A SIMULATION MODEL FOR FORECASTING DOWNHILL SKI PARTICIPATION[1]

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INTRODUCTION

The purpose of this paper is to describe progress in the development of a general computer simulation model to forecast future levels of outdoor recreation participation. The model is applied and tested for downhill skiing in Michigan.

The approach combines a cohort-survival population model with a simple recursive model of skier adoption and dropout decisions. It has been implemented for computer simulation in FORTRAN. Simulations of numbers of skiers (both active and inactive) and their characteristics (age, length of involvement) can be generated for any year between 1950 and 2000. By altering model inputs the user may generate a variety of future scenarios and test various downhill ski promotion and development strategies.

THE APPROACH - COMPUTER SIMULATION

A number of distinct forecasting models have been applied to the prediction of outdoor recreation participation. These are reviewed in Moeller and Echelberger (1974) and Stynes, Bevins, and Brown (1980). Two step linear regression models and simple trend extension methods predominate. Diffusion models (West 1977, Stynes and Szcodronski 1980) and Delphi studies (Moeller et al. 1977) have also been used to predict future participation and characteristics of outdoor recreation activity.

Perhaps the most serious problem with simple analytic forecasting models is their failure to incorporate the time dimension in a meaningful way. The models are mostly static, or at best comparative static. Many are based upon cross-sectional data and do not include dynamic structural features or processes. The models do not therefore work well in a dynamic environment and they generally fail to shed much light upon the processes which underlie trends in outdoor recreation participation.

We argue here that recreation systems are quite dynamic, characterized by timelags, feedback effects, and interactions between variables over time. Understanding of these dynamic processes could yield significant improvements in our ability to forecast the behavior of recreation systems. Simulation models are more suited to the exploration and modeling of such processes.

The Limits to Growth models (Meadows 1972) are perhaps the most widely known applications of computer simulation to futures research. Within recreation, computer simulation models have been applied to planning and management. The Wilderness Travel Simulator (Shechter and Lucas 1978, Smith and Krutilla 1976) and recreation trip distribution models (Cesario 1975, Ellis and Van Doren 1967) are good examples. Ladany (1975) includes a number of simulation models in his collection, Management Science Applications to Leisure Time Operations. More widespread application of these techniques, including forecasting applications, have been constrained by a lack of suitable data bases, lack of needed simulation and modeling skills within recreation, and limited progress in quantification of relationships describing outdoor recreation behavior patterns.

Computer simulation models have several advantages over analytic approaches:

1. They are more realistic, more easily

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understood, and more persuasive.

2. They are more flexible - no standard assumptions, easily modified, and lend themselves to a component approach.

3. They treat time in a meaningful way.

4. They permit a wide range of experiments on the model.

5. They "facilitate understanding of complicated systems of relationships relevant to policymaking". (Hamilton 1969)

6. They contribute to theory development, guide research, and pinpoint data collection priorities.

There are, of course, corresponding disadvantages. Model development can be expensive and complex, simulation models often have extensive and unique data requirements, and model validation is not straightforward.

In this case, the lack of good time series data on skiing ruled out a trend extension model. Existing data was scattered, of inconsistent quality, and very limited except for the two years 1968 and 1978. Even this data was not well-suited to estimating the numbers of skiers or the volume of skiing activity in Michigan. Hypothesized errors in the data bases did not recommend a purely "statistical" approach. Limitations in the data would have to be compensated for by a model which captured important structural features of downhill ski participation decisions.

Given the state of knowledge about the ski market and uncertainty about the future, our purpose became one of not so much to forecast the future, but to create a better understanding of the forces likely to affect the future of downhill skiing in Michigan and to permit the testing of alternative actions. The simulation model is designed to be a tool that ski area managers, planners, and marketing personnel might use to better understand the future and to assist in decision making.

A model was desired that could be adapted, extended, and refined as our understanding of the ski market increases and as the variables influencing skier decisions change over time. A secondary purpose of the model is to guide future research and data collection. The potential long-term benefits of a computer simulation model strongly recommended this approach.

MODEL SUMMARY

The forecasting model combines a cohort-survival population model with a similar model of skier adoption, dropout, and readoption decisions. The population component of the model updates the age structure of the population each year based upon estimates of fertility and mortality.

The skier component of the model determines the numbers of persons of each age that are (1) active skiers, (2) inactive skiers, and (3) non-skiers. Active and inactive skiers are further divided by years of experience in downhill skiing. The model is recursive. Rates of adoption, dropout, and readoption are applied to populations in year N to determine the numbers of active skiers, inactive skiers, and non-skiers in year N+1. New adopters are taken from the population of non-skiers and dropouts move from active to inactive status. Readoption rates are applied to the population of inactive skiers to estimate the number returning to active status each year (Figure 1).

