A SCALING ANALYSIS OF SKI SITE ATTRACTION USING SKIERS' SPATIAL AND ENVIRONMENTAL PREFERENCES AND PERCEPTIONS

by

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ABSTRACT

The purpose of this study was twofold. The first was to derive measures of ski site attraction for 28 Vermont resorts from skier preferences. The second was to identify which site characteristics best explained the derived attraction values.

Two sources of information on skier preferences were used. The first was 363 skiers' stated preference rankings for ski sites; the second was 2492 skiers' revealed preferences. Attraction scales were derived for each source of information using various scaling algorithms. Both scales suggested that larger and more northern Vermont resorts tend to have highest attraction and that smaller and more southern hills tend to have lowest attraction.

To investigate this relationship data on skiers' perceptions of 8 site characteristics was obtained. Average perceptual site characteristic scores were regressed with both attraction scales. The regression of attraction measures from revealed preference could only identify one of the eight variables, length of runs, as partially related to attraction ($r^2 = .45$). The regression of attraction measures from stated preferences identified length of runs, degree of crowding, and quality of runs as strongly related to attraction ($r^2 = .90$). The importance of these variables in skier choice behavior was verified through a multidimensional scaling analysis of skiers' perceptions of resort similarity.

RESUME

Le but de cette étude est double: le premier but était de déduire des préférences des skieurs, des mesures d'attraction de vingt-huit stations de ski du Vermont. Le second but était de découvrir quelles étaient les caractéristiques de la station qui expliquaient le mieux les valeurs d'attraction trouvées.

Nous avons utilisé deux sources d'information sur les préférences des skieurs: les rapports directs de 363 skieurs de leurs préférences par ordre et les préférences observées de 2492 skieurs. Pour chacune de ces sources, nous avons établi une échelle d'attraction selon différents algorithmes. Les deux échelles suggèrent que les stations du Vermont qui sont plus grandes et plus au nord ont tendance à être les plus attirantes, tandis que celles qui sont plus petites et situées plus au sud de l'état semblent être les moins attirantes.

Afin d'étudier cette relation, nous avons obtenu des données sur la perception des skieurs relative à huit caractéristiques des centres. Les comptes moyens de ces perceptions ont été mis en corrélation avec les deux échelles d'attraction. Selon l'analyse de régression des préférences observées, il y a une relation partielle entre l'attraction de seulement une des huit variables, qui est la longueur des pistes ($r^2 = .45$). D'autre part, la corrélation avec les mesures dérivés de leurs rapports directs a montré un rapport significatif entre l'attraction et trois caractéristiques: la longueur des pistes, le nombre de skieurs, et la qualité des pistes ($r^2 = .90$). L'importance de ces variables pour le choix des skieurs a été vérifiée par une analyse d'échelle multidimensionnelle de leur perception de la similitude des stations.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF MAPS

Chapter 1

THE PROBLEM

One of the central themes in many areas of human geography is choice behavior; that is, the act of choosing one alternative and rejecting others. This study examines a recreational situation involving spatial choice behavior. Its general objective is to investigate certain aspects of the rule or rules by which skiers make choices of where to ski. More specifically, this study will concentrate on two points of concern in spatial choice behavior. First, the study will seek to determine measures of site attraction using the stated and revealed preferences of skiers for ski sites. Secondly, the study will attempt to identify from the aggregate preference and perceptual structures of sampled skiers those spatial and environmental ski site attributes which best explain the derived scales of site attraction.

Site Attraction

A skier's choice of where to ski is, essentially, the result of an evaluation process. In this process the skier may be thought to evaluate all known available ski sites on the basis of their ability to provide what could be loosely termed a satisfactory skiing experience. During this evaluation the skier can be thought to assess the quality of the ski experience obtainable at each site and the effort necessary to reach it. It is assumed he then selects that site which to him seems to provide the best combination of ski experience and travel effort.

For the purposes of this discussion this combination can be equated with a site's spatial utility. Spatial utility is defined here as the utility of a location for some purpose as mediated by its distance from the potential user. More specifically, it is postulated that spatial utility is related to certain environmental and spatial variables. Because the activity of skiing is, perhaps, the most important component in the visit to the ski site it is easy to see that the environmental characteristics of the ski site which determine the quality of skiing at the site have a significant bearing on the site's utility. It should be clear that these environmental characteristics will usually vary in quantity between ski sites. Furthermore, it is these characteristics of a ski site which draw or attract people to the site. Hence, site attraction can be defined as a composite measure of a site's environmental characteristics which affect skiing satisfaction and constitutes one element of spatial utility.

The other element of a site's spatial utility relates to the disutility of the effort required to reach the site from any origin. This spatial component can vary in two ways. First, the distance to different ski sites from the same origin will vary because not all sites will be equidistant from an origin. Secondly, as the origin varies so does the distance to any particular ski site.

At this point a very simple, partially-specified model of the spatial utility of ski sites can be constructed. It can be presented symbolically as,

$$ {}_{i}U_{j} = f(A_{j}, D_{ij}) \tag{1.1} $$

where, ${}_{i}U_{j}$ = the utility of ski site j for a skier at origin i;

A_j = the attraction of site j; and

D_{ij} = the distance from the skier's origin at i to ski site j.

As discussed previously, the model simply suggests that the utility of a site for different points in space is related to the attraction of the site and the distance from the site to those points. The model is described as partially specified because we have identified which factors are hypothesized to determine utility but we have not defined precisely how they determine utility.

Spatial choice models typically have shown that these two variables, attraction and distance, have opposite effects on a site's utility. Site attraction is directly related to utility, and distance is inversely related to a site's utility. The latter implies that the same ski site can have high utility for one skier located nearby, and at the same time have low utility for a more distanct skier.

With this information on the relationship of utility, distance, and attraction, the general spatial utility model presented in (1.1) can be more precisely specified as,

$$ {}_{i}U_{j} = A_{j}^{\alpha} D_{ij}^{-\beta} \qquad (1.2) $$

where, α and β = empirically determined constants.

This multiplicative spatial utility function is one of the more common ways of combining site attraction and distance that have been used in geography.

From this discussion it should be clear that any information on a site's utility for different origins reveals some information on both the site's attraction and the disutility of the distance to those origins. This study assumes that skiers' choices reflect spatial utility. In fact, choices reflect a very special type of utility: that the site chosen by a skier is a better combination of attraction and distance (i.e. spatial utility) than all other available combinations. In some choices it is impossible to separate information on site attraction from information on the disutility of distance. However, there are circumstances where choices indicate that one site is more attractive than another. Since, in terms of the above argument, choices are an accurate source of information on a site's attraction, this study focuses on choices made by individual skiers and attempts to extract information on site attraction.

Each skier's expression of a site's attraction is obtained at the individual level. However, these individual expressions can be seen as contributing to a more general picture of attraction existing at the aggregate level, if it is assumed that there are no major interpersonal differences in skiers' preferences. This study concentrates on the derivation and explanation of attraction measures at the aggregate level.

The Identification of Relevant Site Attributes

It is possible to conceptualize two types of attributes-spaces. The first can be called an "objective" attribute-space, and the second "subjective". In the objective attribute space each ski site is positioned in the space such that the projection of its location onto any attribute dimension would reflect the amount of that attribute the ski site actually possesses. The dimensionality of the objective attribute space would reflect the number of attributes for which objective measures could be obtained, and might extend into the hundreds in some cases.

In the evaluation process a skier obviously doesn't consider each ski site's score on such a large number of variables. Presumably the process is much simpler. This skier can be thought to assess and assign each ski site a subjective amount of an attribute, based on the amount of that attribute he perceives each ski site to contain. He repeats this procedure for the number of site attributes he thinks are important ingredients in his choice and, hence, skiing satisfaction. The result is that, in the evaluation process, the objective space of high dimensionality is collapsed into a smaller, subjective attribute-space. During this process, it may happen that a few of the objective dimension are combined into one subjective dimension, or that a completely new dimension is added - one which might not have any objective measurable equivalent. The dimensionality of this final space reflects the complexity of the choice situation. It is the properties of this space and their relation to the derived measures of attraction that this study will investigate.

As suggested earlier, site attraction is related to the environmental characteristics of a ski site which affect skiing satisfaction. Symbolically, this relationship can be shown as:-

$$A_j = f(V_{1j}, V_{2j}, \ldots, V_{kj}, \ldots, V_{nj}) \qquad (1.3)$$

where, A_j = the attraction of site j, and

V_{kj} = the effect of variable k at site j, defined as the part-worth of variable k at site j.

The part-worth of any site attribute in the site attraction measure can be expressed as a function of two quantities: the amount of the attribute skiers perceive the ski site to contain and the weighting or salience they attach to that attribute in their choices. In short,

$$V_{kj} = f(w_k, q_{kj}) \qquad (1.4)$$

where, w_k = the weight that skiers attach to variable k in their choices; and

q_{kj} = the amount of variable k skiers perceive at site j.

Finally, this study assumes that w_k and q_{kj} in (1.4) are combine in a multiplicative fashion, and that the V_{kj} s in (1.3) are combined additively to produce measures of site attraction. Thus an additive attractive function can be specified as,

$$A_j = \sum_{k=1}^{n} w_k \quad q_{kj} \qquad (1.5)$$

where, n = the number of salient variables involved in skiers' choices.

The derived attraction values can be related to the site characteristics of the subjective attribute-space discussed earlier by this attraction function. The derived attraction values can be visualized as a hyper-plane fitted in the subjective attribute space, each value consisting of different amounts of site characteristics. The attraction function in (1.5) specifies the relationship (w_k) between each site's attraction value (A_j) and that site's position (q_{kj}) in each of the n relevant dimensions.

The second purpose of this study is related to identifying those ski site properties related to site attraction and, by extension, skiers' choices. It has three parts. First, the variables affecting ski site attraction must be identified. Second, it will be necessary to identify the amount of each variable which skiers perceive at a site. (q_{kj} in quation 1.5)

Finally it will be necessary to identify the amount of salience attached to each of these variables in the attraction function. (w_k in equation 1.5)

Study Outline

This study is divided into five remaining chapters. In the second chapter actual skier revealed preferences will be examined. This is designed to do two things: first, to acquaint the reader with travel characteristics of skiers and, second, to establish that skier choice behavior isn't simply an attempt to minimize distance but does involve a trade-off between distance and attraction. Also, this chapter will establish that resorts appear to have different propensities to pull skiers past competing resorts.

Chapter 3 will review two general approaches which have been used in analyses of site attraction.

Chapter 4 will present the research design that is used in this study.

In Chapter 5 two measures of site attraction will be derived for each ski site. The first measure will be based on the stated preferences of skiers for ski sites. The second measure will be based on revealed skier preferences.

The final chapter will attempt to explain these derived indices by identifying, weighting, and combining the relevant site variables.

Chapter 2 EMPIRICAL VERIFICATION OF A TRADE-OFF CHOICE RULE AND THE EXISTENCE OF SITE ATTRACTION

In the previous chapter site attraction was theorized to be an element in the spatial utility function and, hence, a major factor shaping skiers' choices. The exact nature of the spatial utility function is related to the rule by which skiers make choices of where to ski. Any choice rule can be categorized as one of four general types. First, skiers can choose sites at random. Under these circumstances the form of the utility function would look very different from that presented in (1.2). Secondly, skiers may simply minimize distance in their choices. In this situation α of (1.2) would equal zero, assigning no importance to a site's attraction. Thirdly, skiers may simply maximize attraction in their choices, in which case β of (1.2) would equal zero and the spatial component of each choice would disappear. Finally, skiers may maximize different combinations of attraction and distance in their choices. In this case α and β of (1.2) would be different than zero and therefore contribute in some way to the site's spatial utility.

At the outset it is important to establish which type of rule is governing skier choices since each is related to a different problem or requires a different methodology. For example, if skiers are governed by either of the first two rules outlined above any attempt to derive site attraction measures from behavior would be futile because that behavior, by definition, would not be related to site attraction. If skier choices are governed by the third choice rule, this study would be examining a situation of simple choice rather than spatial choice. In this case a very simple methodology could be used to obtain attraction measures since skiers' choices would directly reflect ski site attraction rather than a combination of attraction and distance. If, however, skiers' choices are governed by a rule maximizing a utility function which combines attraction and distance, the problem of identifying and explaining site attraction is appropriate and it is necessary to employ a more sophisticated methodology to extract site attraction information from skiers' choices. Thus, it is necessary to verify that the importance of site attraction in skiers' choices, which has been asserted at the theoretical level in Chapter 1, is supported by empirical evidence.

This chapter is designed to do three things. First, it will acquaint the reader with the general travel characteristics of skiers in the sample. Second, it will verify that the general type of choice rule governing skiers' choices is one which involves a combination of attraction and distance. Third, it will establish that ski resorts appear to have differing amounts of site attraction as shown by skiers' revealed preferences.

Vermont Ski Hills

Vermont has long been one of the major ski areas in the northeastern United States. It has well over forty ski hills of varying quality which attract a diverse cross-section of skiers. Most of these resorts are located in the Green Mountains which have a north-south orientation and run the entire length of the state.

This study focuses on Vermont's larger resorts. In all, 28 ski hills are examined in this study.* This sample contains a high degree of diversity from the large, highly commercialized resort complexes like Killington, Mt. Snow, and Stowe attracting regional skiers to small, family-style ski hills like Pinnacle, Prospect and Hogback which attract primarily local skiers. The 28 resorts in the study are shown in Map 2.1.

Spatial Choices

A spatial choice, or more precisely a revealed spatial preference, has two pieces of information associated with it: the revealed preference itself and the origin of the skier revealing the preference. Both pieces of information are necessary to accurately analyze spatial choice behavior. In order to satisfy this requirement, revealed preferences of skiers for different ski sites were collected in the form of license plate registration numbers taken from the parkinglots of 24 of the 28 sites.** A sample of plates, representative of both the total number of skiers at each site and the approximate percentage attending from each origin state, were collected at the 24 sites. Each license plate is assumed to indicate the revealed preference of a skier from the origin indicated by the license plate for

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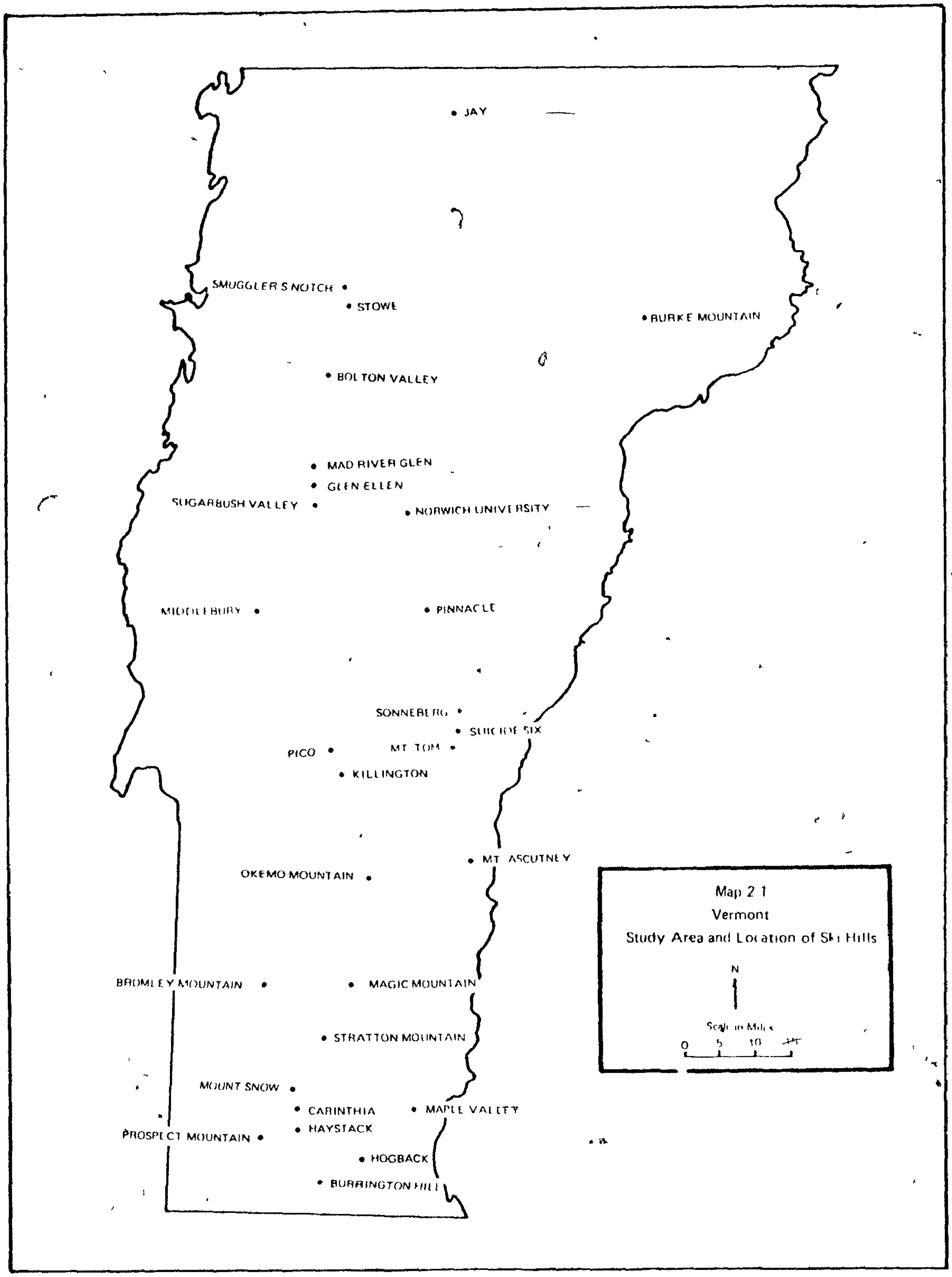
* Every site in Vermont that was open all week was included in the study. Ski hills that are open only on weekends have been excluded.

** Data could not be collected at Norwich University Ski Area, Middlebury College Snow Bowl, and Burrington Hill because of poor skiing conditions. Sampling was not allowed at Mt. Ascutney.



Map 2 1
Vermont
Study Area and Location of Ski Hills

that site. This information was collected during the 1973 ski season.

Since it was only possible to sample each site once during the season, data were collected only on days of similar skiing conditions. Furthermore, sampling was confined to weekends because weekend skiers were felt to be more representative of most skiers than weekday skiers. It is assumed that the data collected at each site are representative of normal skier interaction patterns.

The license plate data revealed eight origin states: Vermont, New York, New Hampshire, Massachusetts, Connecticut, Rhode Island, New Jersey, and Quebec. Table 2.1 shows the total number of skiers originating from each area. State authorities in Vermont and New York provided information on the exact origins of the plates from their states. This information was not available for the remaining states. However, a procedure was developed for identifying which of the pieces of revealed preference data from these states could be use with little or no error even though their exact origins were not known. This procedure is discussed in Appendix II.

During the data collection period, 2492 revealed preferences were collected at the 24 sites. All of the preferences originating from Vermont, New York, New Jersey, Rhode Island, and Connecticut were judged allowable because the origins were either supplied (in the case of Vermont and New York) or a single origin in the state was found which did not violate the order-preserving criteria established in Appendix II (as with New Jersey, Rhode Island, and Connecticut). 99 percent of the revealed preferences originating from Quebec were judged allowable, as were 91 percent

Table 2.1

Skier Origins by State

State	Number of Skiers
New Jersey	283
Connecticut	508
Rhode Island	5
Quebec	94
Massachusetts	612
New Hampshire	59
Vermont	467
New York	464
	2492

of the preferences revealed by Massachusetts' skiers. No preferences revealed by New Hampshire's skiers could be used but these only accounted for 2 percent of the total sample. In all, 95 percent of the 2492 revealed preferences were judged allowable.

Skiers' Choices and Distance Travelled

Certainly one relevant aspect of spatial choice behavior is the relationship between choices and the distance travelled to those choices. Differing choice rules as well as differing amounts of site attraction will both result in different amounts of distance being travelled by skiers. For example, behavior under a distance minimizing choice rule would result in shorter distances travelled by skiers than behavior under an attraction maximizing or trade-off choice rule. Also, more attractive ski resorts would presumably draw skiers from further distances than less attractive resorts.

Figure 2.1 shows the distance travelled by Vermont and New York skiers. All distances have been computed using a straight line distance formula.* Cumulative frequency curves were not constructed for skiers from the other six areas since each area has only one origin. The curve for Vermont skiers indicates that most of them travelled less than

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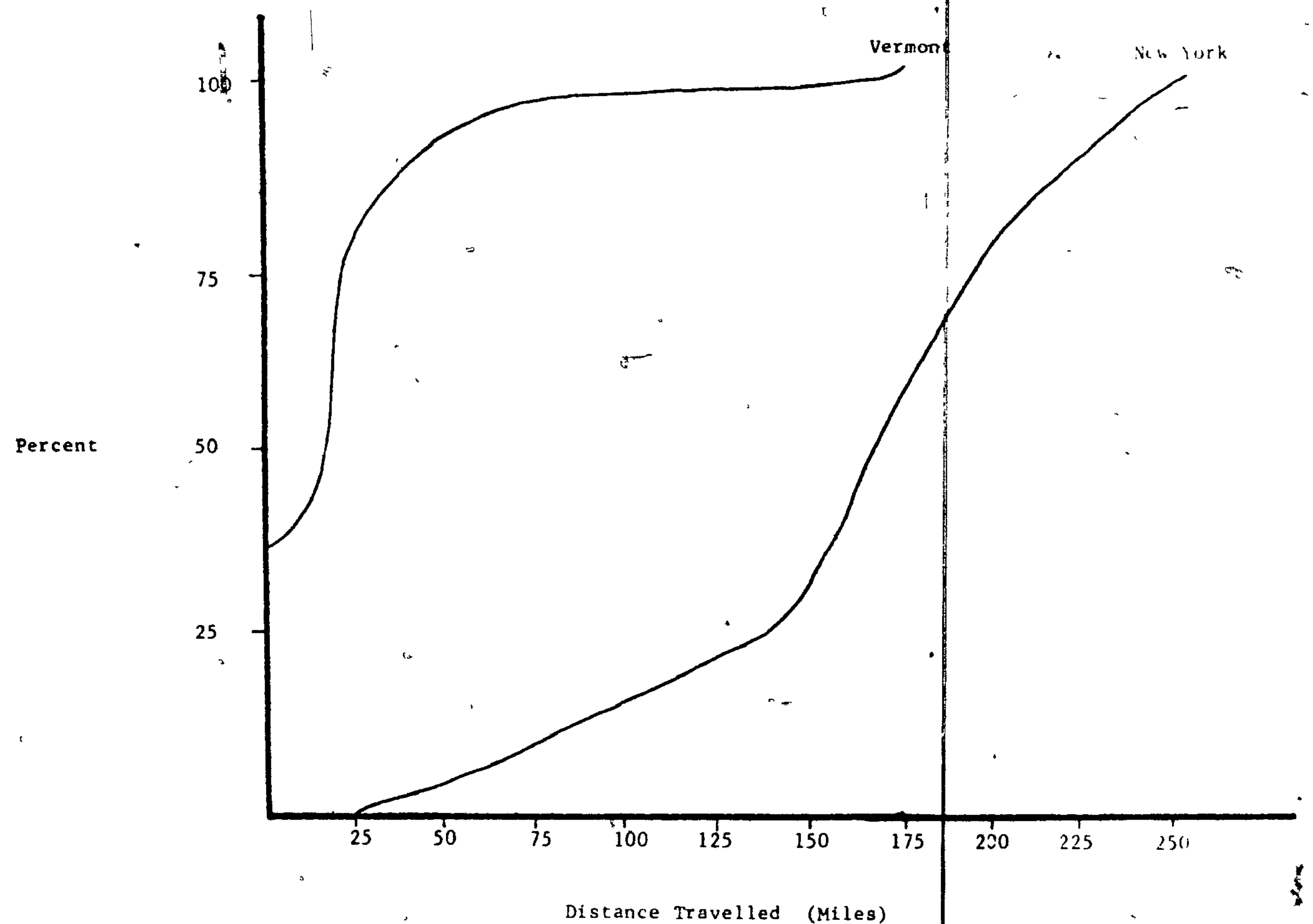
* Only straight line distances are used in this study. A sensitivity test revealed the order of distances between origin-destination pairs to be the same regardless of whether straight line or road distances are used. The results of this test are presented in Appendix I.

Figure 2.1

Cumulative Frequency Curves of Distance Travelled by New York and Vermont Skiers



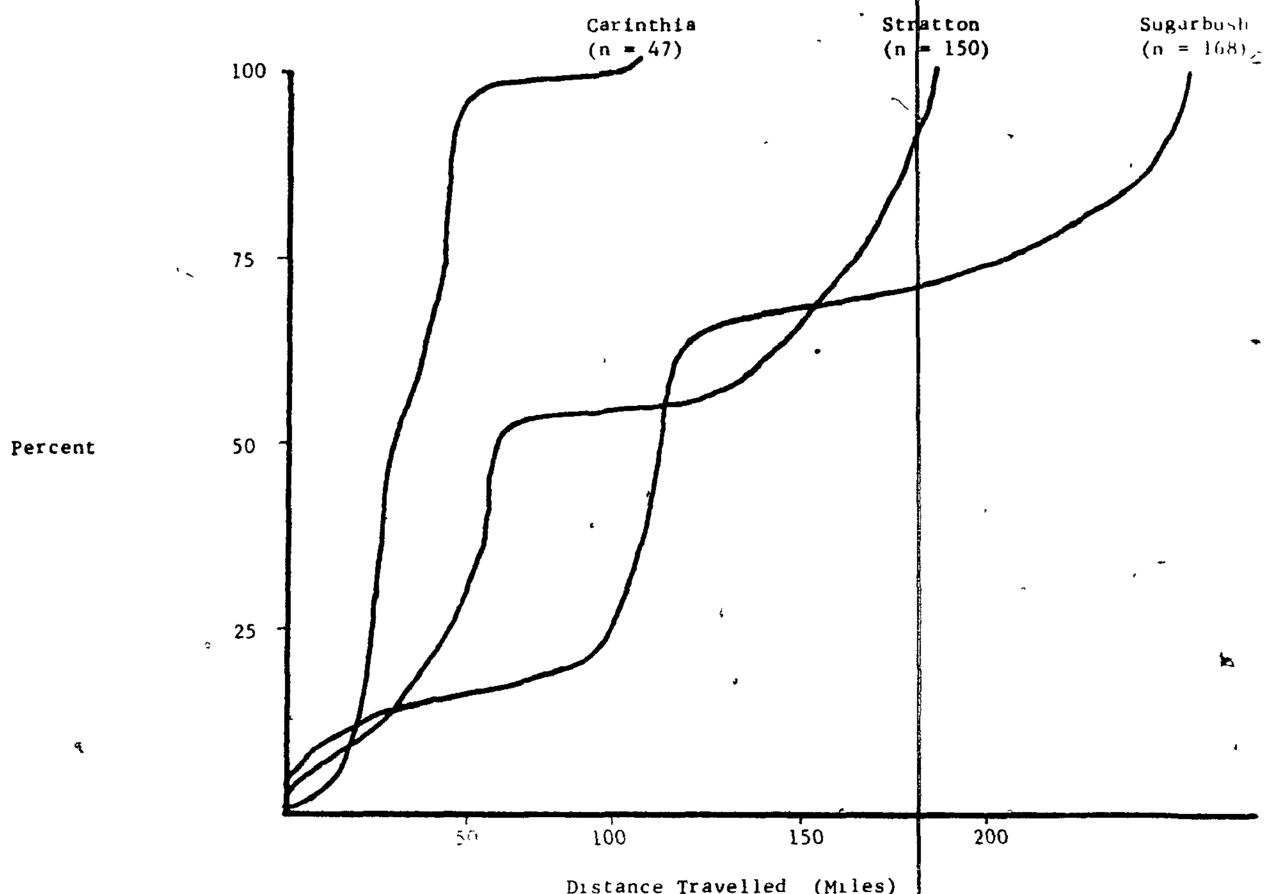
50 miles and a majority travelled less than 20 miles. The curve for New York skiers indicates a much different situation. A majority of skiers from this state travelled at least 170 miles. The shape of the Vermont curve can be attributed to two things: on the average, Vermont skiers are either located near acceptable ski hills and do not have to travel very far to ski or have a choice rule that places a large negative weight on distance. The New York curve most certainly reflects the fact that skiers in that state are less opportunistically located relative to Vermont ski hills than Vermont skiers. Hence, it is necessary for them to travel longer distances to ski in Vermont. However, the curve may reflect a different choice rule operating in which distance is weighted much less than by Vermonters.

The shape of these curves are a result of and therefore reflect the effect of two factors: the choice rule of the skiers and the effect of the distance to sites acting as a constraint on choice behavior. While it is the purpose of this chapter to identify the general nature of skiers' choice rule it is impossible using a cumulative frequency curve to isolate and identify even the most general type of choice rule at work.

The distance travelled to certain ski sites would seem to be related to the sites' attractions. Very attractive sites would tend to draw people from further distances than would sites having less attraction. Figure 2.2 shows the cumulative frequency curves of distance travelled by skiers to three selected sites: Carinthia, Stratton, and Sugarbush. Skiers who have chosen Carinthia have travelled no more than 70 miles, whereas

Figure 2.2

Cumulative Frequency Curves of Distance Travelled by Skiers Choosing Carinthia, Stratton, and Sugarbush



some skiers choosing Sugarbush have travelled over 250 miles. The curve for Stratton lies between these extremes.

From these three curves it would appear that Sugarbush is the most attractive resort of the three since it draws skiers longer distances than the other two resorts. While this statement may be true, its validity cannot be judged since the curve also depends on the different constraints that the varying distance between skier origins and ski sites impose on choice behavior. For example, a very attractive ski site might be advantageously located near a large number of skier origins. In this case skiers would not have to travel very far to interact with a spatial choice having high utility. If, in addition, few skiers lived farther away from the site, the cumulative frequency curve of distance travelled by skiers would look very similar to Carinthia's curve in Figure 2.2 - a curve that we have suggested would be associated with a less attractive site.

Both of these sets of curves undoubtedly indicate something about choice rules and site attraction, respectively. However, they also indicate something about the effect of the relative locations of origins and possible destinations on behavior. The problem is that the effect of the two sets of factors cannot be isolated and, hence, it is impossible to identify the choice rule operating and to establish the importance of attraction in skier choices.

Skiers' Choices and Intervening Opportunities

A second relevant aspect of spatial choice behavior is the relationship between choices and intervening opportunities. Different choice rules will produce correspondingly different patterns of interaction in relation to the intervening opportunities between a skier origin and his final choice. For example, under a distance minimizing choice rule interaction should primarily occur with a nearest or very near opportunity. Under a trade-off rule people will be more likely to pass nearer opportunities to seek a more acceptable combination of attraction and distance. In addition, different amounts of site attraction will also elicit different skier interaction patterns in relation to the intervening opportunities between a particular site and the origins of skiers choosing that site. More attractive sites are more effective at "pulling" skiers past intervening opportunities than less attractive sites. Hence, an investigation of interaction patterns in relation to intervening opportunities will allow an examination of both the type of choice rule operating and the general nature of site attraction.

The general quality of a site's location vis-à-vis competing opportunities is related to the amount of skiers for which it is a reasonably close opportunity. Sites which have a small number of intervening opportunities between themselves and a majority of skiers have a better location in relation to those competing opportunities between themselves and the skiers. This is because the chance of a skier stopping at an intervening opportunity before travelling to a particular site becomes more likely as the number of intervening opportunities that the skier must pass becomes greater.

