Rationing an open-access resource: mountaineering in Scotland

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Abstract

This paper considers alternative means of rationing access to outdoor recreation areas, focussing on rock-climbing sites in Scotland. Such rationing is deemed increasingly important due to crowding and environmental externalities, yet cultural and practical considerations mean that a system of simple entry fees to mountain areas is unrealistic. We use a repeated nested multinomial logit model to predict the impacts on welfare and trips of two alternative rationing mechanisms currently being considered by resource managers: (i) the imposition of car-parking fees and (ii) measures to increase access time.

I. Introduction

Many outdoor recreation areas are characterized by open access, in that users pay no direct fee to gain entry to the site. This is especially true in Northern Europe, where the cultural tradition of "free" access to such areas is strong, whether they are publicly or privately owned. Access is of course costly and not free, since users must pay certain costs to access such sites, notable time and out-of-pocket travel costs. However, any moves to ration access to some European areas (such as National Parks in England and Wales) through direct entry fees are highly unlikely from a political perspective. At public parks and other lands in the US entry fees are a long-standing tradition, but recent suggestions by federal lands managers to impose new or additional fees are also causing protests from outdoor recreational users.

It is becoming increasingly evident that in many parts of the UK, open-access conditions, coupled with a rising demand for outdoor activities, are creating problems at outdoor recreation areas. These problems are two-fold. First, higher visitor numbers may lead to overcrowding, and reduced utility per visit[i]. Second, higher visitor numbers may place more pressure on the natural environment. This environmental externality is manifested in the disruption of wildlife sites, and increased erosion of footpaths leading to a decrease in landscape quality (Wightman, 1996). These two problems have led to calls for action to be taken to reduce access.

In the Highlands of Scotland, a principal outdoor recreation activity is mountaineering, a term which includes hill-walking, rock-climbing and ski-mountaineering. Increasing numbers of people are heading for the hills, as evidenced for example by the increase in the number of people annually registered as completing all 279 mountains over 3,000 feet (the "Munros") from 10 per year in 1960 to 140 per year in 1990 (Crofts, 1995). Figure 1 shows some additional indicators of the rising demand for mountaineering. This trend has led to increased congestion in the most popular mountain areas, and increased environmental damage. Since direct entry fees to mountain areas are culturally inconceivable and also impractical, attention has recently focussed on alternative mechanisms of limiting access and its potentially negative impacts. The first of these is to levy car-parking charges at principal access points in some high-pressure locations. Most mountain areas are privately-owned, so this would constitute a source revenue for private estates, who complain that they are expected to maintain access routes for no direct compensation. Currently there are extremely few examples of such parking charges being levied. The second, and more popular alternative, is the so-called "long walk in" policy (Cairngorm Working Party, 1993). This involves making access to the mountains more time-consuming, by closing off parking areas close to popular sites, closing private estate roads to public vehicles, demolishing foot bridges, and restricting mountain bike use along access tracks. The idea is that by increasing the time price of access, demand will be reduced, and so pressure from overuse will also be diminished.

In this paper, we model the impacts of each of these policy alternatives using a revealed preference model for one important group of mountaineers, namely rock-climbers. Popular rock-climbing sites such as Cairngorms and Glencoe have been particularly affected by increased pressure of use. An additional consideration in choosing this focus was that climbers constitute an easy-to-define group of users for sampling purposes. In what follows, section 2 describes the empirical approach taken, section 3 describes the way in which data was collected, and section 4 presents results. The final section provides a discussion, focussing on policy implications.

II. Empirical approach

We assume that rock climbers make two behavioural decisions that are relevant to issues in this study. These are how many total climbing trips to take in a season (participation), and where to take these trips from amongst a set of possible sites (site choice). We expect both these decisions to be potentially affected by the rationing measures of interest here. Increasing access times at certain sites may directly or indirectly effect both participation and site choice, as may the imposition of car-parking charges.

We apply the familiar travel cost method (TCM), which is used in modelling recreation behaviour and which is a standard non-market valuation technique. There are a host of possible specific versions of the TCM from which to choose, and each has advantages and disadvantages in terms of accurately predicting behaviour, and producing meaningful welfare measures. We apply a nested random utility model as it seems a appropriate modelling strategy here, given that it controls for both site choice and participation and may be consistent with utility maximization and standard consumer theory (see Kling and Herriges, 1995).

