SUBSTITUTION IN RECREATION CHOICE BEHAVIOR

George L. Peterson
Daniel J. Stynes
Donald H. Rosenthal
John F. Dwyer

ABSTRACT: This review discusses concepts and theories of substitution in recreation choice. It brings together the literature of recreation research, psychology, geography, economics, and transportation. Parallel and complementary developments need integration into an improved theory of substitution. Recreation decision behavior is characterized as a nested or sequential choice process. Examples are included from urban and dispersed recreation research.

INTRODUCTION

Recreation resource management is dependent on understanding recreation choice behavior. Many management actions directly affect the attributes of recreation sites, e.g., changes in services and facilities, modification of site quality or capacity, changes in user fees, and congestion management. Such changes may strongly modify the quantity and types of recreation participation in general as well as at specific sites. If management actions are to be efficient and effective, the resulting effects on recreation choice need to be predictable.

How recreationists respond to management actions depends largely on two factors: (1) the underlying preferences of consumers as constrained by their resources, and (2) the available alternatives. If a new campground is established in an area where there are several similar campgrounds, the changes in behavior will be driven largely by reductions in travel cost. The new campground can be expected to intercept those campers for whom it has a lower travel cost, thereby reducing visits at more distant sites. And, because of the lower cost, it may generate increased camping activity. This increase in camping may draw people away from other activities, such as gardening or television watching.

If the new campground also differs from all the others by providing hot showers, still more behavioral change can be expected. The location factor is a price change while the hot showers are a site quality change. There may be people who now drive farther than before in order to have a camping experience that includes a hot shower. And, the availability of showers may attract new campers. Unless we understand how individuals evaluate and choose among recreation opportunities, serious errors may be made in predicting how they will respond to management actions.

The theoretical framework for making such predictions has not been adequately developed and applied. One of the most difficult and least understood parts of this problem is the question of how people tradeoff activities, sites, and site attributes when change is encountered. This paper discusses this concept of "substitution" in recreation choice behavior and exposes some common problems. Theories of choice behavior from several disciplines are reviewed and their implications discussed. Some recent research results from urban and dispersed recreation provide examples.

The concern here is with substitution as it pertains to modeling choice behavior. People make choices in decision situations, and the purpose of a choice model is to allow such choices to be predicted and analyzed. A choice model might be formulated at any of several levels of the choice process. People make choices among recreation sites, among attributes of those sites, among activities that might take place at the sites, and among the consequences or outcomes of performing alternative activities at alternative sites. These consequences include the satisfaction of motives or expectations that may or may not be in the recipient's domain of awareness.

While there are many important reasons for explaining recreation choices at all of these levels, our purpose is to explore substitution among sites and site attributes in models based on observations of overt choice behavior. What goes on inside the mind and body of the consumer is left for others to explore.

Paper presented at the Recreation Choice Behavior Symposium, Missoula, MT, March 22-23, 1984.

George L. Peterson is Project Leader, Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, Fort Collins, CO; Daniel J. Stynes is Associate Professor, Dept. of Park and Recreation Resources, Michigan State University, East Lansing, MI. Donald H. Rosenthal is an Economist, Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, Fort Collins, CO. John F. Dwyer is Project Leader, North Central Forest Experiment Station, USDA Forest Service, Chicago, IL.

WHAT IS "SUBSTITUTION"?

Webster defines "substitution" as, "to put in the place of." Within this concept, substitution can be defined at different levels. At the simplest level, two objects that are physically identical in every respect are likely to be substitutable for each other. Thus, physical similarity is one way to attack the question. At a more general level, substitution may derive from functional similarity. Two physically dissimilar objects may be capable of performing the same function. One object can be put in the place of another and perform similar functions, e.g., pen for pencil.

Whether or not two objects are substitutes can be learned by observing behavioral response to changing opportunities. A simplistic approach would hold that, other things being equal, if the consumption of A goes up when the price of B goes up, the two are substitutes; if the reverse is true, they are complements. If nothing happens to A when the price of B changes, they are independent.

The trouble with this approach is that it reveals only what is known already. It is not possible to predict choices under new circumstances, (i.e., to predict behavioral response to innovation). Neither is it possible to recognize when apparent substitutability is simply the product of spurious correlation. What is needed is a theory of choice behavior that explains choices in terms of those variables to which they are sensitive. Lancaster (1966) and Becker (1965) responded with a new consumer theory based on the concept that the objects of choice are not the goods themselves, but the attributes possessed by those goods. Consumers use the attributes as input factors for a consumption technology that produces utility. For example, they combine time, travel, equipment, facilities, and the features of natural environments to produce outdoor experiences such as camping.

The attributes may be thought of as parameters describing the physical state of a thing. Thus, an automobile can be described in terms of color, make, model, rate of fuel consumption, braking distance, luxury options, etc. In this sense, substitution again reduces to physical similarity, except that in a given decision context only selected physical attributes may be relevant. Substitution is thus physical similarity vis-a-vis only those variables relevant to the decision context. On the other hand, as expressed by Morishima (1959), demand is created by human objectives. Goods are demanded because of their ability to serve human purposes. Certain attributes or context variables may modify the effectiveness of a thing in a given role. Substitution can occur among purposes, among attributes, or among goods, and this complicates matters.

It becomes still more complicated when we allow decision rules to vary. Some goods, attributes, or purposes may be compensatory, others noncompensatory. Some noncompensatory decisions may involve lexicographic decision rules. For example, for aerobic conditioning, jogging and bicycling are generally regarded as compensatory activities. More bicycling can compensate for less jogging in the maintenance of aerobic capacity when a minor injury interrupts a runner's training schedule. However, more carbohydrate in the diet cannot compensate for iron deficiency. The two nutrients have independent functions and are noncompensatory. A lexicographic decision rule requires criteria to be satisfied in sequential or hierarchical order. In shopping for formal wear, a conventional male goes first to the men's department and then compares alternatives. He does not compare evening gowns and tuxedoes. There may also be threshold decision rules such that in a given range the relationship among attributes is lexicographic, while in another range the attributes are compensatory (Peterson and Worrall 1970, de Bettencourt and Peterson 1981, Krumpe and McLaughlin 1982).

