7

A MODEL OF OUTDOOR RECREATIONAL TRAVEL CHOICES

A. S. WISDOM
Transport Analyst,
Ove Arup & Partners, Melbourne.

H. P. BROWN
Lecturer,
Transport Section, Department
of Civil Engineering,
University of Melbourne.

ABSTRACT: *Outdoor recreational travel is a trip purpose that has received little attention from either administrators or modellers. Whilst the problems created by recreational travel are smaller than those created by other types of travel, they are nevertheless, very real. It is important to be able to isolate and understand the influences on recreational travel decisions and to be able to predict the effect of policy changes on travel behaviour. This is of concern both to the transport planner and the administrators of recreational sites concerned with maintaining a balance between the provision of recreational opportunity and congestion of facilities.*

Because of the discretionary nature of recreational travel, its modelling provides problems that are to some extent greater than those associated with more commonly modelled travel choices. This paper describes a set of models of recreational choices (1) based on a data set collected in 1978 for a Joint Advisory Committee composed of representatives from a number of government bodies concerned with outdoor recreation. The models are set in an individual choice frame-work and encompass what are perceived to be the major choices involved in outdoor recreational travel: frequency, duration, activity and destination choices.

---

(1) The models were developed as part of a Master of Engineering Science programme at the University of Melbourne.

A MODEL OF OUTDOOR RECREATIONAL TRAVEL CHOICES

INTRODUCTION

Travel for the purpose of participating in outdoor activities is a small percentage of total travel in an urban area such as Melbourne, and the problems created by it are very much smaller than those created by travel for other purposes. Nevertheless, there exist very real problems which are no less pressing for those who have to deal with them.

The concentration of recreational travel in a few areas of recreational interest, which are typically environmentally sensitive to such concentrations, does constitute a significant and growing problem. Increased leisure, increased affluence and car ownership, decreasing family size, and increasing holiday house ownership are all trends which give rise to increasing amounts of travel undertaken for recreational purposes. Already, major congestion in areas of Melbourne such as the bayside beaches, the Dandenong Ranges, Healesville and the Mornington Peninsula exists at certain times of the year. While the problem does not approach the scale of that existing in most major European cities, where capacity of the road network serving the city is dictated by the weekend peak recreational travel demands, it is significant and growing.

The development of models of recreational travel has two aims The first is to investigate the basis of the choices and the structure of the choice framework involved in the decision to undertake recreational travel. The second is to provide a tool for predicting behavioural responses to changes in the travel environment and in the supply of recreational opportunities. Specifically, those dealing with recreational travel need to know how changes in the level of service of the transport system, changes in the level of recreational facility provision and changing socio-economic levels will affect the demand for recreational participation and hence travel

This project is primarily concerned with the first of the above aims, as little work has been undertaken in this area. The data set used is from the Mornington Peninsula recreational travel survey conducted for the Joint Advisory Committee by John Paterson Urban Systems in 1977.

The models are estimated in an individual choice framework. That is, travel behaviour is investigated and modelled at the level of the individual traveller. Such an approach provides the greatest opportunity to investigate the extremely complex decision structures underlying recreational travel decisions and the large number of influences affecting the choices involved. It is also the only approach capable of providing measures of traveller response to policy changes affecting the travel and recreational environment.

INDIVIDUAL CHOICE MODELLING

The advantages of an individual choice approach to modelling travel behaviour are well known (see, for example, Hensher and Stopher, 1980) and need not be dealt with here. By describing choice alternatives facing an individual in terms of their attributes, the relative utility they afford to an individual and their probability of selection can be determined. This enables the factors important to individual choice and directly manipulable by policy changes to be included in a model and response sensitivity to such changes to be directly determined.

While theoretically appealing, there are a number of difficulties associated with the application of this approach to complex travel decision structures. Consequently, the greatest effort has been concentrated on, and the greatest success achieved with, travel choices made in a constrained environment. Notably, models of work travel - and, in particular, models of mode choice - are the most commonly estimated.

The development of satisfactory choice models of recreational travel is a considerably more difficult task, and has received only limited attention previously. Some exploratory work undertaken by John Paterson Urban Systems for the Commonwealth Bureau of Roads was limited by data deficiencies making it impossible to estimate the models in a consistent utilizing maximizing framework. The first successful application of the approach was that developed by Brown (Brown, et al, 1979) in which models of destination, duration and frequency choices for outdoor recreation travel in Wisconsin, U.S.A., were developed.