As is common to all random utility approaches, we assume that utility is determined by both deterministic and stochastic components. The latter are assumed to follow the extreme value distribution, and this partially determines the exact and specific version applied here, the repeated nested multinomial logit (hereafter RMNL). This approach controls for both participation and site choice as a function of both site-specific and individual-specific parameters, in a linked way, and allows recovery of seasonal, rather than per-choice occasion, welfare measures. The RMNL approach has been recently used in several published recreation demand studies including Montgomery and Needelman (1997), Shaw and Ozog (1999), Fadali and Shaw (1998), Parsons and Needelman (1992), Needelman and Kealy (1995), and Morey, Rowe and Watson (1993). A host of unpublished reports and papers also use this approach (see many references in Fadali and Shaw, op cit). The reader is cautioned to note differences between repeated and non-repeated multinomial logit models. The latter can be nested, but not repeated because the participation, or “go” versus “not go” decision is not modelled.

In applications of the RMNL the top or first level of the nest examines the individual’s decision whether or not to participate in any given period, yielding estimates of the total number of trips taken. This is assumed to be dependent on climber-specific attributes such as climbing ability, and takes into account the inclusive value (expected maximum utility) of lower level decisions. It is also assumed that each choice occasion is independent from any other[ii], and that the decision process repeats throughout the season. In the second level, climber's choices over trip destinations are modelled as a function of site attributes. In our model these include travel costs, approach time (the time taken to reach the start of the climb from the car park) and a number of site-specific constant terms. Policies that impact approach time directly affect the approach time variable. Policies that affect car-parking fees increase the trip price, or travel cost. As is conventional, this is composed of estimated out-of-pocket distance-related costs (return trip-distance multiplied by 10 pence per mile) and car parking fee, if any exists or is proposed at the destination parking area. A recent paper suggests that omission of a money-equivalent time cost may be consistent with the assumption that demands are conditional on, and separable from, labour-leisure choice variables (see Shaw and Feather, 1999).

Earlier RMNL models were estimated sequentially, so that the second stage destination decision is estimated separately from the participation decision, and then results are fed into the participation model (see, for example, Montgomery and Needelman (1997) and Parsons and Kealy, 1992). However, it is quite possible given a manageable number of destinations to estimate both parts of the model simultaneously using Full Information Maximum Likelihood (FIML) techniques. Examples of this approach are Fadali and Shaw (1998), Shaw and Ozog (1999), and Morey, Rowe and Watson (1993, and we adopt that approach here. Using FIML, the log likelihood function estimated is:

$$L = \sum_{h=1}^{H} \sum_{n=1}^{M} \sum_{i=1}^{J} y_{hni} \ln[\text{Prob } (hni)] \tag{1}$$

where:

$$Prob(ni) = \frac{\exp(sV_{ni})\,[\sum_{j=1}^{J}\exp(sV_{nj})\,]^{1/s-1}}{\sum_{m=1}^{M}[\sum_{j=1}^{J}\exp(sV_{ij})\,]^{1/s}} \tag{2}$$

Here, V_{ni} is the conditional indirect utility function given the choice of a visit to the i'th destination, which may include the indirect utility function evaluated for the non-participation decision. We assume that V_{ni} is linear in its arguments. Inclusion of income effects that lead to differences between the Hicks' compensating and equivalent variation requires introduction of non-linear conditional indirect utility functions, but unfortunately leads to no closed-form expression for the welfare measures. Simulation methods are needed to extract the proper welfare measures (see Herriges and Kling (1999)).

The *s* exponent in equation 2 is the usual nesting parameter, and it is common to first assume that it is not equal to one. If s = 1, then the independence of irrelevant alternatives (IIA) assumption holds, and one may just as well include the non-participation (stay at home) alternative in the same group of alternatives as the destinations (see Morey, Shaw and Rowe, 1991). This, as seen below, is a testable hypothesis.

Finally, the RMNL leads to the ability to calculate the seasonal welfare measure, CV_{seas}. This is simply accomplished by multiplying the per-choice occasion welfare measure, CV_{pco} by the assumed number of choice occasions. CV_{pco} is in turn calculated using the usual formula, which examines the difference in the log of the expected maximum utility evaluated at each policy scenario being compared, i.e. the inclusive value term (IV), scaled by the inverse of the marginal utility of income. In the linear RMNL the marginal utility of income is assumed constant, and is the price parameter, β. Therefore, the CV_{pco} is simply found using the formula:

$$CV_{pco} = 1/\beta[\ln(IV(o) - \ln(IV(`)] \qquad (3)$$

Where IV indicates the inclusive value evaluated at the initial (o) and subsequent (‘) levels being assessed.