Whatever the decision rules, it is clear that they must be known and understood if prediction of substitution in recreation choice behavior is to be effective. A given model structure may be entirely inappropriate in a given decision context. What is needed is a theory of recreation choice behavior and interpretation of real choice situations in terms of that theory. Therefore, the next section reviews the approaches of several different disciplines.

REVIEW OF SUBSTITUTION RESEARCH

While there is a great deal of research related to substitution, only a small portion of this research confronts the substitution issue directly. First, the treatment of substitution in empirical studies within recreation will be reviewed, and then, briefly, more basic research from geography, psychology, transportation, and economics. The latter provide some of the pieces for a much needed conceptual and theoretical basis for substitution research within recreation and leisure. We will not at this stage attempt to assemble the pieces, but hope to begin to identify the components of a more comprehensive model in which substitution may be addressed.

Recreation Research on Substitution

There are two major bodies of substitution research within recreation: (1) recreation/leisure activity substitution, and (2) recreation site substitution. The former has largely been the domain of sociologists and psychologists while the latter has been addressed by geographers and economists. A few studies examine substitution between resource settings (O'Leary and Dottavio 1981), geographic areas (Ditton and others 1975, Vaske and Donnelly 1982), and providers (Cordell 1976).

Hendee and Burdge (1974) raised the importance of the substitution concept for recreation planning and management in the context of recreation activity substitution. Growing out of the leisure typology research was an attempt by a number of investigators to shed light on substitution relationships by factor analyzing recreation participation data. Recreation activities were grouped into activity types with the idea that activities within the same group are in some sense "substitutable." Planners could then meet the recreation needs of clientele groups by providing at least several activities from each group, rather than attempting to provide all activities. Beaman (1975) pointed out the inappropriateness of factor analysis for deriving activity packages, recommending cluster analysis as the more suitable tool. Because the activity packages derived through factor analytic methods are based upon correlations between participation in different activities, activities falling in the same cluster are just as likely to be complements as substitutes. Christiansen and Yoesting (1977) tested whether recreationists would derive similar "satisfactions" from activities within the same type category, concluding that the approach of deriving activity packages empirically is too simplistic to yield much insight into substitution behavior.

A more productive approach to activity substitution is the development of recreation activity packages based upon similarity judgments of real or perceived characteristics of recreation activities. Ritchie (1975) and Becker (1976) have used multidimensional scaling techniques (MDS) for this purpose. Holbrook (1980) recommends the method of multidimensionally scaled correlations (MSC) as preferable to both factor analysis and MDS in representing association among recreation activities. MSC performs an MDS procedure on the correlation matrix of variables rather than the variables themselves. A limitation of MDS, MSC, and related attitude scaling methods for substitution research is the problem of linking attitudes with behavior. Becker (1976) notes that situational variables must be studied in conjunction with attitudinal data in order to predict actual behavior.

The problem of how to incorporate the effects of substitute sites is common to both economic demand models and geographic models of spatial choice. Investigators from both disciplines tend to favor revealed preference approaches in which a variety of situational factors must be controlled. Motivational and attitudinal variables that are difficult to observe are downplayed, and observable characteristics of recreationists, recreation sites, and selected environmental variables are studied.

Measures of recreation site substitution have been incorporated into aggregate recreation demand and trip distribution models. The travel cost model (Dwyer and others 1977, Rosenthal and others 1984) and the gravity model (Ewing 1980) have been the primary vehicles for examining substitution in recreation economics and geography, respectively. To predict the number of trips or visits to a set of destinations, those gravity models that include a substitute component typically capture it by means of a single variable measuring the quantity and/or quality of alternative recreation opportunities available from each origin. The selection of sites to be included as potential substitutes and the measurement of their characteristics is most often done by the investigator, rather than the consumers whose choices are to be predicted. Many of these studies limit the range of substitutes to sites managed by the same authority or sites that are similar according to some criteria defined by the investigator. Thus, television viewing is never considered a substitute to visiting a given state park, and in many cases neither is visiting a county or urban park. When studying state parks, only other state parks are likely to be considered. Park visitation models that include a substitution component are those of Grubb and Goodwin (1968), Cheung (1972), Cesario (1973), and Smith (1980).

The substitution issue has also been prominent in the development of travel cost models, which are widely used to estimate the demand for and value of recreation sites. Such models can yield very misleading results if substitute sites are not properly specified. This is well illustrated by Knetsch (1977). Good examples of alternative ways of incorporating substitutes into recreation demand models are the studies of Burt and Brewer (1971) and Cesario and Knetsch (1976). Both studies estimate the demand for individual parks within a system of equations, taking into account the presence and attributes of alternative sites in estimating the demand for any particular site.

Because both the gravity and travel cost models have traditionally been applied to aggregate data, they can only reveal aggregate patterns of substitution. In order to shed more light on individual differences in recreation choices, recent work in geography, economics, and transportation has explored disaggregate modeling of choices. These models can be applied to both activity and site choice problems, provide a stronger theoretical base for aggregate models, and can more fully incorporate a variety of assumptions about substitution. Since these new directions in choice research are not well known within recreation, we first provide a brief background on the development of choice models in psychology and then discuss some recent development in geography, economics, and transportation.

In summary, while sociologists and psychologists have concentrated on motivational and attitudinal determinants of choice, geographers and economists have focused more upon situational factors. However, their studies have examined substitution in the context of site choice, not activity choice, and no one has really attempted to link these two somewhat independent bodies of research.

Psychology

Psychological choice research focuses upon individual choice and relies heavily upon experimental methods. A strength of the psychological research is the reduction of choice to fundamental concepts and relationships, resulting in tight controls in research designs. A corresponding weakness is that to achieve rigid experimental controls the conditions and settings are often oversimplified and sometimes artificial. This makes it difficult to generalize the results to highly complex real-world settings.

The relevant psychological research may be divided into two classes: (1) mathematical models of choice that establish set-theoretic foundations for applied work, and (2) more applied research, which explores choice in terms of individual perceptions, preferences, and information processing. The latter category overlaps considerably with the microlevel geographic research, but tends to have a stronger methodological orientation.

Along with psychophysics and learning, choice is one of the three primary subject areas within mathematical psychology. The models of Luce (1959) and Tversky (1972a, 1972b) have guided much of the theoretical choice research over the past two decades and provide the foundations for the majority of applied studies of choice. Both are highly abstract theories couched in purely set-theoretic terms.