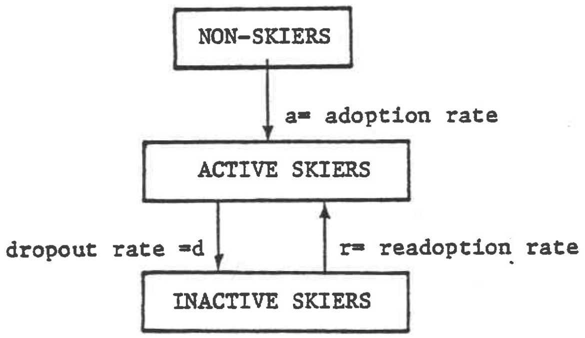


Figure 1. Skier Adoption, Dropout, and Readoption

Adoption, dropout, and readoption rates are all age-specific. This permits the modeling of relationships between family life cycles and ski activity. Age is correlated with income, physical ability, lifestyle, marital status, presence of children of various ages within the household, etc. Thus, age serves as a proxy for a number of variables influencing ski participation decisions.

Dropout rates also depend upon an individual's length of involvement in skiing. Dropout rates are relatively high for first-time skiers and decline with increasing experience in the sport. The model also includes exogenously determined variables that permits the user to adjust adoption and dropout rates over time due to age-independent factors. Entry and exit rates may be altered based upon snow conditions, price increases, travel restrictions, and other variables that have not yet been incorporated into the model. The flexibility in the model permits the addition of new variables and components in the future.

PARAMETER ESTIMATION

The ski forecasting model consists of two principal components: a population model and a skier decision model. Parameters for the cohort-survival population model are the standard fertility, mortality, and migration rates. The interested reader is referred to Pittenger (1976) and Shyrock (1971) for further details on estimating vital rates for populations.

Our concern here is primarily with the skier decision model. The key parameters are age-specific adoption, dropout, and readoption rates for each year. Existing empirical data is not well-suited to straightforward estimation of these parameters. Time series data to estimate changes in rates over time are totally lacking. Adoption, dropout, and readoption rates were therefore estimated using a variety of both statistical and heuristic techniques. Parameters were first estimated independently. Simulation experiments were conducted and parameters were subsequently adjusted iteratively until model behavior was deemed reasonable and selected model outputs corresponded with empirical observations. Inconsistency in empirical data sets required judgement in selecting those variables to focus upon in statistical fitting porcedures.

Data Base

Parameter estimation and model validation draw upon two primary data bases on Michigan downhill skiers. The first complete data on Michigan skiers is provided by Leuschner (1970) in a survey of the North Central region in 1968. A 1978 Michigan skier market survey (Stynes, Mahoney, and Spotts, 1980; Stynes and Mahoney, 1980) provides the data most suited to development of the forecasting model. These two years of fairly comprehensive surveys are supplemented by national survey data from LaPage (1978) where necessary, and from selected reports of estimates of skier volumes found in Domoy (1977) and Farwell (1977).

The 1978 Michigan skier market survey gathered extensive data on adoption, inactivity, and withdrawal from downhill skiing. Active and inactive skiers were included in the design, and recall questions were used to estimate the age and year of adoption and dropout. This recall data forms the basis for estimation of age-specific adoption and dropout rates overtime. Where data was lacking, product life cycle and related theories were used to fill in gaps.

Adoption Rates

The adoption rate for individuals in age group I for year N is given by a product of two terms:

$$a^N(I) = a_1^N * a_2(I)$$

$a_2(I)$ is the adoption rate for age group I in 1970, i.e., the percent of non-skiers adopting in the year.[2] a_1^N is an exogenously determined adjustment factor permitting the model user to adjust adoption rates over time.[3] Figure 2 plots the recommended values for a_1^N for those years N between 1950 and 1978. These were estimated from Stynes and Mahoney (1980).

$a_2(I)$ are age-specific adoption rates. These were estimated for 1970 by distributing new skiers into three year age groups using an empirical distribution measured by Stynes and Mahoney (1980). The age at adoption was calculated for 503 active and former skiers. The resulting distribution is plotted in Figure 3. These estimates represent skiers adopting between the years of 1946 and 1978 and will to some extent reflect the age distribution of the population over this period. We assume that the age distribution of adopters given by Figure 3 is constant over time and can be applied to any year to distribute new skiers by age. Empirical data supports this assumption.

Dropout Rates

Dropout rates include three components. The dropout rate for individuals age I with J years of experience in year N is given by:

$$d^N(I,J) = d_1(N) * d_2(I) * d_3(J)$$

Dropout rates depend upon the year (N), the age of the skier (I), and the number of years of experience (J). These three components are assumed to be independent and to enter multiplicatively. The assumption of independence between age and length of involvement is clearly invalid, but sufficient data did not exist to estimate a joint relationship of the form $d_4(I,J)$.

2 1970 was selected as a base year because of fairly accurate estimates for both population (1970 Census data) and numbers of new skiers (estimated from Leuschner 1970, Stynes and Mahoney 1980, and Farwell 1977).

