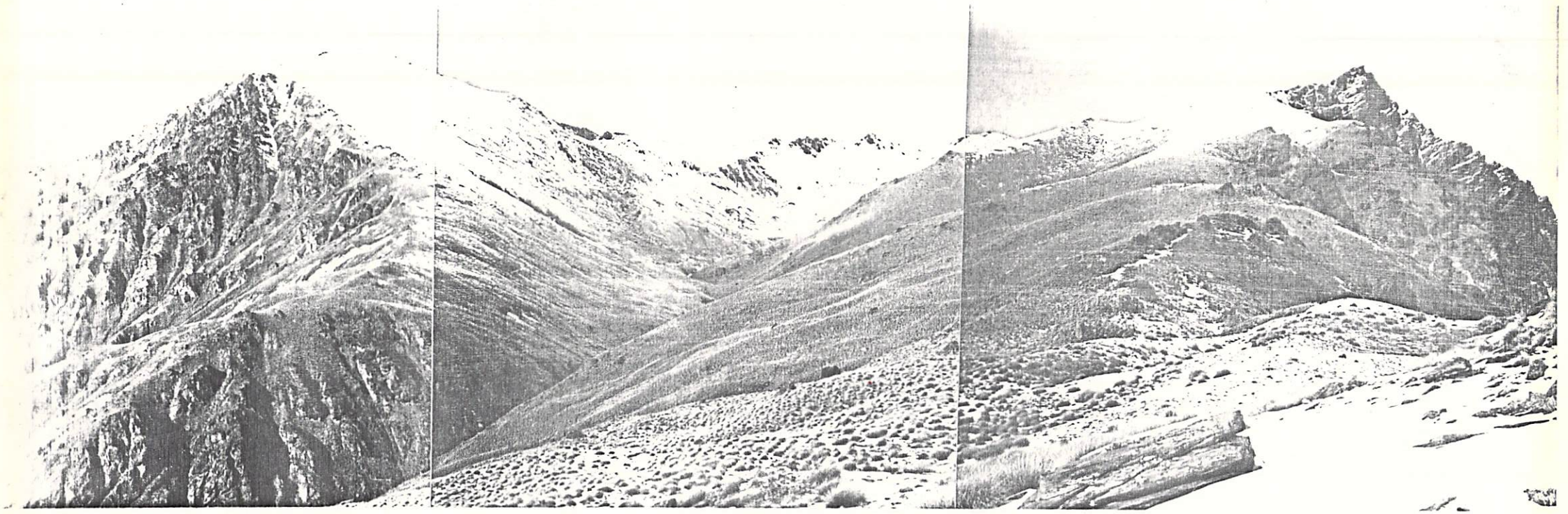


FIGURE 3

PHOTOGRAPH 6



RASTUS BURN FROM NORTHERN END OF REMARKABLES ESCARPMENT
7 July 1979

K D Mason

Proposed base area in apex of valley (centre). Access road alignment across face towards and below photo point. Double Cone (right).
The effect of slope gradient and aspect on snow retention is graphically illustrated by this photograph. The steep north facing slope on the left is snow-free to 1920m a.s.l., while the west-north-west basin behind has a continuous snowline down to 1650 m. A north facing slope (right) is snow free up to 1830 m. Due to a lower receipt of solar radiation on the gently graded valley floor, also with a north aspect, the snowline is down to approx 1700 m. Even a slight orientation away from the incident radiation greatly assists snow retention. The right hand half of the slope on the right with a north-east aspect (appears at 8 o'clock to Double Cone) has significantly greater snow cover than the similarly graded adjacent slope to the left with a north aspect.

Chilton Valley, thus perhaps as much as 70-75% of maximum possible radiation is actually received by horizontal surfaces on Coronet Peak and Rastus Burn.

The effects of shading and slope aspects indicate that Coronet Peak can receive a maximum of 31 langleys per day and that Rastus Burn can receive a maximum of 350 langleys per day in the period June-August. (These values are overall weighted means: Appendix 6).

Thus the proposed Rastus Burn ski runs receive approximately 11-12 times the amount of radiation as the Coronet Peak skifield. This figure does not allow for the much higher sunshine hours in the Rastus Burn, and is therefore very conservative. The major impact that aspect and slope have on snow retention, is graphically illustrated by Photograph 6 where the steep (approx 40-45°) north-facing ridge-end east of the Rastus Burn is snow free to 1920 m.

3.4 Slope Analysis

Using the Branch/Rowan slope classification system, I have measured the slope gradients of all areas I have observed to be "skiable". These are classified into three groups of beginner-novice, intermediate, and advanced intermediate - expert, and shown on Plan 2.

Figures 4-6 are slope profile diagrams of the three proposed ski runs.

LIFT 1: Wye Saddle and Valley Floor

Wye Saddle Section:

This is a relatively narrow run approx 200 m vertical from a saddle between the Wye and Rastus catchments. It is an advanced slope with two short low intermediate steps midway. The underlying surface is coarse scree with small boulders in the upper half, and tussock with small boulders on the lower slopes. The upper section consists of a steep (29°) slope leading into a concave depression which confines skier movement to the fall-line in the base of the depression.

Snow tends to drift into this depression, and to persist longer on this north-facing slope than on the adjacent slopes. Despite this, however, I have observed the top of the larger rocks and scattered scree to either protrude above the surface, or to be visible just below the surface, during the months of August and September at the period of

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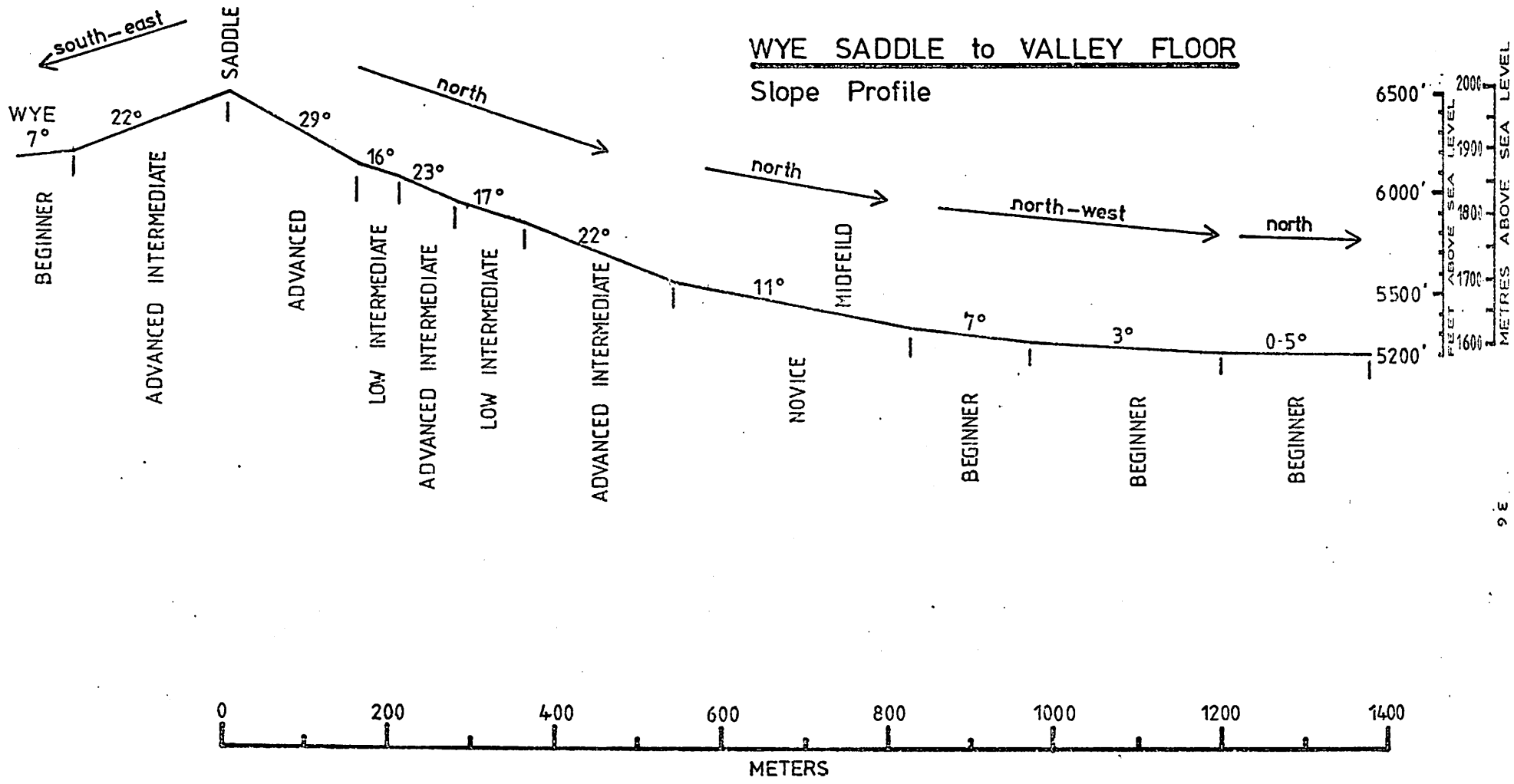