Luce's model formalizes Arrow's (1951) "independence of irrelevant alternatives" (IIA) assumption into a choice axiom. Because it relates to recreation choice modeling, this axiom is discussed and illustrated in a subsequent section. This powerful and simplifying assumption makes the Luce model easy to apply, although it is known to fail in many simple kinds of choices (DeBreu 1960) because of interrelationships among choice alternatives that are not captured in the highly abstract model. Nevertheless, the Luce model provides a reasonable approximation for many kinds of choices (Luce 1977) and, perhaps more importantly, provides a starting point for choice research including substitution phenomena. The Luce model has been shown to be essentially equivalent to Thurstone's (1927) Law of Comparative Judgement (Case V) if Thurstone's assumption of independent, normally distributed random variables is replaced by double exponential, random disturbances (Yellott 1977, McFadden 1973). The difference distribution of two independent double exponential random variables is the logistic distribution, which is the basis for the multinomial logit model (MNL) (Stynes and Peterson 1984). Thus, there is a direct link between the widely applied MNL model and basic theories of choice studied by Luce, Thurstone, and others. The simple counterexamples to the Luce model (DeBreu 1960, Luce 1977, Tversky 1972a) are also cases where the MNL model will fail. These cases have provided the stimulus and direction for revised choice theories that more fully capture interrelationships among the choice objects. Most notable of these within psychology is the Tversky (1972a, 1972b) elimination by aspects (EBA) model.

Although the EBA model, like Luce's, can be formulated in purely abstract set-theoretic terms, the natural interpretation of the model involves the identification of the choice alternatives in terms of a set of attributes or characteristics. Luce's model is a special case in which the alternatives do not have any characteristics in common. The EBA model is lexicographic. A choice is made from a set of alternatives by successively eliminating those that do not possess desired attributes. There is an assumption that individuals have a ranking of desired attributes and eliminate alternatives beginning with the most desired attribute, then the second most desired attribute, etc., until only a single alternative (the choice) remains. The model is noncompensatory because a lack of one desired attribute cannot be compensated by another. Any alternative lacking the most desired attribute is eliminated in the first step regardless of what other desirable attributes it may possess. The EBA model results in nested or sequential decision structures that can become combinatorially complex when the alternatives possess many different attributes (Krumpe and Mclaughlin 1982). Indow (1975) questions whether any mathematical model can fully capture the complexity of individual choice processes, suggesting computer simulation as an alternative approach. Grether and Plott (1979) have found that individual behavior is often at odds with what is implied by the formal, and fairly mathematical, theory of consumer demand in economics.

The strength of the formal mathematical treatment of choice lies in the precision with which concepts can be defined and the manner in which properties may be deduced and tested (See Luce and Suppes 1965, Tversky and Russo 1969). In the absence of such approaches, the essential differences and similarities between alternative choice models, like the Thurstone and Luce models, would remain obscure. By employing a common mathematical language, the theories of choice behavior from psychology and economics can be shown to share common foundations. This helps a great deal to clarify the properties and limits of these models, including the implied assumptions about substitution.

Applied studies of preference, utility, and choice within psychology look more closely at the choice set, choice setting, and attributes of the choice alternatives in order to explore individual differences and common patterns of choice behavior. Many of these studies attempt to identify a utility function, and model choices as a utility maximizing process. The methods are variously known as information integration, functional measurement, conjoint analysis, and policy capturing. These kinds of methods are widely applied in geography, marketing, economics, transportation, and related fields. The psychological contributions to this area have identified a number of methodological issues that must be considered in the design of choice experiments. For example, Tversky's (1977) review of the concept of similarity presents both theoretical and empirical evidence against representing similarities between objects or choice alternatives geometrically. This is precisely what the MDS and related methods do. Tversky suggests that similarity judgments are the result of a feature matching process and may not satisfy the metric assumptions of symmetry and transitivity. Curry and others (1983), in an application to recreation, conclude that a number of contextual and measurement issues can significantly influence the results of choice experiments, making it difficult to generalize from one choice setting to another. These problems may explain many of the apparently conflicting results of choice experiments as well as the difficulty of generalizing from highly artificial settings to real-world choices.

Geography

Geographic choice research focuses upon spatial choice and is therefore relevant to the recreation site choice problem. Geographic measures of substitute and intervening opportunities provided the basis for numerous recreation applications of the gravity and related trip distribution models. At the macrolevel, geographers have become increasingly concerned with the effects of spatial structure on the parameter estimates of gravity models (Fotheringham 1981). Spatial structure of alternative sites cannot be adequately represented by a single variable, and models incorporating spatial structure more fully are being sought. At the microlevel, there have been numerous efforts within geography to better explain spatial choice by examining data for individuals. These investigations have added cognitive dimensions to gravity models (Cadwallader 1981) and explored individual variations in perceptions of distance and alternatives. Much of this work overlaps with work in marketing and psychology on functional measurement, information integration, and the like (see Golledge and Rushton 1976 and Burnett 1981, for examples).

Economics

Economics is the study of the employment and consumption of scarce resources that may have alternative uses (Samuelson 1976). Two questions addressed are (1) how factors of production (e.g., land, labor, capital) should be allocated to firms, and (2) how the goods produced by firms should be distributed to consumers. Substitution in recreation choice is a matter of consumer behavior, so the relevant contribution of economics is the theory of consumer demand, which also has a similar development in the theory of the firm. The economic point of view assumes that prices are the key mechanism regulating the consumer's and firm's allocation of scarce resources.

The theory is well known and is only summarized here. A full exposition is available in, for example, Henderson and Quandt (1980). The amount of a given good consumed by a person is a function of tastes and preferences, prices of that good and of other goods, and income. The consumer's preferences among choice options are assumed to be describable by an ordinal utility function that has certain restrictive properties. Income and prices are generally assumed to be fixed. Faced with a choice among several competing alternatives, the consumer is assumed to pick that option which maximizes utility, subject to a budget constraint. The result of this utility maximization is the individual demand function. This function describes for that person the relationship between the quantities of goods consumed and their prices. The aggregate or market demand function is the sum of individual demand functions. To attain more effective treatment of substitution and complementarity, consumer theory has been extended by Morishima (1959) and Lancaster (1966).