Table 2.2. shows a matrix reflecting the relative quality of the 24 sites' locations in Vermont. Some of the intervening opportunity

Table 2.2

The Percentage of All Sampled Skiers Being Able To Choose
Each Site Over Differing Numbers of Intervening Opportunities

Number of Intervening Opportunities

	0	1	2	3	4	5-9	10-14	15-20	21-23
Bolton	4.37	1.04	2.05	4.45	2.13	1.32	1.12	83.27	0.24
Bromley	0.80	0.72	2.65	0.12	0.08	79.45	1.32	14.85	0.0
Burke	0.80	0.16	0.0	0.20	0.12	6.18	7.38	1.28	83.87
Carinthia	0.60	0.16	1.69	73.07	2.21	2.65	2.41	16.09	1.12
Glen Ellen	0.92	1.73	0.56	0.0	4.25	9.67	4.17	78.69	0.0
Haystack	0.04	76.04	0.96	0.04	0.56	2.13	0.92	3.09	16.21
Hogback	0.72	1.08	49.96	0.20	0.72	26.32	1.40	3.09	16.49
Jay	4.33	0.36	0.08	0.32	0.36	5.58	3.89	0.32	84.75
Killington	0.40	2.33	0.24	1.00	0.40	5.18	90.45	0.0	0.0
Mad River Glen	0.88	3.33	2.61	2.57	4.53	2.29	4.05	79.53	0.0
Magic	1.08	0.32	0.20	0.24	0.84	80.86	1.44	15.01	0.0
Maple Valley	0.64	0.52	0.16	1.12	10.31	65.69	2.81	4.29	14.45
Mount Snow	0.20	0.08	23.88	4.13	40.73	11.64	2.97	16.37	0.0
Mt. Tom	0.68	0.48	1.77	0.60	0.56	2.01	92.58	1.32	0.0
Okemo	1.28	0.60	1.40	0.68	0.96	12.24	2.21	80.62	0.0
Pico	2.21	0.56	0.0	0.48	0.84	63.47	12.44	0.0	0.0
Pinnacle	0.32	0.28	0.56	0.72	1.04	16.73	80.22	0.12	0.0
Prospect	75.92	0.04	0.40	0.16	0.0	2.85	1.32	3.09	16.21
Smuggler's Notch	0.88	6.42	2.29	0.92	1.57	3.09	1.06	0.40	83.35
Sonneberg	0.44	0.28	0.96	2.09	0.20	6.34	88.04	1.65	0.0
Stowe	0.60	0.96	5.82	3.65	0.76	3.17	1.28	0.44	83.31
Stratton	0.36	0.80	0.80	1.08	24.60	55.50	0.64	16.01	0.0
Sugarbush	1.24	0.84	0.52	2.09	0.08	13.88	2.57	78.77	0.0
Suicide Six	0.24	0.84	0.24	0.04	2.37	1.52	93.06	1.69	0.0

categories have been combined. Each cell indicates the percentage of all skiers sampled for whom the row ski site has the column number of intervening opportunities. Some sites like Prospect, Hogback, Haystack, and Mt. Snow have a good relative location since there are very few intervening opportunities between themselves and a majority of sampled skiers. This is because of a biassed distribution of origins. The best location is Prospect which is a nearest choice for 76 percent of all skiers. Other sites have very poor relative locations because there are many intervening opportunities between themselves and a majority of skiers. For example, Burke, Stowe, Jay, and Smuggler's Notch have 20 or more intervening opportunities for more than 80 percent of the sample.

It is possible to identify the general type of choice rule that is shaping skiers' choices by examining those choices in this more abstract spatial framwork. This can be accomplished by comparing the pattern of actual choice behavior in relation to intervening opportunities with one we would expect each of the choice rules to produce.

If skiers are choosing sites at random, a random pattern of choice would be expected to emerge. The matrix presented in Table 2.3 shows the number of choices of the 24 ski sites when the sites had different numbers of intervening opportunities. More interaction takes place with southern ski sites. Also there is more interaction with larger sites. This distribution of choices certainly suggests a trend more closely associated with rational decision making than random choice. The matrix also reflects the fact that skiers' choices are not confined to a small

Table 2.3

The Number of Skier Choices of the 24 Ski Sites
Over Differing Numbers of Intervening Opportunities

	Number of Intervening Opportunities								
	0	1	2	3	4	5-9	10-14	15-20	21-23
Bolton	21	2	8	3	2	2	0	31	1
Bromley	11	1	5	0	1	115	1	2	0
Burke	15	0	0	0	0	2	1	1	9
Carinthia	1	0	0	44	1	0	0	1	0
Glen Ellen	3	9	3	0	14	14	1	68	0
Haystack	0	103	4	0	1	0	0	1	2
Hogback	0	3	5	0	0	13	0	0	1
Jay	48	1	1	0	0	0	0	0	1
Killington	6	11	0	1	1	14	430	0	0
Mad River Glen	0	17	3	1	1	1	1	22	0
Magic	5	1	0	1	0	62	0	1	0
Maple Valley	4	0	0	2	5	3	0	0	1
Mount Snow	3	0	50	12	80	27	1	2	0
Mt. Tom	8	3	0	1	0	1	16	0	0
Okemo	0	0	0	0	0	2	1	115	0
Pico	31	4	0	0	5	268	5	0	0
Pinnacle	7	2	0	1	0	0	6	0	0
Prospect	13	0	0	0	0	0	0	0	0
Smuggler's Notch	12	58	3	1	3	4	1	0	24
Sonneberg	3	0	0	0	0	0	4	0	0
Stowe	13	2	9	18	4	9	0	1	31
Stratton	7	1	6	2	37	94	1	12	0
Sugarbush	8	2	4	5	0	12	4	133	0
Suicide Six	2	7	1	0	3	1	27	0	0

Table 2.4

The Percentage of Skiers at Each Site Choosing the Site Over Differing Numbers of Intervening Opportunities

	Number of Intervening Opportunities								
	0	1	2	3	4	5-9	10-14	15-20	21-23
Bolton	30.00	2.86	11.43	4.29	2.86	2.86	0.0	44.29	1.43
Bromley	8.09	0.74	3.68	0.0	0.74	84.56	0.74	1.47	0.0
Burke	53.57	0.0	0.0	0.0	0.0	7.14	3.57	3.57	32.14
Carinthia	2.13	0.0	0.0	93.62	2.13	0.0	0.0	2.13	0.0
Glen Ellen	2.68	8.04	2.68	0.0	12.50	12.50	0.89	60.71	0.0
Haystack	0.0	92.79	3.60	0.0	0.90	0.0	0.0	0.90	1.80
Hogback	0.0	13.64	22.73	0.0	0.0	59.09	0.0	0.0	4.55
Jay	94.12	1.96	1.96	0.0	0.0	0.0	0.0	0.0	1.96
Killington	1.30	2.38	0.0	0.22	0.22	3.02	92.87	0.0	0.0
Mad River Glen	0.0	16.04	2.83	0.94	0.94	0.94	0.94	77.36	0.0
Magic	7.14	1.43	0.0	1.43	0.0	88.57	0.0	1.43	0.0
Maple Valley	26.67	0.0	0.0	13.33	33.33	20.00	0.0	0.0	6.67
Mount Snow	1.71	0.0	28.57	6.86	45.71	15.43	0.57	1.14	0.0
Mt. Tom	25.81	9.68	0.0	3.23	0.0	3.23	58.06	0.0	0.0
Okemo	0.0	0.0	0.0	0.0	0.0	1.69	0.85	97.46	0.0
Pico	9.90	1.28	0.0	0.0	1.60	65.62	1.60	0.0	0.0
Pinnacle	43.75	12.50	0.0	6.25	0.0	0.0	37.50	0.0	0.0
Prospect	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smuggler's Notch	10.71	51.79	8.04	0.89	2.68	3.57	0.79	0.0	21.43
Sonneberg	42.86	0.0	0.0	0.0	0.0	0.0	57.14	0.0	0.0
Stowe	12.15	1.87	8.41	16.82	3.74	8.41	0.0	0.93	47.66
Stratton	4.37	0.62	3.75	1.25	23.12	58.75	0.62	7.50	0.0
Sugarbush	4.76	1.19	2.38	2.98	0.0	7.14	2.38	79.17	0.0
Suicide Six	4.88	17.07	2.44	0.0	7.32	2.44	65.85	0.0	0.0

set of sites, which would presumably be the case if skiers were simplying choosing the most attractive sites.

If all skiers were simply minimizing distance in their choices we would expect that, of all skiers choosing a particular site, most would be choosing it as a nearest or relatively near opportunity. Table 2.4 expresses the matrix presented in Table 2.3 in percentages. It is clear from this matrix that choices are not confined to nearest or even relatively near opportunities. For example, sites like Stowe are chosen primarily as very distance opportunities. Other sites like Pico, Okemo, and Killington are chosen as moderately distance opportunities. In fact, only a few sites like Jay and Prospect are chosen as primarily nearest opportunities and this is only in relation to Vermont resorts. For out-of-state skiers, these resorts are certainly not nearest choices but only appear as such since the comparison is made only between these and other more distance Vermont resorts. Clearly the choice rule producing this behavior is not simply distance-minimizing.

The contention that skiers' choices are related to both attraction and distance seems to be supported by the choice patterns revealed in Table 2.4. Small ski areas like Prospect, Hogback and Carinthia are chosen primarily as close opportunities. Their attraction values are not sufficient to pull skiers past other opportunities to interact with them. However, the combination of low attraction but close location contains enough utility to draw people living nearby to interact. On the other hand, large sites like Killington, Stowe, Stratton, and Sugarbush are pulling more of their skiers past other sites. For these skiers the resort's poor access is offset by high site attraction. These general patterns of choice appear to be related to the trade-off choice rule and seem to support the contention that skier choices are the result of an evaluation of different combinations of attraction and distance.

The final point to be made in this section is that choice behavior seems to indicate that resorts have different amounts of attraction. The pattern of choices presented in Table 2.4 verifies the existence of site attraction since many resorts draw skiers past competing opportunities. In order for a resort to effectively pull a skier past an intervening opportunity it must offer some compensation for the additional travel effort incurred by the skier. This compensation is hypothesized to be additional site attraction.

The variability of site attraction at different sites can be examined from a slightly different perspective. It would be expected that a highly attractive site would draw most of the skiers for whom it was a nearest opportunity. That site would also be expected to draw some skiers for whom it was a second nearest site. In fact, it would seem that the most attractive sites would even draw some skiers for whom they were furthest sites. Conversely, sites with low attraction would be unable to draw many skiers past other opportunities. Some of these less attractive sites might not even be able to draw a majority of people for whom they are nearest sites. In general, this ability to draw skiers past intervening opportunities is certainly related to the site's attraction relative to other sites' attractions.

The matrix presented in Table 2.5 shows the proportion of all skiers each ski site could draw when competing with successively more intervening opportunities. The cells in the matrix are derived by simply dividing the number of skiers having the opportunity to choose a site at a given position in the opportunity space by the number of skiers who chose the site at that position. Some resorts such as Prospect failed to attract substantial percentages of skiers at any position, even as a nearest site. Others like Pinnacle were more effective at attracting local skiers but could not draw more distant skiers past other sites. Finally, some sites like Stowe, Killington, and Sugarbush not only attracted most skiers for whom they were a nearest site, but also a moderate proportion of skiers for whom they were a more distant opportunity.

The ability of a resort to effectively draw skiers past different amounts of intervening opportunities is graphically portrayed for three selected resorts: Carinthia, Stratton, and Sugarbush in Figure 2.3. Stratton is very effective at drawing most of the skiers for whom it is a nearest site, while Sugarbush can only draw about 25 percent and Carinthia a little more than 6 percent. Carinthia's drawing power is very low, while Stratton and Sugarbush pull roughly similar amounts of skiers past similar amounts of intervening opportunities.

The shape of these graphs is related to two factors. First, the shape is related to the attraction of a site. Those sites with lower amounts of attraction will be unable to draw large or even moderate amounts of skiers past intervening opportunities, whereas sites with greater attraction will. Secondly, the shape of the graph for any site is clearly related to

Table 2.5

The Percentage of All Skiers Each Ski Site Could Attract When Competing With Successively More Intervening Opportunities

Number of Intervening Opportunities

	0	1	2	3	4	5-9	10-14	15-20	21-23
Bolton	19.27	7.69	15.69	2.70	3.77	6.06	0.0	1.49	16.67
Bromley	55.00	5.56	7.58	0.0	50.00	5.81	3.03	0.54	0.0
Burke	75.00	0.0	0.0	0.0	0.0	1.30	0.54	3.13	0.43
Carinthia	6.67	0.0	0.0	2.42	1.82	0.0	0.0	0.25	0.0
Glen Ellen	13.04	20.93	21.43	0.0	13.21	5.81	0.96	3.47	0.0
Haystack	0.0	5.44	16.67	0.0	7.14	0.0	0.0	1.30	0.50
Hogback	0.0	11.11	10.40	0.0	0.0	1.98	0.0	0.0	0.24
Jay	44.44	11.11	50.00	0.0	0.0	0.0	0.0	0.0	0.05
Killington	60.00	18.97	0.0	4.00	10.00	10.85	19.08	0.0	0.0
Mad River Glen	0.0	20.48	4.27	1.56	0.89	1.75	0.39	4.14	0.0
Magic	18.52	12.50	0.0	16.67	0.0	3.08	0.0	0.27	0.0
Maple Valley	25.00	0.0	0.0	7.14	1.95	0.18	0.0	0.0	0.28
Mount Snow	60.00	0.0	8.40	11.65	7.88	9.31	1.35	0.49	0.0
Mt Tom	47.06	25.00	0.0	6.67	0.0	2.00	0.78	0.0	0.0
Okemo	0.0	0.0	0.0	0.0	0.0	0.66	1.62	5.72	0.0
Pico	56.36	28.57	0.0	0.0	23.81	12.88	1.61	0.0	0.0
Pinnacle	87.50	28.57	0.0	5.56	0.0	0.0	0.30	0.0	0.0
Prospect	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smuggler's Notch	54.55	36.25	15.79	4.35	7.69	5.19	3.70	0.0	1.16
Sonneberg	27.27	0.0	0.0	0.0	0.0	0.0	0.18	0.0	0.0
Stowe	86.67	8.33	6.21	19.78	21.05	11.39	0.0	9.09	2.46
Stratton	77.78	5.00	30.00	7.41	8.04	6.80	4.76	3.01	0.0
Sugarbush	25.81	9.52	30.77	9.62	0.0	3.47	6.25	6.78	0.0
Suicide Six	33.33	33.33	16.67	0.0	5.08	2.63	1.16	0.0	0.0

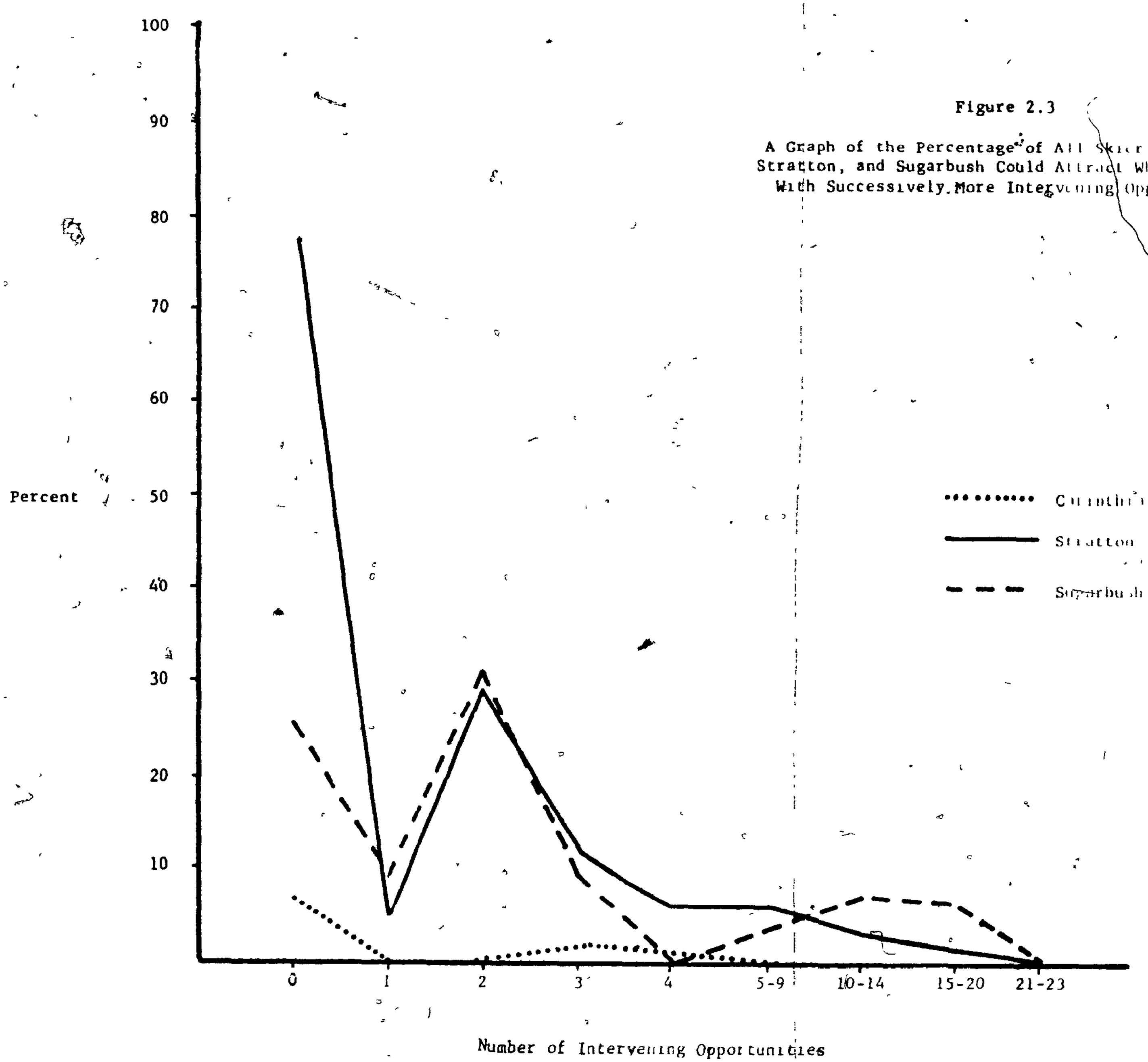


Figure 2.3

A Graph of the Percentage of All Skiers Corinthia, Stratton, and Sugarbush Could Attract When Competing With Successively More Intervening Opportunities its attraction relative to the attraction of surrounding sites. For example, the reason why Carinthia may have draw only 6 percent of those skiers for whom it was a nearest site is because a more attractive site, such as Mt. Snow, was located very close to Carinthia. These other ski sites would have the same approximate distance relationship as Carinthia for most skiers but a higher attraction value and, therefore, greater utility. This site would tend to pull most skiers past Carinthia. This same effect of alternative opportunities would influence the shape of similar graphs for each site to a greater or lesser extent. From this information it appears that site attraction does exist, that it has some effect on skier choices and that it varies from site to site.

It might seem that the data provided in the various intervening opportunities matrices presented in this section could be used for deriving measures of site attraction. For example, a site drawing skiers past two sites could be inferred more attractive than a site drawing skiers past one site. This approach, commonly referred to as the intervening opportunities method, has been widely used by geographers and sociologists (Stouffer, 1940; Bright and Thomas, 1941; Strodtbeck, 1949; Anderson, 1955; Galle and Taeuber, 1966). However, the method assumes that all intervening opportunities have the same effect on the interaction between two places, irrespective of those opportunities' site characteristics and, hence, amounts of attraction. This assumption directly contradicts the fundamental contention of this study that spatial opportunities which have different amounts of important site characteristics will have differing amounts of attraction which will cause correspondingly different choice responses. Also, the method fails

Figure 2.4

Hypothetical Spatial Choice Situation

to identify available yet rejected alternatives. This fairly serious shortcoming can be illustrated by the situation shown in Figure 2.4 where a skier at origin 1 chooses site C and a skier at 2 chooses site D. Using the intervening opportunities method, site C would be more attractive than site D because it could pull skiers past two intervening opportunities, whereas D could only pull skiers past one site. However, the fact that C is an implicitly rejected intervening opportunity for the skier choosing D goes unnoticed, even though this would suggest that D is more attractive than C. For these reasons, a method must be used to derive site attraction measures which takes account of variation in the effect of alternatives on choice behavior and identifies available yet rejected alternatives.

Chapter 3 REVIEW OF LITERATURE

Many researchers have suggested that their initial interest in studying site attraction was related to the observation that the effect of distance between spatial opportunities and user populations was simply not sufficient to explain variation in the usage of or interaction with those opportunities. They theorized that the residual variation had to be related to qualities of the site itself and its ability to draw or attract users. In their work to investigate the effect of site attraction on spatial interaction they have developed a number of method to obtain measures of site attraction. The purpose of this chapter is to review these methods.

Most attraction studies can be divided into two general categories. The first category can be called the "site-variable" approach; the second can be called the "behavioral" approach. Both of these general methods approach the problem of deriving measures of site attraction from entirely different directions. This difference in approach is discussed in the following sections.

The Site Variable Approach

In Chapter 1 site attraction was theorized to be related to the quality and quantity of certain important characteristics at each site. This relationship was presented very generally in (1.3) as,

$$A_j = (V_{1j}, V_{2j}, \ldots, V_{nj}) \quad (1.3)$$

The function in (1.3) specifies how site variables are related to a site's attraction. This combination of variables remains the same for different sites; the only component that changes from site to site is the amount of any given variable.

Using the site variable approach the researcher attempts to <u>define</u> the attraction of a site. He does this by constructing a model reflecting the relationship of site variables to site attraction suggested in (1.3). This construction usually involves these distinct steps. First, the researcher defines the specific function or equation which relates the V_{kj}s of (1.3) to the A_j. Second, he identifies and weights those site variables hypothesized to determine attraction. Thirdly, he then uses data on the identified variables at different sites to derive a measure of each site's attraction.

This approach has been used in a variety of situations. It has been used to define the attraction of city playgrounds (Mitchell, 1967), of parks (Ellis, 1967; Cheung, 1972; Auger, 1974; and Cesario [as reported in Cheung, 1974]), and ski resorts (Ellis and Ker, 1971). In each of these applications the attempt to define attraction differs either in the degree of sophistication of the attraction model or the methods used to identify, weight and measure site variables. At the same time all of these applications share some common characteristics. They all relate site attraction measures to certain site variables by way of an attraction function (as in 1.3). The precise nature of this attraction function is usually determined by the researcher with little apparent behavioral support in most cases. Also, each study has attempted to identify, weight, and measure relevant site variables. This is usually done by the researcher using an arbitarary *ad hoc* procedure also with little apparent behavioral support. These elements characterize the site variable approach.

Each of these applications has some methodological shortcomings. Many of these are discussed by Ross (see Ross, 1973, pp. 12ff). However, three criticisms can be made of the general site variable approach as a method of determining site attraction. First, there is a general problem with the way in which the attraction function must be defined. The final attraction measures are heavily dependent on the relationships which the researcher defines between site variables and attraction at this step. Yet the true nature of this function is unknown and, as Ross has pointed out, (Ross, 1973, p.15) the researcher doesn't have any information regarding its nature. In short, the site variable approach presumes a researcher's accurate assessment of how factors are combined in site attraction.

Second, there is a problem with the way that variables are identified and weighted. Normally the researcher uses some *ad hoc* procedure for identifying and weighting variables - he prescribes which variables determine attraction rather than allowing empirical evidence to indicate these. This is the case with Mitchell's playground study, Ellis' park study, and to a certain extent Ellis and Ker's ski resort study. The major criticism of this approach is that it is based on the premise that an external judge, such as a researcher, can accurately assess which variables affect site attraction and to what extent they affect it. It is the contention of this study that the use of such arbitrary methods, without any strong behavioral support, is highly suspect.

Not all applications have used such arbitrary procedures. In Cheung's park study and Ellis and Ker's ski resort study an attempt is made to incorporate behavioral evidence of variable importance into the attraction measures. Yet both of these attempts have some serious problems associated with them. For example, Cheung uses park-user participation rates to derive "behaviorally supported" measures of the popularity of different activities offered at parks and the importance of facilities at each park. The derivation of these two ratings has however, been criticized by Ross for being unadjusted for potential bias caused by differing opportunities to participate in activities for the participation rating, and differing opportunities to use various park facilities for importance ratings (Ross, 1973, pp. 13-14). Ellis and Ker's study attempts to incorporate "behaviorally supported" measures of the importance of ski site variables into an attraction index at each site. They do this by taking the average importance rating for 43 ski site variables scored by skiers they interviewed. The accuracy of introspective judgements of this nature has been investigated in one study (Green, Maheshwari, Rao, 1969b) and found to be somewhat questionable. In a study of consumer preferences for automobiles, Green et al. found that the correlation between individuals' preference rankings for automobile and a constructed preference ranking using the same individuals' stated importance ratings of automobile attributes to be relatively low. In general the kinds of cars preferred in one case were entirely different than those in the other case. (Green, Maheshwari, Rao, 1969b, p.352). In short, an individual's introspective judgement as to what determine his choices may not accurately reflect the actual determinant. Such a conclusion obviously casts doubt on Ellis and Ker's final attraction measures.

The final criticism of the site variable approach is that there is no way to assess the overall application of the method in the study; there is no way to assess the accuracy of various procedures for identifying, weighting, and measuring site variables; and there is no way to assess the structural accuracy of various attraction functions. This inability to assess results is due to the fact that, using this approach, the derived attraction values are dependent on structural specifications and identification and weighting procedures. Imagine, for example, a particular attraction formulation is suspected of having specification error (i.e. that the function as in (1.3) is an inaccurate reflection of what determines attraction in reality). Changing the function to a more justificable form will presumably cause changes in the attraction values. However, there is no certainity that the new measures are more accurate than the previous set since no standard for comparison is available.

A severe shortcoming of the site variable approach is related to the previous point. The method does not allow the researcher any latitude in experimenting with various forms of an attraction function or procedures for identifying, weighting, and measuring site variables. This is because the A_js on the left side of the equation (1.3) are dependent on the function and the V_{kj}s on the right side. Hence, experimentation with the form of the right side will probably cause changes in the left side which cannot be evaluated.

The Behavioral Approach

Behavioral methods approach the problem of determining site attraction from an entirely different direction. These methods derive site attraction measures from information on the spatial utility of sites for a user population.

The spatial utility of a site for an origin is related to the site's attraction and the distance separating the origin and the site. This relationship was presented very generally in (1.1) as

$$ {}_iU_j = f(A_j, D_{ij}) \tag{1.1} $$

When an individual chooses a particular site he can be interpreted as revealing that the combination of attraction and distance associated with that site has greater spatial utility at that instant than other available combinations at alternative sites. The behavioral method examines these spatial choices and attempts to extract information about site attraction. From this "extracted information" the method derives attraction measures. The method is termed "behavioral" since the indices are derived from an analysis of choice behavior rather than an analysis of site characteristics.

The major methodological problem facing the researcher using this approach is how to separate out from information on a site's spatial utility, that portion related to distance and that portion related to site attraction. If this separation can be successfully accomplished, the researcher can then concentrate on and analyze the information on site attraction that the choice behavior has revealed. The result of an analysis would be measures of revealed site attraction.

Two methods have been devised for solving this problem. Unlike the site variable approach, these two methods have very little in common, except that their measures are the result of a behavioral analysis.

One approach to deriving attraction measures from spatial choices has been developed by Cesario (Cesario, 1973a; 1973b). His general treatment of the distance problem is to artificially remove the effect of distance on people's choice behavior. He accomplishes this through covariance analysis.

In a study of park visitation rates, Cesario hypothesizes that the total number of visits made from any origin to any destination is a function of three variables respectively related to the characteristics of the origin, the characteristics of the destination, and the cost related to travelling from the origin to the destination. Specifically, his generalized trip distribution model is,

$$V_{ij} = k\, E_i\, A_j\, f(C_{ij})\, e_{ij} \tag{3.1}$$

where, V_{ij} = the number of trips made from origin i to destination j;

k = a scaling parameter;

E_i = the "emissiveness" of origin i;

A_j = the "attraction" of destination j;

$f(C_{ij})$ = the cost related to travelling from i to j; and

e_{ij} = an error term.

A trip distribution matrix is constructed from the spatial interaction data. Any cell in this matrix shows the number of trips made from the row origin to the column destination. The analysis of covariance solves for the parameters k, E_i, A_j, and the function of C_{ij} (C_{ij} is taken as the distance between i and j).

The analysis holds distance constant in the following way. The total variation in V_{ij} can be attributed to variations in origin emissivity (E_i), destination attraction (A_j), distance (C_{ij}), and a small amount of error, e_{ij}. The amount of variation in V_{ij} which can be attributed to distance is removed from the total variation through a regression of V_{ij} on C_{ij}. Having neutralized the effect of distance, variation in the trip distribution matrix can then be related to site attraction and origin emissivity. Finally, an analysis of variance partitions the residual variation of the regression to origin and destination effects. The result is a column vector of E_i's, which is argued to be estimates of the emissivity effect of origins, and a row vector of A_j's, estimates of the attraction of the destinations. These estimates are used as the final measures. In addition, the parameter of the distance decay function is also defined from the regression.

Cesario's approach can be thought of as an aggregate approach to the analysis of behavior. The reason is that the actual process of aggregating individuals' choices occurs before the analysis begins; when constructing the trip distribution matrix. This analysis of aggregate patterns of preference can be contrasted to an approach developed by Ross (Ross, 1973). In Ross' approach, aggregation occurs during the analysis rather than before. For this reason, a distinction can be made between the aggregate-behavioral approach of Cesario and the individual-behavioral approach of Ross.

In an analysis of park attraction Ross devises a method of deriving an ordinal scale of park site attraction. Ross uses revealed preferences to derive his attraction indices. His treatment of the distance problem is slightly different than that of Cesario. Instead of attempting to hold the effect of distance constant, he uses its presumed effect on interaction to deduce the comparison of park attraction values by individuals.

When someone chooses one destination and not another, an implicit comparison is made between two sites which enable a researcher to deduce the relative utility of each site. For example, if one site (A_1, D_1) having the properties A_1 and D_1 is chosen over another site (A_2, D_2), then the first must have a higher utility. This relationship can be symbolized as,

$$U(A_1, D_1) > U(A_2, D_2)$$

where, > is read "is greater than".

It is an assumption of Ross' method that actual spatial choice is a result of comparing the utility of different sites. If we assume that distance reduces utility, it is possible to infer that, if the more distant of a pair of sites is chosen and therefore has greater utility, it must be sufficiently more attractive to compensate from the added distance travelled. Thus,

$$\text{When } U(A_1, D_1) > U(A_2, D_2) \text{ and } D_1 > D_2 \qquad (3.2)$$

$$\text{Implies that } A_1 > A_2 \qquad (3.3)$$

Every time an individual's choice reveals the situation occurring in (3.2) the inference in (3.3) can be made. By examining many people having the situation outlined above, inferences about relative attraction can be made. This inferential technique is the heart of Ross' method.

Every time an inference of the type outlined in (3.3) can be made, Ross increments the (i, j)th cell of a comparison matrix by the value one. Hence, each cell in the comparison matrix reflects the number of times the row site was inferred more attractive than the column site. Once all individuals' choices have been examined and all appropriate inferences have been made, the comparison matrix is converted to a proportions matrix by the following formula,

$$P_{ij} = \frac{C_{ij}}{C_{ij} + C_{ji}} \tag{3.4}$$

where, P_{ij} = the proportion of times site i is inferred more attractive than site j;

C_{ij} = the number of times site i is inferred more attractive than site j;

C_{ji} = the number of times site j is inferred more attractive than site i.

The final step is to obtain measures of attraction for each site. Ross does this by scaling the proportions matrix. Specifically, an Index of Attraction is derived for each site by the formula,

$$A_i = \frac{\sum_{j=1}^{n} e_{ij} P_{ij}}{\sum_{j=1}^{n} e_{ij}} \tag{3.5}$$

where, A_i = the attraction index of site i;

P_{ij} = the proportion of times site i is inferred more attractive than site j;

$e_{ij} = 1$ if $P_{ij} \neq -1.0$ (missing data),

0 otherwise.

The final scale of attraction values derived by Ross are of an ordinal nature as opposed to those Cesario obtains which have interval properties. However, this is not a necessary consequence of Rosses method.