Vertical Drop : 380m (1250')
Distance : 1400m (4593')

FIGURE 4

maximum snow accumulation. Any attempt to ski out onto the less confined adjacent slopes are quickly curtailed due to the danger of widespread scree protruding through the snow cover (Photograph 7).

On both occasions that I have skied or walked this run during the 1979 season, there has been a wind or partial melt crest, making uncomfortable skiing conditions. Due to its north aspect and slope (Figure 4) I would expect severe melt crusting on this slope, particularly in the latter half of the season.

The lower portion of this run consists of a final step (22°) leading to the gentler slopes in the valley floor. It is predominently a tussock covered slope with occasional small boulders. Due to its closer proximity to the snowline, north aspect and slope, it tends to be thin on snow cover.

On all occasions I have seen it during winter months the tops of the tussock either protrude or are visible below the surface.

Due to inadequate snow cover this run could not sustain a density of skier use in any way approaching that of a skifield. Any attempts to remove offending rocks would require more than the removal of an occasional small boulder. It would require replacement of the total scree slope. Overall the slope receives a mean maximum potential of 640 langleys/day on 7 August (Appendix 6).

Valley Floor Section:

The valley floor is of beginner and novice gradient from below the Lake Alta moraine, down the true left bank of the Burn, to the continuous August snowline at approx 1585 m. I would not expect the slopes below this level to have a continuous snow cover mid-season, except immediately after a substantial snowfall (e.g. Photograph 8 on 25 September 1979). The proposed terminal for Lifts 1 and 2 is some 60 m below the continuous August snowline.

The upper novice slopes which are in the vicinity of the proposed midfield terminal consist of both medium height tussock with scattered small rocks and occasional small boulders. These would not have been skiable before the time of the opening of Coronet Peak season on 17.7.79.

Photograph 5 shows the beginner terrain from midfield to the 1585m snowline (mid-foreground). There is a more substantial tussock cover overall with scattered medium size boulders. Slope width varies from quite narrow

PHOTOGRAPH 7

RASTUS BURN FROM WYE SADDLE
8 July 1979

K D Mason

Sugar Bowl on right. Despite there being snow cover on upper slopes, these are unusable for skiing due to compaction on to coarse scree near snow surface (e.g. left foreground) and extensive rock hazard.
Coronet Peak directly opposite lower Rastus Burn Valley.

to wide, due to the steeper side slopes above and the incised Rastus Burn which bisects the valley floor. This effectively precludes use of the slopes on the true right (east) bank. I skied this slope on 2.9.75 and again on 25.10.79 and found rocks and tussock protruding on both occasions.

Overall, the valley floor receives a mean maximum potential of 460 langleys/day on 7 August (Appendix 6).

LIFT 2: Shadow Basin

This proposed lift line starts at the lower terminal at approx 1525 m and rises to approx 1950 m below the proposed lookout point. Of this total vertical height of 425 m, only the upper 240 m is normally skiable mid-season. I have indicated this on the slope profile diagram (Figure 5) and Plan 2.

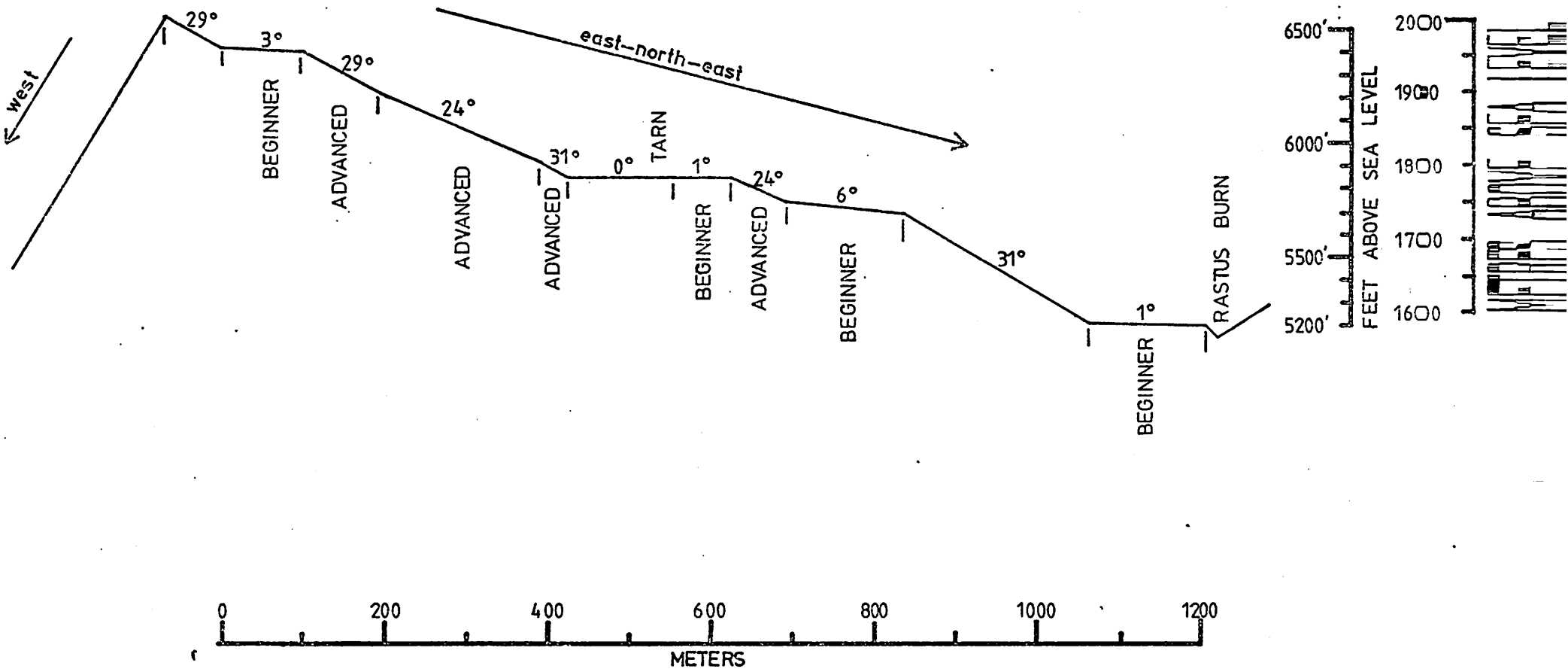
There is a small sub-basin of beginner gradient at the top of the lift line with an advanced slope 24-31° leading down to a tarn on the middle shelf. I have visited this slope on several occasions and skied it once on 25.9.79. Each occasion I have found it very marginal as a ski run due to inadequate snow cover. The whole slope has a coarse scree base with larger rock scattered over it generally. On 25.9.79 I had to carefully pick my way down between rocks constantly aware of many more rocks visible below the surface. With the passage of more than a few skiers, the most favourable line would become worn out. There is absolutely no way this slope, even with grooming could seriously be considered as a ski run.