The theory of consumer demand provides a disciplined framework for the treatment of substitution. The price elasticity of demand gives the percent change in demand for a good (or attribute) resulting from (1) a 1% change in the price of that good (attribute), or (2) a 1% change in the price of some other good (attribute). The price elasticity of demand is dependent on prices and marginal rates of substitution. The marginal rate of substitution (MRS) is defined by the utility function. It is the amount of good Y the consumer is willing to give up to attain one more unit of good X. Two goods are perfect substitutes if the MRS is constant, no matter how much X or Y is owned. The price of a good is determined by the quantity available and the quantity demanded.

When trying to predict demand or estimate value for a recreation activity or site, it is important to assess the availability of substitutes. The demand function is the basis for predicting participation and estimating benefits under alternative management options. Failure to incorporate the effect of substitutes in the demand function can produce incorrect results. For example, assume the managers of a certain recreation site want to raise entrance fees, but are unaware that a perfect substitute with excess capacity is available a short distance away. Raising the fee will simply divert to the alternative site those users whose added travel cost is less than the price increase.

A decision not to close the site may be similarly misguided. Estimates of the net benefits to the public of a government-operated site will be too high if an uncongested nearby substitute is ignored. Assume that closing the site will require all users to travel one mile farther up the canyon. The loss of benefit caused by the closure is only the cost of the added one mile of travel. Of course, if the second site has insufficient capacity, there will be a loss of quality and/or an increase in price that will affect the outcome of the closure.

Thus, the demand for a recreation site or activity is a function of its price plus the prices of all other goods and services in the economy. If demand and substitution are to be tractable in this overwhelmingly complex framework, some simplification is required. Complex demand functions can be accurately represented through the use of "flexible functional forms" (Simmons and Weiserbs 1979). The demand functions themselves can be simplified through assumptions about separability in the utility function (Barten 1977, Powell 1974). If the utility function is weakly separable, all goods can be partitioned into a set of mutually exclusive subgroups such that the MRS between two goods within a group is independent of the quantity consumed (and price) of any good in another subgroup, holding utility constant. This allows consumer decisions to be structured in terms of a nested utility tree (Deaton and Muellbauer 1980), which in turn enables the estimation of conditional demand functions.

What this means is that consumer decisions can be viewed as sequential (Katzner 1970). At one level, the consumer decides how much income to allocate to each of several groups of goods. Given the allocation of income, say, to a group of recreation sites, choices among those sites are independent of choices among goods in other groups. If the partial utility function describing how preferences are ordered within the group is homothetic (Silberberg 1978, p. 254), then proportional allocations of income among goods within the group are also independent of the amount of income allocated to the group. This framework leads to a nested conditional choice structure that includes as special cases the EBA model and the sequential model of Krumpe and McLaughlin (1982).

Such assumptions and conditions greatly simplify the analysis of recreation choice behavior. Unfortunately, these assumptions are too often hidden and unrecognized. These hidden assumptions describe the world to which the model applies. The important question is how far that world is from the real one. This line of economic reasoning reveals the kinds of questions that should be asked when various types of models are used. It also provides a framework for defining and answering questions about substitution. When we decide to consider only a finite set of substitutes in a model, say a group of state parks, we have made a strong implicit assumption about the underlying choice process. Would it not be better, through research, to discover the structure of the choice process, and then to ask what kinds of models and sets of substitutes are implied thereby? This discovery of the underlying choice processes is the objective of relevant research in psychology, geography, and recreation. Integration of this work within the organized framework of economics would be a major contribution. Progress is hampered by a lack of the data needed to verify and interrelate the theoretical propositions.

Transportation

Transportation researchers appear to be at the forefront of applied choice modelling. Most of the work has centered around mode choice and the multinomial logit model or variations thereof. Transportation researchers seem to have been successful in integrating economic, geographic, and psychological variables into formal choice models that can be empirically estimated and tested. Domencich and McFadden (1975) and Stopher and Meyburg (1975) derive the MNL model in the transportation context based upon utility maximization. Much of the recent work in transportation addresses some of the undesirable properties of this model, including assumptions about substitution. This has led to a variety of models with different assumptions about substitution, including nested logit models, probit models, and generalized extreme value models (Chu 1981, Amemiya 1981).

A recent book by Anas (1982) provides a framework for the estimation of conditional demand functions, based on a nested or sequential decision process, as derived from assumptions of separability in the utility function. His approach provides the analytical framework for treatment of substitution in conditional and nested choice models. These models have the advantage of beginning with assumptions about individuals and then generating aggregate results by combining the individual choice models under various distributional and separability assumptions. In this way they can capture the common features of individual decisionmaking processes without attempting to "predict" individual behavior. Recent research has explored interpersonal variations in the choice set (Richardson 1982), and the effects of a number of possible misspecification problems on travel demand forecasting (Williams and Ortuzar 1982). The MNL model has been applied to recreation by Stopher and Ergun (1979, 1982), Peterson and others (1982), and Peterson and others (1983). Stynes and Peterson (1984) provide a general review of logit models, drawing conclusions for applications to recreation choices. They, as does Vickerman (1978), specifically discuss the independence of irrelevant alternatives (IIA) property of the MNL model in the recreation context.

CHOICE MODELING AND NESTED CHOICE STRUCTURE

The demand models typically used in recreation are general share models. They exhibit the IIA property and imply strict assumptions about separability in the utility function. This means, in general, that adding or deleting an option will not change the proportional shares of demand to the other alternatives. For example, let two existing parks, A and B, each receive 50 percent of park use. The IIA property implies that adding a third park, C, might reduce total participation at A and B, but the proportional allocation between A and B will not change. Both will continue to receive half of the participation allocated to A and B. Clearly, this is reasonable in some situations and not in others. The key to proper choice modeling is an understanding of choice structure, including the separability and form of the utility function and the implications for substitution.