The relative strength of the behavioral approach can be best evaluated in relation to three points. First, most applications of this approach seem to have been relatively successful. Even though certain criticisms have been raised about both Cesario's application (Ross, 1973; Cesario, introduction, 1973; Beaman, 1974a) and Rosses application (Cheung, 1974), the criticism has been directed at initial formulations. Subsequent revision of Rosses formulation appears to have alleviated the major spatial bias problem (for discussion of this problem see Ross, 1973; for an application using the revised method see Brooks, 1974). Beaman has expanded Cesario's initial formulation to include an alternative factor, another variable affecting interaction. This addition has solved the major problem for which the initial formulation was criticized.

A second strength of the behavioral method is that the derived indices are far less susceptible to researcher bias than those produced using the site variable approach. This is because the attraction measures are obtained through an analytical solution rather than by an arbitrary definition. In short, the measures reflect a sites' actual ability to draw people rather than a researcher's impression of what site characteristics draw people.

A third strength of the method is that the attraction values are derived independently of any particular specification of an attraction function. For example, the attraction values on the left side of (1.3) are not dependent on the function and V_{jk}s of the right side. Further analysis determines the precise nature of these components. This independence allows the researcher considerable latitude in experimenting with the accuracy of various forms of an attraction function and different methods for defining the V_{jk}s. This is certainly a desirable property in a study examining the nature of site attraction.

For these reasons this study has chosen to use the behavioral approach in an analysis of site attraction rather than the site variable approach. Furthermore this study has chosen to use the method developed by Ross for two reasons. First, the Ross method begins by examining individuals' choices and then aggregates these during analysis. This technique of beginning at the individual level and moving to aggregation in analysis has been adopted in Chapter 1 as the general working method of this study. Hence, the Ross method is more consistent with the intended direction and design of the study than the Cesario approach. Secondly, recall Cesario's general trip distribution model presented in (3.1)

$$V_{ij} = k\, E_i\, A_j\, f(C_{ij})\, e_{ij} \qquad (3.1)$$

The trip distribution function is multiplicative and non-linear in form. In order to use covariance analysis, the model must be converted into an additive, linear function. Hence, Cesario rewrites (3.1) in a logarithmic form as,

$$\log V_{ij} = \log k + \log E_i + \log A_j + \beta \log C_{ij} + e_{ij} \qquad (3.6)$$

The logarithm of zero is undefined so that any cells in the trip distribution matrix which have zero entries would have to have a constant, such as 1, added to them. However, the trip distribution matrix of skier interaction which forms the basis of the site attraction analysis in this study has zero in 61 percent of its entries. Furthermore, a substantial amount of the remaining entries have a value of one. Because of this large amount of missing data and small numbers in the remaining cells of the trip distribution matrix, Cesario's approach could not be used.

Chapter 4 RESEARCH DESIGN

The purpose of this chapter is to outline the methodology to be used in this study. The first section deals with the derivation of ordinal and interval attraction scales. The second section will deal with the explanation of those scales.

Sources of Information for Deriving Attraction Scales

As previously discussed, a skier's choice can be thought to result from a comparison of the relative utility offered by different ski sites. His choice is assumed to be that ski site having the highest utility. In Figure 4.1, a skier at origin i chooses to ski at site 3. From this revealed preference for site 3, the following information can be deduced. First, the utility of site 3 must be greater than the utilities of the other sites. Hence,

$$U_3 > U_2 \; ; \; U_3 > U_1 \; ; \; U_3 > U_4$$

No inference can be made about the relative utilities of sites 1, 2, and 4, except as they relate to the site chosen. Secondly, using the inferential technique of Ross (as in 3.2 and 3.3) it is possible to infer that the attraction of site 3 is greater than the attraction of closer sites, namely sites 1 and 2. So,

$$A_3 > A_2 \; ; \; A_3 > A_1 \qquad (4.1)$$

Figure 4.1

Hypothetical Spatial Choice Situation

Origin	Ski Sites			
1	1	2	3	4

As above, no inference can be made about the relationship of sites 1 and 2, except as they relate to the attraction of site 3.

For every choice there will be n inferences of the form in (4.1), where n is the number of sites located closer to the skier's origin than the site chosen. Therefore, revealed preferences are one source of information about a site's attraction.

A second source of information on the attraction values of a site is a skier's stated preference for the site relative to other sites. If a skier were asked to rank ski sites in the order of his preference for them, he can be thought to rank the sites according to their spatial utility values. However, no direct inference can be made about the relative attraction of the sites from a ranking of their spatial utility values, since the relative distance to each is involved in computing these values. In a stated preference the influence of distance on judgement may be very strong or very weak, but in any case, it is hard to assess.

One way to resolve this problem is to hold distance constant for all skiers. This would be the case, for example, if each skier was located at the same distance from all ski sites. Then D_{ij} in 1.2 would effectively be a constant for each skier. If the skier were to state that, under these circumstances, he preferred site j to site k, then,

$$_iU(A_j D_{ij}) > {}_iU(A_k D_{ik})$$

But because,

$$D_{ij} = D_{ik}$$

the comparison of utility values would be a direct comparison of attraction values. So, the inference that

$$A_j > A_k \tag{4.2}$$

could be made. Thus, in a situation where a skier is equidistant from all opportunities, his preference ranking of sites is, essentially, a ranking of the sites' attraction scores.

As a source of attraction information, stated and revealed preferences have both strengths and weaknesses. For example, many more pair comparisons of attraction values (such as those in 4.2) can be constructed from a skier's ranking of, say, 5 sites than from his revealed preference for one of those 5 sites. Specifically, (n(n - 1)/2) pair comparisons can be constructed from a ranking of n sites whereas only (n - 1) pair comparisons can be constructed from a revealed preference for 1 of n sites. On the other hand, revealed preferences are probably a much more accurate source of information about attraction than are skiers' introspective judgements (this point was discussed in Chapter 3 concerning the Ellis and Ker study). Finally, while a stated preference may be slightly less accurate than a revealed preference, the researcher does not have to assume that the skier has perfect knowledge of all intervening opportunities between his home and the ski site he chooses. This assumption is made in using the Ross method.

This study derives scales of attraction from both stated and revealed preference information. The scale of attraction derived from revealed preference information will hereafter be referred to as a revealed attraction scale; the scale derived from skiers' stated preference rankings will be referred to as a stated attraction scale. A comparison will be made of these two scales.

Derivation of Ordinal Attraction Scales

The first step in calculating attraction values for each site is to derive ordinal attraction values for each site. This will be done for both revealed and stated preferences. It is necessary to use slightly different methods for each information source.

Revealed Attraction

The Ross method, described in Chapter 3, will be used to construct an ordinal scale of site attraction from revealed preference data. This data has been discussed in Chapter 2. Two modifications will be made to the Ross method. The first deals with the conditions under which cells in the comparison matrix are incremented; the second deals with the construction of the proportions matrix.

The (ij)th cell in the comparison matrix is incremented every time a skier goes further to site i than the available alternative site j. There may be situations where sites i and j are so closely located that a skier travelling a long distance would regard their locations as the same. He would not be able to discriminate between the small differences in their distances from him. If he were to choose the more distant of the two it can not be inferred that this decision is related to the attraction of the more distant site, an inference which might be correct for other sites situated much closer to the skier's home. The largest difference in the distance between two resorts which skiers consistently fail to discriminate is referred to as a "just noticable difference" (JND) of distance. Resorts which are separated by less than one JND appear to have the same "spatial relation" to a skier's origin, whereas, resorts which are separated by an amount greater than one JND appear to have different "spatial relations"; namely, that one resort is noticably closer than the other. Any inference about the attraction values of two sites can occur only if the latter situation exists. The JND value is normally expressed as a proportion of the total distance travelled by the skier. In this study the JND is given a value of 10 percent, based on parallel evidence from psychophysics. Thus, a part of Ross' inferential technique can be rewritten as,

$$\text{When } U(A_1, D_1) > U(A_2, D_2) \text{ and } D_1(0.9) > D_2$$

$$\text{Implies that } A_1 > A_2$$

A second modification is made of the formula by which the comparison matrix is converted to a proportions matrix. Ross has pointed out that there are certain spatial arrangements of individuals and sites which will bias the derived attraction scales. Rushton (Ross, 1973, p. 118) has suggested that the method can be made less sensitive to this spatial bias by rewriting (3.4) as:

$$P_{ij} = \frac{\dfrac{C_{ij}}{N_{ij}}}{\dfrac{C_{ij}}{N_{ij}} + \dfrac{C_{ji}}{N_{ji}}} \tag{4.3}$$

where, N_{ij} = the number of individuals for whom i is a more distant opportunity than j; all other symbols are as in (3.4).

What this modification does is to incorporate into each comparison of two sites the number of individuals in a position to show i as more attractive than j and of other individuals in a position to show j as more attractive than i.

Having incorporated these two modifications into the Ross method, attraction scores are calculated for each site using the formula (3.5).

Finally, it is of interest to determine the degree to which the derived scale of revealed attraction accurately expresses the data on which it is based. Ross does this by calculating the Coefficient of Agreement, eta.

$$\text{eta} = 100 \left[\frac{\sum_{i=1}^{n} \sum_{j=i+1}^{n} C'_{ij}\, e_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij}\, e_{ij}} \right] \tag{4.4}$$

where, C'_{ij} = the ijth element of the comparison matrix which has been rearranged to conform with the attraction scale defined from (3.9);

C_{ij} = the number of times site i is inferred more attractive than site j;

e_{ij} = 1 if $P_{ij} \neq -1.0$ (missing data)

0 otherwise.

Eta is the ratio of correct inferences to total inferences. It is computed by counting the originally inferred comparisons (C_{ij}) for which the inference is consistent with the final scale.

Stated Attraction

The derivation of an ordinal attraction scale from the stated preferences of skiers is very similar to that for revealed preferences. This study will use an algorithm developed by Ewing (Ewing, 1971) called Pair Comparison Preference Analysis (PCPA). Various aspects of this algorithm related to the construction of matrices and the derivation of ordinal attraction scales are very similar to Ross' method. The major difference is that PCPA is designed to derive attraction measures from individuals' rankings of sites, whereas Ross' algorithm is designed to derive these measures from individuals' spatial choices. Hence PCPA is a more expedient method for analyzing the stated attraction data.

The first step in deriving an ordinal stated attraction scale is to decompose skiers' preference rankings into $(n(n - 1)/2)$ paired comparisons. Each compares the attraction of any two sites. The (ij)th cell of a comparison matrix is incremented by one each time the pair comparison

$$A_i > A_j$$

appears.

After all rankings have been examined and all inferences made, a proportions matrix is constructed using the formula outlined in (3.9). No adjustment for spatial bias is necessary since each skier has been asked to "filter out" the effect of distance on his preference judgement.

Finally, an attraction measure is derived for each site. This is accomplished by deriving a scale which is consistent with data in the proportions matrix. Each row of the proportions matrix is summed and then divided by the number of valid entries in the row. The ski sites are then arranged in ordinal positions according to their relative values obtained in this scaling procedure. Therefore, an ordinal attraction index of stated site attraction can be defined as:

$$A_i = \frac{\sum_{j=1}^{n} P_{ij}\, e_{ij}}{\sum_{j=1}^{n} e_{ij}} \qquad (4.5)$$

where, P_{ij} = the proportions of times site i is inferred more attractive than site j;

e_{ij} = 1 for all P_{ij}s $\neq$ −9.9, when −9.9 indicates no comparison between site i and site j.

· 0 otherwise.

Derivation of Interval Attraction Scales

An attraction scale having interval properties can be constructed by employing an alternative approach to scaling both of the proportions matrices constructed above. This general technique is known as multidimensional scaling. For a more comprehensive review of these techniques and various applications the reader is referred to Shepard, Romney and Nerlove (Shepard, Romney, Nerlove, 1972), Golledge and Rushton (Golledge and Rushton, 1972), Green and Rao (Green and Rao, 1972), and Green and Carmone (Green and Carmone, 1970).

Consider the properties of each P_{ij} in the proportions matrix. A high P_{ij} score indicates that for most skiers site i was more attractive than site j. Conversely, a low P_{ij} score reflects that for most skiers site j was more attractive than site i. As P_{ij} values approach .5 there is more disagreement over which of the two sites is more attractive, suggesting that the attraction values are becoming more similar. A proportion of .5 can be regarded as the maximum similarity between two sites' attractions. By subtracting .5 from any cell in the proportions matrix, a measure of dissimilarity in the attraction of two sites can be obtained. Hence, a dissimilarities matrix can be constructed using the formula:

$$D_{ij} = \left| P_{ij} - .5 \right| \qquad (4.6)$$

Each cell in this matrix would represent a measure of the dissimilarity between a row and column site. As D_{ij} approaches 0.0, the two sites can be thought of as being closely located on a one dimensional scale of attraction. As D_{ij} approaches .5, the resorts are farther apart on the one dimensional scale. Multidimensional scaling is designed to recover this scale from information provided by the dissimilarities matrix. It does this by deriving a one dimensional configuration of points, representing the ski sites, such that the distance between any two points on the derived scale is a function of their dissimilarity measure obtained in (4.6).

The multidimensional scaling algorithm used in this study is SSA-1, contained in the program MINISSA, developed by Guttman, Lingoes and Roskam (Roskam and Lingoes, 1970). The basic input for the algorithm is the dissimilarities matrix constructed from (4.6). The procedure seeks a configuration of points such that the interpoint distances between the points are a monotonic function of their dissimilarity measures. The method obtains a configuration having the fewest number of dimensions while still maintaining the highest degree of monotonicity between interpoint distances and dissimilarity measures. The researcher can confine the solution to as many or as few dimensions as he wishes. Normally, as dimensionality decreases the degree of violation of the original dissimilarities measures increases. Obviously, it is possible to represent n points in n - 1 dimensions without any violation of monotonicity.

Using MINISSA, an interval scale will be constructed for both the revealed attraction proportions matrix and the stated attraction proportions matrix. The solution will be confined to one dimension because the data in both matrices express a dominance relationship between pairs of row and column resorts and dominance judgements, by definition, occur on a unidimensional scale rather than in a multidimensional space. This unidimensional solution can be interpreted as representing an interval scale of site attraction.

The degree to which the derived interval scales accurately reflect the data on which they are based can be assessed by computing Kruskal's Stress Coefficient (Kruskal, 1964a; 1964b).

$$S1 = \left[\sum_{\substack{i,j=1 \\ i \neq j}}^{n} (d_{ij} - \hat{d}_{ij})^2 \Big/ \sum_{\substack{i,j=1 \\ i \neq j}}^{n} d_{ij}{}^2 \right]^{1/2} \tag{4.7}$$

where, $S1$ = Kruskal's Stress Coefficient;

d_{ij} = the interpoint distance between site i and site j in the configuration produced;

$\hat{d}_{ij}$ = a real number monotone with the original dissimilarity between site i and site j (from 4.6) such that $\hat{d}_{ij} > \hat{d}_{kl}$ whenever $\partial_{ij} > \partial_{kl}$; where ∂_{ij} is the original dissimilarity measure between site i and site j.

The stress coefficient is the normalized residual variance from a monotone regression of configuration interpoint distances and the original dissimilarities measures. Computing stress involves three steps. First, interpoint distances (d_{ij}) are systematically varied to compute a line of best fit between the distances and the original dissimilarities measures (∂_{ij}). Second, monotonic transformations of the distances ($\hat{d}_{ij}$) are computed such that $\hat{d}_{ij} \geq \hat{d}_{kl}$ when $\partial_{ij} > \partial_{kl}$. Finally, the differences between the distances and the monotonic transformations (disparities) are computed. Summing all such differences provides a measure of raw stress which, when normalized to accommodate uniform stretching and shrinking of the configuration, results in the formulation presented above.

Values of stress range between 0.0 and 1.0. Kruskal suggests the following evaluation of goodness-of-fit.

TABLE 4.1

Evaluation of Kruskal's Stress Coefficient

.2	Poor
.1	Fair
.05	Good
.025	Excellent
.0	Perfect

Explanation of the Attraction Scales

At the basis of the spatial decision-making process is a mental search conducted by each individual to identify the one spatial alternative from all those available which offers him the maximum amount of spatial utility. Since it is postulated that the attraction of a particular site is related to the in situ properties of the site, an analysis of site attraction is essentially an attempt to shed light on what these properties are.

In order to accomplish this it is necessary to first suggest candidate properties to be tested and second, to measure the occurrence of these candidate properties at each site. These steps of suggestion and measurement can be carried out by the researcher or the skier. Hence, there are four possible combinations of suggestion and measurement available:

1. The skier suggests and measures
2. The skier suggests and the researcher measures
3. The researcher suggests and measures
4. The researcher suggests and the skier measures.

The first combination is rejected for two reasons. Logistically, it was felt that an open-ended questionnaire necessary for suggestions would not be as successfully completed by sampled skiers as one with very definite questions. Also, there is a strong possibility that a skier might combine a number of variables into one factor and then score the factor. However, this factor might appear very infrequently because other skiers might combine different variables. The second combination was rejected on the conceptual argument that there is no reason why a researcher's ability and method of measuring site properties would have actual behavioral significance. The third combination was rejected on the same argument. The fourth combination was accepted on the basis that, with the aid of a preliminary questionnaire to determine important <u>in situ</u> variables, it provided the most viable logistical, methodological, and conceptually justifiable solution.

An initial survey was conducted among a small group of skiers. Each was asked to list the site variables he considered important in a decision of where to ski. There were eight responses in which eleven variables were cited with varying frequencies. Table 4.2 shows a list of these site characteristics and the frequency with which they were cited.

From this list crowding, verticle drop, distance, price, and number of slopes were selected to be included in a questionnaire to be administered at each ski site. Familiarity was added as a possible explanatory variable in situations where a skier had only attended one or two ski sites but was familiar with an additional five or six more. Consultation with some expert skiers led to two additional variables being added: quality of slopes and microclimate (a catch-all for the general climatic conditions associated with each resort). The final list, with clarifications where necessary, is presented in Table 4.3.

Table 4.2

A List of Candidate Site Characteristics

and the Frequency of Mention

Characteristic	Frequency Cited
Crowding	6
Vertical Drop	7
Snow Making Equipment	1
Distance	8
Tow Ticket Price	8
Number of Slopes	3
Size of Mountain	1
Orientation to Sun	1
Regional Climatic Conditions	1
Apres-Ski Activities	1
Size of Resort	2

Table 4.3

Final Site Characteristic List

Crowding

Tow Ticket Price

Variety of Slopes (number and kind)

Length of Runs

Accessibility (the time it takes you to travel from your home to the resort)

Familiarity

Quality of Slopes (for example, grooming, absence of ice, etc.)

Micro-Climate (for example, windiness on slopes, temperature, exposure)

Each skier surveyed was asked to indicate for those sites he was familiar with* each site's score on the above eight variables. This was done on a scale of one to a hundred where one signifies a small amount of the variable being scored and one hundred a large amount of the variable. The final score for each site on each of these variables is assumed to be an average of these individual scores, defined by

$$q_{kj} = \frac{\sum_{i=1}^{n} {}_i x_{kj}}{n} \tag{4.8}$$

where, q_{kj} = the score of variable k at site j;

${}_i x_{kj}$ = the ith person's scoring of variable k at site j;

n = the number of people scoring variable k at site j.

Hereafter, these scores will be referred to as perceptual scores.

A statistical explanation of the derived scales of revealed and stated attraction will be accomplished through standard step-

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* Familiarity is defined in this study as the union of two groups of resorts for each individual: those resorts where the individual has skied, and those that he has a "working knowledge" of.

wise multiple regression. The attraction function is assumed to have the form as indicated in (1.5). This has an additive linear form. The dependent variables will be taken as attraction scores for each site. Independent variables will be taken as the perceptual scores calculated according to (4.8). Through regression, variables will be identified on the basis of their ability to significantly reduce the amount of unexplained variance in the attraction scores. The method will also be used to calculate variable weights as defined by w_i in (1.5).

Data

From the above discussion two sets of data are necessary: one which relates to revealed and stated preferences of skiers for different ski sites, and data reflecting skiers' perceived scores of resorts on the eight site variables. The stated preference data and the perceptual scores were obtained during the 1973 skiing season in Vermont. Skiers' at 23 of the 28 sites were randomly asked to fill out a questionnaire securing this information. Table 4.4 shows the number of skiers sampled at each of the 23 resorts. These figures are indicative of the relative number of skiers at each of the sites. The remaining five sites were not surveyed for three reasons: sampling was not allowed; there was an inadequate sample base; or the weekend during which sampling was supposed to take place was not representative of the general skiing conditions during which the remainder of the data was collected. Methods for collecting revealed preference information were discussed in Chapter 2.

Table 4.4

The Number of Skiers Sampled at 21 Ski Sites

Site	Number of Skiers Interviewed
Bolton	25
Bromley	27
Burke	16
Carinthia	10
Glen Ellen	20
Haystack	16
Hogback	16
Jay	27
Killington	37
Mad River Glen	20
Magic	27
Maple Valley	13
Mount Snow	25
Okemo	32
Pico	21
Pinnacle	7
Prospect	10
Smuggler's Notch	28
Stowe	25
Stratton	25
Sugarbush (partial sample)	14
total	441

To ensure a representative sample, all data were collected on weekends, since a weekend skier was felt to be more representative of the general skiing public, and all data were collected under approximately the same skiing conditions.

Summary

This chapter has been designed to do two things:

1. Acquaint the reader with the various techniques which will be used to derive scales of site attraction, and explain those scales.
2. To describe the data collected.

The following chapters describe the analysis designed to tackle the problem outlined in Chapter 1.

Chapter 5 THE DERIVATION OF SITE ATTRACTION SCALES

In this chapter two scales of site attraction will be constructed and will yield attraction measures for each site. As discussed earlier, the two scales will be constructed using different sources of information on the relative attraction of ski sites. The first scale will be based on skiers' rankings of sites. The second scale will be derived from the revealed preferences of skiers.

Stated Site Attraction

Skiers were asked to rank all ski sites that they were familiar with in order of preference*, as if all sites were equidistant from them. Hence, each skier's ranking was decomposible into $(n(n - 1)/2)$ comparisons of the ordinal utility of pairs of sites. Since distance had been held constant, each pair comparison was a comparison of the attraction values of each respective pair of sites.

These pair comparisons of attraction values are aggregated by incrementing a comparison matrix in which each cell refers to the number of times the row site (i) was inferred to be more attractive than the column site (j). Each time a pair comparison of the form $A_i > A_j$

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* The word preference was used in the questionnaire since it was felt to have wider exposure than the word utility.

is made the (ij)th cell of the comparison matrix is incremented by one.

Each cell in the comparison matrix can be expressed as a proportion of times the row site was judged more attractive than the column sites. In this study 363 skiers ranked ski resorts on the basis of preference. The proportions matrix constructed from these rankings is presented in Table 5.1. The value -9.9 indicates that no comparison were made of that pair of sites. This condition can arise from the situation where neither of the resorts was ever ranked by any skier.

Table 5.2 shows a matrix reflecting the number of times any row and column pair were compared. This matrix gives some indication as to the sample size upon which each proportions score is based.

Certain inferences can be drawn from these proportions scores for different pairs of sites. Any attraction proportion can range between 1.0 and 0.0. A cell with the value of 1.0 signifies that the row ski site is always regarded as more attractive than the column ski site; conversely, 0.0 means that a row site is always regarded as less attractive than the column site. Only 13 percent of the proportions matrix (Table 5.1) contains cells whose values are either 1.0 or 0.0. In the remaining cells skiers were never completely consistent with one another in their judgements of the attraction of pairs of sites.

This inconsistency can arise from two sources. First, and most obviously, inconsistency between individuals can arise from inter-

Table 5.1

Proportions Matrix, Stated Attraction

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Bolton	1.	-																											
Bromley	2.	0.65	-																										
Burke	3.	0.78	0.53	-																									
Burrington Hill	4.	-9.90	0.33	0.00	-																								
Carinthia	5.	-9.90	0.29	0.00	1.00	-																							
Glen Ellen	6.	0.76	0.62	0.30	-9.90	0.86	-																						
Haystack	7.	0.25	0.32	0.20	0.67	0.68	0.23	-																					
Hogback	8.	0.00	0.25	0.00	1.00	0.47	0.13	0.49	-																				
Jay	9	0.81	0.69	0.45	-9.90	1.00	0.54	0.78	0.86	-																			
Killington	10.	0.73	0.67	0.36	1.00	0.85	0.52	0.80	0.82	0.48	-																		
Mad River Glen	11.	0.68	0.69	0.58	1.00	0.75	0.56	0.75	0.63	0.57	0.61	-																	
Magic	12.	0.75	0.50	0.17	-9.90	0.67	0.37	0.68	0.82	0.33	0.35	0.26	-																
Maple Valley	13.	0.20	0.30	0.00	1.00	0.63	0.50	0.35	0.20	0.25	0.13	0.40	0.00	-															
Middlebury	14.	0.43	0.50	0.33	-9.90	-9.90	0.25	0.38	0.00	0.43	0.39	0.16	0.50	0.50	-														
Mt. Ascutney	15.	0.80	0.32	0.00	-9.90	0.00	0.19	0.55	0.50	0.22	0.26	0.29	0.30	1.00	0.50	-													
Mount Snow	16	0.58	0.47	0.21	1.00	0.71	0.48	0.75	0.77	0.28	0.24	0.31	0.50	0.92	0.52	0.58	-												
Mt. Tom	17.	0.00	0.21	0.43	-9.90	0.71	0.10	0.46	0.50	0.15	0.09	0.17	0.15	0.45	0.50	0.00	0.20	-											
Norwich University	18.	0.30	0.20	0.00	-9.90	1.00	0.00	-9.90	0.00	0.17	0.00	0.13	0.00	-9.90	0.00	0.00	0.10	0.40	-										
Okemo	19.	0.43	0.51	0.15	1.00	0.80	0.36	0.73	0.76	0.18	0.38	0.33	0.59	0.73	0.47	0.53	0.53	0.82	1.00	-									
Pico	20.	0.60	0.66	0.29	1.00	0.63	0.45	0.58	0.81	0.32	0.35	0.35	0.50	1.00	0.64	0.73	0.51	0.80	1.00	0.62	-								
Pinnacle	21.	0.50	1.00	0.50	-9.90	-9.90	0.50	-9.90	-9.90	0.50	0.50	0.50	-9.90	-9.90	0.33	1.00	1.00	1.00	0.67	1.00	0.80	-							
Prospect	22.	-9.90	0.23	0.50	-9.90	0.50	0.40	0.50	0.83	0.25	0.20	0.25	0.29	0.00	0.50	0.67	0.38	0.00	1.00	0.00	0.33	-9.90	-						
Smuggler's Notch	23.	0.71	0.69	0.40	-9.90	0.80	0.59	0.73	0.88	0.39	0.41	0.45	0.68	0.00	0.82	0.77	0.67	1.00	1.00	0.54	0.57	1.00	0.67	-					
Sonneberg	24.	0.00	0.00	-9.90	-9.90	0.00	0.00	0.00	-9.90	-9.90	0.00	0.00	0.00	-9.90	-9.90	1.00	0.00	-9.90	-9.90	1.00	0.00	-9.90	-9.90	1.00	-				
Stowe	25.	0.80	0.81	0.59	1.00	0.77	0.81	0.81	0.91	0.70	0.64	0.63	0.84	0.80	0.84	0.82	0.77	0.97	0.94	0.80	0.74	1.00	1.00	0.77	1.00	-			
Stratton	26.	0.68	0.64	0.42	1.00	0.82	0.46	0.71	0.81	0.43	0.38	0.44	0.59	0.88	0.59	0.71	0.64	0.86	0.71	0.61	0.62	0.50	0.82	0.46	1.00	0.25	-		
Sugarbush	27.	0.83	0.77	0.50	1.00	0.67	0.62	0.83	0.68	0.62	0.52	0.47	0.82	1.00	0.84	0.89	0.65	0.92	0.87	0.67	0.70	0.63	0.57	0.62	1.00	0.26	0.56	-	
Suicide Six	28.	0.50	0.33	0.00	-9.9-	-9.90	0.22	0.25	0.00	0.14	0.40	0.18	0.17	-9.90	0.20	0.38	0.31	0.33	0.67	0.40	0.25	[illegible]	0.33	0.00	1.00	0.00	0.29	0.08	-

Table 5.2

Sample Size Matrix, Stated Attraction

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Bolton	1.	-																											
Bromley	2.	23	-																										
Burke	3.	9	15	-																									
Burrington Hill	4.	0	3	1	-																								
Carinthia	5.	0	21	3	3	-																							
Glen Ellen	6.	38	79	23	0	7	-																						
Haystack	7.	8	76	5	3	19	31	-																					
Hogback	8.	3	36	4	5	15	8	41	-																				
Jay	9.	32	51	29	0	3	65	27	7	-																			
Killington	10.	45	156	33	3	20	129	84	40	84	-																		
Mad River Glen	11.	34	74	19	1	8	105	32	16	56	119	-																	
Magic	12.	8	76	6	0	9	35	41	17	21	71	34	-																
Maple Valley	13.	5	20	4	3	8	2	17	15	4	24	5	9	-															
Middlebury	14.	14	16	9	0	0	32	8	4	21	38	25	8	2	-														
Mt. Ascutney	15	5	19	4	0	1	16	11	12	9	27	14	10	3	8	-													
Mount Snow	16.	33	150	24	5	24	100	95	52	69	206	95	68	24	23	24	-												
Mt. Tom	17.	8	38	7	0	7	20	26	18	13	44	18	13	11	4	7	44	-											
Norwich University	18.	10	5	4	0	1	12	0	1	6	14	15	5	0	7	2	10	5	-										
Okemo	19.	14	65	13	3	5	44	33	25	22	90	46	34	15	19	15	76	22	4	-									
Pico	20.	20	70	14	1	8	62	36	16	41	110	51	38	10	22	11	82	15	4	47	-								
Pinnacle	21.	4	1	4	0	0	6	0	0	2	8	6	0	0	6	1	1	2	6	3	5	-							
Prospect	22.	0	13	2	0	4	5	8	6	4	10	4	7	1	2	3	13	1	1	2	3	0	-						
Smuggler's Notch	23.	34	48	15	0	5	63	26	8	51	79	55	19	1	17	13	66	7	4	24	37	1	3	-					
Sonneberg	24.	1	1	0	0	1	2	1	0	0	1	2	1	0	0	1	2	0	0	1	1	0	0	1	-				
Stowe	25.	55	137	32	4	22	123	72	35	91	209	122	58	20	37	22	186	36	17	75	91	8	8	98	1	-			
Stratton	26.	25	137	19	3	22	79	77	42	49	154	81	74	24	17	17	154	37	7	67	65	2	11	48	1	144	-		
Sugarbush	27.	36	98	18	1	9	114	42	19	68	156	107	44	3	31	18	133	25	15	49	57	8	7	63	2	156	105	-	
Suicide Six	28.	6	9	5	0	0	9	4	4	7	15	11	6	0	5	8	13	3	3	5	8	3	3	6	1	12	7	13	-

personal differences in skiers' preferences for different combinations of site variables. For example, some skiers may prefer long runs and high quality hills whereas other skiers may simply prefer a lack of crowding. Such differences would presumably change attraction rankings for different individuals. A second, but less obvious source of inconsistency comes at the intrapersonal level, specifically, from skiers' inability to accurately discriminate between ski sites whose attraction values are very close on a unidimensional scale of attraction. For example, there may be two sites whose scores are very close; some skiers may judge the first site more attractive whereas other skiers may judge the second site more attractive. However, as resort attraction differences become more apparent greater consistency in judgements should occur.

In constructing the comparisons matrix these individual differences in preference and perception are smoothed over to allow the construction of an average attraction scale. Thus proportion scores which are neither zero or one would be expected to occur simply because not every skier has the exact same attraction function for assigning attraction values to sites or the same discrimination between very similar sites.

It is the purpose of this analysis to derive a scale of attraction from data in the proportions matrix. Thus, it is of interest to examine the metric structure of the proportions matrix presented in Table 5.1. If attraction is an important element of spatial choice behavior and if, in choice behavior, people are actually responding to the attraction they perceive ski resorts to have, it would be expected that each ski resort could be ranked on the basis of its attraction such that all resorts with lesser amounts of attraction would be ranked lower than itself. This property associated with placing a resort in a ranking of other resorts such that the attraction proportions of the resort are greater than .5 for those resorts ranked lower than itself and less than .5 for all resorts ranked higher than itself is described as a transitive relationship.