3 a_1^N for N=1970 should be approximately 1.0. Values of a_1^N larger than one yield higher adoption rates than those observed for 1970, while values less than one yield rates lower than the 1970 standard.

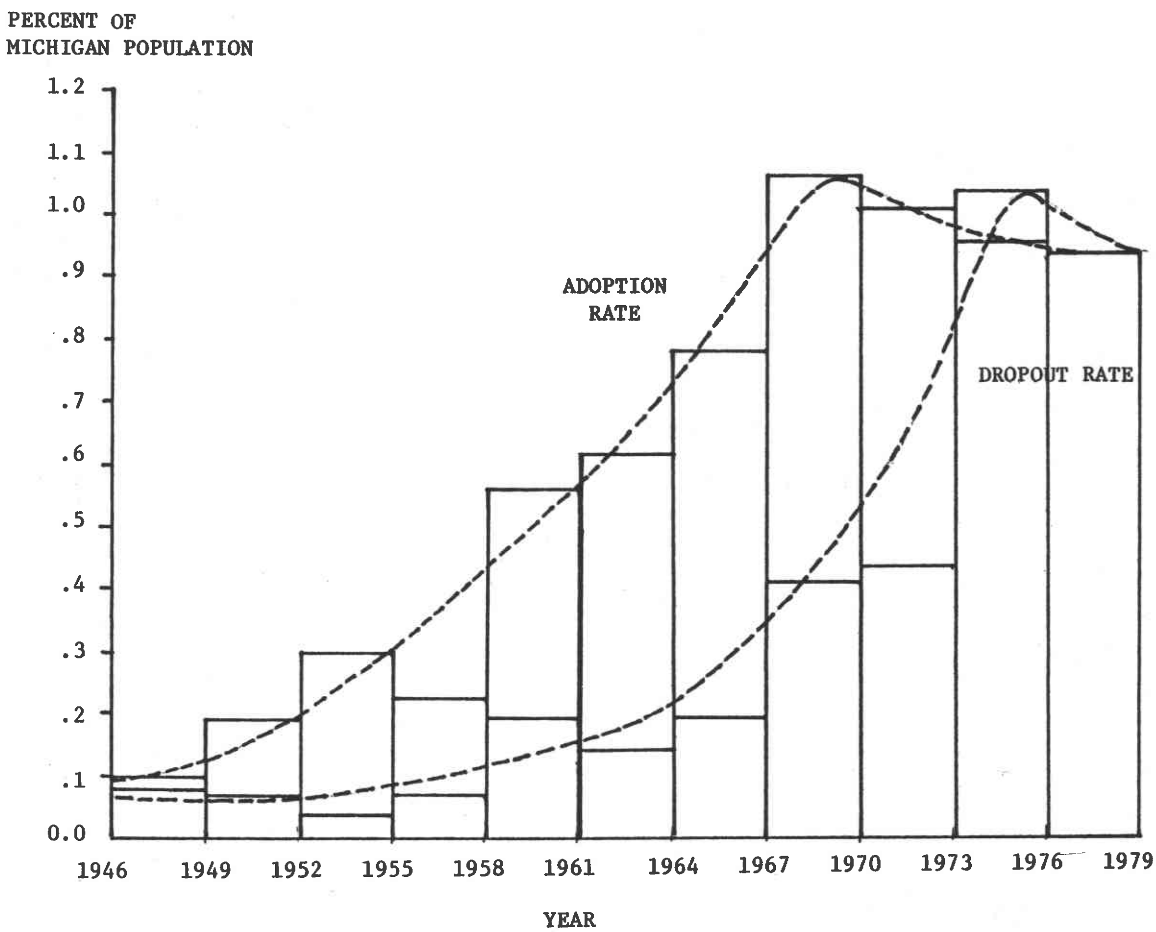


Figure 2. Estimated Adoption and Dropout Rates By Year

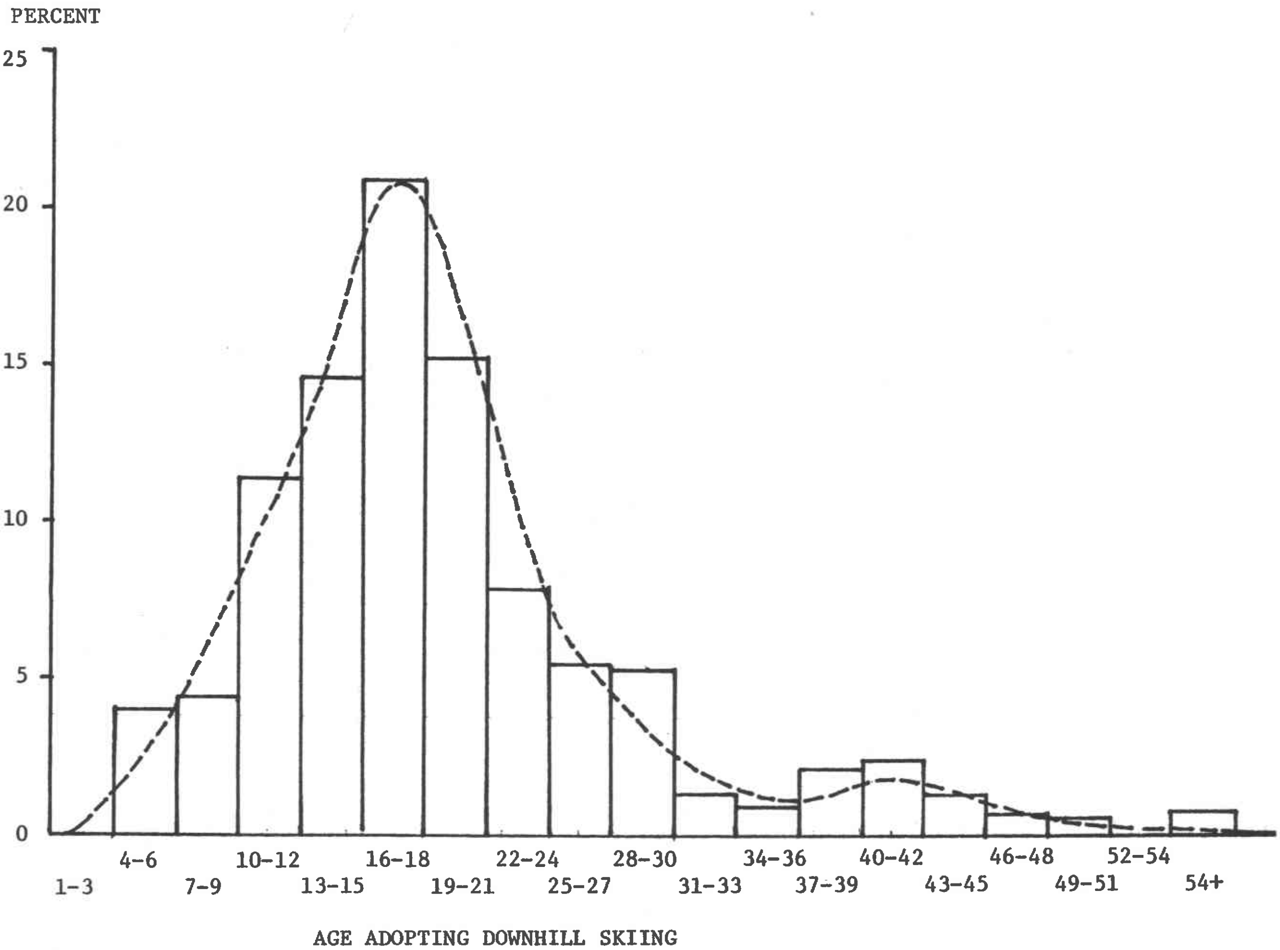


FIGURE 3. Distribution of Skiers By Age at Adoption

The first two components are directly analogous to the corresponding adoption functions, and are estimated in a similar manner. $d_1(N)$ is an exogenously determined variable permitting the user to adjust dropout rates over time. $d_2(I)$ are age-specific dropout rates assumed to be independent of N and estimated for the base year 1970. Figure 4 gives the distribution by age dropped for all inactive and dropout skiers surveyed in the 1978 Michigan ski market survey. Figure 2 plots recommended values for $d_1(N)$. These estimates should be used cautiously as they are based upon limited data.

No data exists to estimate $d_3(J)$, the relationship between dropout rates and length of involvement in skiing. An inverse square root function is assumed.