The difficulty with this trip purpose stems from the unconstrained nature of recreational travel and the consequent diversity of travel choices available to the traveller. The choices that typically go to make up the decision to undertake outdoor recreational travel include the choice of whether or not to travel, the choice of duration and destination, as well as the choice of whether or not to undertake a linked, or multi-destination trip instead of one or several unlinked trips.

These choices are all based on the underlying choice of activity: the ultimate objective of most recreational travel is to undertake a recreational activity. The influences on activity choice are, to a large extent, based on basic and unmeasurable influences such as experience and attitudes and on physical and situational constraints too subtle for measurement. Consequently, the modelling of recreational activity directly is unlikely to meet with any great success. It is therefore necessary to model the travel related decisions that derive from the more basic activity choice. It should be recognised that the inability to successfully model the basic underlying choice is likely to significantly limit the success achieved with models of the derived demand.

The choice of whether or not to undertake multi-destination travel has proved particularly difficult to incorporate. Those that have attempted to model trip chaining behaviour have concentrated not on recreational travel, but on shopping travel. There are a number of similarities between the choices involved with the two travel types - both are discretionary in nature, trip destination is not fixed in either and there exists for both some flexibility in frequency and duration choices - but there is also a fundamental difference. Shopping travel carries the requirement that certain goods must be purchased; whether these goods are purchased on a number of single trips or on one multi-destination trip is the subject of the trip tour modelling effort. It can be construed that the choice between these competing trip types is a rational one made in response to their competing attractions. For recreational travel, however, there is no requirement that certain destinations - or types of destinations - need to be visited, or that certain activities need to be undertaken. The traveller may travel as much or as little as he chooses and the choice of whether or not to make a single or multiple destination trip is likely to depend more on subjective factors and unmeasurable influences than on any quantitative effect.

Despite the problems outlined above, it is possible to identify the choices generally involved in recreational travel making and include them in a feasible modelling framework.

DATA SET

The main body of data for this project comes from the Mornington Peninsula Recreation Survey conducted by John Paterson Urban Systems for the Joint Advisory Council between September and November 1977. 788 households were interviewed and personal, household, attitudinal and recreation data was collected.

The data available from the Mornington Peninsula Survey can be summarised as follows:

(1) Socio-economic data: characteristics of all members of the household.

(2) Attitudinal data: attitudes to activities, attitudes to attributes of activities, attitudes to activity location and expectations of changes in activity participation.

(3) Outdoor recreational travel data: characteristics of all overnight and day trips undertaken in the previous year, including information regarding destination, duration, activity, persons accompanying, and so on.

Twenty three outdoor activities were identified, as shown in Table 1. For the purposes of the survey, Victoria was divided into approximately ninety destinations; for this modelling exercise, the number is reduced to eighteen, by grouping together destinations lying close to each other with similar recreational attractions. The zone system used is shown in Fig. 1.

Several shortcomings of the data set constrain its use. Firstly, overnight trips are identified only by month and day trips only by season. This has a marked effect on the specification of the model and is discussed later. Secondly, it is not possible to identify whether or not a trip was made during a weekend, nor is it possible to determine which trips are made while on vacation. This necessitates an assumption to be made regarding the maximum time available for each trip which introduces a source of potential error into the model.

There are, however, a number of advantages of the data set: most notably, the inclusion of attitudinal information provides valuable information on the perceptions of activities. The potential use of this in modelling is discussed later, although it was not actually used in the work reported here.

MODEL FORMULATION

Choices Modelled

While the decision to undertake recreational travel is characterised by a large number of choices, only a relatively few may be incorporated into the modelling framework. The reasons for this are twofold: firstly, only certain choices lend themselves to being modelled; and secondly, the compounding of errors in estimation sets an upper limit to the number of choices that can be sensibly included.

The choices chosen for inclusion are discussed below:

Frequency. Because of its discretionary nature, the decision to undertake recreational travel has as one of its component choices that of whether or not to travel at all. This is a fundamental choice that plays no part in decisions regarding most work travel. Because of shortcomings in the data set described earlier, frequency choice is modelled as the number of trips undertaken in the year.

It is felt that day trips and overnight trips are of a fundamentally different type, with decisions regarding day trips made on a shorter-term basis than those regarding overnight trips. Because of this difference, it is felt that the two do not compete directly and so frequency choices for the two are modelled separately. The inter-relation of the two trip types is discussed later.