III. Data and Sampling

The initial steps in this study were to identify the choice sets climbers face. To accomplish this, focus groups were conducted with climbers from university mountaineering clubs in Edinburgh and Stirling. Discussions with the Mountaineering Council of Scotland (MCS) also helped in this process. Eight principal climbing areas were identified. These were the Northern Highlands, Creag Meagaidh, Ben Nevis (including Glen Nevis), Glen Coe (including Glen Etive), Isle of Arran, Arrochar, the Cullins of Skye, and the Cairngorms.

A sampling frame was provided by MCS through a list of climbing club members in Scotland. As has been mentioned before (Shaw and Jakus, 1996), randomly drawing individuals who undertake specialised activities such as climbing from the general population of households is cost-prohibitive. A random sample of these addresses was selected, and questionnaires mailed to these individuals, who were asked to complete and return the questionnaire. A donation of £2 was promised to the John Muir Trust (a charity which exists to conserve wilderness areas in Scotland) for every questionnaire returned as an incentive. To widen the sample in terms of being representative of the general population of climbers, questionnaires were also administered at indoor climbing walls in Edinburgh, Glasgow and Falkirk. One major problem which became apparent with the sampling frame was that we had no way of identifying which members of a given club were actually rock climbers, and which were just hill walkers.[iii] This resulted in a very large number of questionnaires being returned by hill-walkers since many of the questions did not apply to them, and thus in a number of additional mail-outs being necessary. Nevertheless, a sample of 267 useable responses from contacted climbers was eventually acquired.

Climbers were asked questions relating to their total climbing trips in the last twelve months in both summer and winter climbing to each of the 8 areas; to evaluate each area in terms of approach time; to provide information on their climbing abilities and experience; to identify their home location; and finally, to provide us with standard socio-economic information.

Descriptive statistics for the sample

Some 55% of all climbers questioned were in the 25-40 years age bracket, which exhibited twice as many climbers as in any other age group. 19% and 24% of climbers were in the age brackets under 25 years and 41-55 years respectively. The majority of those interviewed were male (79%). 55% of the sample were single, whilst 29% of those interviewed had children. The majority of climbers (71%) were university degree holders with a further 16% having completed a certificate or diploma. The mean household income before tax was £27,111. Over 58% of climbers had been climbing for 10 years or less, with another 28% outlining they had been climbing for between 10 and 20 years. Overall respondents had been climbing for a minimum of 1 year, a maximum of 56 years with the mean at 11 years. In terms of participation, 36% of all respondents completed 25 climbs or less in a year, with the next largest group of 31% of respondents completing from 26 to 50 climbs. Overall the mean number of climbs completed per year (any given year) was 57, with the median at 40 and mode at 100 climbs. Climbers were asked how many of a sample of the eight key Scottish climbing sites they had visited at any time in the past. As indicated in Table 1, the climbing area visited by most respondents at some point in the past was Glencoe, followed by the Cairngorms and Ben Nevis. The great majority of trips were of one-day duration.

IV. Estimation Results

As mentioned above, we employ the standard RMNL to predict climbers' choices over participation and site choice. We restricted our attention to summer climbing trips only, since summer climbing on rock and winter climbing on ice and snow may be different sports, and erosion and congestion problems are greatly reduced in winter. Each of these levels is now described in more detail, and results presented.

Participation

The participation decision was assumed to depend on climber-specific attributes. At this level of the nest, climbers can choose to stay at home instead of climbing on any choice occasion. The main determinant of participation is taken to be the climber's own ability, as measured by the maximum grade they can lead. We expect more skillful (and therefore probably more committed) climbers to take more trips. Income influences the decision to stay home, but a separate parameter on income is not estimated, as in the linear version of the RMNL income effects are lost. Total choice occasions (T) were set equal to the maximum number of observed summer trips in the sample, which is 144 per season. Other things being equal, the total number of choice occasions should be set to be in accordance with an assumed one trip per choice occasion, and to avoid dropping individuals in the sample. However, a large number of choice occasions leads to a smaller welfare per choice occasion, while a small number may increase the welfare per choice occasion, and barring some influences in the tails, the modeller's choice of T is balanced out in calculation of the seasonal welfare measure.