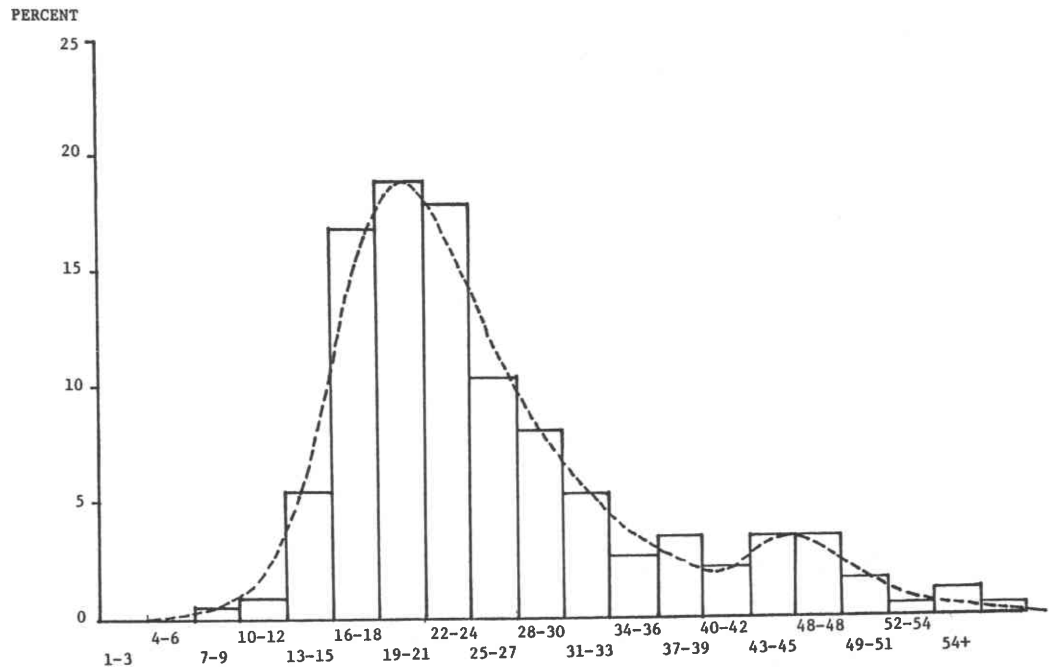
Readoption Rates

There is little data on which to base estimates of readoption. Age-specific readoption rates are based primarily upon the author's judgment and some simple experiments with the simulation model. It was assumed that readoption rates would roughly parallel adoption rates.

VALIDATION AND TESTING

Since model refinement and testing are still in progress we shall only briefly discuss validation here. It will suffice to indicate the general behavior of the model and illustrate the various model outputs. Shechter and Lucas (1978) provide a good discussion and summary of alternative methods for validating simulation models. Forecasting models offer an additional difficulty in that the "true" results are unknown.

The model's behavior is illustrated by first simulating from the year 1950 to the present and then examining forecasts to the year 2000 under alternative assumptions about the future.



AGE DROPPING DOWNHILL SKIING

Figure 4. Distribution of Inactive Skiers by Age when Last Skied

Simulating from 1950 to 1978

The year 1950 was selected as an initial year for downhill skiing in Michigan.[4] The model was initialized using 1950 Census data for non-skiers and begun with no active or inactive skiers. A 28 year simulation period was set. Selected model outputs over this 28 year period are summarized in Tables 1-3 and Figure 5.

Simulation model results were compared with empirical data from Leuschner (1970), Stynes and Mahoney (1980), and other relevant studies of Michigan skiers. The comparisons indicate that the model predicts quite accurately both the numbers of skiers and their distribution by age and length of imvolvement. Leuschner estimates about 128,500 skiers in 1968 (compared with model prediction of 140,700). Leuschner included only skiers 13 years of age and older while the model keeps track of skiers 7 years and older. By 1975 active skier numbers reach 263,000. Estimating about 9 days of skiing per skier that year, this compares favorably with Domoy's (1977) estimate of 2.2 million lift tickets sold in Michigan (skier days). Growth rates of about 10% in the early 1970's drop to about 4% by 1978, resulting in just over 300,000 skiers in 1978.

Distributions of skiers by age and length of involvement compare favorably with the 1978 Michigan survey after corrections for population differences. (The Michigan survey only interviewed skiers 18 years of age and older). The 1978 Michigan skier market survey estimated that 35% of former skiers had skied only one year prior to quitting (compared with 37% predicted by the model). Also the ratio of active skiers to inactives in 1978 is almost exactly 1:2, precisely the ratio measured in the 1978 survey.

In summary, the model predicts skier numbers and characteristics for the year 1978 quite well. Of course some of this same data was used in estimating model parameters so that these comparisons do not provide a true test of the model. This will require future measurements of Michigan's skier population in order to test the model's predictive abilities.

[4] We know both ski resorts and skiers existed prior to 1950, but it is assumed that the numbers of skiers in 1950 were small enough compared with growth over the next decade to have little effect on model outputs by 1968.

Table 1. Downhill Ski Simulation 1951-1978

Numbers of Skiers (Thousands)

Year	Active Skiers	Inactive Skiers	Adopters	Dropouts	Readopters
1951	6	0	6	0	0
1952	9	3	7	3	0
1953	12	8	8	5	1
1954	16	13	8	6	1
1955	20	20	10	8	1
1956	24	26	11	9	2
1957	29	34	13	11	3
1958	35	43	14	13	4
1959	41	53	16	15	5
1960	48	64	18	18	7
1961	56	77	20	21	8
1962	65	92	23	24	9
1963	75	108	26	27	11
1964	87	126	29	31	13
1965	99	146	32	36	15
1966	111	169	34	40	18
1967	125	193	38	45	20
1968	140	220	42	50	23
1969	157	249	46	56	26
1970	175	282	50	62	30
1971	194	317	54	69	33
1972	213	356	57	76	37
1973	232	397	59	83	42
1974	248	439	58	89	46
1975	263	482	57	93	51
1976	277	524	56	97	55
1977	290	566	54	101	59
1978	301	606	51	103	63