TABLE 1: OUTDOOR RECREATIONAL ACTIVITIES

Water Dependent Activities

(1) visiting beach/beachcombing
(2) swimming - surf beach/life saving
(3) swimming - protected beach, freshwater
(4) rowing and canoeing
(5) surfboard riding
(6) power boating activities - cruising, water skiing, fishing from a boat
(7) sailing
(8) fishing - surf, freshwater, bank, pier
(9) skindiving/spear fishing

Land Resource Based Activities

(10) bushwalking - day) includes mountaineering, caving,
(11) bushwalking - overnight) rock climbing and orienteering
(12) nature based activities - short strolls, birdwatching, photography, nature study, painting
(13) gem fossicking
(14) hunting
(15) sight seeing driving
(16) picnicking/barbecueing
(17) visiting historical centres
(18) Puffing Billy
(19) hang gliding
(20) snow skiing
(21) horse/ponyriding

Motor Based Activities

(22) motor cycle activities
(23) four wheel drive/dune buggy activities

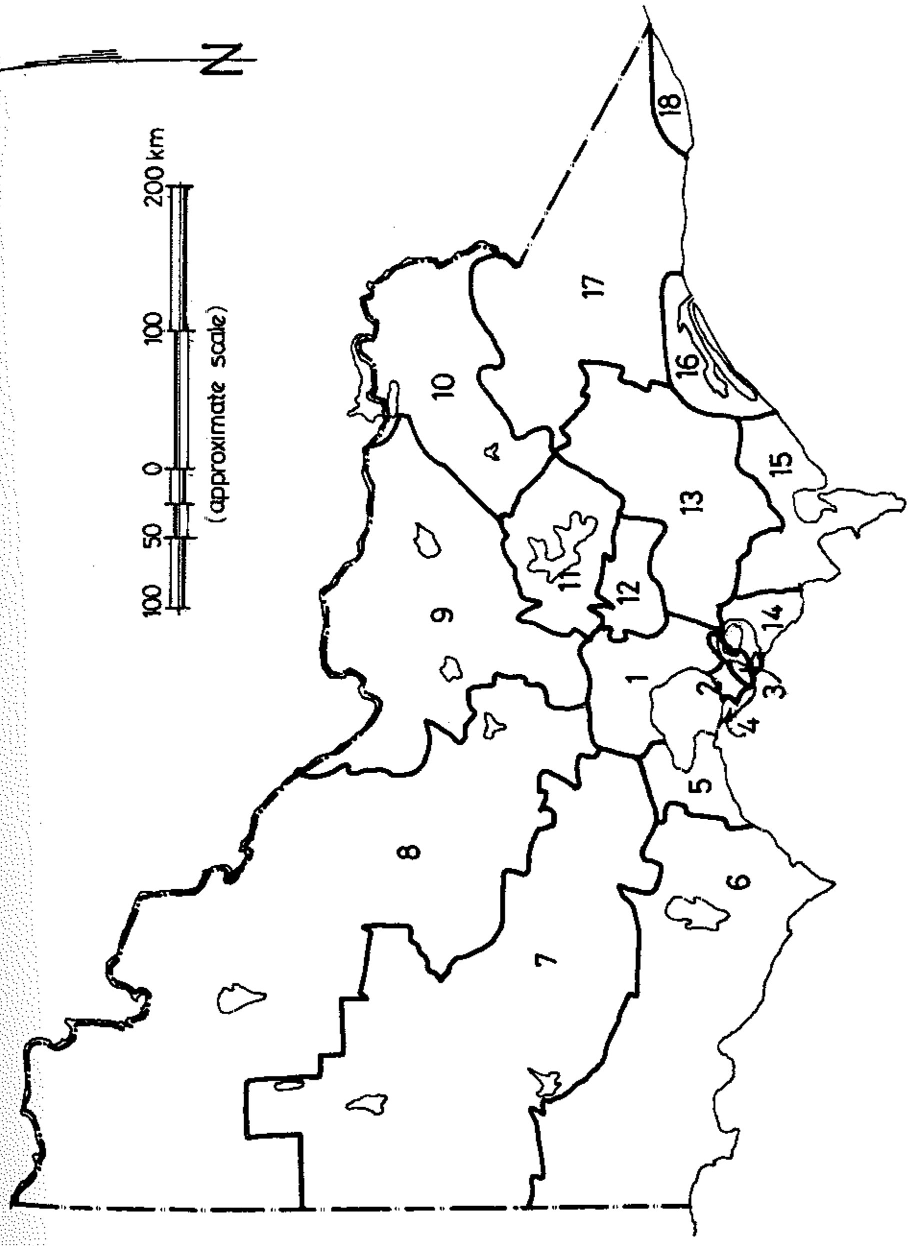

FIG. 1: RECREATIONAL ZONES

Duration. In the context of this model, the alternatives in duration choice are of the number of days taken for an overnight trip. Specifically, the choice is between trips of one or two days duration and longer trips. No duration choice is modelled for day trips, as this is already defined.