The typical example used to illustrate the IIA problem comes from mode choice analysis in transportation planning. The object is to predict how travelers between two locations allocate themselves among automobile, bus, and rapid transit as a function of the characteristics of the three modes. Assume an appropriate general share model (such as a logit model) has been developed, based on observed choice behavior. Assume also that all the buses are red. Now, the planning authority decides to paint half the buses blue and wants to predict the new distribution of riders. The analyst assumes that red buses compete with blue buses in the same way that buses compete with autos and rapid transit. If, before the painting, the three modes each received one-third of the use, the model will allocate one-fourth of the use to each mode after the painting. If the riders are indifferent to color, or less concerned about color than about other things, they will continue to allocate one-third to buses. The new situation will be 1/3 to autos, 1/3 to rapid transit, 1/6 to red buses and 1/6 to blue buses, while the model predicts 1/4 to each.

The mistake arises because the analyst fails to understand the role of color in mode substitution. Red buses and blue buses were seen by the riders as perfect substitutes but were assumed by the analyst to be imperfect substitutes at the same level as buses versus autos. Technically speaking, this problem is caused by lack of independence among the random elements of utility. When some alternatives are more similar than others, the random elements will be correlated and the IIA assumption will be violated. The trouble is, it is practically impossible in recreation applications to correctly identify sets of balanced substitutes without much more theory and information than now available.

Other conditions also cause problems. Different sites may attract different mixes of activity and different mixes of preference for site attributes. Mixing these processes violates the IIA assumption, because the parameters and perhaps even the specification in a model will change for different subsets of a given set of alternative sites. The solution is to isolate the separate components of the mixed process.

In the mode choice example the analyst saw the situation as figure 1, in which riders face four substitutable alternatives. However, the riders saw it as figure 2, in which they face, at one level of choice, three competing alternatives. Given that bus is chosen, a new level of choice is confronted: red or blue. The preferences to which the red versus blue choice relates are different than the preferences that govern, in this case, choice of travel mode. The two sets of preferences may or may not differ in relative importance. In the example, color was assumed to be unimportant to mode choice. In any case, a different utility process applies to the choice of mode than applies to the choice of color. The decisions need to be separated, because while bus substitutes for auto and transit, blue does not.

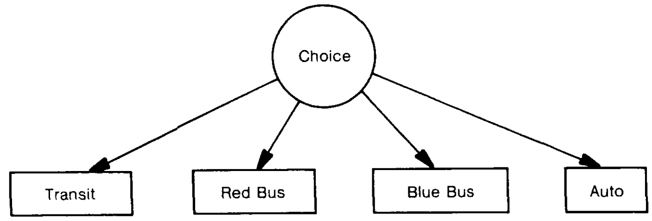

Figure 1.--The Red Bus - Blue Bus problem as a simultaneous choice.

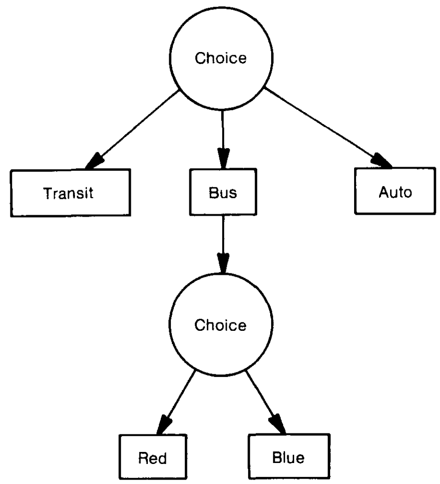

Figure 2.--The Red Bus - Blue Bus problem as a nested choice.

In the extreme case, preferences might be hierarchical. Choices, choice sets, and substitution would have to be nested in terms of the hierarchy of objectives. For example, people have objectives that relate to comfort, convenience, and esthetics, in choice of transportation mode. They also have objectives that relate to cost, safety, and access to desired destination. A mode that does not serve the destination is not acceptable, no matter how cheap or pretty it may be. Given two modes that serve the destination, choice will probably be influenced by significant differences in safety. An abnormally high risk of being killed or injured cannot be compensated by differences in cost, comfort, convenience, esthetics, etc. This approach leads to a nested conditional model of recreation choice behavior that might take the sequential form proposed by Krumpe and McLaughlin (1982).

Figure 3 illustrates a hypothetical (and highly simplified) recreation choice process. The objective of the analyst is to predict participation in fishing at five different sites. Two of the sites (3 and 4) are restricted to fly fishing only, while the other three (1, 2 and 5) are unrestricted. Use of an IIA general share model, which treats all five sites as substitutes, suffers from the "red bus-blue bus" disease.

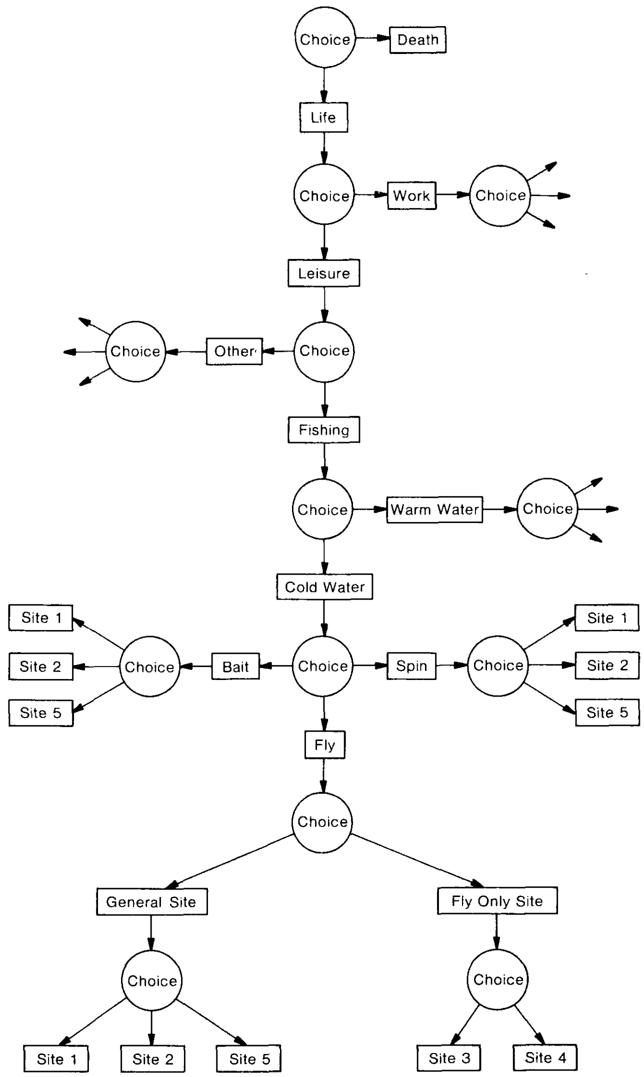

Figure 3.--A nested fishing site choice example.