On a lower shelf is a beginner area, with an advanced slope between it and the tarn on the middle shelf. Assuming that this run had sufficient snow cover to sustain high density skier traffic, there is a very poor separation of ability levels. It is essential to separate faster skiers from beginner areas, and for this reason only the lower shelf has any potential as a beginner area.

There is a steep (31°) slope fromthe lower shelf to the valley floor which I have not observed to be skiable. I have climbed upwards once, on skis on 25.9.79, but would have had great difficulty in descending the slope due to inadequate snow cover. Due to its proximity to the snowline, steepness and aspect (east-north-east) I have observed this slope to be one of the first slopes in the Rastus Basin to clear of snow after a fresh fall. It receives a maximum potential of 520 langleys per day compared to a mean of 440 langleys/day for the whole run on 7 August (photographs 4, 5, 8, 9).

SHADOW · BASIN

Slope Profile



Vertical Drop : 213m (700')

Distance : 850m (2790')

FIGURE 5

PHOTOGRAPH 8

RASTUS BURN : SHADOW BASIN FROM LOWER SUGAR BOWL
25 September 1979 B J Mason

Immediately after a heavy snowfall, indicating normal maximum snowcover. Note light snowcover on wind exposed shoulders. Proposed tourist lookout on ridge (top left). The upper section of the basin consists of a partially snow covered boulder slope. Two level steps occur midway down the basin, the upper one contains a large tarn. The lower slope above the valley floor base area (right of centre) shows tussock protruding across most of this slope which normally becomes unskiable within 1-2 days of a heavy snowfall. This is due to its steep gradient (60%) and east-north-east aspect.
Note snow drift on near (uphill) side of foreground rocks, indicating up-valley wind direction. Large corniced drifts (not shown) on Wye and Doolans side of main ridges indicate that northerly winds transport significant quantities of snow out of the Rastus Burn for deposition in these southerly basins.
Smooth snow covered slopes to the right of the Shadow Basin are skiable at this date, down to the valley floor. Due to the north-east aspect however, these slopes do not retain a usable snow cover for very long. See Photograph 9 (right) for comparison of same slopes.

The remainder of the proposed ski run in the valley floor is below the 1585 m continuous snowline.

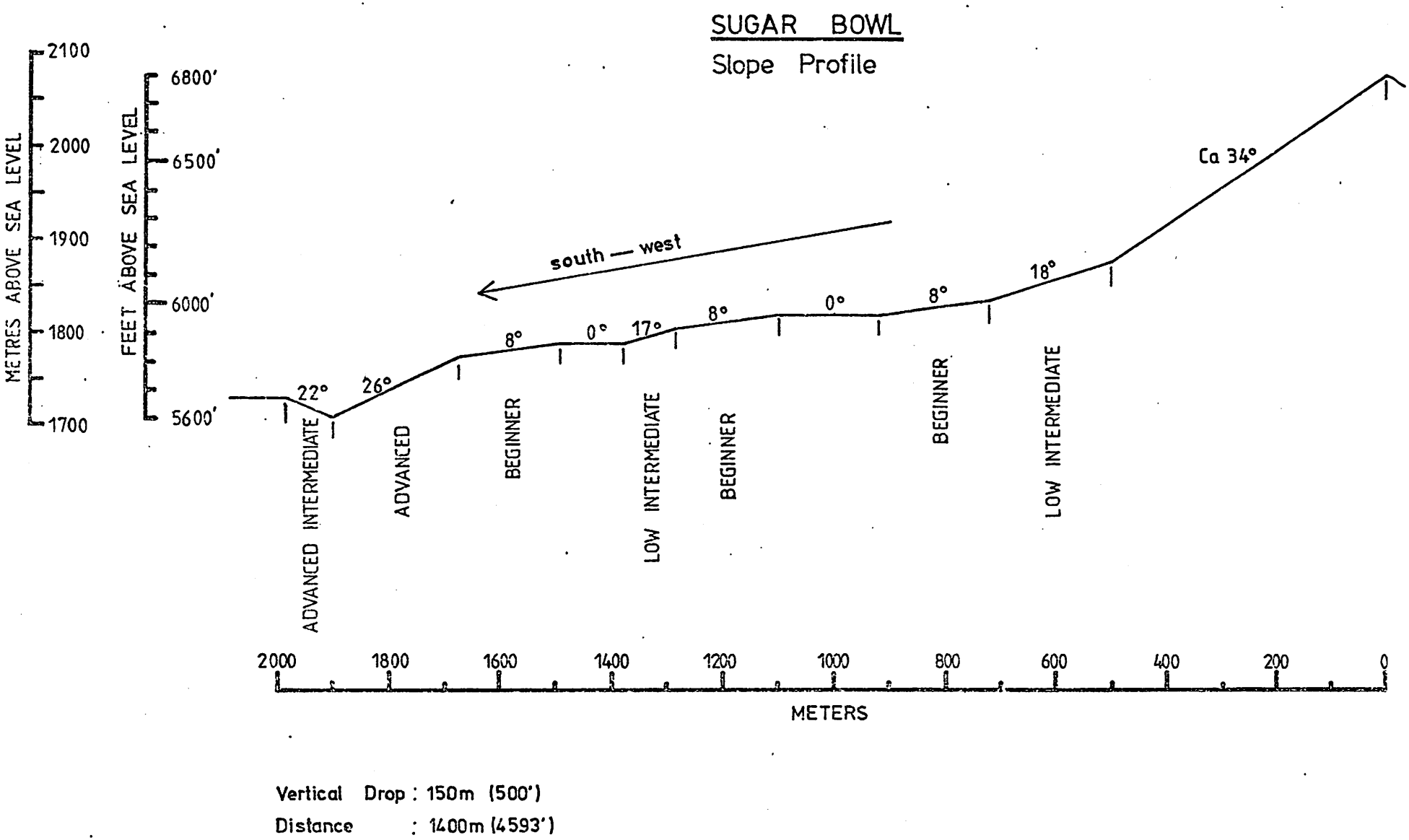
LIFT 3 : Sugar Bowl

The upper terminal of this proposed lift is on the ridge crest at 2044 m with the lower terminal midfield at 1700 m. The upper 150 m of the proposed line is on a slope of approx 34° (67%) with the slope strewn with boulders over its total height, and a line of bluffs below the ridge crest. A skier would need to be more than expert to handle this slope (Photograph 7).