Destination. The choice of an activity site is obviously the key choice in determining the spatial distribution of travel.

Activity. Travel is a derived demand: the decision to travel is generally not made for its own sake, but so that the traveller can undertake another activity. Consequently, although activity choice is not strictly a travel related decision, it can affect other decisions in the choice framework.

Activity choice is important in recreational travel, particularly in destination choice: it may be that not all destinations are available for each activity, or that one destination, while attractive for some activities, is unattractive for others. In the first case, the question of the identification of feasible alternatives becomes important; in the second case, it can be seen that destination choice depends heavily on activity choice.

The infeasibility of successfully modelling activity at its basic level has already been discussed. However, because similar activities are likely to affect destination choice in a consistent way and because these similar activities are likely to have the same available destination set, there is no need to attempt to model the choice between all activites individually. Instead, activities may be collected into groups with similar characteristics. The choice between these activity groups is likely to be explained by less subtle influences and so is more likely to be amenable to modelling. The basis of this grouping is the attitudinal data contained in the data set: each interviewee was asked to rate each activity in the range -5 (dislike) to 5 (like). A factor analysis of the results was used to reveal the underlying characteristics of activities and those activities that scored highly on a common characteristic were grouped together. The groups derived were:

(1) Active Beach
(2) Boating/Fishing - Coast
(3) Boating/Fishing - Inland
(4) Active
(5) Passive

The names of the groupings are self explanatory. It should be noted that the factor analysis revealed only one Boating/Fishing grouping; however, it was felt that characteristics of Boating/Fishing trips made to coastal areas may differ from those made to inland areas and so the two were divided.

Linking of Choices

A single recreational travel choice made by an individual or household is the outcome of a decision on each of the set of choices defined previously. All choices within this set are to some extent interdependent. Successful modelling of the single outcome requires modelling of each component choice, and must reflect the extent and direction of the choice dependencies. A priori evidence of the decision structure of recreational travel choices does not exist, but must be determined in the modelling process. A variety of hypotheses about this structure may be made.

Choices may be independent, simultaneous or sequential. If choices are independent, the models for each may be estimated separately. This simplifies the estimation process but unless one has reason to expect that choices are independent, such an assumption is generally unrealistic. If choices are joint (or simultaneous) it is impossible to model one choice without simultaneously modelling the other. While an assumption of jointness of choices is appealing in some situations, it does often result in computational difficulties: if, for instance, two choices - each with ten alternatives - were modelled jointly, the model would have 10 x 10 = 100 possible joint alternatives. This may present difficulties in estimation. Further, as with an assumption of choice independence, an assumption of jointness may be unnecessarily restrictive.

The third possible choice structure is a sequential one, which is applicable when there is a hierarchy of choices and dependency flows more in one direction than in the other. That is, the outcome of one choice may be independent of the outcome of a second choice, but the outcome of the second choice depends on the outcome of the first. Such a structure may apply to the activity choice-destination choice combination in the present model. The choice of destination may depend quite heavily on the activity to be undertaken, but the choice of activity may be made regardless of the choice of destination. In this case, destination choice occurs lower in the choice hierarchy than activity choice.

However, while choice of activity in the example above is independent of the particular outcome of the destination choice process, it is influenced by the standard of all destinations available for each activity. Thus, if a large number of high quality destinations are available for one activity, that activity is more likely to be chosen than one for which only a small number of poor destinations are available. Consequently, influence flows up a sequential structure as well as down.

The inclusion of the influence of a lower-level choice on the outcome of a higher-level choice is achieved through the use of a variable representing the composite utility afforded by the lower-level choice in the utility function describing the higher (Ben Akiva (1973), McFadden (1976), Hensher and Johnson (1980)). This variable is variously called the "expected utility", "inclusive value" or simply "logsum", because of its formulation, described later. Use of this variable allows both independent, sequential and joint structures to be estimated as a set of independently estimated but linked models, if and only if the sequence assumed in estimation actually represents the underlying choice structure (Ben Akiva, 1973). This significantly decreases the complexity of the modelling and estimation process.

Choice Structure

The assumed sequential choice structure is shown in Fig. 5. Thus frequency choice is assumed to be the highest level choice for both day and overnight trips. There may be some interaction between the two choices, as discussed earlier. For overnight trips, the next choice is that of trip duration; there is no duration choice in the day trip sub-model. Next, choice of activity is made and, given choice of activity, destination choice is made.