If a small degree of intransitivity occurs in the proportions matrix it suggests that all individuals have specified the same general attraction function and that this simple attraction function can be represented by a single scale. However, if a large number of intransitivities occur, it suggests that a number of different attraction functions have been aggregated in constructing the comparison matrix. In this case it would be necessary to derive more than one attraction scale to explain the proportions matrix. Therefore, it is necessary to determine the degree of intransitivity contained in the proportions matrix.

The smallest number of ski sites in which intransitive relations can occur is three (for example, $P_{jk} > P_{kl} > P_{lj}$, where P_{jk} is the proportions of time j was judged more attractive than k). If the members of one of these triplets are intransitively related they are termed a circular triad. The more circular triads that are observed in the proportions matrix the further the matrix departs from being explanable by a single attraction function. The number of observed circular triads can be expressed as a percentage of the total number of triads of the 28 ski sites. In the proportions matrix in Table 5.1, only 1.8 percent of all possible triads were observed to be circular. This small degree of intransitivity suggests that the proportions matrix has a strong ordinal structure.

Derivation of an Ordinal Stated Attraction Scale

An ordinal attraction scale can be constructed using information in the proportions matrix. The ranking algorithm, as described by Ewing (Ewing, 1971, pp. 98-99), used in PCPA derives a rank position for each site by summing all proportions values for each site. Because the method would naturally place sites with missing data cells low in the ranking, the procedure compares two sites at a time and derives relative rankings for those two sites from only sites which they have common proportion scores for.

The ranking of 28 sites using this procedure is shown in Table 5.3. The scale, with a few exceptions, shows that larger sites such as Stowe, Jay, Sugarbush and Killington are the more attractive resorts, whereas, smaller resorts such as Carinthia, Hogback, and Mt. Tom are less attractive resorts.

Table 5.3

Ordinal Stated Attraction Scale

	Rank	Resort
Most Attractive	1	Stowe
	2	Burke
	3	Sugarbush
	4	Jay
	5	Pinnacle
	6	Killington
	7	Mad River Glen
	8	Glen Ellen
	9	Stratton
	10	Smuggler's Notch
	11	Pico
	12	Magic
	13	Mount Snow
	14	Bromley
	15	Bolton
	16	Okemo
	17	Middlebury
	18	Haystack
	19	Mt. Ascutney
	20	Prospect
	21	Maple Valley
	22	Hogback
	23	Carinthia
	24	Mt. Tom
	25	Suicide Six
	26	Sonneberg
	27	Norwich University
Least Attractive	28	Burrington Hill

Derivation of an Interval Stated Attraction Scale

An interval attraction scale is constructed using the proportions matrix information. It is necessary to convert the proportions matrix to a dissimilarities matrix using the formula given in (4.6). However, before this conversion can be made, certain modifications must be made in the original proportions matrix to ensure that a meaningful scale is obtained.

The first modification is to remove as many missing data cells as possible without substantially lowering the amount of information in the resulting matrix. Upon closer inspection of the proportions matrix (Table 5.1) it is clear that most missing data cells (those having a value of -9.9) are associated with a few resorts; namely, Burrington Hill, Norwich University Ski Area, Prospect, Pinnacle, and Sonneburg. By removing these rows and columns from the proportions matrix the amount of missing data is decreased substantially while the amount of information lost is kept at a minimum.

A second modification is to remove those rows whose proportions scores have been determined on the basis of a very small sample size. This modification is especially necessary for those small ski sites which were sampled but have proportions scores based on a very small number of judgements. In these cases the proportions scores are probably not based on a comparison of attraction values by skiers at different sites but rather a comparison of attraction values by skiers at only those sites. Without this "cross-comparison" the derived scores may very well be overestimated. In cases where resorts weren't sampled and their proportions scores are based on a small sample size of skiers at other sites, underestimation of attraction values will probably occur. However, there is no way to prevent this.

Using the above criterion, Prospect and Pinnacle (both sampled and both having proportion scores based on a small number of judgements) are removed from the matrix. The final proportions matrix from which an interval attraction scale is to be derived contains 23 ski resorts. The dissimilarities matrix is presented in Table 5.4.

This dissimilarities matrix is used as input for SSA-1. A one-dimensional scaling solution is sought. This solution is presented in Table 5.5. The scale can be interpreted as an interval site attraction scale for the 23 ski hills. The goodness of fit measure, Kruskal's Stress Coefficient, is 0.368, indicating a relatively large amount of residual variance from the regression of configuration interpoint distances and input dissimilarities measures.

The large residual departure from monotonicity might lead one to suspect that the algorithm has not been able to reliably produce a spatial representation of the numerical structure in the dissimilarities matrix. However, such a conclusion may be inappropriate for two reasons.

First, Kruskal's Stress Coefficient does not necessarily measure how well a scaling algorithm, such as SSA-1, has produced a

Table 5.4

Dissimiliarities Matrix, Stated Attraction

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Bolton	1.	-																						
Bromley	2.	0.15	-																					
Burke	3.	0.28	0.03	-																				
Carinthia	4.	0.11	0.21	0.50	-																			
Glen Ellen	5.	0.26	0.12	0.20	0.36	-																		
Haystack	6.	0.25	0.18	0.30	0.18	0.27	-																	
Hogback	7.	0.50	0.25	0.50	0.03	0.37	0.01	-																
Jay	8.	0.31	0.19	0.05	0.50	0.04	0.28	0.36	-															
Killington	9.	0.23	0.17	0.14	0.35	0.02	0.30	0.32	0.02	-														
Mad River Glen	10.	0.18	0.19	0.08	0.25	0.06	0.25	0.13	0.07	0.11	-													
Magic	11.	0.25	0.00	0.33	0.17	0.13	0.18	0.32	0.17	0.15	0.24	-												
Maple Valley	12.	0.30	0.20	0.50	0.13	0.00	0.15	0.30	0.25	0.37	0.10	0.50	-											
Middlebury	13.	0.07	0.00	0.17	0.03	0.25	0.12	0.50	0.07	0.11	0.34	0.00	0.00	-										
Mt. Ascutney	14.	0.30	0.18	0.50	0.50	0.31	0.05	0.00	0.28	0.24	0.21	0.20	0.50	0.00	-									
Mount Snow	15.	0.08	0.03	0.29	0.21	0.02	0.25	0.27	0.22	0.26	0.19	0.00	0.42	0.02	0.08	-								
Mt. Tom	16.	0.50	0.29	0.07	0.21	0.40	0.04	0.00	0.35	0.41	0.33	0.35	0.05	0.00	0.50	0.30	-							
Okemo	17.	0.07	0.01	0.35	0.30	0.14	0.23	0.26	0.32	0.12	0.17	0.09	0.23	0.03	0.03	0.03	0.32	-						
Pico	18.	0.10	0.16	0.21	0.13	0.05	0.08	0.31	0.18	0.15	0.15	0.00	0.50	0.14	0.23	0.01	0.30	0.12	-					
Smuggler's Notch	19.	0.21	0.19	0.10	0.30	0.09	0.23	0.38	0.11	0.09	0.05	0.18	0.50	0.32	0.27	0.17	0.50	0.04	0.07	-				
Stowe	20.	0.30	0.31	0.09	0.27	0.31	0.31	0.41	0.20	0.14	0.13	0.34	0.30	0.34	0.32	0.27	0.47	0.30	0.24	0.27	-			
Stratton	21.	0.18	0.14	0.08	0.32	0.04	0.21	0.31	0.07	0.12	0.06	0.09	0.38	0.09	0.21	0.14	0.36	0.11	0.12	0.04	0.25	-		
Sugarbush	22.	0.33	0.27	0.00	0.17	0.12	0.33	0.18	0.12	0.02	0.03	0.32	0.50	0.34	0.39	0.15	0.42	0.17	0.20	0.12	0.24	0.06	-	
Suicide Six	23.	0.00	0.17	0.50	0.10	0.28	0.25	0.50	0.36	0.10	0.32	0.33	0.07	0.30	0.12	0.19	0.17	0.10	0.25	0.50	0.50	0.21	0.42	-

Table 5.5

Interval Stated Attraction Scale

	Attraction Value	Resort
Most Attractive	100.00	Stowe
	85.35	Burke
	73.82	Sugarbush
	62.63	Smuggler's Notch
	59.25	Jay
	50.71	Killington
	43.04	Mad River Glen
	37.70	Stratton
	35.37	Glen Ellen
	17.38	Pico
	11.24	Bolton
	9.46	Magic
	5.60	Mount Snow
	-0.47	Bromely
	-4.89	Okemo
	-20.18	Middlebury
	-30.50	Mt. Ascutney
	-46.32	Haystack
	-63.33	Suicide Six
	-69.87	Carinthia
	-88.10	Maple Valley
	-97.36	Hogback
Least Attractive	-100.00	Mt. Tom

Kruskal's Stress Coefficient: 0.368

spatial representation of the dissimilarities data. In one study, Sherman and Young (Sherman and Young, 1968) examine how well a scaling algorithm could reconstruct a known configuration when the rank order of error-preturbed interpoint distances were used as input instead of normally used error-free interpoint distances. In doing so they also examined the sensitivity of Kruskal's Stress Coefficient to different numbers of configuration points and amount of error in the interpoint distances. 20 two-dimensional configurations were constructed from various combinations of number of points and amounts of error. For each configuration the product-moment correlation between the $n(n - 1)/2$ distances in the true configuration and those in the reconstructed configuration was computed to determine the degree of metric reconstruction of the true configuration. Kruskal's Stress Coefficient was also computed to determine the degree of goodness-of-fit of the nonmetric model to the error-preturbed distances. In one of the cases, distances were distorted between 30 points by about one-quarter of their total amount. Kruskal's Stress Coefficient was .2207 suggesting a poor recovery using Kruskal's own criteria outlined in Table 4.1. However, the product-moment correlation between interpoint distances in the true configuration and the configuration derived under these circumstances was .9512, indicating that the algorithm was able to recover the metric properties of the structure underlying the error-perturbed data. What this seems to indicate is that while stress may be moderately high it does not necessarily imply poor recovery when a large number of points are involved and/or there is error associated with the input data. Furthermore, it should be noted that these results are from a two-dimensional configuration; a one-dimensional solution would presumably have greater stress associated with it. Thus, the measure of stress from the stated attraction scale, while moderately high, is not a necessary indication of poor recovery since 23 points are involved, the input measures contain a reasonable amount of error from inconsistent judgements, and the solution is unidimensional.

A second point related to the overall quality of the derived configuration is that the solution is interpretable. Shepard (Shepard, 1972) has suggested interpretability as a relevant consideration in determining and assessing dimensionality. There is little doubt that the derived scale has an intuitively appropriate structure. However, the exact nature of this structure will be discussed later.

The ski resorts' positions on the ordinal scale have been very well preserved on the interval scale. Spearman's Rank Correlation Coefficient computed between the two scales is .968. This is significant at the .005 probability level.

As stated above this scale seems to have an intuitively appropriate structure. The large, well developed resorts such as Stowe, Sugarbush, Killington, Jay and Smuggler's Notch have relatively high attraction values. Slightly smaller, southern resorts such as Bromley, Magic, and Okemo have moderate attraction values. Finally, the small, less developed hills like Hogback, Mt. Tom, and Maple Valley have the lowest attraction scores.

The accuracy of the scale, it must be remembered, is highly dependent on individuals' abilities to successfully filter out the effect of distance in their preferential judgements. If not, the derived scale would not only reflect site attraction but some effect of the spatial arrangement of skiers and ski sites.

It is of interest, then, to assess the extent to which the final scale is free of spatial bias. If the final attraction values are a combination of site attraction and distance, it would be expected that the final values for each site's attraction would be related to that resort's accessibility. Because accessibility is positively related to utility or preference, it would be expected that there should be a positive relationship between accessibility scores for a resort and its derived attraction value.

The simplest way to assess this relationship is through correlation analysis. At the aggregate level the coefficient of determination between sites' average accessibility scores, as scored by skiers, and their derived attraction values is -.807. This indicates that there is a strong inverse relationship between accessibility and attraction scores.

The correlation of aspects of human behavior occuring at the individual level but being measured at the aggregate level may be spurious (Robinson, 1950). In an attempt to minimize such ecological correlation, this relationship is again tested but at the individual level. Skiers were asked to score each resort on its degree of accessibility. 1798 accessibility scores were collected for the 28 resorts. Each accessibility score for a resort was given the corresponding attraction value for that resort. The attraction values were then regressed against the accessibility scores. The value of r^2 for this regression was -.09 suggesting an almost nonexistent relationship between the derived attraction scores and individual site accessibility scores. It can be concluded from this test that the attraction scores are reasonably free of detectable spatial bias.

The General Nature of the Stated Attraction Scale

The positions of ski hills on the attraction scale is very interesting. In general, those sites with the largest hills have high site attraction. This is the case with Stowe, Sugarbush, Killington and Smuggler's Notch. Smaller hills like Mt. Tom, Hogback, and Maple Valley have low attraction values. Sites with a high degree of development, i.e., many slopes and tows, large chalets, etc., have high attraction values. Two notable exceptions are Burke, having moderate development but high attraction, and Mt. Snow which has the greatest amount of development in both skiing and nonskiing activities of any Vermont resort, but only moderate attraction.

Northern ski areas tend to have higher attraction values than more southern resorts which tend to have moderate to low attraction values. Such locational characteristics have a crucial bearing on the degree of crowding found at the resorts. Most southern resorts are much more accessible to the New York-Connecticut-Massachusetts ski market than more northern resorts.

Resorts which were not surveyed tend to have moderate to low attraction values. This is the case with Middlebury, Ascutney, Suicide Six and Mt. Tom. This is to be expected since skiers who would presumably judge these sites to have higher attraction would be those skiers at the resorts and the preferences of these skiers could not be sampled.

Revealed Site Attraction

A scale of attraction has been produced using the stated preferences of skiers for ski sites. A second scale of site attraction can be constructed using the revealed preferences of skiers for ski sites. The method used in this section of the analysis is the Ross method discussed earlier. Discussion will concentrate on three points: various assumptions made by the Ross method and the sensitivity of derived attraction scales to these assumptions; distance constraints placed on allowable revealed preferences and their effect on derived attraction scales; and, finally, the derivation of ordinal and interval attraction scales.

Assumptions of the Ross Method

The Ross method makes two assumptions which appear to be violated in certain cases by individuals' behavior. It is the purpose of this section to assess the extent to which such violations would affect scales of attraction derived by the method.

First, the method assumes that a skier can accurately discriminate between differences in the distances from his home to alternative ski resorts, irrespective of the amount of difference. In many cases the difference is very great and inaccuracy would rarely occur. However, there are situations where the differences are very small and inaccurate judgements may occur often. For example, a skier can tell that a resort 10 miles from his home is closer than a resort 100 miles from his home. It would be much harder for that skier to accurately judge a resort 99 miles away as being closer than a resort 100 miles away. If a resort is not a "noticeably closer" alternative, then any inference about it being less attractive than a more distantly chosen alternative would be erroneous, since the skier would not, in his own mind, be sacrificing more travel effort for more attraction.

To alleviate this possible source of error, the comparison of attraction values are made only between resorts which are "noticeably closer" to a skier's origin than the site he has chosen. The amount of distance which places alternative resorts noticeably closer to a skier is expressed as a percentage of the total distance the skier travels to the site he chooses. This amount of distance is referred to as a "just noticeable difference" (JND) of distance and is given a value of 10 percent in this study. Under such constraints, pair-comparison information is used only if the site chosen is at least 10 percent further than unchosen sites.

A second assumption of the method is that a skier has complete knowledge of intervening opportunities between himself and the chosen site. From this assumption all intervening sites are inferred less attractive since the skier "knew of them" yet elected to choose a more distant site. This assumption, while violated in certain individual cases, can be supported at the aggregate level. Certainly every person doesn't have perfect knowledge of all intervening opportunities. This knowledge varies from individual to individual and is related to skiing experience, information fields, etc. Whenever such a person doesn't know he has passed a site, the site should not be inferred less attractive since the person never actually compared the site's utility to another's. On the other hand, the assumption seems to have some support. If a person has passed the site by, there is a good chance that his not knowing of the site is related to it having a lower attraction value than other sites which he does know. In fact, it seems plausible that there is a strong correlation between a resort's exposure to skiers and its attraction. Under these circumstances the inference made using the Ross method is correct and, as more people are sampled, individual exceptions to the proposed relationship between attraction and knowledge have increasingly less significance on the final measures.

The effect of deriving attraction scales when incorporating these two concepts of JND and knowing of intervening opportunities was tested using information gathered in the questionnaire survey described in Chapter 4. Each skier interviewed was asked to give his home town and list those Vermont ski sites that he was familiar with. The site where he was interviewed was assumed to be his preferred site. A scale of attraction was derived using the origin and revealed preference information. This first scale assumes perfect discrimination of distance differences (i.e. no JND) and perfect knowledge of all intervening opportunities. A second scale was derived with a 10 percent JND in which pair comparison information was used only if the site chosen was at least 10 percent further than the unchosen sites. Finally, a scale was derived with the same 10 percent JND requirement and with the additional requirement that a site could only be inferred less attractive than a chosen site if the skier had prior knowledge of its existence. Kendall's Rank Correlation Coefficients were computed for each pair of scales. These are presented in Table 5.6. The positions of the resorts on the three scales are shown in Table 5.7.

The result of this analysis shows that none of the assumptions cause scales to deviate greatly. As would be expected, the JND and knowledge requirements cause less comparisons to be allowed. The JND criterion affects resorts having the same general spatial positions relative to the sample. For example, Smuggler's Notch, Jay, Stowe, and Burke have the same approximate locations relative to most of the sampled skiers who come from New York, Massachusetts, and Connecticut. Without a JND requirement Burke is the least attractive of the group. This ranking may simply be related to the plausible situation that Burke

Table 5.6

Kendall's Rank Correlation Coefficients for Pairs of Attraction Scales Produced Under Different Behavioral Constraints

	no constraints	with JND constraints	with JND and Knowledge constraints
no constraints	-	.869	.726
with JND constraints		-	.838
with JND and Knowledge constraints			-

Table 5.7

Resort Positions on 3 Attraction Scales Produced Under Different Behavioral Constraints

Resort	no constraints	with JND constraints	with JND and Knowledge constraints
Bolton	5	6	3
Bromley	9	8	12
Burke	4	1	1
Carinthia	17	15	14
Glen Ellen	6	5	4
Haystack	16	17	17
Hogback	21	21	19
Jay	2	3	7
Killington	11	10	11
Mad River Glen	7	9	8
Magic	10	7	6
Maple Valley	19	20	20
Mount Snow	15	16	15
Okemo	13	12	10
Pico	12	11	9
Pinnacle	20	19	21
Prospect	18	18	18
Smuggler's Notch	1	2	2
Stowe	3	4	5
Stratton	14	14	13
Sugarbush	8	13	16

is slightly closer to these general regional origins than the other sites. When preferences are revealed for the other three sites Burke is always inferred to be less attractive. However, with a JND requirement all four sites are relegated to the same "spatial position" for these skiers, leaving the actual comparison of attraction values to other skiers for whom some of the four are noticably closer. Under these circumstances Burke is positioned as the most attractive of the group.

The knowledge criterion causes larger resorts' positions to be lowered on the scale, as evidenced by the positioning of Bromley, Jay, Killington, Stowe, and Sugarbush on the two scales. However, the knowledge criterion appears to introduce more bias in the final ranking than refine naive assumptions. To elaborate, using this criterion small resorts' positions would be expected to move upward, large resorts downward, and moderate size resorts to remain more or less stable. The scale shows a much different situation. Large resorts like Bromley, Jay, and Stowe do move downward in the ranking. The smaller resorts show very little change and, in fact, Haystack, Maple Valley, and Prospect have the exact same position regardless of whether the knowledge criterion is used. Major positive differences in ranking are only associated with moderate size resorts like Bolton, Pico, and Mad River Glen which have been essentially "displaced" upward by the large resorts shifting downward. A good example of this is Bolton. In short, the only notable change is large resorts being shifted downward. The absence of any notable change in other resorts' positions, except as a reaction to large resort change is indicative of the size bias. For this reason the knowledge requirement has been excluded from the final revealed attraction analysis. The JND criterion is included since it has strong behavioral justification.

Distance Travelled and Revealed Preference Type

A very important relationship exists between the type of preference revealed by a skier and the distance travelled to a ski site. Preferences are being revealed, in the case of Vermont skiers, by a variety of types of skiers. Some skiers are skiing just for the day. Some are skiing for the weekend, and some are skiing for longer than that. At the same time some skiers are coming from local origins, some from intraregional origins, and some from extraregional origins. All of these preferences by different types of skiers coming from different origins have been grouped together.

It seems plausible that different kinds of variables are affecting the nature of choices made by members of these different groups. For example, what a day skier looks for in a ski site may be entirely different than what a weekend skier desires. Presumably these preferences will appear in the choice a skier makes.

By imposing a limit on the distance travelled by a skier to a ski site, the preferences of certain groups of skiers can be examined. Shorter distances would allow the examination of day-skiers' preferences. Longer distances would allow examination of both day and

and weekend skiers. At the same time very long distances would reflect extraregional skier trips. These trips would probably be shaped by many factors in addition to skiing. Since the explanation of such complex choices is beyond the scope of this study, revealed preferences of the extraregional type should be excluded from the analysis. Thus, a limit on distance travelled would perform two functions: it would allow the examination of different groups of skiers and also exclude more complex choice behavior from analysis.

The most preferable group of skiers to examine in the context of this analysis is day skiers. These skiers are probably least affected by extraneous variables such as quality of accommodations, night-life, etc. Their choices are presumably a result of the quality of skiing at each site and it is this property that the study seeks to explain. As skiers come from greater distances the effect of extraneous variables on choice becomes greater and the component in these choices which is related to the simple quality of skiing becomes harder to identify. However, it is impossible to determine which maximum distance would best reflect the choices made by day and weekend skiers, except at an intuitive level by using a method of trial and error.

Different ordinal site attraction scales can be derived by using different maximum distance criteria. Three values were selected: 120 miles, 180 miles, and 220 miles. An ordinal scale was derived for each value. The 120 mile value is regarded as a reasonable maximum distance for day skiers. The 180 and 220 mile values are designed to examine local and regional preferences simultaneously. The 180 mile value has been selected to include preferences from all local skiers and most regional skiers; the 220 mile value will include all local and regional skier preferences.

Ordinal Revealed Attraction Scales

Three ordinal attraction scales have been derived while constrained by the respective maximum distance travelled values of 120 miles, 180 miles, and 220 miles. The scale derived under the 120 mile constraint is presented in Table 5.8. This scale has a very interesting shape: it has separated the central Vermont resorts from those in the north and south. The first nine positions are occupied by the central Vermont resorts; the next group is a mixture of northern and southern resorts, and the final six, with the exception of Sonneburg) are peripherally located resorts. This scale is based on 1651 skiers with 9806 pair comparisons of sites. The final proportions matrix is 94 percent occupied.

The characteristic shape of this scale can be directly attributed to the 120 mile constraint imposed on skier trips. Most of the sampled skiers come from outside Vermont from origins in Massachusetts, Conneticut, New York, and Quebec. Given such a distribution, central resorts have an optimal location since few skiers can compare these resorts with both northern and southern resorts and still satisfy the 120 mile travel constraint. What probably happens is that they are compared with other northern resorts or southern resorts, but not both

Table 5.8

Ordinal Revealed Attraction Scale,
120-Mile Travel Constraint

	Rank	Resort
Most Attractive	1	Glen Ellen
	2	Sugarbush
	3	Pico
	4	Killington
	5	Okemo
	6	Stratton
	7	Mad River Glen
	8	Mt. Tom
	9	Suicide Six
	10	Stowe
	11	Bromley
	12	Bolton
	13	Magic
	14	Smuggler's Notch
	15	Haystack
	16	Mount Snow
	17	Pinnacle
	18	Carinthia
	19	Burke
	20	Sonneberg
	21	Maple Valley
	22	Hogback
	23	Jay
Least Attractive	24	Prospect

simultaneously. Furthermore, few comparisons are probably made between northern and southern resorts. The positioning of the five peripheral resorts of Burke, Maple Valley, Hogback, Jay, and Prospect occurs because these resorts are always passed by skiers choosing other Vermont resorts towards the interior of the distribution.

The scale derived under a 180 mile constraint is presented in Table 5.9. It is considerably different than that derived under the 120 mile constraint. The most noticeable change is that the central resort block has dispersed. This comes as a result of allowing skiers to compare northern, central, and southern resorts. This scale is based on 2019 skiers with 12,200 pair comparisons of sites. The proportions matrix on which this ranking is based is 99 percent occupied.

It is interesting to note that 20 of the 24 resorts' positions change between the 120 mile and 180 mile scale. All upward movement in rank position is confined solely to northern resorts like Stowe, Bolton, Smuggler's Notch, Burke and Jay. Conversely, all downward movement is confined to central and southern resorts.

The third ordinal scale is shown in Table 5.10. The maximum allowable distance was 220 miles. The positioning of resorts on this scale is very similar to that derived under a 180 mile constraint with the exception of Bolton and Mad River Glen which show moderate negative changes in rank, and three peripheral resorts, Jay, Carinthia, and Hogback, which show slight changes in rank position. These small

Table 5.9

Ordinal Revealed Attraction Scale,
180-Mile Travel Constraint

	Rank	Resort
Most Attractive	1	Glen Ellen
	2	Sugarbush
	3	Stowe
	4	Bolton
	5	Mad River Glen
	6	Pico
	7	Killington
	8	Stratton
	9	Okemo
	10	Smuggler's Notch
	11	Burke
	12	Mt. Tom
	13	Bromley
	14	Suicide Six
	15	Magic
	16	Jay
	17	Haystack
	18	Mount Snow
	19	Pinnacle
	20	Carinthia
	21	Maple Valley
	22	Sonneberg
	23	Hogback
Least Attractive	24	Prospect

Table 5.10

Ordinal Revealed Attraction Scale,
220-Mile Travel Constraint

	Rank	Resort
Most Attractive	1	Glen Ellen
	2	Sugarbush
	3	Stowe
	4	Pico
	5	Killington
	6	Stratton
	7	Mad River Glen
	8	Bolton
	9	Okemo
	10	Smuggler's Notch
	11	Burke
	12	Mt. Tom
	13	Bromley
	14	Suicide Six
	15	Magic
	16	Haystack
	17	Mount Snow
	18	Jay
	19	Pinnacle
	20	Hogback
	21	Carinthia
	22	Maple Valley
	23	Sonneberg
Least Attractive	24	Prospect

changes are probably a result of a few people travelling extremely long distances and choosing, for example, Hogback. This would cause Hogback's position to increase and the others to decrease, but only slightly since such preferences are revealed by a small number of skiers. The more dramatic changes in Bolton's and Mad River Glen's positions can be attributed to a comparison with a select group of resorts; namely, Pico, Killington, and Stratton. Under a 180 mile constraint such comparisons may not be allowable, but under a 220 mile constraint the comparisons are made and Bolton and Mad River Glen are found to be less attractive. This third scale is based on 15,000 pair comparisons of sites by 2341 skiers. The proportions matrix is 99 percent occupied.

It is difficult to say which of these three scales best represents skiers' preferences. Certainly, the scale derived under a 120 mile constraint not only excludes most regional skier preferences but also produces a very odd shaped attraction ranking. At the same time such a distance constraint does not even allow for a significant comparison of southern, central and northern ski resorts by even Vermont skiers. The 180 mile constraint enables comparison of the three groups by Vermont skiers. In addition it allows many preferences from regional skiers coming from Massachusetts, Conneticut, and New York. However, some northern resorts are still too far north to allow these skiers to compare them with the central and southern resorts - most comparison is simply between central and southern resorts. The 220 mile constraint allows for an examination of skier preferences from the entire region.

It also allows for a substantial comparison of northern, central, and southern resorts not only by Vermont skiers but also most regional skiers. For this reason, the scale derived under the 220 mile distance constraint is used in subsequent analysis to determine the interval properties of revealed site attraction.

Derivation of an Interval Revealed Attraction Scale

It is the purpose of this section to construct an interval attraction scale from the proportions matrix described above. The procedure is the same as that used in deriving an interval scale from stated preference information. Before this procedure can be used, it is necessary to modify the proportions matrix slightly to ensure both a minimum amount of technical difficulty in deriving the scale and a meaningful solution.

Each value in the proportions matrix indicates a dominance relationship between the row and column ski sites. The row site either dominates or it is dominated. This dominance relates to the attraction values of each site. In some cases a resort will always dominate all other resorts as reflected in all proportions for that resort being very near 1.00. Other times, les attractive sites will always be dominated by other resorts. This is true of resorts whose proportions scores are all nearly 0.00. These dominance relationships pose a problem for the algorithm: it must position the one resort as far as possible from all other resorts. The algorithm normally positions the one resort having, for example, very low scores at one end of the scale and clusters all other resorts at the opposite end. Slight adjustments are then made in the interpoint distances of resorts at the clustered end. This solution is the only way that the algorithm can satisfy the requirement that the final distances between all resorts are some monotonic function of the unusual dissimilarities measures. This type of scaling solution is usually termed degenerate and is, essentially, meaningless. Thus, it is necessary to remove such strong dominance relationships from the proportions matrix before it is scaled.

By examining the proportions matrix derived under a 220 mile distance constraint (presented in Table 5.11), it is clear that Prospect has this type of relationship with other resorts. Prospect is completely dominated by all 23 sites. There is a very strong chance that these proportion scores will produce a degenerate scaling solution.

A second modification is to remove those resorts whose proportions scores have been determined by a relatively small sample size. Scanning the sample size matrix presented in Table 5.12, it is clear that the scores for Burke and Jay are based on small sample sizes.