Table 2. Downhill Ski Simulation 1951-1978

Distribution of Active Skiers

Year	AGE 7-12	AGE 13-18	AGE 19-24	AGE 25-30	AGE 31+	YRS EXPERIENCE 1	YRS EXPERIENCE 2	YRS EXPERIENCE 9+
	percent					percent		
1951	16	25	27	16	14	100	0	0
1952	16	25	26	16	14	74	25	0
1953	16	25	26	16	14	62	26	0
1954	16	25	26	16	14	54	26	0
1955	16	26	26	16	14	49	25	0
1956	15	26	27	16	14	45	25	0
1957	15	26	27	16	14	44	23	0
1958	15	26	27	16	14	41	23	0
1959	14	26	27	16	14	39	23	1
1960	14	27	27	16	14	38	22	1
1961	13	26	27	17	14	36	21	1
1962	13	25	27	17	15	35	21	2
1963	13	26	27	17	15	34	21	3
1964	13	26	27	17	15	33	20	3
1965	12	26	28	17	15	32	20	4
1966	11	25	28	18	15	31	20	5
1967	11	25	28	19	16	30	19	5
1968	10	25	28	19	16	30	19	6
1969	10	25	28	19	16	29	19	7
1970	9	24	29	19	16	28	19	7
1971	8	24	29	20	17	28	18	8
1972	8	23	29	21	17	26	18	9
1973	7	22	29	21	18	25	18	9
1974	7	21	30	21	19	23	18	10
1975	6	20	30	23	20	22	17	11
1976	6	18	29	24	21	20	17	12
1977	5	17	29	24	22	18	16	13
1978	5	15	28	25	24	17	15	15

Table 3. Downhill Ski Simulation 1951-1978
Distribution of Inactive Skiers

Year	AGE 7-12	13-18	19-24	25-30	31+	YRS EXPERIENCE 1	2	9+
	percent					percent		
1951	0	0	0	0	0	0	0	0
1952	11	21	30	17	19	100	0	0
1953	10	20	30	18	20	87	12	0
1954	9	19	30	18	22	79	16	0
1955	8	19	29	19	23	74	18	0
1956	7	18	29	19	24	69	20	0
1957	7	18	29	19	26	65	20	0
1958	6	17	28	19	27	63	20	0
1959	6	17	27	20	28	60	21	0
1960	5	17	27	20	28	58	21	0
1961	5	16	27	20	29	56	21	0
1962	5	16	27	21	30	55	21	0
1963	5	16	26	21	30	53	21	1
1964	5	16	26	20	31	52	21	1
1965	4	15	26	20	31	51	21	1
1966	4	15	26	20	32	50	21	1
1967	4	15	26	21	33	49	21	1
1968	4	15	25	21	33	48	20	2
1969	3	14	26	21	34	47	20	2
1970	3	14	26	20	34	46	20	2
1971	3	13	25	21	35	45	20	3
1972	2	13	25	22	36	44	20	3
1973	2	12	25	22	37	43	20	3
1974	2	11	25	22	37	42	20	4
1975	2	11	25	22	38	41	20	4
1976	2	10	24	23	39	40	20	5
1977	1	9	23	23	41	38	20	5
1978	1	8	22	23	43	37	19	6

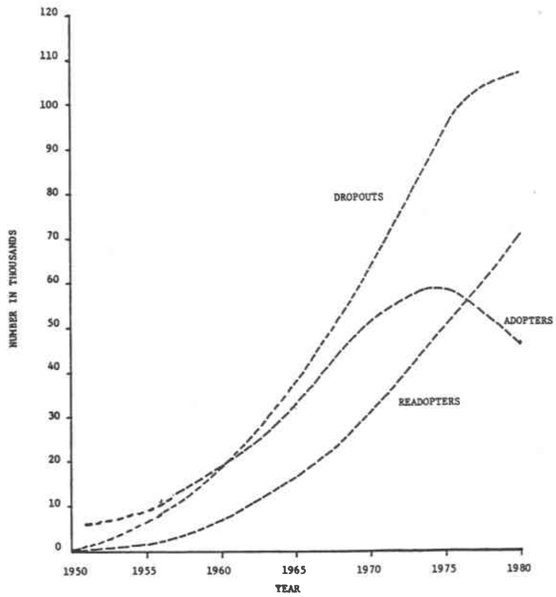


Figure 5. Growth in Downhill Ski Adoption, Dropout and Readoption 1950-1980.

However, the model's ability to begin in 1950 with no skiers and simulate 28 years ahead to accurately describe Michigan's 1978 active and inactive skier populations is very encouraging.