Site Choice

Site choice was assumed to depend on site-specific attributes. These were measured as (i) out-of-pocket travel costs from the respondent's home to each site, represented as round-trip distance calculated from post-codes using AUTOROUTE multiplied by 10 pence per mile (an estimate of the marginal cost of motoring for the UK[iv]); (ii) approach time for each site, measured as estimated minutes from parking the car to reaching the foot of the climb; and (iii) a range of site-specific dummies. These site dummies represent the somewhat unique physical characteristics of each climbing area[v]. In addition, approach time-site interaction dummies were included for two sites, Arran and the Cuillins, since access to both of these island sites requires a short sea crossing. For these two areas, the costs of the sea crossing were included as a fixed cost item in out-of-pocket costs.

Table 2 gives estimation results for both levels of the nested model, using Full Information Maximum Likelihood. Travel costs are strongly significant determinants, with climbers preferring cheaper sites; whilst approach time is strongly significant also, showing climbers to prefer shorter walk-in times (since this leaves more time in the day for actual climbing). Most of the site dummies are significant as well, including the approach interaction dummies for Arran and the Cuillins. In terms of participation, the individual climbers ability level, as measured by the maximum grade she can climb, is positively related to the participation decision. The scale parameter is significantly different from zero, but that is of less interest than whether it is significantly different from one. As mentioned above, $s = 1$ indicates that a simple MNL (non-nested) could be estimated, and staying at home is just another alternative to any one of the J destinations. Assuming that errors are asymptotically normal, we use a simple t-test, giving a t-value of 0.34. This implies that s is not in fact significantly different from one, so that we could have estimated a non-nested model with non-participation as one of any of the alternative destinations for a visit. This may be due to the fact that the stay at home decision for this sample of climbers is not fundamentally different from the site choice decision.

V. Welfare Measures

The main objective of this paper is to estimate the welfare effects of alternative rationing policies for climbers' access to popular mountain areas in Scotland. We also want to illustrate the changes in participation related to these policy alternatives. Accordingly, we look at five alternatives, focussing on the three most popular (and most crowded) sites, Glencoe, the Cairngorms and Ben Nevis. These are briefly detailed below:

Ben Nevis: Ben Nevis is the highest mountain in Scotland, and the site of a number of very popular climbing areas. The main policy options discussed recently are the introduction of car parking fees at the only two feasible parking locations; and banning car parking at current sites. Climbers would then face a much longer walk in. Accordingly the policy options are specified as: Option A: impose £5/day car parking fee. Option B: increase access time by 2 hours/day.

Glencoe: The pass of Glencoe contains a number of climbing areas, including the Three Sisters, which are very popular due to their proximity to the road and general high quality. However, overall visitor pressure is now viewed as a serious problem by the National Trust for Scotland, who own the land. The National Trust is considering a move to ban all car parking in Glencoe itself, and require all visitors to park in Glencoe village (at the end of the pass) and then walk. There has also been an on-going debate about the desirability of taking down foot bridges over the River Coe to make access to the hills behind more difficult. Accordingly, we specify Option C as increasing access time to the main climbing sites in Glencoe by 2 hours/day.

Cairngorms: The Cairngorms form the largest continuous high-level massif in Scotland, and contain many of Scotland’s highest mountains. Climbing is greatly aided by the presence of a high-level car park belonging to the Cairngorm Ski-lift Company, which operates down-hill ski-ing activities on the northern slopes. Parking in this area is currently free for anyone. However, concern over increasing levels of erosion on the plateau, and the future designation of the Cairngorms as a national park, have produced pressure for change. The most likely reactions are either that a car-parking fee will be introduced (Option D: levy parking fee of

£5/day), or that climbers will be forced to park at a much more distant site (Option E: increase approach time by 2 hours/day). Finally, we also consider the implication of a policy which combined all of these options.

Given the structure of the RMNL approach, welfare estimates are produced as per season compensating variation.[vi] Results are given in column 2 of Table 3. As may be seen, for the three policy options which increase access time by 2 hours, welfare losses are similar for Glencoe and Cairngorms, which in turn are about double that for Ben Nevis. For the scenarios involving car-parking fees, losses are again much higher at the Cairngorms site than for Ben Nevis. This does not necessarily mean that utility of an average trip to Ben Nevis is much less than for Cairngorms, however, since attributes other than access time are assumed to contribute (positively or negatively) to utility.