The basin has a low, rounded shoulder dividing it into two halves. The northern half has an extensive boulder field, many of the individual boulders being the size of small houses. The scale and general distribution of these boulders precludes any prospect of skifield use unless there are large scale earthworks. Most of this half faces west-south-west and has a separate drainage from the other half to the south of the shoulder. The shoulder itself has more isolated boulders in its upper section, providing only limited impediment to skier movement. However, the lower part of the shoulder (Helicopter Ridge) is particularly windswept with the prevailing wind flowing up-valley with extensive patches of small rocks exposed (Photograph 8).

The reliably skiable area is confined to the south of the shoulder crest and is marked as the extent of skiable terrain on Plan 2. Figure 6 shows the slope profile down the fall-line of the basin floor. It has a south-west aspect and receives an overall maximum potential radiation of 190 langleys/day on 7 August. It has the most favourable aspect for snow retention, of all slopes in the Rastus Burn.

It is predominantly beginner terrain with short low intermediate slopes at the head of the basin and midway. There are no transitional novice slopes between. The exit from the basin is down to a 26° advanced slope into the creek bed, from which there would be a 22° slope to climb to reach the proposed lower lift terminal midfield. The alternative is to traverse advanced slopes on the true right bank of the creek until a crossing can be found leading onto the main valley floor slopes at approx 1675 m.



Vertical Drop : 150m (500')

Distance : 1400m (4593')

FIGURE 6

Alternative Ski Slopes in the Rastus Burn

An earlier proposed alignment for Lift 1 was to the Doolans Saddle with the ski run down the north facing expert slopes into the Sugar Bowl. The saddle is very windswept with the slope itself loosing its snowcover ahead of most other slopes. There are two other basins further down valley; one, an advanced slope on the east side of the valley has a variable snowline making servicing by lift very difficult. The ridge crests suffer from strong winds (Photograph 6); on the opposite side of the valley is an advanced intermediate slope which is very prominent when viewed from downvalley or from Coronet Peak. It faces north and north-east and experiences highly variable snowlines (Photographs 4, 6).

There are no other slopes within the Rastus Burn which have any potential for skifield development.

3.5 Slope Capacities and Development Constraints

Only the Sugar Bowl and two other small slopes appear to have adequate snow cover mid-season, to be considered as capable of sustaining skifield density usage. They are all of beginner gradient and are:

(a) Lower Step of Shadow Basin:

There is 1 ha at 1708 m with a gradient of 10%, 120 m above the main valley floor. Robinson's objections[4] to running chairlifts at low speed for ingress and egress would have to be overcome and/or for egress a very gently graded ski trail would need to be constructed from the lip of the step to the valley floor in an up-valley direction. Due to the steep side slope (approx 31°)(photograph 5) by necessity this trail would be relatively narrow to avoid large side batters, and to minimise visual impact. Being located on a sunny, often snow free slope, the trail is unlikely to retain snow cover over its entire length under ski traffic. The presence of bluffs and rock outcrops may necessitate steeper pitches on such a trail, than what can be comfortable handled by beginner skiers. Allowing for relative narrowness, the maximum grade could not be much more than 1:10 (10%). This would require a trail length of approx 600 m, allowing a 60 m drop to the rising valley floor. The trail planned by the Mount Cook Company is approx 400 m long with a grade of 1:6.6 (15%) which is the maximum beginner gradient. This would create difficulty for beginners learning on the 10% slope above.

Once on the valley floor, in the vicinity of the proposed midfield terminal, the problem remains of transport down the valley to the car parks. The logistics of utilising this potential beginners' slope plus the problem of the evacuation of relatively immobile beginners to shelter when there are sudden weather changes make it unattractive as a development option.

(b) Beginners' Slope below Lake Alta Moraine:
This is an 11% slope at 1750 m confined by the Lake Alta Moraine and the Wye Saddle Face. The Rastus Burn bisects the area, leaving approx 0.4 ha as a contiguous slope. Being in the valley floor and relatively closer at hand to base facilities than the Shadow Basin beginners' slope, this would be more attractive than area (a) as a development option.

(c) Sugar Bowl:
From Plan 2 it can be seen that there are four potential beginners' areas, distributed from the head of the Bowl to the lip above the main valley floor. For all these to be utilised would require connecting ski trails suitable for beginners (i.e. 1:10 or 10%). The exit from the lip of the Bowl, and back into the main valley, presents the largest obstacle to utilisation of these slopes. A 1:10 ski trail would have to be constructed across a side slope of 26-28° and then traverse north-west facing slopes which are relatively snow free. This would lead onto gentler novice slopes and so to the mid-field terminal. A total of approx 600 m of trail would be required. Similar logistic problems to those of the Shadow Basin would be involved.

Table 8 RASTUS BURN : MAXIMUM SKI FIELD SLOPE CAPACITY: BEGINNER SKIERS

Location	Area (ha)	Density/ha	Slope Capacity
a. Shadow Basin	1.0	125	125
b. Lake Alta Moraine	0.4	125	50
c. Sugar Bowl	2.5	190	475
			650

PHOTOGRAPH 9

RASTUS BURN VALLEY
13 October 1979 B J Mason

Thirteen days after the closure of the Coronet Peak skifield, the lower slopes of the Shadow Basin and the valley floor above the proposed lower lift terminals are unskiable. The south-west Sugar Bowl (not shown) probably has a continuous snow cover except in the boulder field areas.

On this date Coronet Peak above the halfway station had a discontinuous but skiable snow cover with the Back Basin having a continuous cover.

The effect of slope aspect on snow retention is illustrated by this photograph. On the left of the Rastus Burn is a south-west face, with north-east slopes on the right.

FOUR

EVALUATION OF MOUNT CARDRONA SKIFIELD

On 3 November 1979 I visited the area of this recent development to do a slope analysis with the Branch/Rowan slope classifications. The initial development is confined to a south-east facing basin from 1585 to 1830 m with an approx area of 14 ha to be serviced by a beginners' tow, a platter lift and a chairlift. The total developable area in this basin is approx 30 ha.

The terrain consists of gently undulating slopes with average gradients between 15% and 26%. This is predominantly novice terrain with shorter low intermediate pitches available. There is a good lateral progression of ability levels across the basin. When viewed from below the beginner slopes are on the left with novice slopes occupying the centre, and low intermediate on the lower right.

Future plans are for a chairlift to service the low intermediate slopes and for a T-bar lift to service extensive intermediate slopes down to an elevation of 1250 m. Long term, the development company sees potential for two more chairlifts on intermediate terrain in an adjacent basin further to the north[19].

The south-east aspect is probably the most favourable aspect possible for a skifield. This aspect is more shaded during early afternoon when air temperatures normally reach a peak. I have not visited this field mid-season (August) however, on 3 November 1979 the consistent snowline was at 1585 m which was still below the lower terminals for the three lifts planned in the initial development. Due to their similar aspects, I would expect the consistent snowline to be similar to that at Coronet Peak (approx 1190 m). The developer's future plans for an intermediate T-bar with a lower terminal at 1250 m adds weight to my expectation.

The area of the initial development is therefore 400 m higher in elevation than the lowest lift terminal at Coronet Peak.

As snow accumulation increases with elevation in the form of a "snow wedge" a distinctive characteristic of snow storage on temperate mountains[15], it could be expected that on different mountains with similar aspects and snowlines that the higher mountain would accumulate more snow

than the lower. This is, of course, quite different from the Mount Cook Company's assumption that higher elevation in the case of the Rastus Burn, but dissimilar aspects and snowline provides a valid basis for comparison.

PHOTOGRAPH 10

MOUNT CARDRONA SKIFIELD
25 August 1979
P Dale

Initial skifield development is to be confined to the extensive south-east facing novice to low intermediate Little Meg basin (centre to left).
Future options include T-bar access below the existing road terminal (lower right) and chair lifts in the adjacent intermediate Pringles Creek basin (upper right).