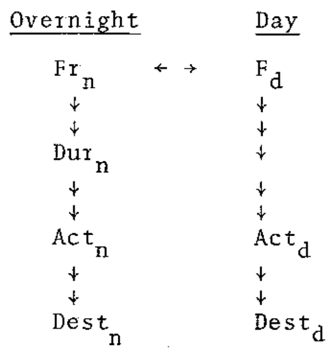

Fig. 2 Assumed Choice Structure

Such a structure does not necessarily apply to all people or in all situations, but it is regarded as the most generally representative choice structure for recreational travel. Verification of its validity will come in part from the estimation process itself, from the value and sign of the coefficient of the expected utility (or "logsum") variable, as discussed later.

MODEL FORM AND ESTIMATION

Model Form

The model form used is the familiar multinomial logit (MNL) model of individual choice, written in simplified form as

$$P_m = \frac{\exp(U_m)}{\sum_k \exp(U_k)}$$

where P_m = the probability an individual will choose the m^{th} alternative from the set containing k alternatives

U_m = the utility afforded to the individual by the m^{th} alternative

$= \Sigma (X,S)\beta$

where X is the vector of attributes describing the alternative, S the vector of socio-economic characteristics describing the individual, and β the set of parameters to be estimated, associated with each element of X, S.

More simply, the utility function may be written as

$$U_m = \sum_{\ell} \beta_\ell X_{\ell m}$$

The theoretical basis of this model and its properties are fully developed in Hensher and Johnson (1980).

Linking of models in a sequence to represent inter-dependent choice structures is achieved by first modelling the lowest level choice, then including the natural logarithm of its denominator as a variable in the utility function of the next highest level choice. For example, considering the assumed choice sequence D←M where the choice of an alternative m from the set M influences the choice of alternative d from the set D, we may write

$$P(m/d) = \frac{\exp(U_m)}{\sum_k \exp(U_k)}$$

$$P_d = \frac{\exp(U_d + \Theta I_m)}{\sum_{d^1} \exp(U_{d^1} + \Theta I_m)}$$

where $I_m = \ln \sum_k \exp(U_k)$, the inclusive value or logsum variable

The value of the coefficient Θ has considerable significance; a value of 0 indicates that the two choices are independent, while a value of +1 indicates the choices are joint or simultaneous. A value between these two bounds indicates that the assumed sequence is probably correct and, as well, the extent to which a sequential rather than simultaneous choice structure applies.

For the reasons explained above, estimation must proceed from the lowest choice in the assumed structure to the highest. The models developed to explain recreation travel choices are therefore discussed in this order.

Before presenting the model forms and results of their estimation, some terms used in assessing model performance must be briefly defined. Maximum likelihood estimation is used to obtain the parameters which are those that minimise minus the log of the likelihood function. Accordingly, the reduction of the function from its value when the parameters are zero to the value at the convergent set of parameters gives a measure of the "strength" of the model. Both values are given in Tables 2 - 5, as is the value of "pseudo R^2", ρ^2, where

$$\rho^2 = 1 - \frac{LLHD(F)}{LLHD(O)}$$

However, as an absolute measure of performance, this test is very weak, and should be interpreted with caution.

Model Estimation

Destination Choice

For the purpose of model estimation, Victoria is divided into eighteen zones, as shown in Fig. 1. These represent eighteen areas of more or less common recreational attributes. No trips outside Victoria are considered. The explanatory variables included in the model are few: a measure of travel cost (in this case travel time) and a measure of destination attractiveness. Thus, destination choice is presumed to consist of a "trade-off" between the difficulty of reaching a destination and its attractiveness.

The representation of destination attractiveness creates some problems. Firstly, it is difficult and time consuming to gather quantitative measures of destination attractiveness describing the variety of opportunities available for each activity. Further, even if quantitative measures of destination attractiveness were available, it is unlikely that these would represent destination attractiveness completely: it is likely that subjective influences play a considerable part in the perception of destinations. Finally, the use of more than one measure of destination attractiveness causes problems in estimation (Daly, 1981).

While the use of attitudinal data may be used fruitfully in this context, an alternative approach is adopted. This approach is discussed by Brown in detail in another paper presented at this Forum (Brown, 1982) and so it is presented here in outline only.

The technique involves estimating aggregate measures of destination attractiveness from the data set used for model estimation. The aggregate measures are obtained from estimating a form of the gravity model, and are then directly included as attractiveness measures in the destination choice model. Destination attractiveness is represented by the natural logarithm of these attractiveness measures entered in the equation with a coefficient of one. This is necessary in order to satisfy assumptions underlying the inclusion of destination attractiveness in the model (Daly, 1979). The advantage of this approach is that no separate destination attractiveness data need be collected in order to estimate the model. While it may be contended that the removal of policy-sensitive measures of attractiveness from the model negates one of the potential advantages of the individual choice modelling approach, this is not necessarily the case; the aggregate measures may be related to particular measures of destination attractiveness in a later stage. Indeed, the removal of the need to identify important measures of destination attractiveness from the model estimation process may represent a real advantage.