We can also make some qualified statements about impacts on aggregate welfare. Since our model controls for both participation and site choice, and since non-participation is allowed for, per-season welfare change estimates from the sample can be aggregated to the population of Scottish climbers, assuming our sample is broadly representative. The most recent survey of total UK visits to the Highlands is that reported in HIE (1996), and gives a figure of 767,000 mountaineers. This includes English, Welsh and Irish respondents as well as Scottish respondents. Of this total, 10.7% gave the main purpose of their trips as climbing, implying 82,836 climbers visiting the area. A reasonable guess would be that around 15% of these individuals live in Scotland (our sample refers only to climbers living in Scotland). This implies a total of 12,425 climbers resident in Scotland. Taking this figure as suitable for indicative purposes, we arrive at the aggregate welfare losses in column 3 of Table 3, which allow both for changes in participation and site substitution under any of the policy scenarios. Combining all policies results in an aggregate welfare loss per season of just under £0.5 million. It should be noted that the figure of 12,425 used for the relevant population is probably an under-estimate since many of those giving their “main purpose” as other than climbing (almost 90% of the sample) will climb occasionally. The aggregate welfare estimates are probably thus on the low side.

Finally, it is interesting to look at the implications for each policy option at predicted trips for each site in the choice set (ie to dis-aggregate the quantity changes implicit in column 3 of Table 3). Estimates are given in Table 4, where for each site we show predicted trips under each policy option relative to the baseline predicted trips. This shows, for example, that imposing a parking fee at Ben Nevis increases predicted trips per season at most other sites. However, since total participation also changes, the reduction in mean trips to Ben Nevis is larger than the aggregate increase in mean predicted trips to all other sites. Trips to Arrochar and Arran, for example, are un-affected in any of the scenarios, but this is not unexpected since both are far away from any of the three study sites.

6. Conclusions

The demand for outdoor recreation can be expected to increase over time for a variety of reasons. As Krutilla and Fisher (1975) pointed out many years ago, this has implications for the management of what are essentially open-access resources in many countries. In Scotland, increasing use of mountains is having undesirable impacts on landscape quality (through erosion) and wildlife (through disturbance), as well as imposing a crowding externality. In this paper, we show how the Repeated Nested Logit model can be used to predict the effects of alternative management policies on both participation and site choice, where direct pricing of users is not possible.

One un-answered question is the exact extent to which use needs to be reduced at different sites. Currently, mountain ecologists have not come up with such estimates. Furthermore, we do not know the damage cost functions for access: it is thus not possible to comment on optimal levels of time-price or parking fee. However, one interesting aspect is to look at the different policy measures in terms of both the reductions in numbers of visitors and the lost consumer's surplus. To do this, we estimate the aggregate reduction in visits per season at each site, and divide this into the aggregate consumer surplus loss. This gives the results in Table 5. Taking Ben Nevis as an example, it may be seen that the car parking fee (option A) has a higher welfare loss per reduced visit than the increase in access time (option B), since the former imposes a higher per-climber welfare loss but is less effective in reducing visits. The per-reduced visit cost for Glencoe is, however, higher than for Ben Nevis. Car parking fees seem less effective than increasing access time, on this criteria, for Cairngorms as well.

Finally, re-specifying our model as a site-choice only RUM, we could compare the mean consumers' surplus per climbing trip for Scottish climbers under existing access conditions with equivalent estimates for the US, as provided in Shaw and Jakus (1996). This would provide an interesting test of international benefits transfer for outdoor recreation.

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Table 1: Visits to climbing sites in Scotland in the past: summer plus winter trips combined.

Climbing sites	No. of respondents	% of respondents*
Arran	109	41
Arrochar	115	43
Ben Nevis	179	67
The Cairngorms	195	73
Creag Meagaidh	117	44
The Cullins	156	58
Glencoe	205	77
Northern Highlands	159	60

*percentage excluding non-respondents.

Table 2: Repeated Nested Multinomial Logit for Summer Trips (N=244)

Variable	**Estimated Coefficient (White's Std. Errors)**
Price (£)	-0.082 (0.012)*
approach time (minutes)	-0.005 (0.001)*
site 1 constant	0.487 (0.173)*
site 2 constant	-1.70 (0.352)*
site 5 constant	-1.39 (0.710)*
site 6 constant	-2.40 (0.447)*
site 7 constant	-0.251 (0.542)
site 8 constant	0.198 (0.121)
site 5 approach interaction dummy	0.016 (0.004)*
site 7 approach interaction dummy	0.011 (0.003)*
max grade can climb	0.056 (0.03)
Log likelihood at convergence	-14793.19
Scale parameter	0.94 (0.191)

* Significant at the one percent level. White's standard errors are robust to specification choices.