FIVE

SECTION V

CONCLUSION

From this evaluation of three existing or proposed skifields in the Wakatipu district, it is clear that the introductory hypothesis remains valid.

None of the "Stated Problems" with Coronet Peak can be overcome by development of the Rastus Burn, however, further development of Coronet Peak and the Mount Cardrona field would overcome much of the former field's deficiencies and provide a regional balance of skier opportunity.

Specific Conclusions

1. Reliability of Snow Cover

(All three fields are dependent on the passage of the same cold fronts for their snow precipitation):

Coronet Peak:	Snow cover has been highly variable from the fields inception
Rastus Burn:	No more reliabile for snow cover than Coronet Peak
Mount Cardrona:	Due to a snow wedge effect, this field is likely to retain a greater depth of snow than Coronet Peak. It is therefore less vulnerable to closure due to inadequate snow cover.

2. Length of Ski Season

Coronet Peak :	Start of season highly variable, ranging from late May to mid/late July. Directly related to adequacy of snow cover. End of season consistently at the end of September and not normally related to snow cover.
Rastus Burn :	No significant difference from Coronet Peak in length of season.
Mount Cardrona :	Start of season may be marginally earlier than Coronet Peak, due to snowfall at higher elevation. End of season significantly later than Coronet

Peak due to greater snow retention. Potential for season to be extended up to one month (i.e. end October).

3. Need for Extended Ski Seasons

There are strong commercial and skier needs for earlier ski seasons than can be normally provided at Coronet Peak. However, it is most improbable that neither the Rastus Burn or Mount Cardrona could meet such needs on a reliable basis.

There is no established skier need for later (spring) skiing as the opportunity for such has existed at Coronet Peak for many years without utilisation.

4. Slope Capacities

Coronet Peak: Overall is underutilised, and could accommodate at least twice the existing usage. Its primary characteristic is the surplus of intermediate slopes, but is notable for a major deficiency in novice slopes and to a lesser extent in low-intermediate terrain.

Rastus Burn: Can provide less than one fifth the developable skier capacity of Coronet Peak and is confined to beginner slopes.

Mount Cardrona: Extensive novice and low intermediate slopes give the means of providing complimentary terrain to that of Coronet Peak and correcting the slope imbalances of the Wakatipu district.

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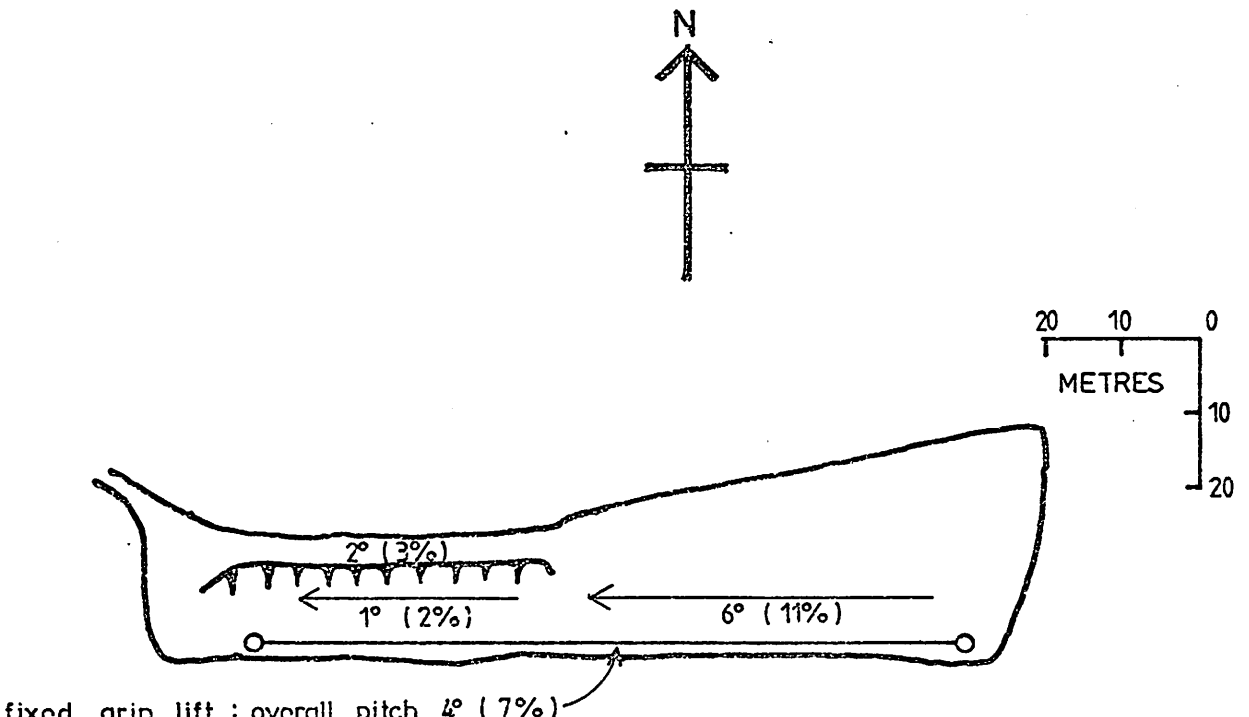
APPENDICES