Following Brown et al (1979), it is hypothesized that the "cost" of increasing travel is regarded differently by those with children and those without children. Accordingly, in both day and overnight trip destination choice models, travel time is stratified according to whether children accompanied on the trip or not. In the overnight trip models, it is further hypothesized that the valuation of travel time depends on the duration of the trip: travel time is presumed to be valued more highly on short duration trips The results of destination choice model estimation are shown in Table 2. It can be seen that there is some variation in the success of the models (as measured by ρ^2) In particular, the overnight Passive trip model performs poorly. This may be due, in part, to the inapplicability of the assumed disbenefit of travel time to Passive trip-making: sight-seeing driving, for instance, does not fit into a framework that treats increasing travel time as an increasing disbenefit.

The relative values of the travel time parameters provide insight into the influences on destination choice: it can be seen that the values of travel time coefficients are higher for short duration trips than for long duration trips and are generally higher on those trips with children accompanying than on those trips made without children.

Activity Choice

It is hypothesized that activity choice is influenced by a number of socio-economic factors, trip circumstance factors as well as the expected utility from the destination choice model. Socio-economic factors are entered in the form of "dummies" on various activities. The results of activity choice model estimation are shown in Table 3. In both the overnight and day trip activity choice models, the coefficient of the logsum from the destination choice model is approximately 0.3. This indicates that activity and destination choices are made sequentially, as hypothesized.

A number of socio-economic influences are evident. The effect of the lifecycle stage is shown in the significance of those variables relating to age, marital status and parenthood. Generally, it can be seen that young people favour energetic activities and older people more relaxed activities. Those with children also tend to favour energetic activities. The possession of a motorboat tends, not surprisingly, to increase the likelihood of Boating/Fishing trips being made.

Finally, a number of trip related influences are significant. Trips made in summer are more likely to be Active-Beach trips; if children actually accompany on the trip, the trip purpose is more likely to be Active-Beach or, in the case of overnight trips, Passive. Trips of longer duration are more likely to be Active trips.

Duration Choice

As in the activity choice models, duration choice is assumed to depend on the inclusive price from the activity choice, together with socio-economic effects. The estimated model is shown in Table 4. It can be seen that it performs reasonably well. The logsum term, although indicating a sequential structure, is not significant. This may indicate one of the problems inherent in model estimation in a sequential structure: errors in lower choice models are passed up into higher choice models, resulting in increased errors and lower parameter significance.

A constant is included in the model to reflect the overall tendency to make shorter duration trips. Other effects included in the model are the increase in trip duration if accompanied by children, the tendency towards shorter duration if trips are made regularly or in the summer or autumn. Finally, householders with unemployed heads tend to make longer trips.

TABLE 2: DESTINATION CHOICE MODELS

t-values given in brackets

1. Overnight Trips

	Active Beach	Boating-Fishing Coastal	Boating-Fishing Inland	Active	Passive
time ≤2 no kids	-0.690 (4.71)	-1.454 (14.68)	-1.440 (8.53)	-0.761 (6.17)	-0.678 (5.95)
>2 no kids	-0.372 (2.48)	-0.675 (4.98)	-0.808 (3.99)	-0.781 (5.61)	-0.219 (1.94)
≤2 kids	-1.032 (3.26)	-2.364 (3.52)	-0.740 (2.66)	-1.191 (5.04)	-0.431 (3.21)
>2 kids	-0.728 (2.98)	-0.807 (3.65)	-0.447 (2.27)	-1.113 (5.53)	-0.265 (2.38)
Aggregate attractiveness	1	1	1	1	1
LLHD(O)	-406.5	-367.6	-336.2	-733.8	-920.8
LLHD(F)	-267.4	-250.1	-232.9	-643.5	-890.6
ρ^2	0.34	0.19	0.31	0.12	0.03

2. Day Trips

	Active Beach	Boating-Fishing Coastal	Boating-Fishing Inland	Active	Passive
time no kids	-1.576 (6.16)	-1.609 (11.91)	-0.762 (10.25)	-1.297 (8.45)	-1.405 (15.44)
kids	-2.025 (6.59)	-1.404 (9.37)	-1.122 (12.64)	-1.514 (7.78)	-1.397 (16.92)
Aggregate attractiveness	1	1	1	1	1
LLHD(O)	-550.3	-1133.0	-956.8	-453.8	-2182.0
LLHD(F)	-370.6	-853.8	-797.1	-358.9	-1689.0
ρ^2	0.327	0.246	0.167	0.209	0.226