Different fishing methods (e.g. fly fishing) involve different site choice rules, because the requirements of the methods and the objectives of the fishermen differ. Effective modeling requires exposure of the nested conditional structure in the choice process. It is then necessary to stratify models and population subgroups in terms of that structure. On face value it is the same old problem of "interaction" commonly encountered in social and behavioral research (Sonquist 1970). In terms of economic theory, it arises in recreation choice behavior because of 1) conditions of separability in the individual utility function, 2) differences among individual utility functions, and 3) similarities and differences among the choice options.

Using a general share model to predict demand for a proposed new fly-only site (site 6) would violate the IIA assumption because of mixed processes and mixed levels. Site 6 competes with sites 1, 2, and 5 only for people who have decided on fly fishing. Sites 3, 4 and 6 compete, given that the choice is to go to a fly-only site. Fly fishing competes with bait and spin fishing at a different level. The problem is corrected in part by stratifying by fly fishermen, but fly fishermen who select a fly-only site may follow a different utility process, given this choice, than those who go to a general site. The problem is ultimately solved only by modeling each decision level conditional on the outcome of the higher level. It is noteworthy that an early concern with this type of problem is implicit in the Burt and Brewer Model (1971). They classified their sites into subgroups of perfect substitutes with imperfect substitution among subgroups.

Direct Evidence From Site Choice Modeling in Urban Forest Recreation

In a recent study, Peterson and others (1983) found the IIA property to be violated in an application of an MNL model to urban forest recreation site choice. The choice set contained 21 sites in the Chicago metropolitan area, including two indoor conservatories, a large arboretum, a large botanical garden, and 17 forest preserve areas. Variables used in the model were travel distance (price) and four perceived site attributes: stimulating-educational, quiet, safe, and forested. When the model was estimated for different subsets of the 21 sites, the distance coefficient was found to be quite stable. Coefficients for the perceived site attributes fluctuated considerably, however, with those for "quiet" and "forested" actually varying in sign. This is prima facia evidence of violation of the IIA property, and plausible causes were discussed. Apparently, the specified choice set contained sites that represented different levels in a nested choice process. Consequently, different sites tended to attract people with different purposes. While the model presumed these sites to obey specific substitution rules, they clearly did not.

Subsequently Lin (1983) used the same data to estimate a nested choice model. Based on the perceived attribute scores, Lin used cluster analysis to partition the 21 sites into three groups. Within a group the sites were perceived as more similar than among the groups. It is not surprising that the arboretum and botanical garden formed one group, the conservatories formed a second group, and the forest preserves made up the third group. These groups were then used to set up a nested choice process as in figure 4. At the first decision level, the consumer faces a choice among conservatory, botanical garden, or forest preserve. These represent different activity types, perhaps selected to satisfy different objectives. At the second level the alternatives depend on the outcome of the first.

In the earlier study, Peterson and others used a simultaneous choice model that forced substitution across those hypothetical decision levels. When the mix was changed, the model had to change. Lin used tests developed by McFadden and others (1976) to reject the hypothesis that

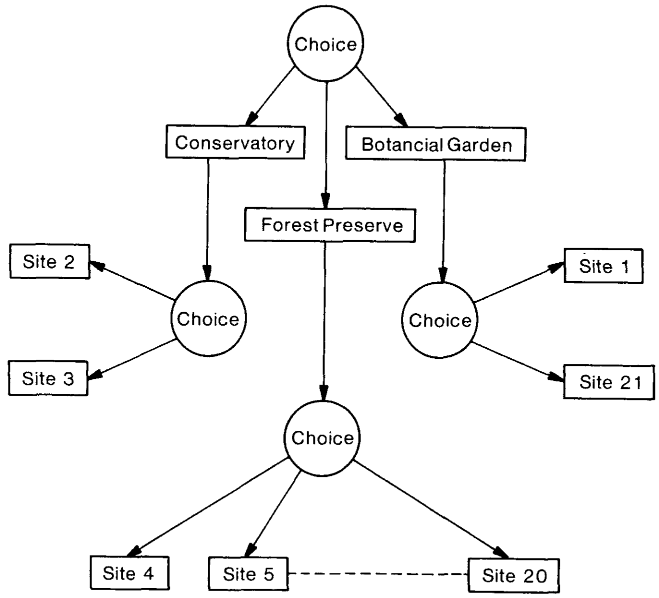

Figure 4.--Lin's nested urban recreation site choice model.

the 21 alternatives obey the IIA property required by the simultaneous choice model. He then estimated the nested logit choice model with the structure illustrated in figure 4. The explanatory power was improved significantly and the meaning of the model was improved. Within the conditional groups, the IIA property was obeyed. Between the groups, different but meaningful choice processes were seen to be operating.

Indirect Evidence From a Wilderness Site Demand Model

In an earlier study, Peterson and others (1982) developed a site-demand model for the Boundary Waters Canoe Area Wilderness (BWCAW). The model was stratified by 12 types of use occurring in the same wilderness. The data consisted of a census of trips for the period 1974 through 1977. No attempt was made to include substitute sites for any of the 12 types of use. The model simply distributes trips among origins under the assumption of no substitutes.

The distance elasticity of demand (percent change in demand percent change in distance) was found to differ by type of use. These differences demonstrate that different demand processes are at work among the different types of use. The different user groups have different objectives, their on-site activities have different input requirements, and they face different sets of substitute sites. Therefore, they respond differently to travel cost and, by implication, to on-site attributes.

DIRECTIONS FOR FUTURE RESEARCH

In this paper we have attempted to expose and motivate interest in a major problem in recreation choice, that of substitution in recreation choice behavior. It is an important question in many aspects of recreation resource management and research, yet it is poorly understood. Toward correction of this inadequacy, we have tried to define the question and review various lines of research that seem to be converging on it, albeit from different points of view and with different languages. Finally, drawing on this research, we have framed the substitution problems in terms of nested choice structure, which we illustrate with hypothetical and empirical examples.