Burke, Jay, and Prospect were removed from the proportions matrix which was then converted to a dissimilarities matrix. The dissimilarities matrix was then used as input for SSA-1. This scaling solution is presented in Table 5.13. Kruskal's Stress Coefficient for the solution is .407 indicating about a 40 percent departure from mono-

Table 5.11

Proportions Matrix, Revealed Attraction

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Bolton	1	0.0	0.66	0.95	0.85	0.15	0.67	0.85	0.97	0.03	0.22	0.85	0.85	0.75	0.62	0.58	0.51	1.00	1.00	0.83	1.00	0.43	0.33	0.27	0.84
Bromley	2	0.34	0.0	0.73	0.90	0.20	0.92	0.99	0.91	0.03	0.19	0.39	[illegible]	0.82	0.43	0.15	0.04	0.68	1.00	0.54	0.80	0.27	0.26	0.13	0.31
Burke	3	0.05	0.27	0.0	0.44	0.03	0.45	0.45	-1.00	0.28	1.00	0.43	0.44	1.00	0.33	1.00	0.16	1.00	1.00	0.04	1.00	1.00	0.06	1.00	1.00
Carinthia	4	0.15	0.10	0.50	0.0	0.07	0.38	-1.00	0.64	0.01	0.07	0.11	-1.00	0.08	0.20	0.05	0.01	0.39	1.00	0.27	0.55	0.11	0.18	0.04	0.12
Glen Ellen	5	0.85	0.80	0.97	0.93	0.0	0.53	0.94	0.97	0.79	0.99	0.92	0.94	0.83	0.81	0.99	0.01	1.00	1.00	0.90	1.00	0.77	0.48	0.71	0.91
Haystack	6	0.33	0.08	0.55	0.12	0.17	0.0	0.63	0.91	0.02	0.17	0.10	1.00	0.06	0.42	0.12	0.04	0.65	1.00	0.54	0.79	0.26	0.05	0.11	0.30
Hogback	7	0.15	0.01	0.35	-1.00	0.06	0.37	0.0	0.63	0.01	0.06	0.10	1.00	0.19	0.19	0.04	0.01	0.38	1.00	0.28	0.55	0.11	0.02	0.04	0.12
Jay	8	0.03	0.09	-1.00	0.15	0.03	0.09	0.17	0.0	0.04	0.00	0.16	0.16	1.00	0.13	1.00	1.00	1.00	1.00	0.00	1.00	0.02	0.02	0.02	0.13
Killington	9	0.37	0.97	0.72	0.99	0.21	0.98	0.99	0.96	0.0	0.21	0.99	0.99	0.98	0.88	0.16	0.55	0.80	1.00	0.53	0.84	0.28	0.88	0.14	0.84
River Glen	10	0.78	0.81	0.0	0.93	0.01	0.83	0.94	0.94	0.79	0.0	0.93	0.94	0.86	0.81	0.39	0.62	1.00	1.00	0.48	1.00	0.17	0.49	0.18	0.93
Magic	11	0.15	0.61	0.57	0.83	0.06	0.90	0.90	0.64	0.01	0.07	0.0	0.95	0.36	0.19	0.05	0.01	0.39	1.00	0.28	0.56	0.11	0.56	0.05	0.12
aple Valley	12	0.15	0.05	0.55	-1.00	0.06	0.0	0.0	0.64	0.01	0.00	0.07	0.0	0.0	0.20	0.05	0.01	0.39	1.00	0.28	0.55	0.11	0.24	0.04	0.12
Mount Snow	13	0.25	0.13	0.0	0.92	0.17	0.94	0.81	0.0	0.02	0.14	0.14	1.00	0.0	0.23	0.10	0.03	0.56	1.00	0.0	0.71	0.0	0.19	0.08	0.22
Mt Tom	14	0.38	0.57	0.07	0.80	0.19	0.58	0.81	0.87	0.12	0.17	0.41	0.80	0.57	0.0	0.15	0.18	0.77	1.00	0.53	1.00	0.28	0.21	0.13	0.68
Okemo	15	0.42	0.85	0.0	0.92	0.01	0.88	0.76	0.0	0.54	0.51	0.75	0.95	0.90	0.85	0.0	0.76	0.94	1.00	0.43	1.00	0.24	0.58	0.02	0.94
Pico	16	0.49	0.96	0.54	0.99	0.39	0.96	0.99	0.0	0.65	0.55	0.94	0.94	0.97	0.82	0.24	0.0	0.55	1.00	0.67	0.85	0.40	0.82	0.27	0.77
Pinnacle	17	0.0	0.32	0.0	0.51	0.0	0.35	0.62	0.0	0.20	0.0	0.51	0.61	0.44	0.23	0.05	0.15	0.0	1.00	0.0	1.00	0.0	0.09	0.09	0.29
Prospect	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ler's Notch	19	0.17	0.46	0.90	0.73	0.10	0.46	0.72	1.00	0.47	0.52	[illegible]	0.72	1.00	0.47	0.57	0.33	1.00	1.00	0.0	1.00	0.0	0.20	[illegible]	0.73
Sonneberg	20	0.0	0.20	0.0	0.45	0.0	0.21	0.45	0.0	0.16	0.0	0.44	0.45	0.29	0.0	0.0	0.15	0.0	1.00	0.0	0.0	0.0	0.05	0.0	0.0
Stowe	21	0.57	0.73	0.0	0.89	0.23	0.74	0.99	0.95	0.72	0.53	0.84	0.84	1.00	0.72	0.76	0.60	1.00	1.00	1.00	1.00	0.0	0.43	0.43	0.89
Stratton	22	0.57	0.74	0.94	0.32	0.52	0.92	0.95	0.90	0.12	0.51	0.44	0.72	0.51	0.77	0.42	0.13	0.91	1.00	0.80	0.95	0.57	0.0	0.39	0.69
Sugarbush	23	0.73	0.67	0.0	0.90	0.29	[illegible]	[illegible]	0.96	[illegible]	0.52	[illegible]	0.90	0.92	0.67	[illegible]	0.73	0.91	1.00	0.76	1.00	0.57	0.61	0.0	0.94
Suicide Six	24	0.16	0.59	0.0	0.84	0.09	0.70	0.68	0.67	0.16	0.07	[illegible]	[illegible]	0.76	[illegible]	0.66	0.23	0.71	1.00	0.27	1.00	0.11	0.31	0.06	0.0

Table 5.12

Sample Size Matrix, Revealed Attraction

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Bolton	1	0	31	8	28	61	29	26	3	30	18	26	27	30	28	19	32	27	27	11	25	38	40	37	26
Bromley	2	31	0	6	54	58	117	80	3	432	62	35	19	29	18	85	264	9	117	16	6	43	39	96	29
Burke	3	8	6	0	5	7	5	5	0	5	6	5	5	4	5	6	6	7	4	8	4	6	15	6	4
Carinthia	4	28	54	5	0	56	23	0	2	426	59	56	0	13	16	82	256	7	44	14	4	40	29	93	27
Glen Ellen	5	61	58	7	55	0	58	56	3	59	29	57	56	58	59	17	63	49	55	37	46	67	68	21	47
Haystack	6	29	117	5	23	58	0	15	3	432	61	61	1	53	18	84	262	9	48	15	6	42	128	96	29
Hogback	7	[illegible]	80	5	0	56	15	0	2	426	59	28	2	65	16	82	258	7	13	13	4	40	40	92	27
Jay	8	3	3	0	2	3	3	2	0	4	2	2	2	1	2	1	1	1	1	46	1	8	12	5	2
Killington	9	30	432	5	425	59	432	426	4	0	62	425	423	429	9	85	13	9	435	17	6	43	442	95	11
Mad River Glen	10	18	62	6	59	29	61	59	2	62	0	60	59	60	61	4	67	57	58	23	58	57	71	19	59
Magic	11	28	35	5	50	57	61	28	2	425	60	0	15	44	17	83	258	7	59	14	4	41	44	94	29
Maple Valley	12	27	19	5	0	50	1	2	2	423	59	15	0	6	16	82	258	7	1	13	4	40	4	92	27
Mount Snow	13	30	29	4	13	56	53	65	1	429	60	44	6	0	17	83	260	8	93	13	5	40	29	94	28
Mt. Tom	14	26	18	5	16	59	18	16	2	9	61	17	16	17	0	65	6	9	15	17	4	43	30	95	10
Okemo	15	19	85	6	82	17	84	82	1	85	4	62	62	63	65	0	67	81	81	22	82	49	95	12	83
Pico	16	32	264	6	258	63	262	258	1	13	67	256	258	260	6	67	0	11	261	18	6	45	276	100	10
Pinnacle	17	27	9	7	7	49	9	7	1	9	57	7	7	6	9	81	11	0	6	17	2	44	21	47	8
Prospect	18	27	117	4	44	55	48	13	1	435	58	59	1	93	15	61	261	6	0	12	3	39	125	94	26
Smuggler's Notch	19	11	16	8	14	37	15	13	46	17	23	14	13	13	17	22	18	17	12	0	14	10	24	27	15
Sonneberg	20	25	6	4	4	46	6	4	1	6	58	4	4	5	4	82	6	2	3	14	0	41	18	63	2
Stowe	21	38	43	6	40	67	42	40	6	43	57	41	40	40	43	49	45	44	39	10	41	0	51	54	41
Stratton	22	40	39	15	29	68	128	40	12	442	71	44	4	29	30	95	276	21	125	24	18	51	0	105	41
Sugarbush	23	37	96	6	93	21	96	92	5	95	19	44	92	94	95	12	100	47	94	27	63	54	105	0	65
Suicide Six	24	26	29	4	27	47	29	27	2	11	59	29	27	28	10	83	10	8	26	15	2	41	41	65	0

Table 5.13

Interval Revealed Attraction Scale

	Attraction Value	Resort
Most Attractive	100.00	Sugarbush
	90.62	Stowe
	74.60	Killington
	74.19	Pico
	68.33	Mad River Glen
	64.13	Okemo
	51.84	Bolton
	43.55	Glen Ellen
	37.86	Stratton
	22.75	Smuggler's Notch
	9.14	Mt. Tom
	7.54	Bromley
	2.64	Suicide Six
	-9.42	Haystack
	-32.50	Maple Valley
	-32.52	Magic
	-42.73	Pinnacle
	-50.38	Mount Snow
	-62.10	Carinthia
	-66.53	Hogback
Least Attractive	-100.00	Sonneberg

Kruskal's Stress Coefficient: 0.407

tonicity.

The General Nature of Revealed Site Attraction

In general, larger ski hills like Stowe, Sugarbush, Killington, and Stratton have revealed high attraction. One notable exception is the large development Mt. Snow which has low revealed attraction. Many medium size hills have moderately high revealed attraction. Good examples of these hills are Pico, Mad River Glen, Okemo, Bolton, and Glen Ellen. However, other medium size hills, like Magic and Haystack, have lower revealed attraction. As would be expected, most small hills such as Sonneberg, Hogback, Pinnacle, and Maple Valley have low revealed attraction.

Northern and north-central have more attraction than do southern and south-central hills. For example, Sugarbush, Stowe, Mad River Glen, Bolton, and Glen Ellen have northern locations and are all in or near the upper one-quarter of the scale. One exception to this trend is the northern resort Smuggler's Notch which reveals moderate attraction. Some central resorts like Killington, Pico and Okemo have moderately high attraction. Southern resorts are far less attractive on the whole than any other geographic group. The lower half of the derived scale consists principally of southern resorts. The major exception to this is Stratton which has moderately high attraction.

A Comparison of Stated and Revealed Site Attraction Scales

Having derived two site attraction scales based on entirely different sources of information, a relevant point in this discussion about site attraction is to consider the degree of correspondence between resort positions on the two scales. High correspondence between the two scales would suggest little difference between skiers' judgements and their actual behavior. Low correspondence may indicate inaccuracies in the methods used to derive the two scales or a discrepancy between introspective judgement and actual behavior.

It is quite obvious that the same general trends in resort attraction have emerged from both scales. Both scales indicate that northern and large ski sites are, in general, more attractive than smaller and southern ski sites. However, there are notable exceptions to this general rule on both scales. This general trend seems to suggest that *in situ* properties common to large resorts are directly related to attraction. Such properties may be length of runs, variety of runs, effective verticle drop, etc. The trend also suggests *in situ* properties common to southern resorts may be inversely related to attraction since big hills with wide variety are not sufficiently strong enough to cause large southern resorts like Stratton and Mt. Snow to have high attraction. In short, something must be discounting the effect of these desirable characteristics in southern resorts. The obvious candidate is the degree of crowding at a resort, because southern resorts are more accessible to the large population centres of the region and consequently are more crowded.

Spearman's Rank Correlation Coefficient was computed for all pairs of the ordinal and interval scales from both analyses. This was done for resorts common to all four scales. A matrix of these coefficients is presented in Table 5.14. As would be expected, the strongest correlations are between the stated ordinal and interval scales, and the revealed ordinal and interval scales.

There is a moderately strong correspondence between both ordinal and interval scales. The correspondence between the two ordinal scales is slightly higher (r_s = .775) than it is between the two interval scales (r_s = .7544). However, it is clear from a listing of resorts' positions on all four scales, presented in Table 5.15, that some positions are substantially different when based on stated attraction rather than revealed attraction, or vice versa.

Nine resorts have rank differences of four positions or more between the ordinal stated and revealed attraction scales. These are Bolton, Glen Ellen, Maple Valley, Magic, Mt. Tom, Mt. Snow, Okemo, Pico, and Suicide Six. The rank positions of all these resorts, except Mt. Snow and Magic, are higher on the revealed scale than on the stated scale.

The positive changes in Pico, Mt. Tom, and Suicide Six can be attributed to skiing conditions on the day they were sampled. These three resorts were all sampled on the same day which happened to have the best skiing conditions of the season. This would presumably

Table 5.14

Spearman's Rank Correlation Coefficients Between Pairs of Ordinal and Interval Stated and Revealed Attraction Scales

	Stated Ordinal	Stated Interval	Revealed Ordinal	Revealed Interval
Stated Ordinal	-	.947	.775	.724
Stated Interval		-	.784	.754
Revealed Ordinal			-	.908
Revealed Interval				-

Table 5.15

Resort Positions on Ordinal and
Interval Stated and Revealed Attraction Scales

Resort	Stated Ordinal	Stated Interval	Revealed Ordinal	Revealed Interval
Bolton	12	9	8	7
Bromley	11	12	12	12
Carinthia	17	16	18	18
Glen Ellen	5	7	1	8
Haystack	14	14	15	14
Hogback	~~16~~	18	17	19
Killington	3	4	5	3
Mad River Glen	4	5	7	5
Magic	9	10	14	16
Maple Valley	15	17	19	15
Mt. Tom	18	19	11	11
Mount Snow	10	11	16	17
Okemo	13	13	9	6
Pico	8	8	4	4
Smuggler's Notch	7	3	10	10
Stowe	1	1	3	2
Stratton	6	6	6	9
Sugarbush	2	2	2	1
Suicide Six	19	15	13	13

result in an overestimation of the resorts' attractions because they will draw skiers from longer distances on good ski days than on average ski days.

The remaining six positional changes are much harder to explain. However, one general trend seems to have emerged: larger and more southern resorts, like Magic and Mt. Snow, reveal less attraction and more northern and smaller resorts, like Glen Ellen and Bolton, reveal more attraction than as judged by skiers. These differences seem to suggest that either the stated attraction scale overstresses the importance of resort size which results in large resorts appearing more attractive, or, the revealed attraction scale overstresses the importance of variables inversely related to resort development causing smaller resorts to appear more attractive. It is impossible to identify which of the two conditions exists because it is impossible to identify which of the two scales is more accurate.

Similar differences in resort rank occur between the <u>interval</u> stated and revealed attraction scales. In general, smaller resorts have higher positions on the revealed attraction scale and larger resorts have higher positions on the stated attraction scale.

Perhaps the most encouraging point related to scale similarity is that both scales have identified three groups of resorts: those with high, medium, and low attraction, and that both scales are in agreement as to which resorts are highly attractive, such as Stowe, Sugarbush, Killington, and Mad River Glen, and which resorts have low attraction like Hogback, Carinthia, and Maple Valley. Major differences in positioning are confined primarily to moderately attractive resorts. This is understandable insofar as these moderately attractive resorts' positions are more sensitive to small errors in sampling than the other two groups.

To elaborate on this point, consider three resorts, one with high attraction, one with moderate attraction, and one with low attraction. The highly attractive resort is considered attractive by 3/4 of all sampled skiers, the remaining 1/4 do not feel it is attractive. The moderately attractive resort is considered attractive by 1/2 of all skiers, and unattractive by the other 1/2. The resort with low attraction is considered attractive by only 1/4 of the skiers, and unattractive by the remaining 3/4. After having sampled all skiers, it is highly improbably that each resorts' percentage, based on the sample, would be the same as those above. A moderate amount of error throughout the entire sample would not greatly affect the high and low attraction resorts since the difference between each resorts' two proportions scores is so large. However, the same amount of error might make the moderate resort appear to have moderately high attraction or moderately low attraction. Furthermore, it is highly likely that scales derived from different samples of revealed preferences or stated preferences would show the same scale differences.

Summary

This chapter has been designed to derive scales of site attraction from skiers' revealed and stated preferences for ski sites. The ordinal scales produced by these two sets of data are highly consistent with the pair comparison matrices of attraction values. There has been some difficulty in deriving interval scales from the same data without violating monotonicity between the final configuration distances and the original dissimilarities measures. However, both the stated and revealed attraction scales have a recognizable shape and both scales suggest the same trend between certain resort characteristics and site attraction. The following chapter will attempt to explain which site variables cause variation in the derived scores.

Chapter 6 AN EXPLANATION OF SITE ATTRACTION SCALES

As stated in Chapter 1, it is the goal of this study to identify the properties of ski resorts which are hypothesized to govern the spatial choices of skiers. It has been suggested throughout this study that the spatial utility of a ski site is related to a combination of important site properties discounted by their distance from the skier. Some concatenation of these important properties at any site determines its attraction.

In the previous chapter, the distance component was separated out from expressions of relative site utility, leaving information on the relative attraction of sites. From this information measures of site attraction were derived. It is the purpose of this chapter to identify the ski site variables or properties which best explain the derived attraction measures.

This chapter will concentrate on three areas of analysis related to the above purpose. First, candidate properties will be identified as will each site's score on these properties. Second, regression analysis will be used to construct and calibrate a linear model of site attraction. Third, the results of an alternative method for identifying important site properties will be discussed.

The Selection and Scoring of Candidate Properties

An individual's preference for a spatial alternative can be thought of as being composed of a series of partworths attached to each important property of an alternative. These partworths are related to two quantities: the preference weight an individual attaches to a property and the amount of the property he perceives the alternative to have. The amount of a property any alternative has can be expressed as an objective amount or as a perceived or subjective amount.

In this study data were collected on the perceived amounts of properties for two reasons. First, it is difficult to obtain objective measures of certain abstract properties such as the degree of crowding or quality of runs. Second, since we postulate that an individual's choice is a response to perceived amounts of site properties, it would be necessary to relate objective measures to perceived measures by some psychophysical function whose nature is unknown. This would require additional analysis. In short, perceived measures were felt to be more accurate and relevant.

The site properties on which perceptual scores were obtained were selected, as discussed earlier, on the basis of a preliminary survey. This list was augmented by additional variables suggested by some expert skiers. The final list included eight properties or variables:

1. Crowding
2. Tow Ticket Price

3. Variety of Slopes
4. Length of Slopes
5. Accessibility
6. Familiarity
7. Quality of Slopes
8. Micro-Climate

The precise definition of these variables were left to the individual skier. Each was to mean what he thought it should.

Lists of the average perceptual scores for each resort on each variable and the number of individuals scoring the variable appear in Tables 6.1a-h.

Some interesting points can be made about scores in this list. There is a fair amount of variation in the number of times that any site was scored on any variable. On the variable of length of runs Burrington Hill was scored only 5 times whereas Killington was scored 196 times on the same variable. This variation reflects the fact that certain large resorts, such as Killington, are more widely known than smaller resorts like Burrington Hill.

It is also interesting to note the variation occurring in the average number of times any variable was scored. The site property scored most often was crowding, and the least often scored was micro-climate. This variation has two possible explanations: either some variables are easier to score resorts on, thus eliciting greater res-

Table 6.1a

Resort Average Crowding Scores

Resort	Average Score	Number of Times Scored
Bolton	34.97	44
Bromley	66.63	150
Burke	27.57	35
Burrington Hill	36.00	6
Carinthia	25.48	25
Glen Ellen	44.19	111
Haystack	44.93	79
Hogback	37.00	40
Jay	51.30	81
Killington	75.26	219
Mad River Glen	43.18	88
Magic	44.03	76
Maple Valley	37.32	31
Middlebury	35.89	28
Mt. Ascutney	34.08	25
Mount Snow	80.43	193
Mt. Tom	52.00	41
Norwich University	23.25	8
Okemo	50.14	74
Pico	49.78	87
Pinnacle	16.00	9
Prospect	21.27	11
Smuggler's Notch	45.11	70
Sonneberg	15.00	2
Stowe	70.15	199
Stratton	74.25	140
Sugarbush	62.65	125
Suicide Six	38.00	12

Table 6.1b

Resort Average Tow Ticket Price Scores

Resort	Average Score	Number of Times Scored
Bolton	46.62	29
Bromley	71.83	125
Burke	37.09	31
Burrington Hill	45.66	6
Carinthia	39.34	23
Glen Ellen	61.53	82
Haystack	53.62	59
Hogback	33.33	36
Jay	58.85	63
Killington	77.87	174
Mad River Glen	62.08	71
Magic	62.21	62
Maple Valley	32.66	30
Middlebury	42.66	18
Mt. Ascutney	41.74	17
Mount Snow	79.17	154
Mt. Tom	44.73	34
Norwich University	24.28	7
Okemo	61.27	58
Pico	61.52	67
Pinnacle	11.22	9
Prospect	22.60	10
Smuggler's Notch	60.47	59
Sonneberg	24.00	2
Stowe	83.44	169
Stratton	82.18	121
Sugarbush	75.62	101
Suicide Six	45.30	10

Table 6.1c

Resort Average Variety Scores

Resort	Average Score	Number of Times Scored
Bolton	35.15	39
Bromley	57.21	139
Burke	49.63	31
Burrington Hill	27.60	5
Carinthia	28.00	22
Glen Ellen	61.62	95
Haystack	47.61	77
Hogback	34.26	38
Jay	71.09	74
Killington	83.12	218
Mad River Glen	60.97	93
Magic	53.87	70
Maple Valley	30.76	26
Middlebury	32.72	22
Mt. Ascutney	43.58	24
Mount Snow	76.10	177
Mt. Tom	35.37	35
Norwich University	21.00	8
Okemo	55.33	69
Pico	56.62	80
Pinnacle	23.30	10
Prospect	31.61	13
Smuggler's Notch	68.64	67
Sonneberg	15.00	2
Stowe	87.37	196
Stratton	72.80	135
Sugarbush	76.07	129
Suicide Six	34.90	10

Table 6.1d

Resort Average Length Scores

Resort	Average Score	Number of Times Scored
Bolton	36.27	37
Bromley	57.30	130
Burke	52.40	30
Burrington Hill	22.60	5
Carinthia	23.36	19
Glen Ellen	66.91	86
Haystack	47.98	66
Hogback	29.88	35
Jay	73.63	71
Killington	83.04	196
Mad River Glen	64.48	84
Magic	52.32	71
Maple Valley	36.45	24
Middlebury	38.55	18
Mt. Ascutney	48.04	22
Mount Snow	74.82	161
Mt. Tom	35.25	28
Norwich University	15.37	8
Okemo	57.06	59
Pico	58.28	80
Pinnacle	21.25	8
Prospect	25.12	8
Smuggler's Notch	70.90	62
Sonneberg	18.50	2
Stowe	88.71	197
Stratton	71.30	120
Sugarbush	78.08	118
Suicide Six	38.53	13

Table 6.1e

Resort Average Accessibility Scores

Resort	Average Score	Number of Times Scored
Bolton	63.62	40
Bromley	64.85	128
Burke	46.89	29
Burrington Hill	89.75	4
Carinthia	69.15	19
Glen Ellen	49.50	98
Haystack	71.09	78
Hogback	76.77	36
Jay	35.97	75
Killington	53.62	191
Mad River Glen	46.40	89
Magic	69.67	64
Maple Valley	76.27	22
Middlebury	50.05	20
Mt. Ascutney	52.48	25
Mount Snow	67.00	166
Mt. Tom	70.88	35
Norwich University	58.37	8
Okemo	60.92	65
Pico	59.02	76
Pinnacle	61.42	7
Prospect	89.50	10
Smuggler's Notch	43.30	70
Sonneberg	51.50	2
Stowe	37.70	195
Stratton	62.90	126
Sugarbush	46.28	125
Suicide Six	58.75	12

Table 6.1f

Resort Average Familiarity Scores

Resort	Average Score	Number of Times Scored
Bolton	87.97	39
Bromley	85.52	133
Burke	82.69	26
Burrington Hill	89.25	4
Carinthia	80.23	17
Glen Ellen	87.13	100
Haystack	80.19	71
Hogback	92.03	33
Jay	80.62	74
Killington	88.07	196
Mad River Glen	83.01	89
Magic	84.20	69
Maple Valley	89.57	26
Middlebury	69.68	25
Mt. Ascutney	76.60	25
Mount Snow	86.44	173
Mt. Tom	85.45	35
Norwich University	60.88	9
Okemo	84.36	74
Pico	86.15	86
Pinnacle	79.12	8
Prospect	79.72	11
Smuggler's Notch	87.91	74
Sonneberg	33.75	4
Stowe	86.26	184
Stratton	85.46	126
Sugarbush	81.59	131
Suicide Six	67.25	12

Table 6.1g

Resort Average Quality Scores

Resort	Average Score	Number of Times Scored
Bolton	59.39	28
Bromley	72.40	107
Burke	49.24	25
Burrington Hill	25.25	4
Carinthia	59.00	15
Glen Ellen	62.09	72
Haystack	44.55	49
Hogback	45.89	29
Jay	73.63	63
Killington	76.15	163
Mad River Glen	64.03	69
Magic	60.07	53
Maple Valley	32.81	21
Middlebury	51.11	18
Mt. Ascutney	35.80	20
Mount Snow	69.94	137
Mt. Tom	53.53	28
Norwich University	29.12	8
Okemo	54.64	53
Pico	61.90	65
Pinnacle	27.50	8
Prospect	43.14	7
Smuggler's Notch	66.41	61
Sonneberg	90.00	1
Stowe	80.49	164
Stratton	75.27	97
Sugarbush	71.98	94
Suicide Six	41.16	6

Table 6.1h

Resort Average Micro-Climate Scores

Resort	Average Score	Number of Times Scored
Bolton	63.89	28
Bromley	65.74	97
Burke	67.36	19
Burrington Hill	60.00	3
Carinthia	72.33	12
Glen Ellen	56.55	60
Haystack	54.42	52
Hogback	73.32	25
Jay	47.50	61
Killington	58.90	149
Mad River Glen	55.91	59
Magic	65.16	49
Maple Valley	53.85	20
Middlebury	62.38	13
Mt. Ascutney	50.50	20
Mount Snow	65.23	132
Mt. Tom	61.08	23
Norwich University	43.00	6
Okemo	64.90	43
Pico	64.13	65
Pinnacle	52.00	5
Prospect	51.80	5
Smuggler's Notch	55.70	58
Sonneberg	55.00	1
Stowe	57.68	144
Stratton	59.42	88
Sugarbush	60.97	79
Suicide Six	53.33	6

Table 6.2

Average Number of Scorings for Each Variable

Variable	Average Number of Times Scored
Crowding	71.75
Tow Ticket Price	58.03
Variety	67.96
Length	62.78
Accessibility	64.71
Familiarity	66.21
Quality	52.32
Micro-Climate	47.21

ponse; or, because of the order in which the variables were presented skiers would be more probable to score the first presented than the last. Table 6.2 shows the variability in the average number of times each variable was scored.

In the following section the distributions of resort scores for each variable will be examined. Six resorts are excluded from this discussion because their site scores are based on very small sample sizes. These resorts are Burrington Hill, Norwich University, Pinnacle, Prospect, Sonneberg, and Suicide Six.

Crowding

Average perceptual scores for crowding range from a low of 27.57 at Burke to a high of 80.43 at Mt. Snow. From the distribution of scores (Table 6.1a) it would appear skiers divide resorts into two groups: those resorts with a high degree of crowding such as Mt. Snow, Stowe, Killington, and Sugarbush with scores ranging between 60 and 80, and those with a more moderate degree of crowding having scores between 25 and 50. However, even within this latter group, distinctive subgrouping has occurred. Upon closer inspection three subgroups occur: 1) medium crowding, including Okemo, Mt. Tom, Jay, and Pico (values between 49 and 52); 2) medium-low crowding, including Haystack, Smuggler's Notch, Glen Ellen, Magic, and Mad River Glen (values between 43 and 45); and 3) low crowding, including Maple Valley, Hogback, Middlebury, Bolton, and Mt. Ascutney (values between 34 and 37).

Tow Ticket Price

Average perceptual scores of resorts on tow ticket price have a very similar distribution to scores on crowding (Table 6.1b). There is a wide range of scores from a high at Stowe of 83.44 to a low at Maple Valley of 32.66. Three distinct groups can also be identified. First, there is a high priced group consisting of Bromley, Sugarbush, Killington, Mt. Snow, Stratton, and Stowe. This group's values range from 71 to 83. Second, there is a medium priced group consisting of the resorts Smuggler's Notch, Jay, Glen Ellen, Pico, Magic, Mad River Glen, Okemo, and Haystack. This medium priced group's values range from 53 to 60. A final lower priced group is quite distinct. Its members include Bolton, Mt. Ascutney, Mt. Tom, Middlebury, Carinthia, Burke, Hogback, and Maple Valley. This final group's values range from 32 to 46, a much wider range than the other groups.

Variety of Runs

Average perceptual scores on variety of runs tended to spread out a bit more than in the two previous distributions of scores. The scores range from a high of 87.37 for Stowe to a low of 28.00 for Carinthia. While grouping is not as distinctive as in the earlier cases, some subgrouping is nevertheless evident. Smaller resorts with less variety had scores ranging from 28 to 35. These smaller resorts include Bolton, Hogback, Mt. Tom, Middlebury, and Maple Valley. A second group of larger resorts, with scores on variety ranging from 43 to 61, appears evident. Interestingly enough the smaller members of this group, such as Mt. Ascutney, Haystack, Magic, and Burke, have been given correspondingly smaller scores than the larger members of the group like Pico, Bromley, Mad River Glen, and Glen Ellen. A final group consisting of the unquestionably largest resorts has variety scores ranging from 68 to 87. As in the second group just described, there is a recognizable gradient of size in this final group. The smaller resorts such as Smuggler's Notch and Jay appear at the low end of the group with the largest resorts of Killington and Stowe at the top.

Length of Runs

Scores of ski resorts on length of runs range from a low of 23.36 for Carinthia to a high of 88.71 for Stowe. As with the previously reported scores on other properties, there is a very distinctive grouping of small resorts. The members of this small resort group are identical, member for member, with those of the small resort group defined on variety of runs. However, further grouping beyond the smallest resorts doesn't occur as neatly as in the previous cases. Nevertheless, there is a steady upward gradient of length from the smaller resorts like Mt. Ascutney and Haystack to the very large resorts like Stowe and Killington. Upon closer inspection, the relative positions of members in this large group of resorts defined on the basis of length of runs are very similar to the relative positions of members of the two larger groups defined on variety of runs. The only difference is that the absolute positions of Mad River Glen and Glen Ellen have shifted from a lower position on the variety scale to a higher position on the length scale. This has the effect on the length scale of providing a transition from medium sized to larger sized resorts which was not evident on the variety scale.

This subtle change is very interesting and suggests a certain sensitivity of this scoring method to actual changes in perception. In terms of variety Glen Ellen and Mad River Glen are more similar to resorts like Bromley and Pico than Killington and Stowe. After all, variety is related to the degree of resort development and not necessarily the physical characteristics of the hills. However, length of runs is related very closely to effective vertical drop, a physical characteristic of hills and not of resort development. The effective vertical drop of hills tends to increase as one moves north in Vermont because the size of hills becomes larger. This causes the length of runs to increase. The fact that skiers, on the average, perceived the more northernly resorts of Mad River Glen and Glen Ellen to be more accurately aligned with smaller resorts on variety and larger resorts on length seems to suggest the method is fairly sensitive to slight changes in perception.

Accessibility

Accessibility scores reflect the general distribution of skiers sampled in the study. Higher scores have been assigned to hills in southern Vermont, whereas lower accessibility scores have been associated with northern resorts like Jay and Stowe. This is due to the fact that most skiers sampled in the study reside in New York, Connecticut, and Massachusetts. It is interesting to note that the interval difference between moderately accessible resorts and poorly accessible resorts on the perceptual scale is much different than the interval differences between these resorts in actual distance. As would be expected, poorly accessible resorts such as Jay and Stowe, about 40 actual miles apart, have respective perceptual scores of 35.97 and 37.7, while Mt. Tom and Suicide Six which are more accessible for most of the skiers sampled are only 5 miles apart, and yet have respective perceptual scores of 70.88 and 58.75. Another point can be made about northern resorts which have moderately high accessibility scores. Resorts like Bolton, Burke, and Pico are used by a lot of local skiers. This causes their accessibility scores to be unusually higher than other resorts in their immediate vicinity which are used by nonlocal skiers. A case at point is Pico and Killington. Pico is used by a lot of Rutland skiers, residing about 10 miles away. However, Killington which is only 10 miles from Pico, has a lot of New York and Massachusetts skiers. This causes their respective accessibility scores to differ.

Familiarity

Familiarity was originally included in the analysis as a possible explanatory variable of skier preferences. It was felt that skiers could express preference for resorts they had never actually skied at but knew of through various sources. In this case preference might vary somewhat according to the amount of information the skier had about a particular resort. Therefore, skiers were asked to score only those resorts they had never been to, presuming that resorts where they had skied would be reasonably familiar. However, the directions were disregarded by many skiers filling out the questionnaire and they would score resorts that they had been to. When the scores were compiled it became obvious that some skiers had correctly followed the instructions while others had not. Thus the scores are not reliable measures of familiarity and are not included in the analysis.