TABLE 3: ACTIVITY CHOICE MODELS

t-values given in brackets

1. Overnight Trips

Logsum	0.304	(8.49)
Kids on trip on P	0.992	(6.75)
Motor boat ownership on BFC	2.505	(13.82)
" " " " BFI	1.897	(9.59)
Summer on AB	1.022	(6.46)
Head of household >60 on P	0.805	(4.54)
Married, kids <5 on ACI	1.193	(5.48)
Married, kids >12 on AB	0.353	(2.55)
Head of household <25 on AB	0.895	(3.96)
Head of household completed secondary education on P	0.756	(5.87)
Kids on trip on AB	0.367	(1.88)
Duration >2 days on ACI	0.556	(3.59)

LLHD(O) = -1711

LLHD(F) = -1480

ρ^2 = 0.135

2. Day Trips

Logsum	0.289	(2.33)
Not (young, unmarried, living with others) on P	2.462	(18.67)
Summer on AB	0.937	(4.90)
Head of household <25 on AB	0.954	(2.87)
Head of household <30 on ACI	0.730	(2.31)
Motor boat ownership on BFC	1.422	(4.22)
" " " " BFI	0.928	(2.64)
Married, kids >12 on ACI	0.850	(3.98)
Married, kids >12 on AB	0.530	(2.47)
Kids on trip on AB	0.721	(3.56)

LLHD(O) = -1022

LLHD(F) = -743.0

ρ^2 = 0.273

Frequency Choice

Frequency choice is hypothesized to depend on two main factors: the "attractiveness" of all lower choice combinations (as measured by the inclusive price) and the increasing "cost" of travel as the frequency increases.

Overnight and day trip frequency models are shown in Table 5. Because no variables in lower choice models of either day or overnight trip making vary with trip frequency, it is not possible to include a pure logsum term that varies across the frequency alternatives in either frequency choice model. In the overnight trip model, the logsum from lower choice models is included as a dummy on all but the no trip alternative. Thus, it is hypothesized that, as the attractiveness of all duration/activity/destination choice alternatives increases, so does the likelihood of making at least one trip. It can be seen that the coefficient of this variable is very close to zero and is not significant. This may indicate either that frequency choice is independent of other overnight trip choices or that the composite logsum formulation is inadequate.

In the day trip frequency model, the increasing attractiveness of higher frequency choices is represented by the logsum term from the lower day trip models multiplied by the natural logarithm of trip frequency. This approach is adopted because it is felt that decreasing increments of enjoyment are derived from succeedingly higher trip frequencies. It will be seen that the coefficient of this variable is significant, which adds credence to the approach.

The increasing "cost" of travel is included in both models through the inclusion of a composite frequency/number in family term. In both cases it is negative and significant, indicating the higher "cost" of higher frequency choices.

The competition between trip types is represented by an "unmodelled trip" variable in the overnight frequency choice model. It is hypothesized that, as the number of trips not modelled increases, so the likelihood of making no overnight trips increases. This variable proves not significant. In the day trip model, the interrelation of day and overnight trips is represented by a variable reflecting the number of overnight trips taken included for the high day trip alternative. The rationale for this variable is that, as the number of overnight trips increases, so the likelihood of undertaking a large number of day trips decreases. This variable proves to be not significant.

TABLE 4: OVERNIGHT DURATION CHOICE MODEL

t-values given in brackets

Logsum	0.477	(1.72)
Kids on trip on 3+ days	0.801	(4.20)
Regular trip on ≤2 days	2.252	(8.13)
Summer/Autumn on ≤2 days	0.599	(3.81)
Head of household unemployed on 3+ days	1.303	(6.13)
Constant on ≤ days	1.608	(3.18)

LLHD(O) = -747.2
LLHD(F) = -605.8
ρ^2 = 0.189

TABLE 5: FREQUENCY CHOICE MODELS

1. Overnight Trips

logsum on all but F=0	0.040	(1.27)
Freq/(NFAM*100)	-26.671	(6.14)
Head of household >25 on no trips	1.232	(6.06)
Head of household >65 on no trips	0.866	(3.13)
Head of household not born in Aust. or NZ on no trips	1.066	(6.08)
Married, children <12 on F=1	0.389	(1.72)
Unmodelled trips on F=0	-0.015	(1.24)
Head of household non-professional on F=1	0.714	(5.21)
Head of household professional on F=3+	0.242	(1.06)
1 person household on F=0	1.013	(3.38)