The problem of substitution is still far from resolved. Questions arise which point directions for much-needed future research. One important need is for researchers and managers to recognize that the decisions they make about model specifications and substitute sets in demand and participation analyses carry some important implied assumptions about choice behavior. These assumptions should be exposed and challenged.

A second important need is for better integration of the related concepts of several disciplines into a theory of recreation choice. Well-developed bodies of literature in psychology, geography, economics, and transportation, for example, provide the basis for a powerful theoretical framework. Once integrated, such a framework needs to be made operational in terms of practical models and research methods. Further, the concepts need to be turned into facts about recreation choice behavior. What are the nesting structures that describe the actual choice processes of different types of people in recreation choice situations? What decision rules do they follow? What are the practical choice sets that are considered when decisions are made? Are these ad hoc questions that must be encountered in every practical or research problem or can empirical research be generalized into useful rules and principles?

Depending on the objectives, still more work may be needed in explaining the decision processes thus revealed. Are we satisfied with the descriptive approach of revealed preference, or is there a need to delve into motivational factors that lie behind and are the object of recreation choice? The work of Morishima (1959), Lancaster (1966), and Becker (1965) presents an interesting extension of the powerful and well-developed theory of economics, which seems to be reaching toward behavioral research in the psychology of recreation choice.

At first glance there appears to be lack of consensus among researchers from different disciplines on the merits of further emphasis on these behavioral aspects. For estimation of demand, the benefits at least include exposure of the assumptions implied by various demand specifications. In general, though, the question should be asked in the context of the purpose to be served. Different purposes require different kinds of information. The information needed to answer questions asked by economists, for example, may be different than is needed to satisfy designers or planners. Indeed, this may be an example of the most serious obstacles to multi-disciplinary integration of a theory of substitution in recreation choice. Different disciplines, different studies, and different applied contexts seem to be answering mixtures of different questions which have not been asked clearly or adequately separated. One of the most needed contributions may simply be to identify the different questions being stirred in the research pot, the applied contexts from which they derive, and the kinds of answers they require.

REFERENCES

Amemiya, T. Qualitative response models: a survey. J. of Econ. Lit. 19:1483-1536; 1981.

Anas, Alex. Residential location markets and urban transportation: economic theory, econometrics, and policy analysis with discrete choice models. New York: Academic Press; 1982.

Arrow, K. J. Social choice and individual values. John Wiley and Sons, New York; 1951.

Barten, A. P. The systems approach of consumer demand functions: a review. Econometrica. 45(1):23-51; 1977.

Beaman, J. Comments on the paper "The substitutability concept: implications for recreation research and management." J. of Leis. Res. 7(2):146-152; 1973.

Becker, G. S. A theory of the allocation of time. Econ. J. 75(1965):493-517; 1965.

Becker, Boris W. Perceived similarities among recreational activities. J. of Leis. Res. 8(2):112-122; 1976.

Burnett, Pat (Ed.). Study in choice, constraints, and human spatial behaviors. Special issue of Economic Geography 57 (October); 1981.

Burt, Oscar and Durward Brewer. Evaluation of net social benefits from outdoor recreation. Econometrica 39:812-827; 1971.

Cadwallader, Martin. 1981. Towards a cognitive gravity model: the case of consumer spatial behavior. Regional Studies. 15(4):275-284; 1981.

Cesario, F. J. A generalized trip distribution model. J. of Regional Sci. 13(2):233-247; 1973.

Cesario, F. J. and J. L. Knetsch. A recreation site demand and benefits estimation model. Regional Studies. 10:97-104; 1976.

Cheung, H. K. A day-use visitation model. J. of Leis. Res. 4(2):139-156; 1972.

Christiansen, J. E. and D. R. Yoesting. The substitutability concept: a need for further development. J. of Leis. Res. 9(3):188-207; 1977.

Chu, Chausie. Structural issues and sources of bias in residential location and travel mode choice models. Ph.D. Dissertation. Northwestern University, Evanston, Illinois; 1981.

Cordell, H. K. Substitution between privately and publically supplied urban recreational open space. J. of Leis. Res. 8(3):160-174; 1976.

Curry, D. J., J. J. Louviere, D. Rauch, and G. Woodworth. Recreation destination choice. Oakdale, Iowa. University of Iowa, Institute for Urban and Regional Research; 1983.

Deaton, A., and J. Muellbauer. Economics and consumer behavior. Cambridge: Cambridge University Press; 1980.

de Bettencourt, James S., and George L. Peterson. Environmental threshold functions for user oriented resource planning and management. Water Res. Bull., Vol. 17, No. 6, December. 1981; p. 1050-1055.

DeBreu, G. Review of R. D. Luce individual choice behavior. Amer. Econ. Review 50:186-188; 1960.

Ditton, R. B., T. L. Goodale, and P. K. Johnsen. A cluster analysis of activity, frequency, and environmental variables to identify water-based recreation types. J. of Leis. Res. 4(4):282-295; 1975.

Domencich, Thomas, and Daniel McFadden. Urban travel demand. North Holland Press, Amsterdam, Holland; 1975.

Dwyer, John F., John R. Kelly, and Michael D. Bowes. Improved procedures for valuation of the contribution of recreation to national economic development. Water Resources Center, University of Illinois at Urbana-Champaign. Research Report No. 128; 1977.

Ewing, G. O. Progress and problems in the development of recreational trip generation and trip distribution models. Leis. Sci. 3(1):1-24; 1980.

Fotheringham, A. Stewart. Spatial structure and distance-decay parameters. Annals of the Assoc. of Amer. Geographers 71(3):425-436; 1981.

Golledge, Reginald G., and Gerard Rushton (Eds.). Spatial choice and spatial behavior. Ohio State University Press, Columbus; 1976.

Grether, D. M., and C. R. Plott. Economic theory of choice and the preference reversal phenomena. Amer. Econ. Review 69(4):623-638; 1979.

Grubb, H. W., and J. T. Goodwin. Economic evaluation of water-oriented recreation. Report No. 84. Texas Water Development Board, Austin, Tex.; 1968.

Hendee, J. C., and R. J. Burdge. The substitutability concept: Implications for recreation research and management. J. of Leis. Res. 6(2):157-162; 1974.