Quality of Runs

Perceptual scores on the quality of runs range from a low of 32.81 for Maple Valley to a high of 80.49 for Stowe. In general the relative positions of resorts on the quality scale remain similar to their positions on the length and variety scales. There are some notable exceptions. Smaller resorts such as Carinthia and Bolton and medium resorts like Bromley have higher quality scores. This simply indicates that while the size of hills and amount of development at a resort may not be great, the quality of runs can still be good. In general scores tended to be high and most resorts have scores between 60 and 80. This suggests that perhaps skiers have a harder time accurately discriminating between relatively similar sites on an intangible property like quality of runs than on a more concrete property such as tow ticket price.

Micro Climate

Average perceptual scores on micro-climate range from a low of 47.5 for Jay to a high of 73.32 for Hogback. This is the smallest range of variation in any of the variables on which scores were obtained. Furthermore, most of the scores are confined to the range between 50 and 65, suggesting that this variable was the hardest to discriminate differences between resorts.

A matrix of the correlation coefficients between each pair of variables based on mean resort scores is presented in Table 6.3. This matrix reveals that many of the variables are highly intercorrelated. Crowding is most strongly correlated with price (r = .897) while it is also strongly correlated with variety (r = .802), length (r = .761) and quality (r = .734). This strong correlation of crowding and price points out that large volumes of skiers are skiing at more expensive resorts. However, it does not necessarily suggest that resort price has a relatively small impact on skiers' choices. It is also understandable that crowding would be strongly correlated with such ski site variables as length, variety, and quality of runs. Obviously as these properties improve from site to site they will attract larger and larger crowds.

Price is most strongly correlated with variety of runs (r = .907) and equally well correlated with length of runs (r = .876) and quality of runs (r = .857). This relationship reflects the fact that skiers perceive resorts with better variety, higher quality, and longer runs as the higher price resorts.

Table 6.3

Product Moment Correlation Between Average Resort Site Characteristic Scores

	Crowding	Tow Ticket Price	Variety	Length	Accessibility	Familiarity	Quality	Micro-Climate
Crowding	-	.897	.802	.761	-.119	.313	.734	-.080
Tow Ticket Price		-	.907	.876	-.347	.232	.857	-.115
Variety			-	.908	-.572	.298	.818	-.245
Length				-	-.645	.238	.767	-.345
Accessibility					-	.239	-.454	.464
Familiarity						-	.315	.293
Quality							-	.067
Micro-Climate								-

Variety is very highly correlated with length (r = .988) and less strongly correlated with quality (r = .818). This reflects the relative interdependence of each of these variables. One would expect that most resorts with a large variety would probably have the longer runs. However, quality of runs is more independent of physical characteristics of a hill such as length and variety of runs.

The remaining three variables of accessibility, familiarity, and micro-climate show no outstanding interrelationships either amongst themselves or with previously discussed variables.

Regression of the Site Attraction Scales and Site Variable Scores

Site attraction can be expressed as a function of important site variables or properties. In the previous chapter two measures of site attraction were derived for most of the ski sites included in this study. One scale, termed stated site attraction, was derived from skiers' rankings of sites in terms of preference. The second scale, termed revealed attraction, was derived from the revealed preferences of skiers for resorts.

In this part of the study both of these measures of attraction will be taken in turn as a dependent variable to be explained in terms of the independent variables identified in the preceding section of this chapter. The purpose of this step is to, first, identify which variables are related to site attraction and, second, identify the contribution each of these variables makes to a measure of attraction at each site.

This study assumes that site attraction is an additive function of important site variables. More specifically, attraction is equal to the sum of products of the quantity of a variable perceived at a resort times the preference weighting attached to the variable. This attraction function was presented earlier in this study in (1.5) as:

$$A_j = \sum_{k=1}^{n} (w_k q_{kj}) \tag{1.5}$$

where, A_j = the attraction of site j;

w_k = the preference weighting skiers attach to the kth variable;

q_{kj} = the average amount of the kth variable skiers perceive at site j.

The known quantities in (1.5) are the attraction scores for each site (A_j) and the quantities of different variables perceived at the sites (q_{kj}). The specific problem is to identify the weightings (w_k) for each variable and identify which n variables are to be included.

The above attraction function can be rewritten as:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_7X_7 + e \tag{6.1}$$

where, y = the attraction of a site;

X_1 = degree of crowding;

X_2 = tow ticket price;

X_3 = variety of runs;

X_4 = length of runs;

X_5 = accessibility;

X_6 = quality of runs;

X_7 = micro-climate;

$b_1 \ldots b_7$ = preference weightings attached to each of the seven site variables;

a = a scaling parameter;

e = an error term.

In this form the attraction function can be calibrated through stepwise multiple regression. The regression will identify which variables significantly reduce the amount of unexplained variance in attraction values and what the values of the preference weightings are.

Three site variables are identified as best explaining variation in stated site attraction values. They are length of runs, quality of runs, and degree of crowding. The final attraction function was calibrated as

$$\hat{A}_j = -167.32 + 3.52\ X_4 - 2.61\ X_1 + 1.69\ X_6 \qquad (6.2)$$

This model accurately predicts 90 percent of the observed variation in stated attraction values (r^2 = .909) using the three variables of length of runs, quality of runs, and degree of crowding. Various statistics associated with this regression are presented in Table 6.4.

The standard error of the estimate (SEE) is 19.23, suggesting a low amount of scatter in the measures of stated site attraction around the fitted regression plane. 83 percent of the attraction values are within 1 SEE of their predicted values; and 96 percent of the actual measures are within 2 SEE of their predicted values. Table 6.5 shows the observed and estimated attraction values for each ski resort along with each resort's residual and standardized residual.

It is interesting to note which resorts the regression poorly predicts, i.e., those falling outside 1 SEE of the regression plane. Four resorts are included in this group: Burke, Glen Ellen, Jay, and Stratton. All four resorts are big resorts having high stated attraction values. The regression underpredicts the values for Burke and Stratton. In other words, on the basis of the regression both of these hills would be assigned lower attraction values than they were given by the skiers. A plausable explanation for this is that both Burke and Stratton have additional variables which affect their attraction. The case of Stratton is a good example. It is one of the biggest resorts, in a commercialized sense, in the state. Skiing is only one of the many activities offered at this resort complex. Additionally, there is a huge housing development where skiers have built condominiums. All of these extraneous variables may cause skiers to perceive Stratton in a more complete recreational sense, than in a specific skiing sense.

Table 6.4

Regression Statistics For Stated Attraction Analysis

Variable	Regression Coefficient	Standard Error of the Regression Coefficient	Computed T	Beta Coefficient
Length	3.525	.392	8.974*	1.084
Crowding	-2.614	.432	-6.042*	-0.690
Quality	1.696	.513	3.307*	0.382

* significant at the .005 probability level

Multiple Correlation Coefficient	.953
Standard Error of the Estimate	19.237

Table 6.5

Derived Stated Attraction Measures, Predicted Attraction Measures, Residuals, and Standardized Residuals

Resort	Derived A_j	Predicted A_j	Residual	Standardized Residual
Bolton	-11.244	-30.094	18.850	0.980
Bromley	-0.476	-16.632	16.156	0.840
Burke	85.356	29.058	56.298	2.927
Carinthia	-69.875	-51.467	-18.408	-0.957
Glen Ellen	35.379	58.366	-22.987	-1.195
Haystack	-46.328	-40.019	-6.309	-0.328
Hogback	-97.363	-80.834	-16.529	-0.859
Jay	59.257	83.104	-23.848	-1.240
Killington	50.716	57.925	-7.209	-0.375
Mad River Glen	43.042	55.798	-12.756	-0.663
Magic	9.462	3.966	5.496	0.286
Maple Valley	-88.108	-80.698	-7.410	-0.385
Middlebury	-20.186	-38.507	18.322	0.952
Mt. Ascutney	-30.501	-26.291	-4.210	-0.219
Mount Snow	5.608	4.893	0.715	0.037
Mt. Tom	-100.000	-88.149	-11.851	-0.616
Okemo	-4.896	-4.505	-0.391	-0.020
Pico	17.383	13.055	4.328	0.225
Smuggler's Notch	62.630	77.410	-14.780	0.768
Stowe	100.000	98.638	1.362	0.071
Stratton	37.701	17.680	20.021	1.041
Sugarbush	73.822	66.325	7.497	0.390
Suicide Six	-63.339	-60.975	-2.364	-0.123

The reason for an underprediction of Burke's attraction is much harder to explain. It is not at all commercialized in the way that Stratton is. The only outstanding attribute not accounted for in the regression is that it is highly inaccessible to most of the east coast skiing market. This may be a very important aspect in Burke's actual attraction. However, this is purely speculation and is not supported by other resorts with equally poor accessibility but which the regression overpredicts.

The regression overpredicts attraction values for Jay and Glen Ellen. Put another way, the variables and weightings identified in the regression suggest that Jay and Glen Ellen should be more attractive than skiers think they are. The overprediction is easily explanable by the fact that both resorts have excellent skiing facilities and not a tremendous amount of crowding. However, the factors which cause a lower observed attraction value to occur are not readily identifiable.

One might conclude that the regression poorly predicts larger ski resorts as evidenced by the cases of Burke, Stratton, Jay, and Glen Ellen. However, this is not the case. The largest but not necessarily most attractive resorts' attraction values are very accurately predicted: Stowe's standardized residual is .071, Killington's is .375, and Mt. Snow's is .037. Smaller resorts are also relatively well predicted, with all observed attraction values falling within 1 SEE of their predicted values.

In conclusion, this additive model of attraction is reasonably accurate in predicting the stated attraction values for most ski sites in the sample. It has revealed that attraction is related to the length and quality of runs at a resort and the amount of crowding.

Site attraction scores derived from the revealed preference analysis were also regressed against site variable scores. This regression identified one variable, length of runs, as the best predictor of the revealed site attraction values. The calibrated model is,

$$\hat{A}_j = -79.863 + 1.77\, X_4$$

Regression statistics associated with this analysis are presented in Table 6.6. This model explains about 45 percent of the variation in the revealed attraction values ($r = .675$). Other attraction functions with additional variables were calibrated. However, as Table 6.7 points out, the inclusion of additional variables had very little effect at reducing the amount of unexplained variance in the revealed attraction scores.

TABLE 6.7

Alternative Attraction Models

Variables	r	r^2	Increase in r^2
Length	.6754	.4562	.4562
Length, Quality	.7200	.5191	.0629
Length, Quality, Crowding	.7328	.5371	.0180

Table 6.6

Regression Statistics For Revealed Attraction Analysis

Variable	Regression Coefficient	Standard Error of the Regression Coefficient	Computed T
Length	1.776	.457	3.886 *

* significant at the .005 probability level

Correlation Coefficient	.675
Standard Error of the Estimate	40.364

The fact that the revealed attraction scale is not as accurately predicted as the stated attraction scale may be related to three sources of error. First, Rosses inferential technique, outlined in 3.6 and 3.7) may not provide sufficiently accurate information on the relative attraction of two sites. This inadequacy may be related to a second source of spatial bias. This point will be discussed further in the following chapter.

Second, the attraction scale derived from stated preferences may reflect measures of attraction which have been "simplified" by the interviewed skiers. It is conceivable that skiers, when making introspective judgements on their preferences for ski sites, only focus on variables of seemingly apparent importance. These variables may, however, have only moderate actual importance in their behavior. Because it is variables of apparent importance which have been regressed with the attraction measures, it is hardly surprising that they better predict introspective judgements than actual behavior.

A third reason why the stated attraction measures are better predicted is that both the stated preference rankings and the site variable score were obtained from the same group of skiers. Skiers, in answering the questionnaire, may have attempted to justify their preference rankings by giving site variable scores consistent with the rankings. In short, there is more internal consistency between the site scores and the stated attraction measures than between the site scores and the revealed attraction measures.

Explanation of Site Attraction Scales

The regression analysis of stated attraction scores has been successful at identifying and weighting the effect of three site characteristics on site attraction. The analysis of revealed site attraction was successful in identifying and weighting one site variables. Because of the predictive accuracy of the stated attraction model, any further discussion on the relationship between site attraction and site variables will focus on information obtained from this regression.

From the analysis of stated site attraction scores certain inferences can be drawn about the effect of variables on site attraction scores. First, the analysis has identified length and quality of runs and degree of crowding as the site characteristics which best explain the site attraction scores. Interestingly enough, they have the same approximate importance as skiers suggested in the Ellis and Ker study (Ellis and Ker, 1971). Furthermore, length of runs may also be the best representative of a more general factor describing the overall characteristics of a ski hill (eg., length and variety). Secondly, the regression has identified how site attraction is related to these three variables: it is positively related to length and quality of runs and inversely related to degree of crowding. Site variables like length of runs and quality of runs certainly have positive utility associated with them. That is, the more of them at a site, the better the skiing. It would be expected that they would be positively related to site attraction. Crowding, on the other hand, has negative utility and therefore it would be expected that site attraction would decrease as it increased.

Length of runs has been identified as the most important of the three variables. It is about three times as important as quality of runs and a little less than twice as important as degree of crowding. Crowding is the second most important characteristic and it is about twice as important as quality of runs.

The fact that the two most important variables have an entirely different effect on site attraction scores suggests that there is a trade-off between these two variables at each site. For some sites the long runs offset high crowding, resulting in moderately high attraction. Smaller sites having the same amount of crowding may be much less attractive because they do not have enough positive utility in the form of long runs to offset the negative utility of crowding.

Figure 6.1 shows the derived attraction surface plotted in a two dimensional attribute space defined by crowding on the x axis and length of runs on the y axis. This shows graphically the trade-off relationship between length and crowding identified in the stated attraction analysis. Site attraction is high in the upper left of the graph where there is moderate length of runs but very low crowding. The attraction surface slopes downward toward the lower right hand corner where there is high crowding and short hills. There are no hills in these corners because either such attractive opportunities don't

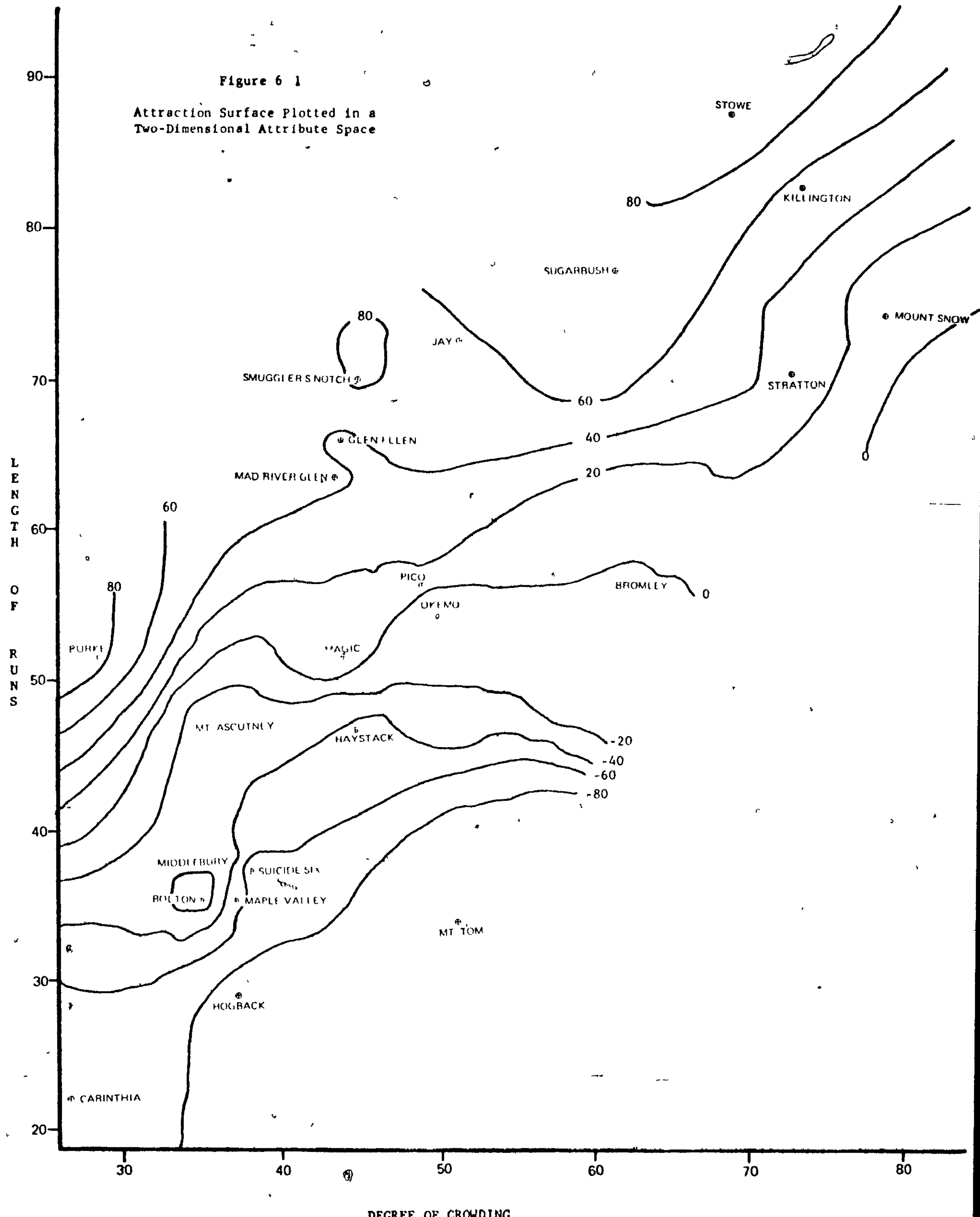


Figure 6 1

Attraction Surface Plotted in a Two-Dimensional Attribute Space exist (as would be the case in the upper-left hand corner where resorts would have long runs and low crowding) or they would not have sufficient attraction to survive economically (as would be the case in the lower-right hand corner where resorts would have short runs and large crowds).

The general shape of the attraction trade-off surface illustrates the notion that as length increases so does attraction and as crowding increases attraction decreases. Resorts, such as Burke, with moderate sized hills but very low crowding have high attraction. Hills with the same amount of length of runs but more crowding show substantial decreases in attraction, as is the case with Magic. On the other hand, hills with high crowding and small hills have very low attraction. This is the case with Mt. Tom. As the length of hills increase attraction increases in spite of the same degree of crowding, as with Jay, Pico, and Okemo.

In general, as the degree of crowding increases it takes proportionately greater amounts of length of runs for a hill to obtain a higher attraction value. In certain areas of the surface, the gradient is not very steep, suggesting that it takes larger amounts of either crowding or length to increase or decrease attraction values. This is the situation in the middle of the graph. In other areas the surface rises and falls off very sharply. A good example is the surface around Burke. Very small changes in either crowding or length of runs cause very big changes in attraction values. For example, Mt. Ascutney which has slightly shorter runs and slightly more crowding than Burke has substantially less attraction than Burke.

The Identification of Important Site Characteristics Through Perceptual Scaling

In the preceeding regression analysis the site characteristics of length of runs, quality of runs, and degree of crowding were identified as important determinants of site attraction. This section will examine an alternative method for identifying the important characteristics of spatial alternatives. This method, termed similarities analysis by Coombs (Coombs, 1964), was developed in psychology and has been tested in a number of situations.

When presented with three sites, people can perceive the first site as more similar to the second site than the third site. In the case of skiers, they can perceive some resorts being more similar and some as being more dissimilar. Such a comparison must, however, be made according to some standard. It is hypothesized that this standard is one or a number of attributes shared by all sites, which a skier uses to discriminate between sites. These attributes can be regarded as the dimensions of an aggregate perceptual space within which judgements of resort similarity occur.

It is of interest to see whether or not this group of variables will contain site variables which govern preference; namely, those related to site attraction. Furthermore it is of interest to examine the relative importance that "preference related variables" have in judgements of perceptual similarity. One might expect a strong relationship between these two sets of variables. Hence, it is the purpose of this section to construct a similarities space which would reflect the perceived similarity between ski resorts and then identify properties which bound this space.

Data

Each skier in the sample was asked to separate the resorts he was familiar with into as many groups as he thought necessary so that all members of each group would be more similar to each other than to members of any other group. Each time a skier grouped a set of resorts this was recorded in a sample size matrix. Each cell in this matrix denotes the number of times that the row and the column ski sites were compared. A second matrix was simultaneously constructed and each time any site i and any site j were grouped by a skier, the ijth cell of this second matrix was incremented. After all skiers' groupings were examined a similarities matrix was constructed. This was done by simply dividing each cell of the first matrix, representing the maximum number of times that a row and column site could be judged similar, by the same cell in the second matrix which showed the number of times the two resorts were actually judged to be similar. This matrix of similarity measures is presented in Table 6.8.

Values in this matrix represent the perceptual similarity between any row and column ski site. This representation is in a numer-

Table 6.8

Similiarities Matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Bolton	1.	-																						
Bromley	2.	0.42	-																					
Burke	3.	0.50	0.13	-																				
Carinthia	4.	0.32	0.13	0.32	-																			
Glen Ellen	5.	0.36	0.30	0.20	0.33	-																		
Haystack	6.	0.25	0.42	1.00	0.45	0.44	-																	
Hogback	7.	0.75	0.07	0.50	0.57	0.33	0.67	-																
Jay	8.	0.20	0.29	0.31	0.00	0.39	0.13	0.25	-															
Killington	9.	0.21	0.28	0.17	0.00	0.26	0.08	0.13	0.40	-														
Mad River Glen	10.	0.26	0.17	0.80	0.00	0.57	0.17	0.20	0.50	0.22	-													
Magic	11.	0.67	0.60	0.32	0.00	0.50	0.69	0.40	0.29	0.15	0.40	-												
Maple Valley	12.	1.00	0.28	0.50	0.43	0.00	0.58	0.82	0.00	0.06	0.33	0.43	-											
Middlebury	13.	0.50	0.21	0.50	0.32	0.10	0.50	1.00	0.09	0.05	0.19	0.50	1.00	-										
Mt. Ascutney	14.	0.50	0.24	0.00	0.00	0.25	0.71	0.50	0.00	0.16	0.21	0.33	0.00	0.50	-									
Mount Snow	15.	0.20	0.40	0.07	0.00	0.20	0.11	0.07	0.19	0.50	0.11	0.20	0.05	0.00	0.20	-								
Mt. Tom	16.	1.00	0.32	0.33	0.40	0.20	0.57	0.44	0.20	0.10	0.20	0.17	0.33	0.32	1.00	0.14	-							
Okemo	17.	0.55	0.45	0.38	1.00	0.32	0.65	0.63	0.25	0.11	0.43	0.68	0.55	0.31	0.78	0.07	0.42	-						
Pico	18.	0.54	0.45	0.14	0.33	0.45	0.38	0.71	0.20	0.25	0.30	0.58	0.14	0.43	0.64	0.22	0.33	0.54	-					
Smuggler's Notch	19.	0.43	0.09	0.38	0.00	0.53	0.06	0.25	0.43	0.40	0.38	0.33	0.00	0.17	0.25	0.19	0.00	0.41	0.46	-				
Stowe	20.	0.12	0.16	0.20	0.00	0.27	0.07	0.05	0.48	0.53	0.37	0.08	0.00	0.20	0.05	0.32	0.05	0.09	0.08	0.44	-			
Stratton	21.	0.20	0.54	0.00	0.20	0.30	0.11	0.11	0.23	0.48	0.18	0.30	0.21	0.11	0.13	0.52	0.05	0.16	0.41	0.43	0.41	-		
Sugarbush	22.	0.15	0.21	0.13	0.00	0.42	0.08	0.00	0.32	0.50	0.23	0.15	0.00	0.05	0.08	0.49	0.00	0.07	0.16	0.30	0.51	0.46	-	
Suicide Six	23.	1.00	0.33	0.33	0.32	0.20	0.75	1.00	0.60	0.14	0.33	0.67	0.32	1.00	0.75	0.14	0.32	1.00	0.60	0.25	0.38	0.00	0.17	-

ical form and is an aggregate expression in the sense that no value may necessarily represent the perception of an individual skier but rather what all skiers have indicated in the aggregate.

Scaling the Similarities Matrix

This perceptual similarity between any two ski sites can also be represented physically in a multidimensional space. In this space perceptual similarity is represented by the distance separating points corresponding to the ski sites. Small distances signify a high degree of perceived similarity between the two resorts and large distances reflect a high degree of dissimilarity.

The transformation of the aggregate measures of perceptual similarity from their numeric form in Table 6.8 to a physical or distance form is done through the use of the multidimensional scaling algorithm SSA-1, described in Chapter 4.

The advantage of scaling the similarities matrix in this manner is twofold. First, the configuration of points and their derived spatial relations produced by SSA-1 provide easily visualizable relationships of the perceptual similarity between different resorts. Such relationships are very hard to discern in the original similarities matrix. Second, once this configuration is derived, and provided that it satisfactorily reflects relationships inherent in the similarities matrix, further analysis can be performed on the configuration of points that cannot be performed on the matrix of similarity measures.

The similarities measures presented in Table 6.8 were used as input for SSA-1. The rows and columns for the resorts Burrington Hill, Norwich University, Pinnacle, Prospect, and Sonneberg have been removed because they contained a large amount of missing data (i.e., no comparisons). The dimensionality of the scaling solution was to be determined on the basis of two criteria suggested by Shepard (Shepard, 1972, p. 9): low residual departure from monotonicity (STRESS), and configuration interpretability. A two-dimensional configuration was arbitrarily selected for initial examination; subsequent enlargement or reduction of dimensionality was to be directed by the amount of STRESS contained in the initial configuration (i.e., high STRESS suggesting higher dimensionality and very low STRESS suggesting fewer dimensions, namely, one).

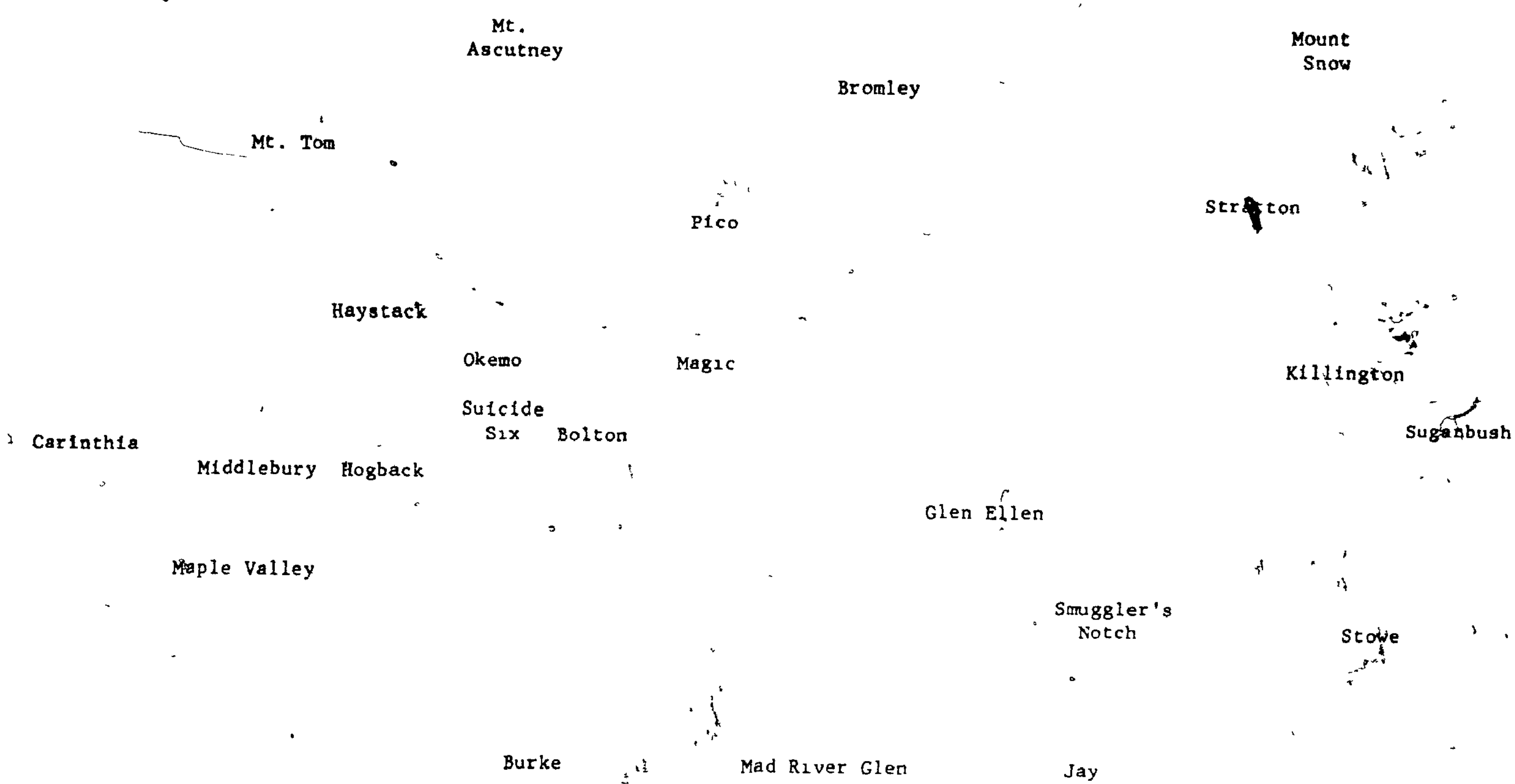
The two-dimensional configuration is presented in Figure 6.2. The computed stress value for this configuration is a reasonably low 0.186, suggesting an 18 percent departure from monotonicity. The algorithm has positioned most of the larger resorts in the lower right of the configuration, the moderate sized resorts in the middle of the configuration, and the smaller sites to the left. Such a distinguishable gradient of resort size suggests that the configuration has some fairly obvious underlying properties. Because STRESS was sufficiently low and the configuration had a very obvious shape, no further solutions were sought.

Fitting Property Vectors to the Perceptual Space

It can be reasonably asserted that if the shape of this

Figure 6.2

Perceptual Similiarity Space



Kruskal's Stress Coefficient: 0.18644

derived space is a result of the comparison of resorts on the basis of common characteristics, these characteristics should be identifiable in the space in the form of vectors which span or bound the space. However, no method has been devised which allows the dominant properties shaping a scaling configuration to reveal themselves. Instead, various vectors of property scores for each point in the configuration are "fitted" in the space. The degree to which these tested properties accurately fit in the space is taken as a measure of how well the properties explain the shape of the space. Properties which fit the space very accurately are inferred to be the characteristics by which resorts are compared.

The algorithm used to fit property vectors in the perceptual space is PROFIT, developed by Carroll and Chang (Carroll and Chang, 1964). The procedure used by the algorithm to fit vectors in a scaling configuration can be described as though it was heuristic, although the actual procedure derives a solution analytically. The procedure begins by taking the first site property, which is in the form of a vector of scores for each site on that property, and positions it in the configuration of ski sites. Each site's position is projected onto the vector of scores. The correlation coefficient is then computed between the projected scores of the ski resorts and the actual scores on the vector. The vector is then rotated slightly until a new set of projected scores occur. The correlation coefficient is again computed between the new projected scores and the actual vector scores. This procedure continues until each possible ranking of projected scores with its associated orientation in the space has been tested for the degree to which it correlates with the actual vector scores. The final orientation is that for which the correlation of projections and actual scores is maximized. This entire procedure is then repeated for each candidate property.

All site properties were fitted to the similarities configuration with the exception of familiarity. The direction of these vectors in the configuration are shown in Figure 6.3 and a list of correlation coefficients for each property vector is presented in Table 6.9.

Most of the vectors have fairly high r^2 values. The most similar correspondence between projected and actual scores occurs for the site properties of length of runs (r^2 = .897) and variety of runs (r^2 = .905). Price (r^2 = .834) and crowding (y^2 = .794) have a slightly less accurate correspondence as do accessibility (r^2 = .569) and quality of runs (r^2 = .661). Micro-climate has a very low correspondence (r^2 = .09).