Table 3. Predicted welfare changes

(1) Policy Option	(2) Change in seasonal compensating variation per climber[1]	(3) Change in aggregate seasonal compensating variation[2]
A	-£13.00	£161,525
B	-£12.50	£155,312
C	-£24.00	£298,200
D	-£20.00	£248,500
E	-£23.00	£285,775
All of the above simultaneously	-£40	£497,000

1 all figures rounded to nearest £0.50

2 based on population of 12,425 active climbers living in Scotland

Table 4: Changes in Predicted Trips*

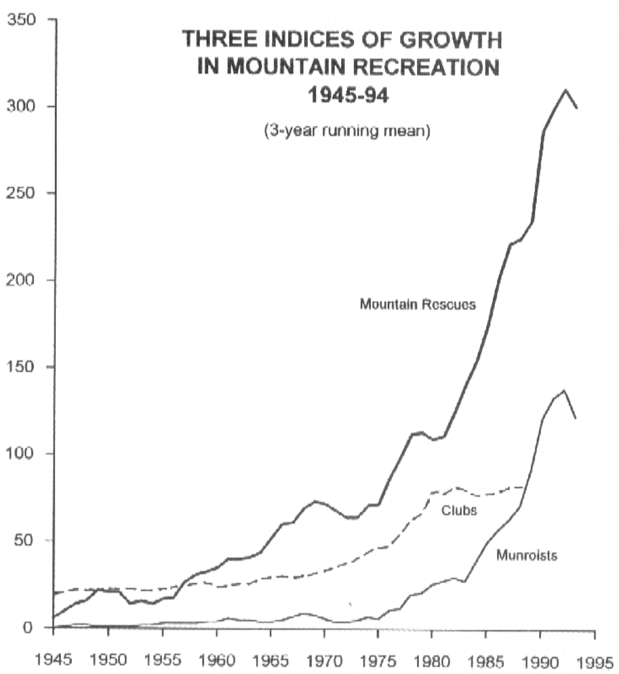
Site/Mean Baseline Predicted Trips	Policy Option				
	A: Fee increase at Ben Nevis	B: Two hour approach increase at Ben Nevis	C: Two hour approach time increase at Glencoe	D: Fee increase at Cairngorms	E: Two hour approach time increase at Cairngorms
(1) North Highlands 4.09	4.13	4.14	4.17	4.17	4.20
(2) Creagmeagaidh 0.97	0.98	0.98	0.99	0.98	0.99
(3) Bennevis 4.18	2.88	2.33	4.28	4.25	4.27
(4) Glencoe 7.77	7.83	7.86	4.35	7.87	7.91
(5) Arran 0.66	0.66	0.66	0.67	0.66	0.67
(6) Arrochar 0.002	0.002	0.002	0.002	0.002	0.002
(7) Cullins 2.04	2.06	2.07	2.09	2.08	2.09
(8) Cairngorms 7.881	7.87	7.90	7.59	5.41	4.39

* Trips are predicted using the repeated nested multinomial logit model.

Table 5. Cost-effectiveness indicators for the policy alternatives

Policy option/site	**Reduction in seasonal visits per climber, dV**	**Aggregate dV**	**Aggregate welfare loss, £/season**	**Welfare loss per reduced visit, £**
A: Ben Nevis	1.3	16,152	161,525	10.00
B: Ben Nevis	1.85	22,986	155,312	6.76
C: Glencoe	3.42	42,493	298,200	7.02
D: Cairngorm	2.47	30,689	248,500	8.09
E: Cairngorm	3.49	43,363	285,775	6.59

Figure 1



Base data derived from annual listings of mountain rescues and Munro completions in the *Scottish Mountaineering Club Journal,* and from the records of the Mountaineering Council of Scotland. [Wightman, 1996.]

ENDNOTES

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[i] It is interesting to note that Harding (1968) pointed to this problem in national parks as one example of his "tragedy of the commons". However, charging was notably absent from his list of suggested remedies.

[ii] This is one of the main weaknesses of the RMNL model

[iii] Hill walkers in Scotland would be equivalent to that group of people in the U.S. who hike or walk up mountains without the benefit of technical mountain climbing equipment.

[iv] Based on petrol consumption, but excluding insurance and depreciation.

[v] See Hanley et al (1999) for an investigation of the impact of dis-aggregating site attributes on site choice.

[vi] Again, recall that in this model with no income effects, the CV = EV.