Formal comparisons of model outputs with empirical data bases raises a number of questions. First of all, the model produces a much greater volume of quite specific information than can be found in any empirical study. The model can predict, for example, the numbe of active or inactive skiers in 1962 who are 10 years old and have been skiing two years. No one would ever attempt to estimate this figure empirically. Secondly, empirical data generally does not precisely correspond with the model's outputs and survey data is subject to perhaps quite significant measurement errors. Differences in populations (age restrictions in surveys, for example), recall errors, and the manner in which surveys define "active" skiers are just a few of the problems that arise. Thus, in comparing model outputs with empirical data one cannot confidently assume that the empirical figure is the "true" measure. Rowan (1980) has noted the inconsistency in estimates of numbers of skiers nationally. In examining data on Michigan skiers, we uncovered similar inconsistencies.

Forecasting Experiments

Although additional model experimentation, refinement, and testing are required before the model can be used in policy analysis, we can illustrate the model's potential contribution by means of four simple experiments. In each case the model is initialized for the year 1978 and forecasts are generated through the year 2000 under alternative assumptions. The scenarios were selected to illustrate a range of possibilities.

Forecast #1 takes an optimistic view assuming that growth rates observed in 1970 will continue to the year 2000. Even under this optimistic scenario the numbers of skiers peak at 414,000 by the year 2000. The curve exhibits and S-shaped (logistic) pattern characteristic of the product life cycle (Kotler 1976). The eventual decline is in part due to an aging population structure, and also a result of market saturation. This scenario yields an active skier population in the year 2000 that is significantly older and more experienced than today's skiers.

Forecast #2 assumes a reduction in both dropout and adoption rates. This would characterize a sport with more limited entry, but with existing skiers remaining active a little longer. Skiers reach a peak in 1990 of about 373,000 and then decline to about 350,000 by the year 2000. The pattern is similar to scenario #1, but peaks a decade earlier and at a lower level.

Forecast #3 assumes a decline in adoption rates and an increase in dropout rates. It reflects a general diminishing in popularity of the sport. Under these assumptions numbers of active skiers fall to 265,000, receive a small boost from the second "baby boom," and then drop to 240,000 by the year 2000.

Forecast #4, the most pessimistic scenario, assumes that adoption rates fall to one-fifth of their 1970 values and dropout rates increase by 25%. Skier numbers drop off immediately and rapidly to less than 200,000 by 1990 and to 139,000 by the year 2000. The scenario illustrates that even under quite radical assumptions, the downhill ski market has a certain degree of inertia that will provide a degree of stability. (Figure 6)

These scenarios have illustrated only the simplest of forecasting experiments. The user may also adjust readoption rates or age-specific adoption and dropout rates to simulate skier numbers under more complex assumptions about the future. For example, a promotional campaign aimed at returning inactive skiers, or attracting skiers from older age groups could be simulated by adjusting the relevant age-specific readoption or adoption rates for years after 1980.

Experiments can also examine more datiled characteristics of future downhill ski populations. Under most scenarios future skier populations are more experienced and older than

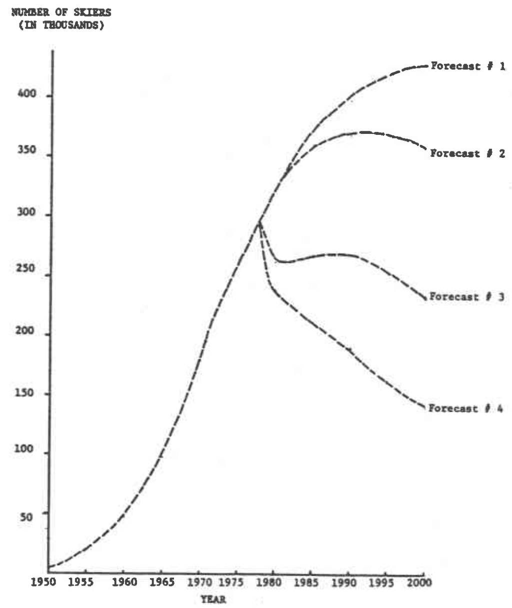


Figure 6. Downhill Ski Forecasts to the Year 2000.

today's downhill skiers. This suggests changes in marketing and ski area offerings. One may test the effects of alternative population scenarios. In one experiment the population and age structure were fixed at 1950 levels and skier numbers were simulated to 1978. This resulted in 100,000 fewer skiers than under observed population growth, indicating that approximately half of the growth in numbers of skiers since the mid-sixties can be attributed to population changes. The remainder is due to expansion in supply of skiing opportunities and increased popularity of the sport.

FUTURE MODEL DEVELOPMENT AND TESTING

Although the simulation model is operational, more testing is needed before the model can be used directly in policy analysis. Sensitivity analyses should be conducted on model parameters in order to better understand the effects of small changes in parameters on model results. This will also pinpoint key data needs of the model and guide future data collection efforts. Improved time series data on skier visits and numbers should be collected in a consistent manner in order to evaluate the predictive ability of the model and to revise and update parameter estimates. Model testing should be conducted with ski area personnel, who have a more intimate knowledge of the industry.