LLHD(O) = -1566
LLHD(F) = - 971.1
ρ^2 = 0.380

TABLE 5 (CONT.): FREQUENCY CHOICE MODELS

2. Day Trips

Logsum* log (frequency)	0.060	(4.18)
Frequency/(no. in family*100)	-0.435	(2.02)
Overnight trips >0 on F=27+	-0.086	(0.60)
Head of household >65 on F=0	0.986	(4.73)
Head of household born outside Aust. or NZ on F=0	0.685	(3.49)
Head of household completed secondary education on F>0	0.698	(2.91)
Head of household unemployed on F=0	0.493	(2.13)

LLHD(O) = -1412

LLHD(F) = -1378

ρ^2 = 0.024

Other variables are of a socio-economic nature. A number of conclusions can be drawn: as age of household head increases, so the likelihood of making no day or overnight trips increases; households with children less than 12 are more likely to undertake just one overnight trip for the year; single person households are more likely to make no overnight trips than others, and so on.

It is interesting to note that the overnight trip frequency choice model performs well, while the day trip frequency model performs very poorly. The reason for this is likely to stem from the nature of the two types of trip: overnight trips are generally regarded as a relatively major exercise and so they are planned ahead to some extent and the yearly overnight trip pattern is quite ordered: day trips, on the other hand, represent a much smaller outlay of time and resources and so are more likely to be made in the short term. Consequently, the concept of a travel budget - in which a certain number of day trips are presumed to be made in the year - does not fit this type of trip making well.

CONCLUSIONS

The success of the models needs to be judged on two grounds, corresponding to the two aims outlined earlier; their ability to describe and their ability to predict travel behaviour.

The descriptive ability of the models is good overall. Given the complexity and wide diversity of recreation travel behaviour, the large degree of credence given the assumed decision framework by the results of model estimation is cause for satisfaction. Many of the models perform well, both statistically and in terms of the variables found to be significant descriptors of behaviour.

One shortcoming of the models is centred on the frequency choice models. The specification of frequency choice is not felt to satifactorily represent the decision process; this specification, however, was forced by the insufficiency of the frequency related information in the data set. Further, the means used to include attractiveness of lower level choices in the frequency choice models is not satisfactory; this, of course, stems from the lack of frequency related variables in the lower level choices.

A second shortcoming of the models is the general lack of policy sensitive variables. One of the claimed advantages of the individual choice modelling approach is that, through the inclusion of policy-related explanatory variables, it is possible to investigate the effect of policy actions on travel behaviour. Inasmuch as these models lack policy related variables, their use as tools for the analysis of policy changes is limited. Notwithstanding this lack, the inclusion of variables likely to reflect changes in the travel environment means they may be used as a quite useful predictive tool.

The use of the aggregate measure of destination attractiveness appears to have a certain potential. The generally poor performance of destination choice models can be traced, in part, to the inability to adequately represent destination attractiveness. The use of the aggregate measures of attractiveness avoids this problem. This has the added advantage that, because the destination choice models are lowest in the sequential hierarchy, the minimisation of errors in their estimation improves the performance of the other models.

Notwithstanding the shortcomings noted above, the attempt made to model a complex and difficult choice process has significantly increased understanding of the choice influences and structures involved. It has highlighted some definitional and data problems in a way that should considerably aid subsequent work in this area Finally, it has demonstrated the versatility of the individual choice modelling approach in uncovering complex decision structures and in highlighting the choice influences involved.

REFERENCES

Ben Akiva, M., (1973). "Structure of Passenger Iravel Demand Models", Ph D Ihesis, Massachusetts Institute of Iechnology (Unpublished).

Brown, H.P., Daly, A., Kocur, G. and McMann, J., (1979). "A Model of Statewide Recreational Travel Demand", P.I.R.C. Summer Meeting, University of Warwick, 1979.

Brown, H.P., (1982). "Aggregate Attraction Measures for Disaggregate Destination Choice Models", 7th Australian Transport Research Forum, Hobart, 1982.

Daly, A., (1982). "Estimating Choice Models Containing Attraction Variables", Iransportation Research B (forthcoming)

Hensher, D. and Johnson, (1980). "Applied Discrete - Choice Modelling" Croom Helm.

Hensher, D., and Stopher P., (Eds), (1980). "Behavioural Travel Demand Modelling". Croom Helm.

McFadden, D., (1976). "Properties of the Multinominal Logit (MNL) Model", UIDFP Working Paper No. 7617.