APPENDIX 1

SNOW CONDITIONS AND DURATION OF SKI SEASON : CORONET PEAK 1938-1979[6,9,12,22,2

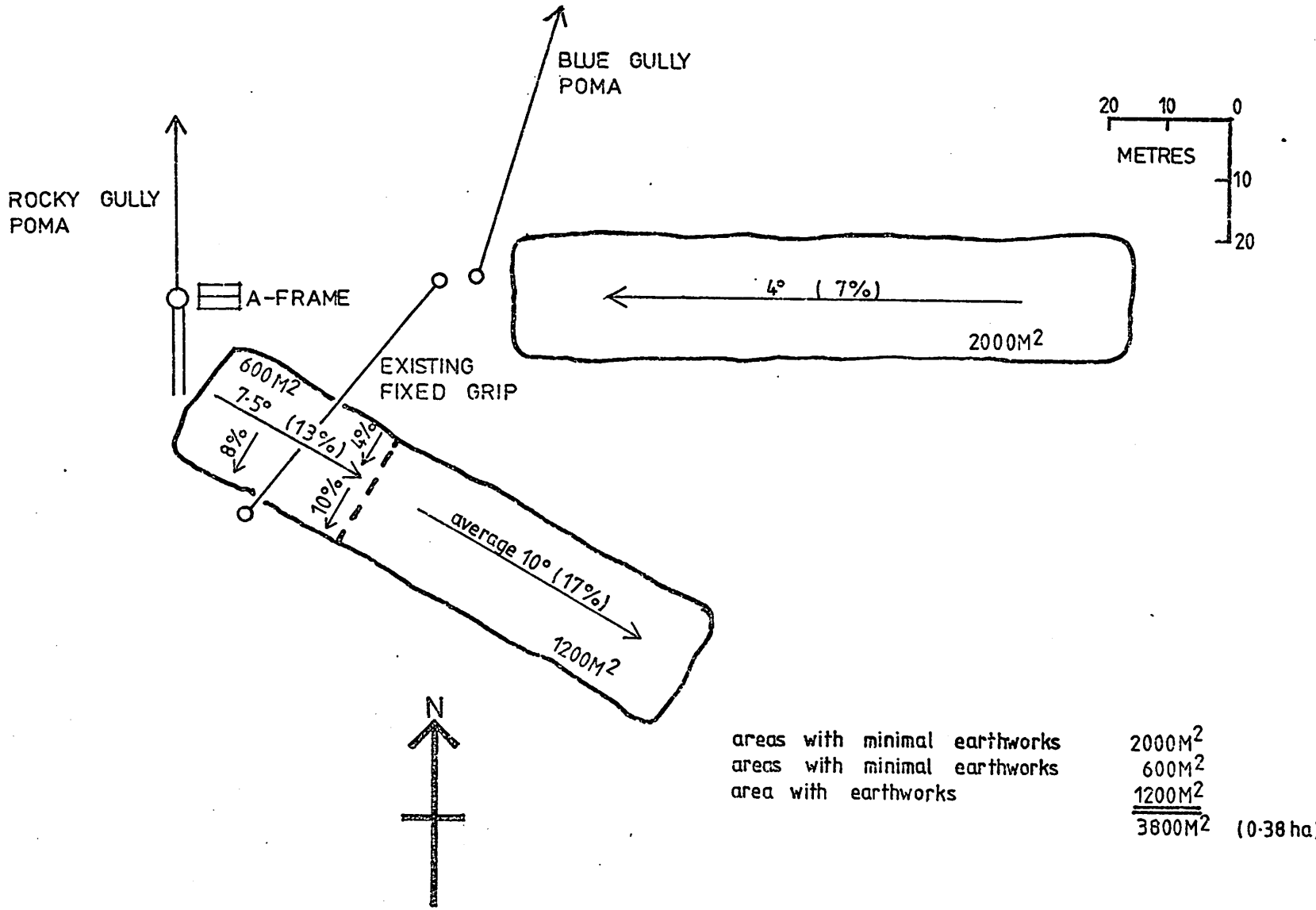
Year	Snow Conditions	Season Duration
1938	Snow-line 15-20 min climb from Skippers Saddle	Until late September
1939	'Great Snowstorm' Mount Cook Co. promotes skiing on Crown Range	
1940	Mount Cook Co. puts ski hut near Skippers Saddle Skiable snow 1 hour's walk above Saddle	
1941		
1942		
1943	'an abundance of good snow'	
1944		
1945	'excellent', 'Bad conditions late August' Snowline 1190 m	Until October
1946	'Good conditions' last week July and first week August	
1947	First rope two installed: lower terminal 1068 m.	
1948	'Very good powder all July' 'Snow late arriving, high snow level' Tow moved higher up mountain	Late June until late September
1949	'A light snow year' Tow shifted again and lower terminal 1190 m	29 June until 1 October (first snow)(heavy thaw)
1950	'Exceptional deep powder'	
1951	'weeks of powder' 'grand skiing' 'early snow falls'	23 May to 30 September
1952	'Good early fall but very little further snow'	21 June onwards
1953	'temperamental'	'short'
1954	'much improved on 1953'	
1955	'very icy, rough, lack of snow, relatively poor'	Very late starting
1956	'very poor'	'shortest season yet'
1957	'very poor' 'variable'	21 July onwards

1958	'quite good compared to 1956/57' 'snow late' 'high snow level'	Late starting, very short
1959	'best for several years'	May until end September
1960	'not as heavy as last year' 'moderately good season'	
1961	'best for many years'	Until early October
1962		Late starting; until early October
1963	'one of best on record' 'good supply of snow'	Early June to late September
1964	'disappointing' 'insufficient mid August' (top half only) Double chair lift installed	First week of August onwards
1965	'very good' 'excellent'	
1966	'most disappointing' 'Only patches 31 July'	
1967	'Worst on record!' Rocky Gully Poma installed	
1968	'Excellent' 'abundance of snow'	
1969	'Good but not as abundant as 1968' Happy Valley Poma installed	
1970		
1971	905mm snowfall	Early start 5 May, then 30 June on
1972	'abundance of snow' 1930 mm snowfall	12 June until late September
1973	1194 mm snowfall	mid-June until late September
1974	Triple chairlift installed 1626 mm snowfall	late June until late September
1975	'poor on lower slopes' 'poor' 787 mm snowfall	early July until mid-September
1976	1880 mm snowfall	late June until late September
1977	991 mm snowfall	19 June until 2 October
1978		8 July to 11 August, 19 August to 27 September
1979		17 July until 30 September



Existing Area 1800 M^2 (0·18 ha)

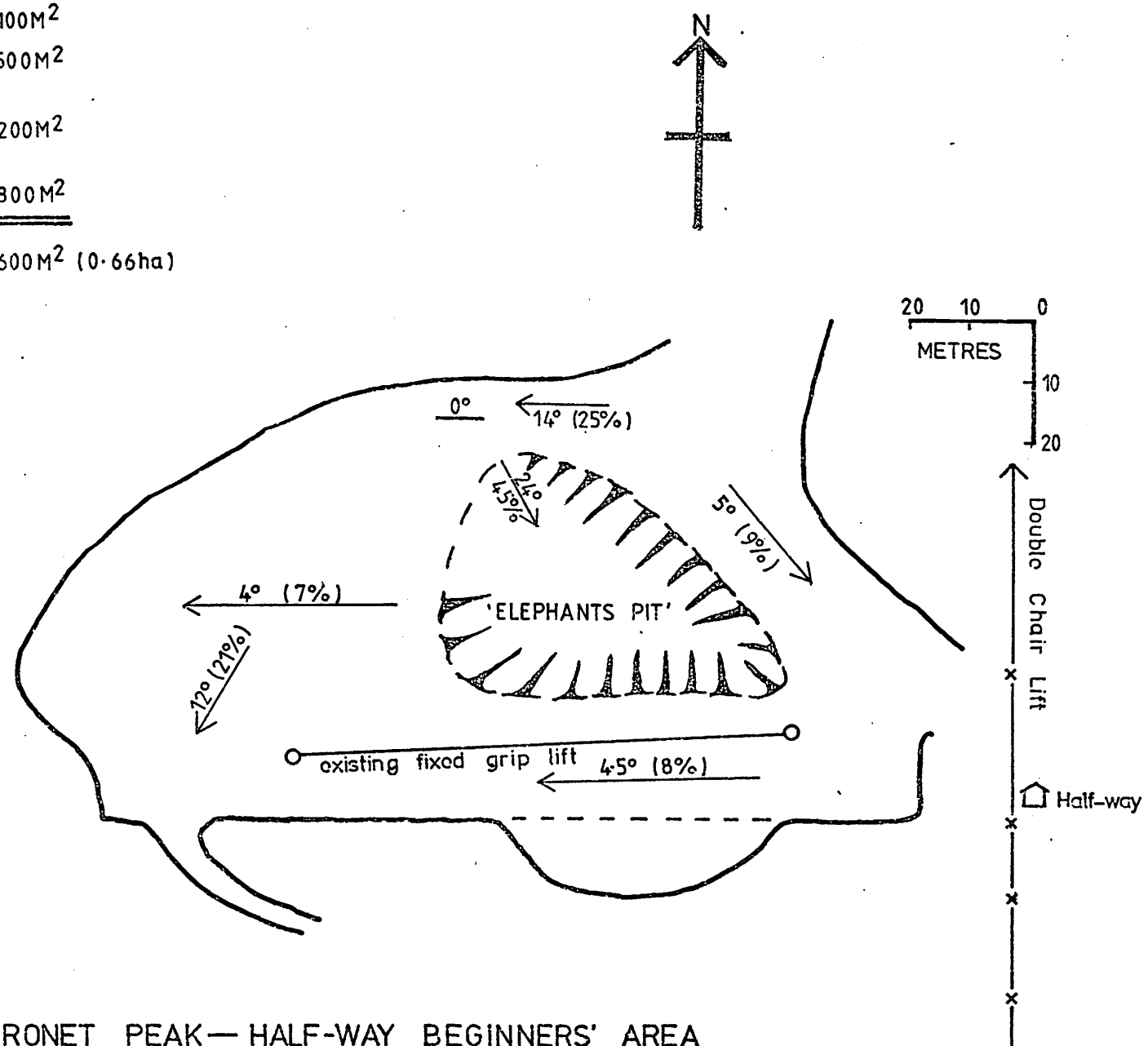
APPENDIX 2 — CORONET PEAK — CHALET BEGINNERS' AREA



areas with minimal earthworks	2000M^2
areas with minimal earthworks	600M^2
area with earthworks	1200M^2
	3800M^2 (0·38 ha)