As with most simulation models, the number and variety of possible refinements is virtually endless. We have interrupted model testing and development in order to summarize our progress to date. There are four additions to the model that we recommend:

(1) Adding a weather variable to account for good and bad snow years

(2) Adding growth in potential substitutes like cross country skiing

(3) Predicting skier days in additon to numbers of skiers

(4) Development of a regional model

The development of a regional model is the most complex and costly and also of the greatest potential benefit. This would involve dividing the state into regions, expanding the population model to a regional one, estimating demand and supply of skiing in each region, and then predicting origin-destination patterns using a trip distribution model.

The regional model would require more data on skier trip patterns and population change within each region. Such a model could provide forecasts of more use to individual ski areas and assist in making regional development and promotion decisions.

GENERAL MODEL EVALUATION AND CONCLUSIONS

Although the model is still in a testing phase, a number of advantages over alternative forecasting approaches are already evident. Not to be overlooked is the knowledge and insight gained in the model development process itself. Raser, Campbell, and Chadwick (1970) cite five ways that simulation modeling contributes to theory development:

(1) Confrontation - modelers must confront what they do not know

(2) Explication - simulation modeling forces precise specification of relationships and assumptions

(3) Expansion - it forces a broadened, more comprehensive view

(4) Involvement - it stimulates the researcher to fill in gaps

(5) Serendipity - simulations reveal new problems, new solutions and new hypotheses

Our experience with this model confirms these advantages of computer simulation models.

The model provided a framework for evaluating the comparability and consistency of past empirical studies of downhill skiing. Many ambiguities and inconsistencies in reported market studies and forecasts were identified. Efforts to estimate model parameters and validate the model uncovered a number of gaps in existing data bases. Concentration upon active skiers in market surveys has resulted in a limited understanding of inactivity and downhill ski entry and exit decisions.

How do dropout rates change with length of involvement? Under what circumstances and at what ages do individuals tend to adopt or drop the sport? Is Michigan a net importer or exporter of downhill skiers? What are the short and long term impacts of a poor snow year on the sport? What effects will growth in cross country skiing and changing energy conditions have on downhill skiing's future? These and other questions arose during stages of model development, parameter estimation, validation, and refinement. Answers to these types of questions from future research can be directly translated into improvements and refinements of the simulation model. The simulation model therefore plays a much stronger role in the research process than one generally finds with more traditional types of models.

In concluding we discuss what we view as the five most important features of the model and then briefly address model limitations.

(1) The model is dynamic. It not only can predict change over time, but its basic structure captures the processes of entry and exit within the ski market. Timelags, feeback effects, and other dynamic features of the model can be explored to better understand change in recreation activity markets. In particular, the model illustrates a number of general growth concepts and theories including the product life cycle, diffusion theories, market saturation, and consumer involvement cycles. These processes may be generalized to other activities.

(2) The model is both simple and logical. Adoption, dropout, and readoption of activities are easily understood processes. Complexity is introduced in the model primarily in the estimation of critical model parameters. This permits a separation of the more technical aspects of the model from the more easily understood, making the model easy to use and understand for practitioners, while permitting researchers to explore more detailed and complex features of the model and the system being modeled.

(3) The model is completely general. It could be applied to virtually any activity or product in any state or region. One must simply add a population model for the region in question and estimate adoption, dropout, and readoption rates over time. The generality of the model facilitates the transfer of findings about recreation activity dynamics across regions and activities.

(4) The model is extremely flexible. It can generate an infinite array of outputs in a variety of forms. Components may be easily added to the model. Thus, it provides a framework for both guiding and integrating future research on recreation participation decisions.

(5) Finally, the model may be used in a variety of settings. Researchers will find it useful in suggesting hypotheses and in exploring dynamic aspects of the ski market. The model can also help in directing future data collection efforts by identifying gaps or inconsistencies in current data and suggesting the relative importance of precision in the measurement of different variables. For ski area personnel and students, the model may be used in a gaming format to explore futures and to test the relative effects of alternative promotional and development strategies. The effects of population change can be dramatically illustrated with the model.

Since the model in its current state is a statewide aggregated model, it cannot be tied directly to individual ski area decisions. It can however contribute to broader statewide and industrywide policy and promotion decisions. While the model could be disaggregated into a regional model including ski travel behavior, this refinement would require considerably more modeling and data collection.

Limitations of the model relate primarily to the lack of data that are ideally suited for parameter estimation or validation. The model requires estimates of adoption, dropout, and readoption rates over time. Future research should develop models to predict these rates based upon social, economic, and environmental variables. Such relationships could then be added to the existing model to internalize relationships that must presently be estimated outside the model.

Development of the model cost about $5000. A similar amount was required for the 1978 Michigan ski market survey, which in addition to gathering data to estimate model parameters, also produced two ski marketing reports (Stynes, Mahoney and Spotts 1980, Stynes and Mahoney 1980). A typical forecast to the year 2000 costs less than a dollar in computer costs and generates a wealth of data. Computer simulation models do not have to be expensive.

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