Of equal interest is the direction of these fitted vectors relative to one another. Table 6.10 shows a matrix of the cosines of angles between the vectors. The variables of variety, length, and quality are highly colinear. This group of properties have the most accurate fit in the space on the basis of r^2 values. Also these variables are the only candidate properties which are related to the actual physical properties of ski sites. Because they are colinear and fit very accurately in the configuration, it would appear that this is one factor spanning the perceptual space.

Figure 6.3

Perceptual Similiarity Space With Fitted Property Vectors

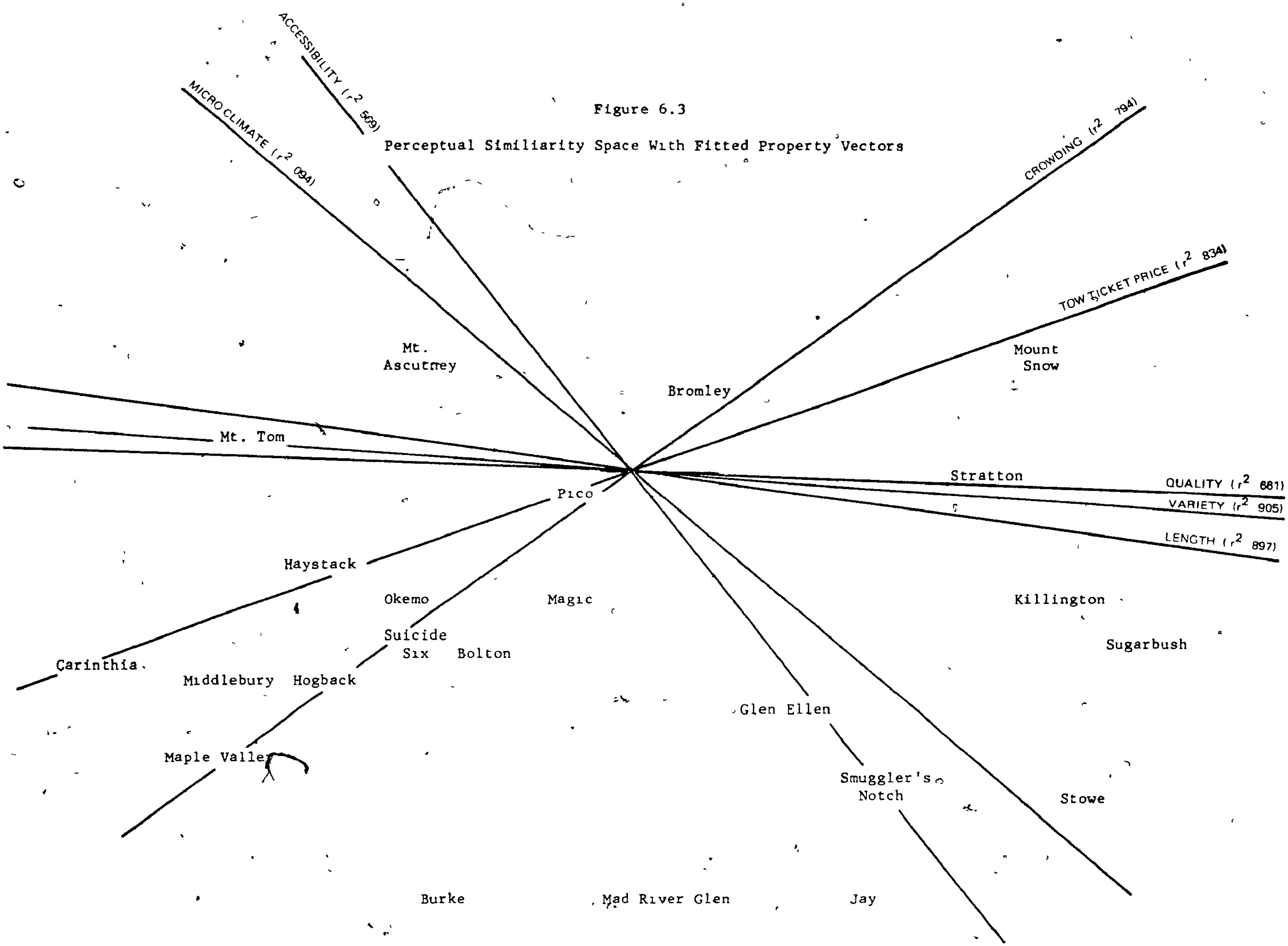


Table 6.9

Product Moment Correlation For Fitted Property Vectors

	r	r^2
Crowding	.890	.794
Tow Ticket Price	.913	.834
Variety	.951	.905
Length	.947	.897
Accessibility	.754	.569
Quality	.813	.661
Micro-Climate	.308	.094

Table 6.10

Cosines of Angles Between Pairs of Fitted Property Vectors In the Perceptual Space

	Crowding	Tow Ticket Price	Variety	Length	Accessibility	Quality	Micro-Climate
Crowding	-						
Tow Ticket Price	0.9625	-					
Variety	0.7401	0.8948	-				
Length	0.6835	0.8560	0.9967	-			
Accessibility	0.0874	-0.1862	-0.6052	-0.6674	-		
Quality	0.7943	0.9009	0.9999	0.9955	-0.5942	-	
Micro-Climate	-0.0371	-0.3070	-0.6995	-0.7548	0.9922	-0.6896	-

The variables of crowding and price have fitted vectors which, while not being as strongly colinear as the physical characteristic variables, are in the same general area as those site characteristics. It is also interesting to note that these are, essentially, the only nonphysical characteristics associated with each site which have been tested. Like the physical characteristics, they have grouped together.

The final variable vector of accessibility fits moderately well in the space. However its orientation is much different than those related to actual site characteristics. Its orientation is orthogonal or oblique to the other fitted vectors. An examination of this vector's position in the space shows clearly that more northern resorts such as Jay, Stowe, Sugarbush, and Smuggler's Notch have low accessibility projections while southern resorts like Mt. Tom, Haystack, and Carinthia have high projected scores.

This fitting solution suggests that skiers use two or three general factors to compare sites. A first factor is certainly related to the physical properties of a ski site. In this study, this factor is characterized by the vector representing length, variety, and quality of runs. These vectors are highly colinear and fit quite accurately in the space. These properties have been shown to be strongly related to the quality of skiing. Because of their importance they may be the actual site properties which skiers have used to judge the perceptual similarity of resorts and, thus, bound the derived space. These vectors also represent the most tangible properties of ski sites. Because of this, skiers may choose these properties to base comparisons of resort similarity since sites may be more easily differentiated in terms of tangible rather than intangible properties.

A second factor appears to combine other site characteristics which are more extraneous to the actual activity of skiing and less tangible than those properties mentioned above. This factor is characterized by the two vectors crowding and price.

These two factors of physical and non-physical site characteristics may, in fact, represent a more comprehensive factor related to general site characteristics. Since the importance of physical and non-physical components of a site will vary for different activities and situations, the actual dominance of the overall factor by one of these two components may depend on how important the physical and non-physical components are in the activity being investigated. In skiing, for example, physical aspects of a site may predominate because of their obvious importance. In other activities, such as shopping behavior, non-physical variables may emerge as more representative of the general site. Unfortunately, the precise nature of this relationship cannot be verified by this study because physical characteristics dominate the list of candidate variables. This surely biases the final results.

A final factor which skiers appear to compare sites on is a site's relative spatial position. This factor is characterized by the accessibility vector. Most of the interviewed skiers came from Massachusetts, New York, and Connecticut. For these skiers, northern Vermont resorts are very inaccessible whereas southern resorts are more accessible. Hence, the emergence of this dimension is strongly related to the biassed distribution of respondents and shows the affect of aggregating many individual perceptual judgements. If a more even distribution of respondents had been obtained, perhaps the dimension would not have emerged as strongly. This would be unfortunate since this factor seems to be considered an important element of the similarity between two resorts; namely, their relative location in space.

It is also interesting to note that the two major variables explaining the stated attraction measures fit quite well in the derived space (crowding $r^2 = .79$; length $r^2 = .89$). This would seem to support the notion that there is a strong relationship between site variables affecting preference and those affecting perception.

The purpose of this section has been to offer an alternative method for identifying the characteristics skiers use to compare different sites. The method has identified three general factors: a site's spatial position, and the physical and nonphysical characteristics of ski sites. Each of these has been represented by specific property vectors fitted in a perceptual similarity space. The accuracy of fit is very good in most cases, leading to the conclusion that the method has successfully identified important properties of skiers' perceptual judgements, and that these properties are very similar to those related to skiers' preferences.

Summary

The purpose of this chapter has been to explain the derived scales of site attraction. Using regression analysis, three variables of length of runs, degree of crowding, and quality of runs, were identified and weighted in an additive attraction function. This function accurately accounted for 90 percent of the variation in stated attraction scores. The same analysis was performed on the revealed attraction scale. However, this analysis could only identify one variable, length of runs, and this single variable could only account for 45 percent of the variation in the revealed attraction values.

In the final section, an alternative method was used to identify the characteristics which skiers used to compare different ski sites. These characteristics were hypothesized to be the same as those related to site attraction. The analysis uncovered three factors from fitting property vectors in a perceptual similarity space. These were the physical and non-physical site properties and the spatial position of each resort. These results tend to support those obtained from the regression analysis.

CONCLUSION

The general objective of this study has been to investigate certain aspects of the rule by which skiers make choices of where to ski. The study has focused on the effect of site characteristics on skiers' choices. The purpose of the study has been twofold. The first was to derive measures of site attraction for 28 ski sites in Vermont. The second was to identify which site characteristics best explained the derived site attraction measures.

In the first chapter a skier's choice was assumed to indicate that ski site having the highest spatial utility of all available sites. The spatial utility of a ski site for each skier was defined as the attraction of that site discounted by its distance from the skier. This trade-off relationship between the positive utility of site attraction and the negative utility of distance was verified in Chapter 2 by examining skiers' choices in relation to intervening opportunities. This chapter also verified that different sites appeared to have differing amounts of attraction. This was demonstrated by a site's ability to draw skiers past various amounts of intervening opportunities. Some sites were observed to draw skiers past many sites while other sites could not. However, no attraction measures could be derived from these varying "drawing-propensities" since such a method would necessarily assume all intervening opportunities to have a homogeneous effect on skier choices, regardless of the differing site characteristics of these opportunities. This assumption clearly violated the major premise of this study that sites with different site characteristics and, hence, attraction would have correspondingly different effects on behavior. For this reason alternative methods were examined for measuring site attraction.

Two alternative methods for obtaining site attraction measures were discussed in Chapter 3. Using the first of these, the researcher defines site attraction measures by identifying, weighting, and combining important site variables into a single, representative measure of attraction at each site. This method was termed the site-variable approach. The second of these, the behavioral approach, obtains attraction measures through an analysis of spatial choices or revealed preferences in which the effect of distance is neutralized. The behavioral method was selected for two major reasons: first, it was far less susceptible to researcher bias, and second, it allowed more flexibility in examining the accuracy of different attraction functions and calibration procedures. In particular, Ross' approach was selected over an alternative approach for methodological reasons.

Two measures of site attraction were derived for each site. Each measure was based on a different source of information on the relative attraction of sites. A first measure of <u>stated</u> site attraction was derived for each site from skiers' stated preference rankings for ski sites. These measures were based on 363 respondents' rankings. An ordinal attraction scale was first derived using PCPA.

An interval scale was then constructed through multidimensional scaling.

A second measure of revealed site attraction was derived for 24 ski sites using skiers revealed preferences for sites. These measures were based on 2341 ~~revealed~~ skier preferences. The Ross method was used to obtain an ordinal scale which was also given interval properties through multidimensional scaling.

These two scales were observed to have a high degree of similarity. In particular, both scales identified the same groups of resorts having high and low attraction. Major differences between the two scales were confined almost entirely to the group of moderately attractive resorts. This is to be expected as resorts' positions in this group would be most sensitive to sampling variability. Both scales suggested that larger and more northernly resorts tend to have highest attraction and small and southerly resorts tend to have lowest attraction.

In the final chapter analysis was undertaken to explain the derived attraction measures. The focus of this analysis was on identifying the relevant site variables related to site attraction. Site attraction measures were assumed to be an additive combination of weighted site characteristics. Under these circumstances linear regression could be used to identify and weight candidate variables.

To obtain site characteristic measures, skiers were asked to score resorts on 8 site variables: degree of crowding, price, length variety, and quality of runs, resort accessibility, familarity, and resort micro-climate. Average site scores were used as independent variables in a stepwise multiple regression with both sets of site attraction measures.

The regression of variable scores with stated attraction scores identified length of runs, degree of crowding, and quality of runs as explaining 90 percent of the observed variation in the stated values. Length and quality were observed to be directly related to attraction, whereas crowding was inversely related. This additive model proved to be quite accurate at predicting most resorts' scores.

The regression involving revealed site scores identified only one of the candidate variables, length of runs, as significantly reducing the amount of unexplained variance in the attraction scores; this was about 45 percent. Additional site variables showed no major increase in explained variance and, for this reason, were excluded from the final model. The inability of regression analysis to accurately predict site attraction scores was attributed to two possible reasons: methodological problems of the Ross approach, and the complex nature of revealed preference.

From the analysis of stated preferences, site attraction was shown to be positively related to length of runs and negatively related to degree of crowding. Thus, attraction could be regarded as a trade-off between these two quantities. This notion was shown graphically by plotting the attraction surface in a two-dimensional attribute space defined by the variables degree of crowding and length of runs. The surface illustrated, for example, that ski sites with moderately long runs and low crowding have high attraction. Other sites with the same length of runs but more crowding were observed to have lower attraction.

Certain areas of the attraction surface were seen to be very steep, showing that small changes in either length or crowding would result in large changes in attraction. In other areas, the surface was quite flat, indicating that large changes in length or crowding were required to increase or decrease resort attraction.

In the final section of Chapter 6, a similarities space was derived from skiers' perceptual judgements on overall resort similarity. This space was constructed through multidimensional scaling. The purpose of this analysis was twofold. The first was to identify which site characteristics are used by skiers to compare sites. The second was to determine whether the same site characteristics which are related to attraction are used to compare sites.

In general, the similarity between any two resorts was observed to be related to two general factors: a site's relative spatial position and its site characteristics. Furthermore, the two site properties related to attraction were seen to fit quite accurately in the derived space (crowding $r^2 = .794$; length $r^2 = .897$), suggesting a fair amount of correspondence between variables related to site attraction and variables skiers use to compare sites.

<u>The Ross Method and Spatial Bias</u>

In the previous chapter, the revealed attraction scale was only partially explained by the length of runs. The poorly predicted scale was attributed to three possible reasons, one of which was possible error in the Ross method. This point will be discussed in the following section.

The Ross method has two types of spatial bias associated with it. Both are related to the effect that particular arrangements of individuals and available opportunities has on derived attraction measures. The first type of spatial bias arises when one resort is located in such a way that it is always judged more attractive than most resorts and less attractive than none. This is usually caused by an unevenly distributed sample of individuals. However, this spatial bias was corrected by rewriting the formula for the proportions matrix as (4.3). This revision expresses all comparisons of two sites' attractions as a percentage of those skiers in a position to make the comparison.

Unfortunately, a second form of spatial bias also appears to exist. This bias is related to the fact that, because all resorts are rarely equidistant from a skier, some resorts have a greater chance of being judged more attractive than others. Consider the situation presented in Figure 7.1. Skiers located at origin i have three available ski opportunities at j, k, and l. Suppose one skier at i chooses site k. Using the Ross method, the following inferences can be made;

$$U(A_k \; D_{ik}) > U(A_j \; D_{ij})$$
$$\text{and } D_{ik} > D_{ij} \qquad (7.1)$$
$$\text{so } A_k > A_j$$

Suppose also that another skier from i chooses l. Then,

$$U(A_l \; D_{il}) > U(A_j \; D_{ij})$$
$$\text{and } D_{il} > D_{ij} \qquad (7.2)$$
$$\text{so } A_l > A_j$$

Hence, skiers have shown that sites k and l are more attractive than j. However, because

$$D_{il} > D_{ik}$$

the inference in (7.2) is less likely to occur than that in (7.1) if A_k and A_l are similar since greater travel effort is required to show that

$$A_l > A_j$$

than is required to show (7.3)

$$A_k > A_j$$

Figure 7.1

Hypothetical Spatial Choice Situation

Origin	Ski Sites		
i	j	k	l

In fact, A_i must be substantially greater than A_j, while A_k need be only slightly greater.

In the Ross method, both inferences in (7.3) supply the same amount of information about how "unattractive" site j is, irrespective of the fact that the inference $A_k > A_j$ is more easily made than the inference $A_i > A_j$. It seems appropriate that the inference that $A_i > A_j$ should be weighted more heavily than the inference that $A_k > A_j$ to accommodate this obvious difference in attraction values.

One method for weighting is through sampling; that is, also sample people for whom the inference that $A_i > A_j$ is more easily made than $A_k > A_j$. This would tend to balance out inferential errors. However, there is no way such a sample could be obtained since it would require that

$$D_{ik} > D_{il} > D_{ij}.$$

Nowhere in Figure 7.1 does this situation exist. Hence, this spatial bias cannot be removed through sampling.

A second method for removing this bias is by artificially weighting certain inferences about the attraction of two sites. Again, consider the situation in (7.1). Skiers at origin i have two opportunities: j at 50 miles and k at 75 miles. If a skier at i was to choose k, then

$$U(A_k, 75) > U(A_j, 50) \tag{7.4}$$

Assuming a simple spatial utility model as that presented in 1.2, and a distance exponent of unity, (7.4) could be rewritten as

$$\frac{A_k}{75} > \frac{A_j}{50} \tag{7.5}$$

Clearly

$$A_k > A_j(75/50) \tag{7.6}$$

From this, the inference that k is more attractive than j should be weighted by the ratio of 3/2, or, the distance to the chosen site over the distance to the rejected site. This procedure would begin to remove such bias. Unfortunately, this also brings to light the error involved in estimating the relative attraction of two sites. The inferential procedure outlined above obtains minimum estimates for two sites' attractions. For example, any ratio greater than 3/2 will satisfactorily weight the inference that $A_k > A_j$. Under such circumstances any derived attraction scale would represent minimum attraction values for a set of resorts. However, the entire scale could be "stretched" and still yield results which would satisfy the inequalities such as those in (7.5). This seems to suggest that Ross' method is incapable of providing accurate, unbiased estimates of site attraction.

Suggested Research Areas

The most important direction in which further research appears necessary is the improvement of Rosses technique. Rosses method is a significant improvement over previously used methods of analysing revealed preferences, namely the intervening opportunities approach. This improvement relates to Rosses incorporation of the effect of available, yet rejected opportunities on spatial choices. However, the method does not adequately account for the effect that different spatial positions of intervening opportunities have on spatial choices. This causes some opportunistically located sites to have a greater chance of being inferred more attractive than other less opportunistically located sites. This probability is primarily related to a site's relative spatial position, implying that the final attraction measures may be spatially biased. To correct this bias certain revealed preferences can be weighted. However, such weighting does not eliminate error associated with the estimation of the relative attraction of two sites.

A logical progression is the improvement of Rosses approach. Such improvement should be directed at two problem areas. First, the effect of differences in distances between chosen and rejected opportunities must be incorporated into the method. At present, the method accounts for the fact that, for example, Stowe will have a different effect on preference than will Prospect. The method does not take into account that Stowe at 5 miles will have a different effect on preference than will Stowe at 100 miles. It is this situation that must be corrected. One of the most promising techniques for resolving this problem appears to be through weighting each inference by a ratio indicative of the added travel effort necessary to choose a particular site over a nearer, available site.

A second point of improvement relates to obtaining more accurate estimates of the difference between two sites' attractions. For each revealed preference, the Ross method simply identifies which of two sites has greater attraction. By weighting inferences as in the previous section, some improvement is made by indicating how much the minimum amount of attraction difference must be. However, it is also necessary to derive an upper estimate on this difference, and do so in such a way that the range between minimum and maximum estimates is sufficiently small.

Moving to the study's results, future research might also examine skier preferences in other regions with the purpose of verifying the relationship established in this study between site attraction and the site variables length/variety of runs and crowding. In these other regions the average size of hills and degree of crowding may be quite different than in Vermont. This may cause the relative importance of these site variables in site attraction to change drastically. It would be interesting to examine the relationship between variations in regional characteristics and regional skier preferences.

Finally, the general success of the perceptual scaling approach to identifying important site characteristics would seem to warrant further application and development. For example, further research might verify the proposed importance of site variables identified in Chapter 6. This could be accomplished by fitting additional property vectors in the similarities space presented in Figure 6.2 and examining the orientation and degree of fit of these additional vectors in relation to those previously fitted vectors.

APPENDIX I

A Test to Assess the Accuracy of Straight-Line Distance in Site Attraction Analysis

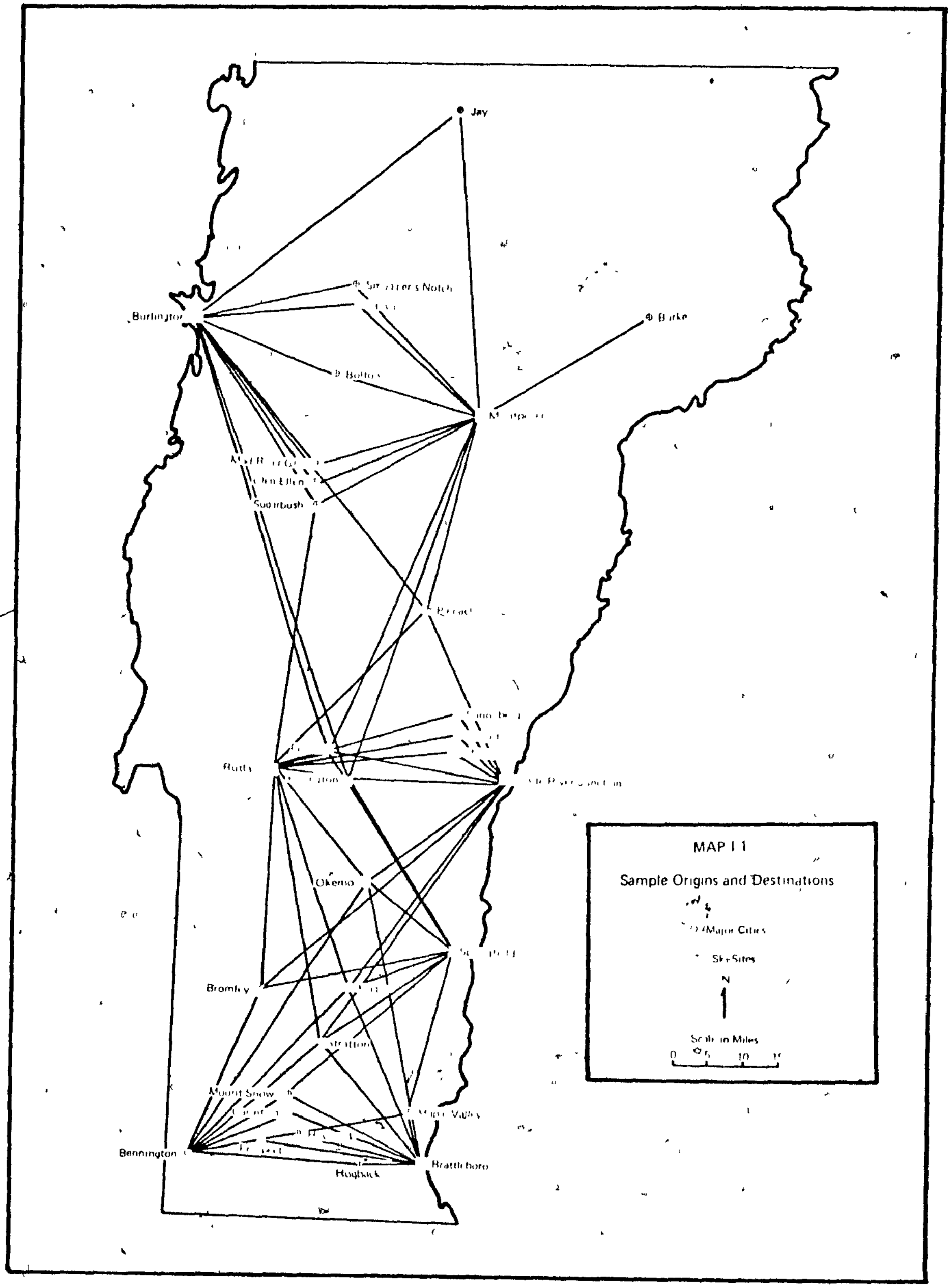
It is the purpose of this section to determine whether straight-line distance can be used to represent the spatial separation between origins and destinations instead of actual road distance. The reason is that the straight-line distance between an origin and a destination can be calculated given the x and y coordinates of both points, whereas road distances must be measured. Because there are approximately 8500 origin-destination pairs in the revealed preference data used in this study, the calculation of these distances would be much simpler and far less time-consuming than actual measurement.

Before using straight-line distance, it is important to consider how well it correlates with actual road distances in Vermont. Certain physical features such as mountains and rivers may cause low correlation to occur. If low correspondence is observed it would be necessary to use road distance since it would be more representative of the actual spatial separation between two places.

One aspect of the correspondence between straight-line and road distance is particularly relevant to this study. It relates to the way different distance measures can be used to rank a set of resort destinations on their ordinal proximity to a given skier origin. This property should be given important consideration since the Ross method, discussed in Chapters 3 and 4, derives site attraction measures from inferences based on the ordinal proximity of a chosen site to a rejected site (see 3.2). The chosen site is inferred more attractive than rejected sites nearer to a skier's origin.

This section focuses on this aspect of similarity between straight-line and road distance. It is of interest to determine whether the ordinal proximity of destinations for a given origin is the same for straight-line and road distances.

To test this notion seven sample origins were selected. These cities are the seven largest cities in Vermont from where, it was felt, most skiers would come. They are White River Junction, Springfield, Brattleboro, Bennington, Montpelier, Burlington, and Rutland. For each city a list of every feasible resort choice for a skier living in that city was assembled. The number varied from 8 for Springfield to 11 for Montpelier and Rutland. A map of these sample origins and destinations is presented in Map I.1. Road distances and straight-line distances were then calculated for all origin-destination pairs. Finally, for each origin-destination pair a list of closer destinations based on straight-line distance was compared with a list of closer destinations using actual road distances. The results of the comparison are presented in Table I.1.



MAP I.1

Sample Origins and Destinations

Table I.1

Results of Straight-Line Distance Sensitivity Analysis

Origin	Destination	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
Burlington	Jay	Pinnacle		
	Smuggler's Notch		Stowe	
	Stowe	Smuggler's Notch Mad River Glen Glen Ellen		
	Bolton			
	Mad River Glen	Glen Ellen	Stowe	Stowe
	Glen Ellen		Stowe Mad River Glen	Stowe
	Sugarbush			
	Pinnacle		Jay	
	Pico			
	Killington			

Percent Correctly Included	86.3
Percent Incorrectly Included (No JND)	16.3
Percent Incorrectly Included (JND)	7.4

Table I.1 cont.

Origin	Destination	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
Bennington	Okemo			
	Bromley		Stratton	Stratton
	Magic		Stratton	Stratton
	Stratton			
	Maple Valley		Stratton	Stratton
	Mount Snow			
	Carinthia			
	Haystack			
	Hogback		Mount Snow Carinthia Haystack	Mount Snow Carinthia Haystack
	Prospect			

Percent Correctly Included 86.5
Percent Incorrectly Included (No JND) 13.1
Percent Incorrectly Included (JND) 13.1

Table I.1 cont.

Origin	Destination	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
Brattleboro	Prospect		Stratton	
	Okemo			
	Magic	Prospect		
	Bromley			
	Stratton	Prospect		
	Maple Valley			
	Mount Snow			
	Carinthia			
	Haystack			
	Hogback			

Percent Correctly Included	92.7
Percent Incorrectly Included (No JND)	1.8
Percent Incorrectly Included (JND)	0.0

Table I.1 cont.

Origin	Destination	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
Springfield	Pico		Killington Bromley Stratton Maple Valley	Bromley Stratton Maple Valley
	Killington	Pico	Stratton Maple Valley	
	Okemo			
	Bromley			
	Magic			
	Stratton	Pico Killington Maple Valley		
	Maple Valley	Pico Killington		
	Mount Snow			

Percent Correctly Included	83.5
Percent Incorrectly Included (No JND)	15.2
Percent Incorrectly Included (JND)	8.6

Table I.1 cont.

Origin	Destination	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
White River Junction	Pinnacle		Pico	
	Okemo			
	Sonneberg		Killington	Killington
	Suicide Six			
	Mt. Tom		Pinnacle Killington	
	Pico			
	Killington	Pinnacle Okemo Pico		
	Bromley			
	Stratton			
	Magic			

Percent Correctly Included	90.6
Percent Incorrectly Included (No JND)	13.1
Percent Incorrectly Included (JND)	1.8

Table I.1 cont.

Origin	Destination	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
Rutland	Pico			
	Killington			
	Pinnacle	Bromley	Sonneberg	Sonneberg
	Sugarbush			
	Okemo			
	Bromley		Pinnacle Sonneberg	Sonneberg
	Stratton	Magic		
	Sonneberg	Pinnacle Bromley Suicide Six Mt. Tom		
	Suicide Six			
	Mt. Tom		Sonneberg	

Percent Correctly Included	92.6
Percent Incorrectly Included (No JND)	7.6
Percent Incorrectly Included (JND)	4.4

- 183 -

Table I.1 cont.

Origins	Destinations	Incorrectly Excluded Resorts	Incorrectly Included Resorts Without JND	Incorrectly Included Resorts With JND
Montpelier	Jay	Killington		
	Smuggler's Notch			
	Stowe			
	Bolton		Mad River Glen Glen Ellen	
	Mad River Glen	Bolton Glen Ellen		
	Sugarbush	Bolton		
	Pinnacle		Smuggler's Notch Stowe	
	Pico			
	Killington			
	Burke		Smuggler's Notch	Smuggler's Notch

Percent Correctly Included	86.5
Percent Incorrectly Included (No JND)	16.3
Percent Incorrectly Included (JND)	4.3

Two quantities were examined: the amount of correctly included closer destinations, and the amount of incorrectly included closer destination. The first quantity reflects the amount of information lost in using straight-line distance instead of actual road distance. The second quantity reflects the amount of erroneous information included by using straight-line distance.

To summarize, the total percentage of correctly included closer resorts is 88.3 percent. The percentage of incorrectly included closer resorts is 11.9 percent. With a 10 percent JND the percentage of incorrectly included closer resorts is only 5.64 percent. It is the latter of these two figures which would affect the final attraction measures since a 10 percent JND is used in the analysis. Because the percentage of correctly included resorts is very high and the amount of incorrectly included resorts is very low, straight-line distance is used in this study to represent the spatial separation between two points.

APPENDIX II

The Evaluation of Skier Trips With Unknown Origins

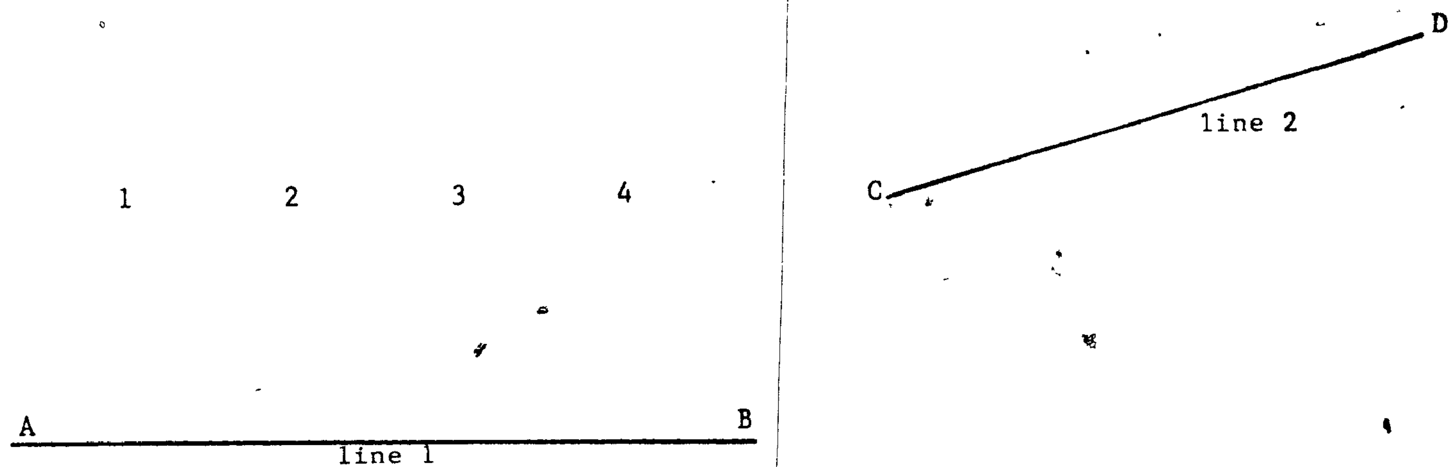
The purpose of this appendix is twofold. First, it will describe the method used in this study to determine what origin-ski resort flows, or skier trips, are allowable when the exact geographic origins of these flows are not known. Second, it will outline the method used for determining a single origin within the state from which these "generalized skier trips" can be dispatched.