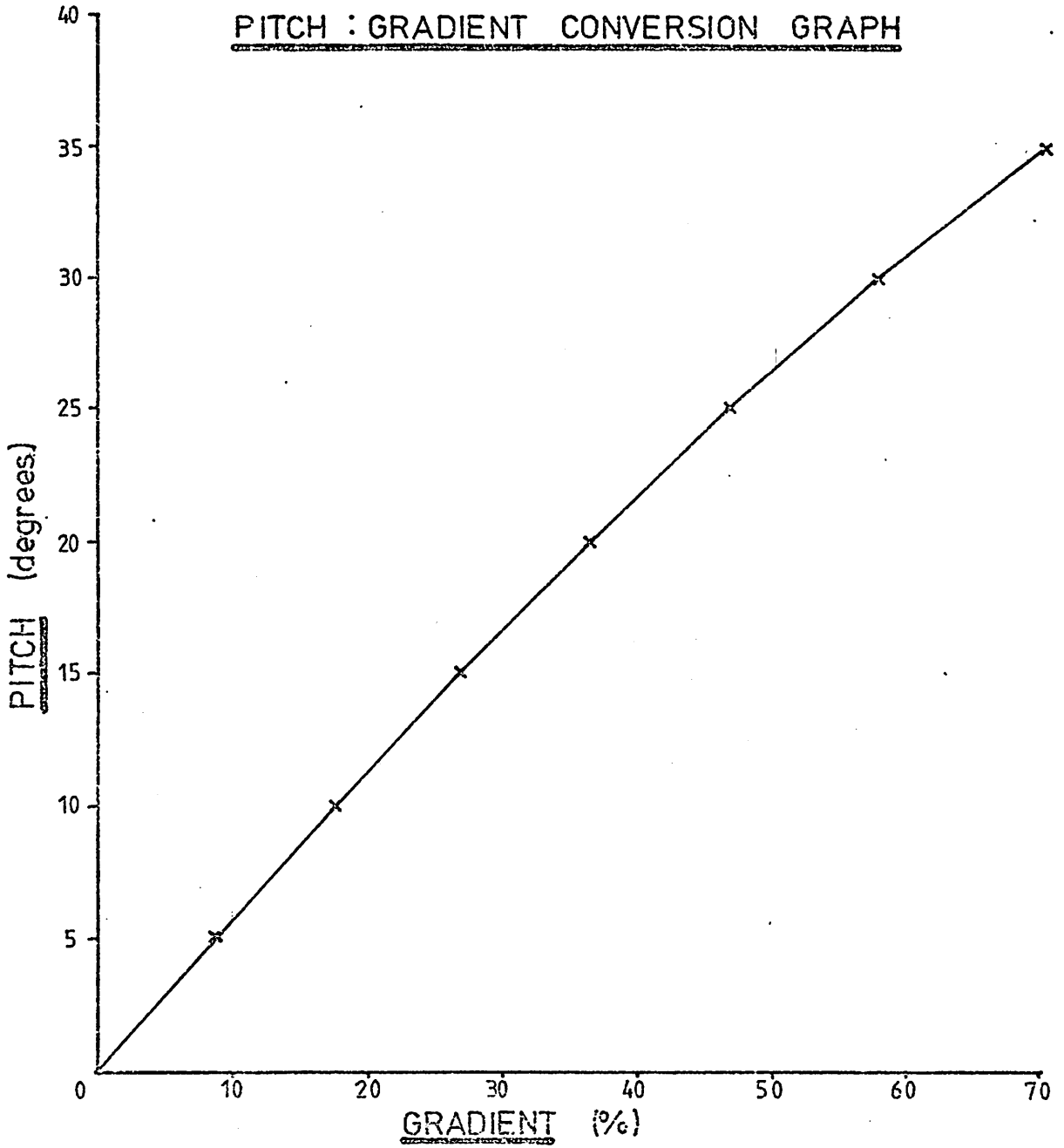
APPENDIX 3 CORONET PEAK — POTENTIAL BEGINNERS' AREAS AT ROCKY GULLY

AREAS	Existing lift serviced	1100M^2
	Existing available (no earthworks)	1500M^2
	Available with minor earthworks	2200M^2
	Available with filling of elephants pit	1800M^2
		6600M^2 (0·66ha)



APPENDIX 4

CORONET PEAK— HALF-WAY BEGINNERS' AREA


PITCH : GRADIENT CONVERSION GRAPH
PITCH (degrees)
GRADIENT (%)
0
5
10
15
20
25
30
35
40
10
20
30
40
50
60
70

APPENDIX 5

APPENDIX 6

MAXIMUM POTENTIAL WINTER RADIATION RECEIVED ON THREE SKI RUNS IN THE RASTUS BURN AND ON CORONET PEAK

Radiation Units = Langleys (ly) = calories/cm^2
Zero atmosphere and latitude 46° south

LIFT 1: Wye Saddle to Valley Floor of Rastus Burn

Slope Distance (% of total)	Aspect	Gradient (%)	Langleys/day^{24}	
			21 June	7 August
14	NNW	55	585	705
4	NNW	28	440	565
6	NNW	43	530	650
7	NNW	30	454	578
16	NNW	40	512	633
24	NNW	19	382	510
11	NW	12	310	438
18	NW	5	270	400
Weighted Means			418	544

LIFT 2: Shadow Basin

Slope Distance (% of total)	Aspect	Gradient (%)	Langleys/day	
			21 June	7 August
9	ENE	5	255	385
11	ENE	55	387	512
22	ENE	44	365	392
4	ENE	60	394	520
7	ENE	2	245	375
7	ENE	44	365	392
14	ENE	10	271	401
26	ENE	60	394	520
Weighted Means			344	442

LIFT 3: Sugar Bowl

Slope Distance (% of total)	Aspect	Gradient (%)	Langleys/day 21 June	7 August
16	SW	32	190	207
14	SW	14	160	280
13	SW	14	160	280
7	SW	30	96	213
13	SW	14	160	280
18	SW	50	49	147
Weighted Means			110	187

CORONET PEAK: Period June-August

Mean Gradient of 45 measured south facing slopes
= 40% (23.5°)

	21 June	7 August	
Langleys/day	0	58	11

Greengates Area : SW aspect
Mean Gradient = 37% (20°)

	21 June	7 August	
Langleys/day	75	188	117

Calculation of Weighted Mean Radiation Received

195 ha with south aspect = 81% of total area
45 ha with south-west aspect = 19% of total area

240 ha

Weighted mean (ly/day)	21 June	7 August	
	14	83	31

Comparison of Maximum Potential Radiation Received:

Coronet Peak and Rastus Burn:

	21 June	7 August
Coronet Peak (weighted mean)	14	83 ly/day
Aspect : south, south-west		
Rastus Burn (mean of 3 ski runs)	300	400
Aspect : east-north-east north-north-west north west, north south-west		
Rastus : Coronet	x 21	x 4.7

APPENDIX 7

CHRONOLOGY OF EVENTS: RASTUS BURN SKIFIELD PROPOSAL

October	1973	Mount Cook Company made application for lease within Rastus Burn; declined by Land Settlement Board
September	1974	Reapplication supported by original EIR; declined by Land Settlement Board "At this stage the Board was generally not convinced that the site applied for was the best one and that other areas could be more suitable"[25]. Board decides to institute a land use study of the whole Remarkables-Hector Mountains.
December	1975	Company updates EIR and submits for audit
April	1976	Commission's Audit recommends that the proposal should not proceed in the form described in the EIR, and that the Land Settlement Board consider the overall need for further skifields in the region; the intrinsic suitability of the Rastus Burn as a skifield; any viable skifield alternatives
October	1976	Company publishes a commentary on EIR Audit
December	1976	Revised application by Company for lease from Land Settlement Board
March	1977	Remarkables Study Team's report published, but not released until June. Team recommends that in balance with broader land uses, only the Doolans Basin is suitable for further skifield investigation[26]
June	1977	Concurrent with Study Team's Report, Company releases Report on Investigations following the EIR
September	1977	Land Settlement Board approves in principle Company's application to establish a skifield in the Rastus Burn, subject to planning consents
December	1978	Company applies to Lake County Council for planning consent 52 objections received
April	1979	Hearing of objections before County Planning Committee
June	1979	County grants application subject to 29 conditions
April	1980	Appeal to Planning Tribunal by Remarkables Protection Committee disallowed

Chch

DoS

Barringer JRF Soil Erosion in relation to Snowline in The Remarkables Central Otago. Unpubl. M Sc Thesis. U. of O, Dn. Nov. 1986.

Abstract:

-- snowline behaviour was investigated using a computer model
-- No trend was apparent in the alt. of snowlines simulated for 1930 to the present. The model also indicated that snow rarely lies for more than a few days below 1500m on northerly aspects.
--- Temps during 1984 & 1985 indicated that daily freeze/thaw frequency was at a max. between 1100 & 1500 metres.

Briefly: "A perceived trend of accelerated erosion on northerly aspects of the mtn. ranges of C. Otago has been attributed to snowline retreat since 1930, and to a consequent increase in frost action at altitudes between 1100 & 1500 m. This study set out to establish whether accelerated erosion had occurred, & whether a retreat of snowline & increase in frost action were likely to have been its prime cause. Aerial photos were analysed to determine the distr. of bare ground in the study area. The proportion of bare ground on northerly aspects between 1100 & 1500 metres (c 35%) was found to be an order of magnitude gtr than elsewhere in the study area (c 4%). However no trend of acc. erosion could be demonstrated using sequential b & w photos. In the absence of specific snowline data, snowline behaviour was investigated using a computer model. A standard degree-day model of snow accumulation & ablation was modified to apply temp. data recorded over a range of alts. This signif. improved the models resolution of the snow/rain boundary. A method for estimating topographic temp. lapse rates where no recorded data was available was also developed. Both versions of the model gave good results over the two yr. calibration period. No trend was apparent in the alt. of snowlines simulated for 1930 to the present. The model also indicated that snow (=4572m) rarely lies for more than a few days below 1500m on northerly aspects. Temps. during 1984 & 85 indicated that daily freeze/thaw frequency was at a max. between 1100 & 1500 m

The soils of the Remarkables are not highly frost-susceptible and there is no evidence indicating that soil creep between 1100 & 1500 m predispose this alt. zone to frost action. Furthermore, knowledge of the ecology of the plant species present suggests that they are well adapted to this environment. Therefore veg. depletion & accel. erosion are unlikely to result from frequent freezing & thawing in isolation from other factors. Nonetheless, slow plant growth & the harshness of the environ. in this alt. range ensures that any large grazed forests for decades. At higher alts. snow insulates the veg. during winter, while at lower alts. the climate is less harsh, & farming practices have generally improved veg. cover. Thus, a relatively high proportion of bare ground between 1100 & 1500 m is expected, but does not necessarily indicate accel. erosion rates.

---

pg 78. Snow

Owens & Prowse (1979) have shown that total winter snowfall at CP is related to the winter frequency of southerly airflows following the passage of cold fronts.

Fitzharris (1978) has noted that NZ is generally characterised by a mid-latitude maritime climate where freezing level intersects the alpine zone. With such high freezing level most winter precipitation should fall in near-freezing temps. Thus during many storms temp. may rise above zero at some stage. This implies that it often rains during primarily snow events. Temps will rarely, if ever, fall below -10°C during storms (Chinn 1975).

Snow might be expected to comprise roughly 33% of the ann. precip. above 1500 m, but to be negligible below 900 m (O'Loughlin 19

Chapter 5 : Changes in Snowline on the Remarkables pg 90

5.2.1. Long Term Climatic Fluctuations.

For the period from 1000 AD to 1900 AD a mod. accurate record of climatic change for NZ can be obtained from proxy records notably tree growth ring, data of glacier termini & moraines, data of erosion & depositional events & the study of veg. distrib. & dynamics.

-- the last millenium has been one of fluctuating mean temps with a max. amplitude of about 0.2°C prior to 1600 & about 0.5°C since. In the latter period cold spells have occurred at about 1700 & 1800 with warm spells in the mid 17th, 18th & 19th centuries. Regular glacial oscillations since 1750 suggest a quasi-cyclic climatic oscillation of about 30 to 60 yrs, the glacial maxima ~~only~~ lasting only for short periods of 5 to 15 yrs

5.2.2. Recent Climatic change. pg 91.

Records indicate lower temps in the early 1860's, mid 1890s to 1900's, 1930, & mid 1940's

- with higher temps in the late 1880's, 1914, mid 1930's, mid 1950's, & mid 1960's to mid 1970's.

1900 to 1960's NZ temp increase of c. 1°C, accompanied by glacial recession mostly after 1950.

since 1950's ~~mean temps~~ no period since 1000 AD has been as warm.

Engine 5.10 Daily Snowlines for the Remarkables 1931 - 1984.

Mean = c. 1570 m.

Smoothed
1931 c.1570 m 4785'
1940 c.1700 m 5182'
1950 c.1650 5029'
1970 c.1480 · 4511'
1980 c.?1480 m. ?4511

notable lowering of snowline (recent yrs only)
1959 - 64
1968 - 73
1978 →

Compare with Fig.

notable rising of snowline.
1959 | 1960 | 1977 | 1982

-7- -11- -5-

[illegible]

(Simulated) / irrespective of aspect?

Fig 5.13 : Winter Snowlines for the Remarkables 1931 – 1984

mean = 1900 m. higher than base @ 5300'

Smoothed 1940	1900 m	5791' (+500')	notable high	1958
1950	1800 m	5486' +180'		1963
1960	1750 m	5334 +34'		1966
1970	1700 m	5182' -100'		1976
1980	1630 m.	4968' -400'		1982
				1984
	av.	5352'	notable low	1961
		(50' higher than base.		1962.
				1964
				1970-72 est. 1971.
				1980.

Compare with C.P.

a slight decrease in av snowline alt. since 1930 of order ~250'

but no overall trend

30 years previously av above base area, lower by between 30' & 500'.

– Snow lies for no more than a few days below 1500 m, 4572' in both aspects

Chapter 7 Veg. of the Remarkables pgs 170 – 191.

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