Henderson, James M., and Richard E. Quandt. McGraw-Hill, New York, N.Y.; 1980.

Holbrook, Morris B. Representing patterns of association among leisure activities: A comparison of two techniques. J. of Leis. Res. 12(3):242-256; 1980.

Indow, T. On choice probability. Behaviometrica. 2:13-31; 1975.

Katzner, D. W. Static demand theory. MacMillan Co., London, England; 1970.

Knetsch, Jack L. Displaced facilities and benefit calculations. Land Econ. 53:123-129; 1977.

Krumpe, Edwin E. and William J. McLaughlin. A model of recreationists' decision making process. In Forest and river recreation: research update. Edited by David W. Lime. Misc. Publ. 18. The Agricultural Experiment Station, University of Minnesota; 1982. pp. 94-99.

Lancaster, Kelvin J. A new approach to consumer theory. J. of Political Economy. 74:132-157; 1966.

Lin, Yann-Jou. Recreation site substitution and urban recreation site choice models. Ph.D. dissertation. Northwestern University, Evanston, Ill; 1983.

Luce, R. D. Individual choice behavior. John Wiley and Sons, New York, NY; 1959.

Luce, R. Duncan. The choice axiom after twenty years. J. of Math. Psyc. 15:215-233; 1977.

Luce, R. D., and P. Suppes. Preference utility and subjective probability. p. 242-410. In Handbook of mathematical psychology, Vol. III. R. D. Luce, R. R. Bush, and E. Galanter (eds.). John Wiley and Sons, New York, N.Y.; 1965.

McFadden, Daniel. Conditional logit analysis of qualitative choice behavior. In Frontiers in econometrics. P. Zarembka, editor. Academic Press, New York, N.Y.; 1973.

McFadden, Daniel, W. Tye, and K. Train. Diagnostic tests for the independence from irrelevant alternatives property of multinomial logit models. Working paper 7616. University of California, Berkeley; 1976.

Morishima, M. The problem of intrinsic complementarity and separability of goods. Metroeconomica. 11(3):188-202; 1959.

O'Leary, J. T., and F. D. Dottavio. Recreation activity clusters in different resource settings. p. 173-181. In Outdoor recreation planning, perspectives, and research. T. L. Napier, editor. Kendall Hunt Publishing Co., Dubuque, Iowa; 1981.

Peterson, George L., Dorothy H. Anderson, and David W. Lime. Multiple-use site demand analysis: An application to the Boundary Waters Canoe Area Wilderness. J. of Leis. Res. 14(1):27-36; 1982.

Peterson, George L., John F. Dwyer, and Alexander J. Darragh. A behavioral urban recreation site choice model. Leis. Sci. 6(1):61-81; 1983.

Peterson, George L., Alex Anas, Frank S. Koppleman, Peter R. Stopher, Gökmen Ergün, M. Muthusubramanyam. Prediction of urban recreation demand. Final report. NSF Grant No. APR76-19086, Northwestern University, Evanston, Ill.; 1978.

Peterson, G. L., and R. D. Worrall. An analysis of individual preferences for accessibility to selected neighborhood services. p. 99-111. Highway research record no. 305: Socioeconomic considerations in transportation planning. Highway Research Board, NRC, NAS-NAE. Washington, D. C.; 1970.

Powell, A. Empirical analysis of demand systems. Heath, Lexington; 1974.

Richardson, Anthony. Search models and choice set generation. Transportation Research. 16A:403-419; 1982.

Ritchie, J. Brent. On the derivation of leisure activity types--a perceptual mapping approach. J. of Leis. Res. 7(2):128-140; 1975.

Rosenthal, D. H., J. B. Loomis, and G. L. Peterson. The travel cost model: concepts and applications. Gen. Tech. Rep. RM-109. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO; 1984.

Samuelson, P. A. Economics, New York: McGraw-Hill; 1976.

Silberberg, Eugene. The structure of economics: A mathematical analysis. New York: McGraw-Hill; 1978.

Simmons, P., and D. Weiserbs. Translog flexible functional forms and associated demand systems. Amer. Econ. Review. 69(5):892-901; 1979.

Smith, S. L. J. Intervening opportunities and travel to urban recreation centers. J. of Leis. Res. 12(4):296-308; 1980.

Sonquist, John A. Multivariate model building: the validation of a search strategy. Ann Arbor: The University of Michigan; 1970.

Stopher, Peter R., and Göokmen Ergün. Population segmentation in urban recreation choices. p. 59-65. Transportation Research Record. 728; 1979.

Stopher, Peter R., and Gökmen Ergün. The effect of location on demand for urban recreation trips. Transportation Research. 16A:25-34; 1982.

Stopher, Peter R., and Arnem H. Meyburg. Urban transportation modeling and planning. Lexington Books, D. C. Heath and Co., Lexington, Mass; 1975.

Stynes, Daniel J., and George L. Peterson. A review of logit models with implications for modeling recreation choices. J. of Leis. Res. 16:295-310; 1984.

Thurstone, L. L. A law of comparative judgement. Psychological Review. 34:273-286; 1927.

Tversky, A. Choice by elimination. J. of Math. Psych. 9:341-367; 1972.

Tversky, A. Elimination by aspects: A theory of choice. Psych. Review. 79(4):281-299; 1972.

Tversky, A. Features of similarity. Psych. Review. 84:327-352; 1977.

Tversky, A., and J. E. Russo. Substitutability and similarity in binary choices. J. of Math. Psych. 6:1-12; 1969.

Vaske, J. J., and M. P. Donnelly. Predicting alternative resource choices. In Forest and river recreation research update. Misc. Publ. 18-1982. University of Minnesota Agr. Expmt. Sta., St. Paul; 1982.

Vickerman, R. W. Travel choices for recreational journeys. In Determinants of travel choice. D. Hensher and O. Dalvi, editors. Saxon House, London, England; 1978.

Williams, H. C. W. L., and J. D. Ortuzar. Behavioral theories of dispersion and the mis-specification of travel demand models. Transportation Research. 16B:167-219; 1982.

Yellott, J. I. The relationship between Luce's choice axiom, Thurstone's theory of comparative judgement, and the double exponential distribution. J. of Math. Psych. 15:109-144; 1977.