It is important to understand the role of distance in the inferential procedure on which the revealed site attraction analysis is based. The absolute or real distance between an origin and any destination is only important in relation to other absolute distances from the same origin to other destinations. There is a real distance, d_{ij}, for every origin-distination pair. These d_{ij}'s can be used to rank each destination on its degree of "closeness" to an origin. In Ross' inferential procedure, any chosen site is inferred to be more attractive than all other ski sites located closer to the origin than itself.

As an origin's geographic location changes relative to the same distribution of destinations, so to will those destinations' rankings on the basis of closeness to the origin. This relationship is graphically portrayed in Figure II.1. There are five destinations:

Figure II.1

Hypothetical Spatial Choice Situation



1, 2, 3, 4, and 5. As an origin for those five destinations moves along line 1, the ranking of the destinations' closeness to the origin changes. At point A this ranking is $d_{A1} < d_{A2} < d_{A3} < d_{A4} < d_{A5}$ (where, $d_{A1} < d_{A2}$, is read as "the distance from point A to destination 1 is less than the distance from point A to destination 2"). At point B the ranking is, $d_{B5} < d_{B4} < d_{B3} < d_{B2} < d_{B1}$. On line 2 a much different situation exists. The rankings at point C are the same as the rankings at point D. On line 1 the relative spatial position of destinations vis a vis an origin changes as the origin's position changes, while on line 2 this relative spatial position is preserved for any original location. From this example we can conclude that there are some cases where this ordinal distance ranking is independent of an origin's specific location.

The analytical problem, then, is to examine each state in which the exact origins of ski trips are not known and, by using sample origins within the state, determine whether the ordinal rankings of distances between each of the sample origins and the ski sites change as the location of the origin changes. Furthermore, if some of the rankings do change as the origins change, identify which ski sites always maintain the same rank positions for each sample origin. If such instances can be accurately identified, the ski trips to these sites can be included in the analysis.

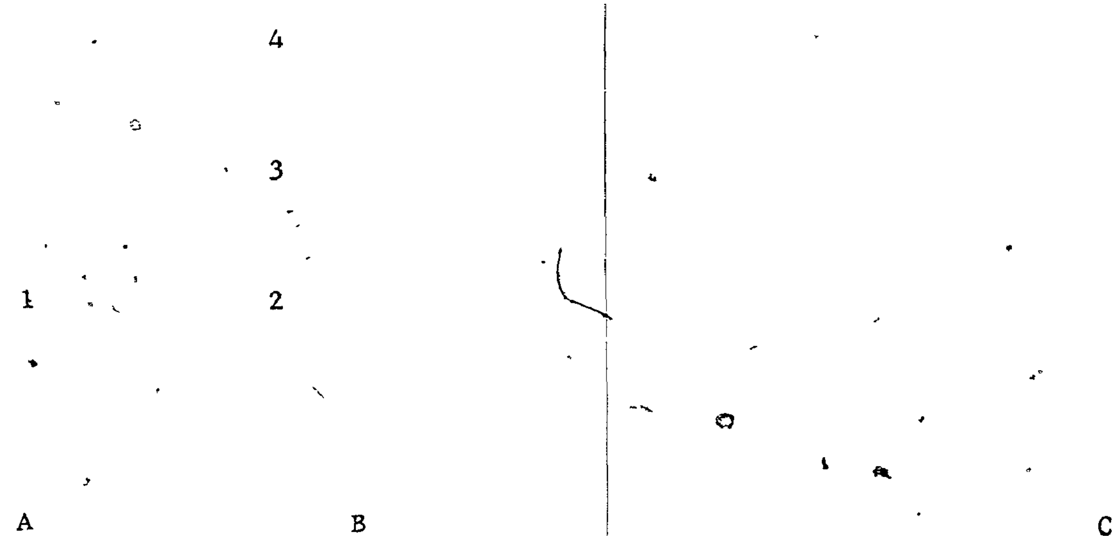
Ski sites which have been excluded from the analysis on the basis of the above criterion can be allowed if they satisfy the following criterion. In the revealed attraction analysis, if the absolute difference in distance between an origin and any two destinations is so small that it could be considered "about the same", and the further of the two destinations is chosen, no inference about the relative attraction of the chosen place to the rejected place is made. This amount of difference in the absolute distances between an origin and two destinations within which no inferences can occur is termed the just noticeable difference (JND) and is usually expressed as a percentage of the total distance travelled to the chosen site. In this study the JND is 10%. In light of this procedure, if two ski sites' ordinal positions to an origin do shift, but shift so slightly so as to always fall within the JND of each other, no inference is made about the attraction of these two places relative to each other. Inferences are only made about those sites which lie outside their JND, and for whom they maintain the same ordinal position. So, if two ski sites' ordinal positions do change as different sample origins are selected but the amount of this change in absolute spatial position is always within each site's JND, the sites can be included in the analysis.

Having determined which sites, and consequently which trips, are allowable for a state when the exact origin of the trips are not known, the next step is to establish an origin from which the "generalized trips" can be dispatched to their appropriate destinations. In doing this one must minimize the amount of inferential error occurring for destinations whose ordinal positions do shift and, hence, have been excluded from analysis. Two categories of inferential error can occur for this group of resorts: underestimation of their site attraction and overestimation of their site attraction. Fortunately, overestimation can only occur if flows are allowed to these sites. Because the flows have been disallowed by the previously discussed criteria this type of error will never occur. However, the first form of error, underestimation, can occur if a resort is placed closer to an origin than it actually is. This would result in more skiers inferring it to be less attractive than it may be. Therefore, the best origin for dispatching the "generalized skier trips" for each state will be that which minimizes the possibility of underestimation occurring for excluded destinations' attractions.

For any resort destination, the origin which will minimize the amount of underestimation will be that one which ordinally positions the resort the farthest away. Figure II-2 portrays this idea for destination 1. There are four destinations: 1, 2, 3, and 4, and three origins: A, B, and C. At point A the rankings are $d_{A1} < d_{A2} < d_{A3} < d_{A4}$. At B, $d_{B2} < d_{B3} < d_{B1} < d_{B4}$. Finally, and C, $d_{C2} < d_{C3} < d_{C4} < d_{C1}$. As the generalized ski trips are dispatched from point A, ski site 1 will always be inferred less attractive than 2, 3, and 4. At point B, ski site 1 will be inferred less attractive for only those trips to site 4. At point C, however, 1 will never be inferred less attractive. At the same time it cannot be inferred more attractive than sites 2, 3,

Figure II.2

Hypothetical Spatial Choice Situation



and 4 because no trips are made to it (trips are not allowed because its ranking changes as the origin changes). Clearly, point C is the best dispatch point in the example because it minimizes the possibility of underestimating the attraction of site 1, whose flows are not allowable.

This procedure is carried out for all skier trips coming from Quebec, Massachusetts, and Connecticut. In summary, the general procedure consists of two steps for each state:

A) Based on the following criteria, determine which ski trips from each state are allowable.

   1. either, that the destination maintains the same ordinal spatial position relative to other destinations regardless of the origin selected; or

   2. that when the ordinal positions do change with different origins, the amount of this change in absolute distance is always less than the JND.

B) Determine a dispatch origin for these generalized ski trips which minimizes the possibility of underestimation of attraction for those sites excluded by criteria in part A.

Skier trips from New Hampshire were not included because they obviously violated both criteria outlined in Section A above.

Quebec

Skiers in this province went to 9 different ski hills in Vermont. Four sample origins were considered: Montreal, Granby, Sherbrooke, and the far Eastern Townships. (See Map II.1.) In order to compare each of the nine resorts' spatial positions, a graph of the absolute and ordinal positions of each of the nine hills from the four sample origins was made. Figure II.3 shows this graph. Lines connect the same hills for different sample origins. These lines represent the hills' ordinal positions from each origin. The intersection of any of these lines signifies that ordinal positions are changing.

In Figure II.3, the only ordinal change for any four origins is Burke Mountain. Since the difference in the absolute distance between Burke and those resorts that it changes position with is greater than a 10% JND, Burke is excluded as a possible destination for Quebec skiers.

The second consideration is to determine a dispatch point for the allowable ski trips. If the Eastern Townships is selected as an origin Burke will always be inferred less attractive for each of the allowable 93 trips. If Sherbrooke is selected, 56 possible errors can be made, and with Granby 10 errors can be made. However, if Montreal is used as the dispatch point no errors can be made.

Therefore, trips to Burke are excluded in the analysis and Montreal is chosen as the dispatch point for ski trips originating

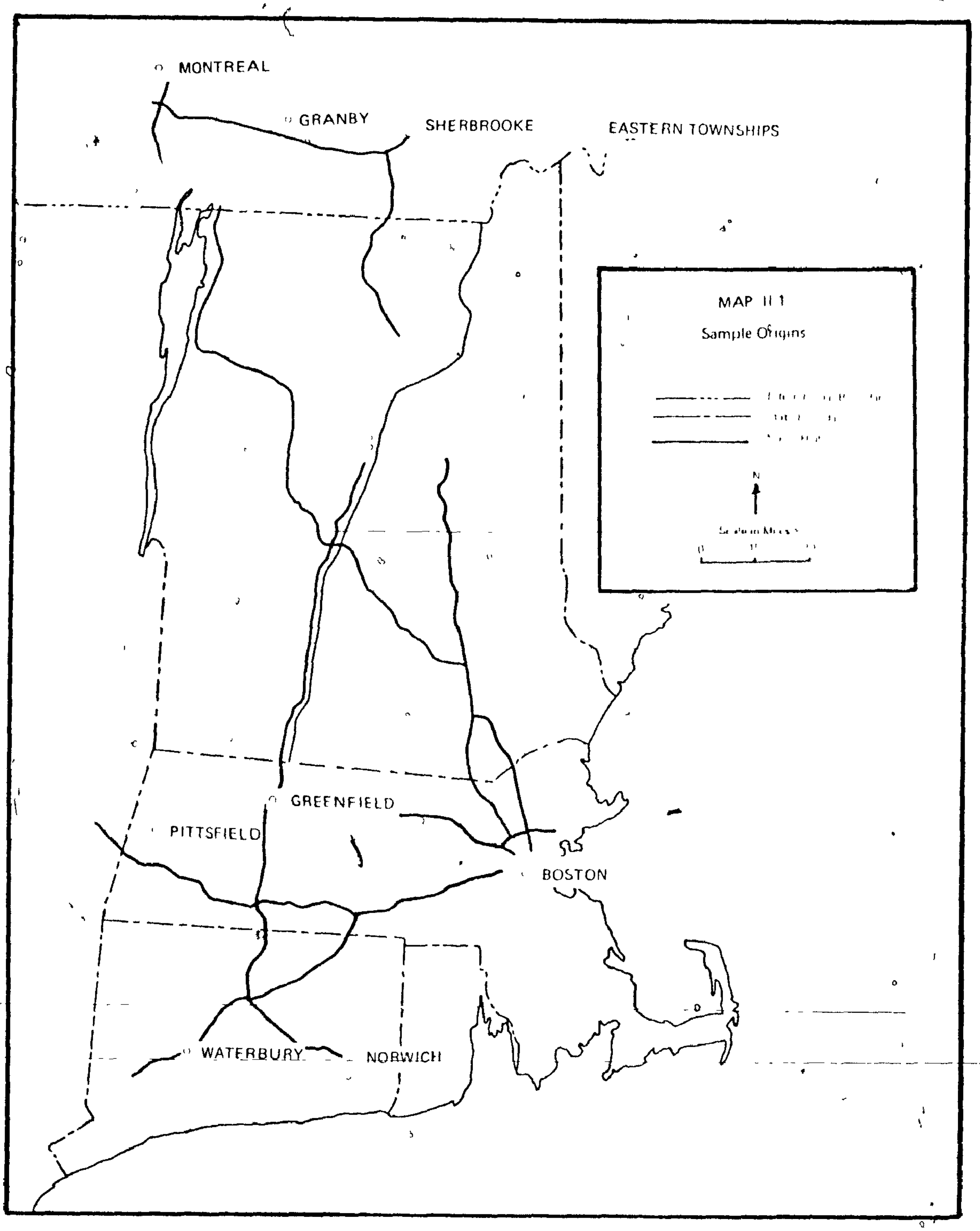
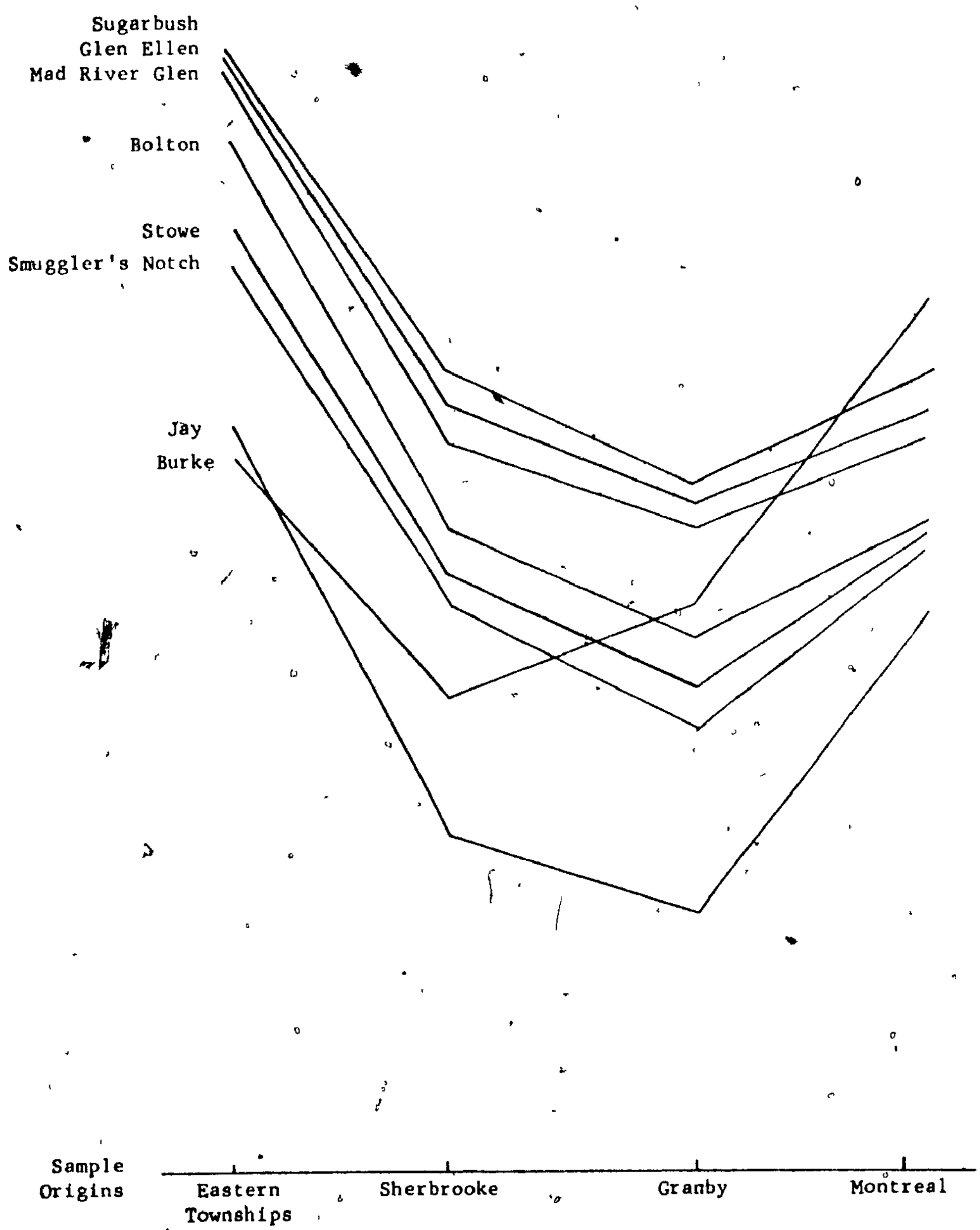

MONTREAL
GRANBY
SHERBROOKE
EASTERN TOWNSHIPS
MAP II 1
Sample Origins
N
GREENFIELD
PITTSFIELD
BOSTON
WATERBURY
NORWICH

Figure II.3

A Graph of Vermont Ski Resorts' Spatial Proximity to Four Quebec Sample Origins



in Quebec.

Connecticut

Skier trips from Connecticut were made to 20 ski resorts in Vermont. The amount of change in the ordinal spatial positions of these hills with each other as different origins with the state are used was tested with two sample origins: Waterbury in the western section of the state and Norwich in the east. A graph of the ordinal and interval positions of these resorts from Waterbury and Norwich is shown in Figure II.4.

Upon examination all but five of the hills retain their same ordinal position relative to one another as different origins are selected. These five hills, Burke, Mt. Tom, Suicide Six, Prospect Mountain and Maple Valley account for 13 trips (no trips were made to Prospect or Maple Valley). However, by applying the criterion that these ordinal changes always fall within a JND, all five resorts (and the trips made to them) can be included in the analysis. This is verified by data provided in Table II.1, which shows that difference in distance between resorts which change ordinal positions is always less than the appropriate JND.

Since all resorts in Vermont have been allowed as possible destinations for Connecticut skiers, the dispatch point for these skiers can be located anywhere in the state. The site chosen in this study is the state capitol, Hartford. This city was selected not only

Figure II.4

A Graph of Vermont Ski Resorts' Spatial Proximity to Two Connecticut Sample Origins

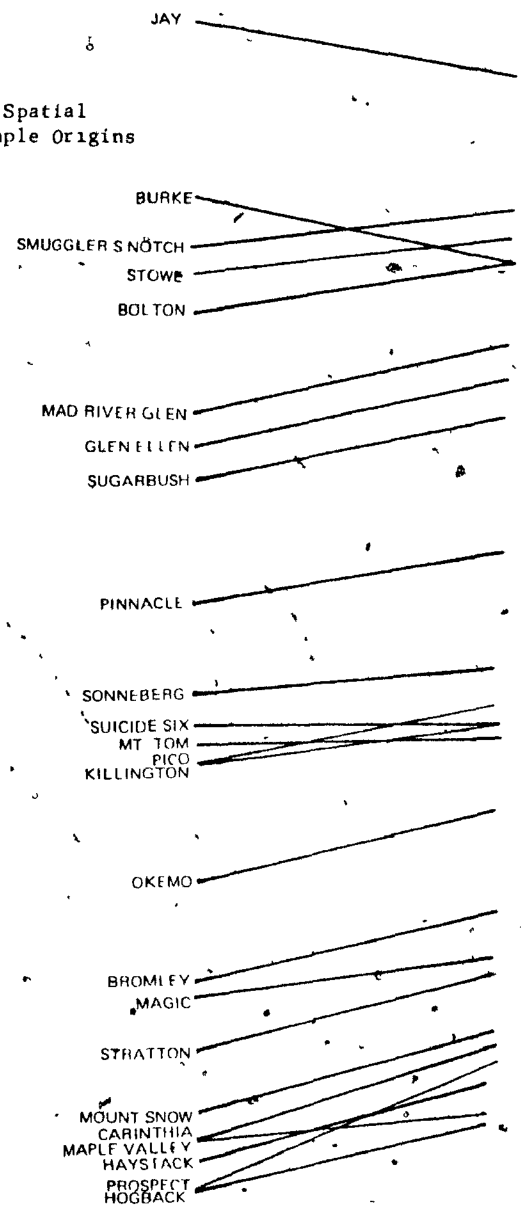


Table II.1

An Evaluation of Position-Switching Resorts for Connecticut Sample Origins

Comments		Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts*	JND	Difference Between Nearest and Furthest Resorts
Case 1.	Burke Switching	Waterbury	Burke Smuggler's Notch Stowe Bolton	29.5 27.6	2.95	1.9 < JND **
		Norwich	Smuggler's Notch Stowe Bolton Burke	29.3 28.5	2.93	.8 < JND **
Case 2.	Pico and Killington Switching	Waterbury	Suicide Six Mt. Tom Pico Killington	20.5 19.8	2.05	.7 < JND **
		Norwich	Pico Suicide Six Killington Mt. Tom	21.0 20.4	2.10	.6 < JND **

* Distance measured in millimeters from Figure II.4
** Resorts judged allowable according to criterion 1-B

Table II.1 cont.

Comments	Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts	JND	Difference Between Nearest and Furthest Resorts
Case 3. Maple Valley and Prospect Switching	Waterbury	Maple Valley Haystack Prospect	13.5 12.5	1.35	1.0 < JND **
	Norwich	Prospect Haystack Maple Valley	14.8 13.9	1.48	.9 < JND **

** Resorts judged allowable according to criterion 1-B for its central location but also because it is located on the major interstate highway (US-91) that connects Connecticut and Vermont. Presumably most skiers coming from Connecticut would pass this point on their trip.

Massachusetts

Massachusetts skiers were observed at every Vermont ski hill except Prospect Mountain. Because of Massachusetts' location relative to Vermont, a high degree of change in ordinal positions of Vermont ski resorts with each other was observed when three sample origins of Boston, Greenfield and Pittsford were used. This switching can be seen in Figure II.5, a graph of the Vermont ski hills' ordinal and interval positions relative to each other at different sample origins. With a large amount of position switching only 13 of the 24 resorts maintained the same ordinal positions relative to each other irrespective of the sample origin. Of the remaining eleven resorts of Burke, Mt. Tom, Okemo, Sonneberg, Suicide Six, Killington, Pico, Magic, Hogback, Prospect and Maple Valley, all but Burke, Okemo, Magic, Sonneberg, Hogback, Prospect, and Maple Valley conformed to the JND criterion. This is verified in Table II.2.

The problem of selecting a dispatch point in the state was more complex than in the two previous cases since there were seven rather than one site being disallowed in the analysis. The dispatch point had to minimize the amount of underestimation for all seven resorts.

Figure II.5

A Graph of Vermont Ski Resorts' Spatial Proximity To Three Massachusetts Sample Origins

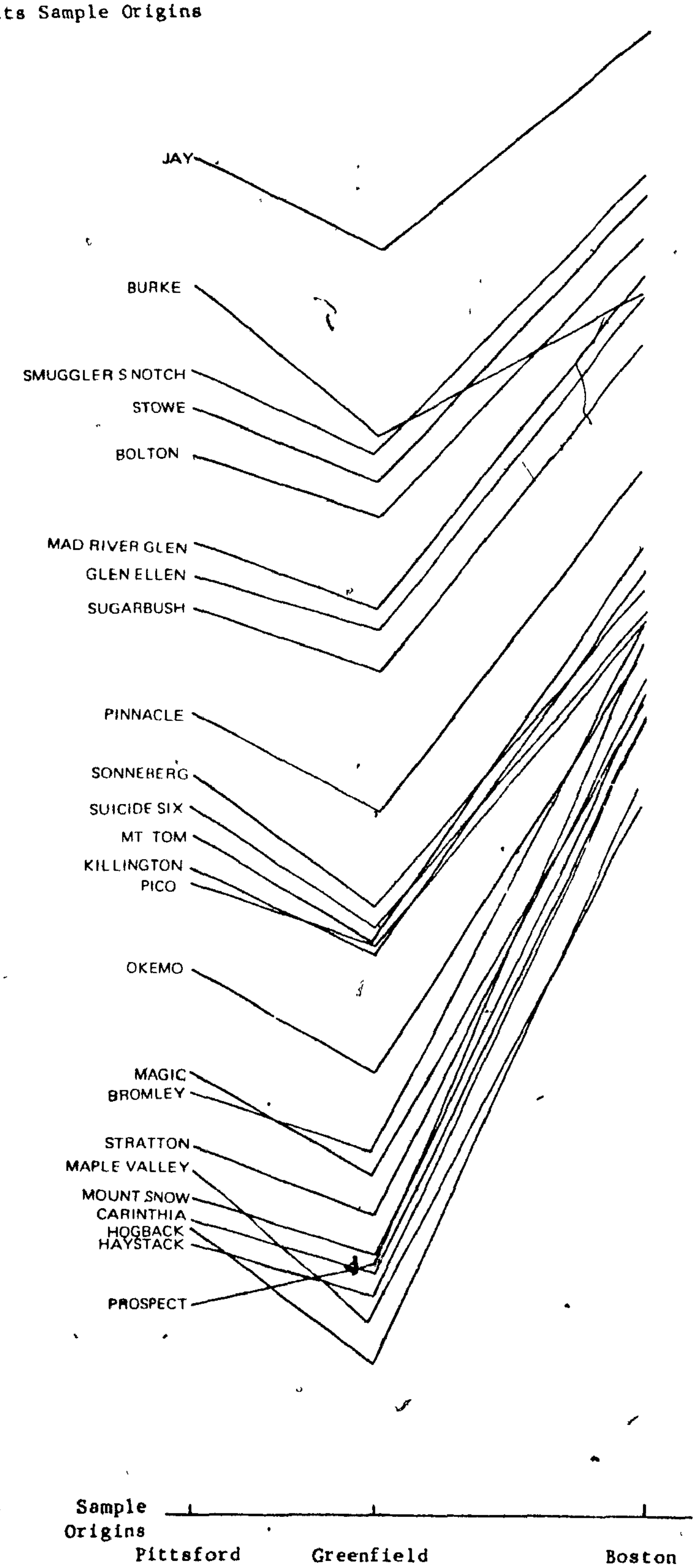


Table II.2

An Evaluation of Position-Switching Resorts for Massachusetts Sample Origins

Comments	Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts*	JND	Difference Between Nearest and Furthest Resorts
Case 1. Sonneberg Switching	Pittsford	Sonneberg	13.1		
		Suicide Six ****			
		Mt. Tom ****		1.31	1.6 > JND ***
		Killington	11.5		
	Greenfield	Sonneberg	10.7		
		Suicide Six ****			
		Mt. Tom ****		1.07	.9 < JND
		Pico ****			
		Killington	9.8		
	Boston	Killington	16.7	1.67	.4 < JND
		Sonneberg	16.3		

* Distance measured in millimeters from Figure II.5
*** Resort switching judged unallowable using criterion in 1-B
**** Resort simultaneously switching; ignore in calculations

Table II. 2 cont.

Comments		Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts	JND	Difference Between Nearest and Furthest Resort
Case 2.	Magic Switching	Pittsford	Magic Bromley Stratton	7.8 6.6	.78	1.2 > JND ***
		Greenfield	Bromley Magic Stratton	6.4 5.1	.64	1.3 > JND ***
		Boston	Bromley Stratton Magic	15.3 14.3	1.53	1.0 < JND
Case 3.	Pico and Killington Switching	Pittsford	Killington Pico	11.5 11.3	1.15	.2 < JND **
		Greenfield	Pico Killington	10.0 9.8	1.00	.2 < JND **
		Boston	Pico Sonneberg **** Suicide Six **** Killington	17.0 16.7	1.70	.3 < JND **

** Resort switching judged allowable using criterion in 1-B
*** Resort switching judged unallowable using criterion in 1-B
**** Resort switching simultaneously; ignore in calculations

Table II.2 cont.

Comments	Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts	JND	Difference Between Nearest and Furthest Resorts
Case 4. Maple Valley Switching	Pittsford	Maple Valley Mount Snow Carinthia	6.2 5.3	.62	.9 > JND ***
	Greenfield	Mount Snow Prospect **** Carinthia Haystack Maple Valley	4.5 3.3	.45	1.2 > JND ***
	Boston	Mount Snow Magic **** Carinthia Haystack Hogback **** Maple Valley	14.3 12.4	1.43	1.9 > JND ***

*** Resort switching judged unallowable using criterion in 1-B
**** Resort simultaneously switching; ignore in calculations

Table II.2 cont.

	Comments	Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts	JND	Difference Between Nearest and Furthest Resorts
Case 5.	Prospect Switching	Boston	Prospect	15.1		
			Okemo ****			
			Stratton			
			Mount Snow		1.51	1.3 < JND
			Magic ****			
			Carinthia			
			Haystack	13.8		
		Greenfield	Stratton	5.1		
			Mount Snow			
			Prospect		.51	1.3 > JND ***
			Carinthia			
			Haystack	3.8		
		Pittsford	Stratton	6.6		
			Maple Valley ****			
			Mount Snow			
			Carinthia		.66	2.8 > JND ***
			Hogback ****			
			Haystack			
			Prospect	3.8		

*** Resort switching judged unallowable using criterion in 1-B
**** Resort simultaneously switching, ignore in calculations

Table II. 2 cont.

Comments	Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resorts	JND	Difference Between Nearest and Furthest Resorts
Case 6. Burke Switching	Pittsford	Burke Smuggler's Notch Stowe Bolton Mad River Glen	21.7 17.3	2.17	4.4 > JND ***
	Greenfield	Burke Smuggler's Notch Stowe Bolton Mad River Glen	19.1 16.1	1.91	3.0 > JND ***
	Boston	Smuggler's Notch Stowe Bolton Mad River Glen Burke	23.7 21.6	2.37	2.1 < JND
Case 7. Okemo Switching	Pittsford	Okemo Magic **** Bromley	9.5 7.5	.95	2.0 > JND ***
	Greenfield	Okemo Bromley	7.7 6.4	.77	1.3 > JND ***
	Boston	Bromley Okemo	15.3 15.1	1.53	.2 < JND

Table II.2 cont.

Comments	Sample Origin	Order of Resorts in Group	Distance to Nearest and Furthest Resort	JND	Difference Between Nearest and Furthest Resorts
Case 8. Suicide Six and Mt. Tom Switching	Pittsford	Suicide Six Mt. Tom	12.5 12.0	1.25	.5 < JND **
	Greenfield	Suicide Six Mt. Tom	10.3 10.0	1.03	.3 < JND **
	Boston	Mt. Tom Suicide Six	15.9 15.8	1.59	.1 < JND **
Case 9. Hogback Switching	Pittsford	Hogback Haystack	5.2 4.9	.52	.3 < JND
	Greenfield	Haystack Hogback	3.8 2.6	.38	1.2 > JND ***
	Boston	Haystack Hogback	13.8 12.8	1.38	1.0 < JND

** Resort switching judged allowable using criterion in 1-B
*** Resort switching judged unallowable using criterion in 1-B

Recalling an earlier discussion, the origin which causes the minimum amount of underestimation to occur for a resort is that origin which ordinally places the resort furthest from itself. With seven resorts, the optimal location would be that origin which places as many of the resorts as far as possible from itself. Considering the candidate origins, Boston would place only 1 resort at its furthest ordinal position, Greenfield would place 3 resorts in this position, and Pittsford would place 6 of the 7 in this position. Furthermore, Pittsford would also minimize the number of inferential errors that could occur for the seven resorts, as shown in Table II.3. For these reasons, it was selected as the dispatch point for the "generalized skier trips" from Massachusetts.

Table II.3

The Number of Possible Erroneous Inferences For Excluded Resorts For Three Candidate Massachusetts Dispatch Origins

	Pittsford	Greenfield	Boston
Burke	0	0	70
Sonneberg	0	0	198
Okemo	0	0	3
Magic	0	17	8
Maple Valley	0	92	92
Hogback	0	30	30
Prospect	112	60	0
	112	199	401

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