Linking the Economy and Environment of Florida Keys/Florida Bay

NONMARKET ECONOMIC USER VALUES OF THE FLORIDA KEYS / KEY WEST

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Preface

This report provides estimates of the nonmarket economic user values for recreating visitors to the Florida Keys/Key West that participated in natural resource-based activities. It is the fifth in a series that is being developed as part of the project entitled “Linking the Economy and Environment of the Florida Keys/Florida Bay.” The overall project objectives are to 1) estimate the market and nonmarket economic values of recreation/tourism uses of the marine resources of the Florida Keys/Florida Bay ecosystem; 2) provide a practical demonstration of how market and nonmarket economic values of an ecosystem can be considered an integral component of the economy of a region when formulating sustainable development objectives and policies; and 3) foster cooperative management processes.

To achieve the above objectives it is necessary to develop information about the users of marine resources, the way users interact with resources (their recreation activities), the amount and pattern of spending associated with their uses, and users’ assessments of natural resources, facilities and services. It is also important to develop the necessary tools to analyze the information in practical applications.

The project provided for the design and implementation of a survey of both residents and nonresidents of Monroe County (visitors) with respect to their recreational activities in the Florida Keys/Florida Bay Area, and analyses of the data collected to provide the following:

- Estimation of the number of residents and visitors to the Florida Keys and Florida Bay by type of use, along with estimation of the extent of use by geographic areas (Upper Keys, Middle Keys, Lower Keys, Key West, and access to Florida Bay through Everglades National Park).
- Development from survey data of profiles of residents and visitors including age, race/ethnicity, sex, income, education, place of residence, activity participation and spending in the local and regional economy.
- Estimation of the economic contribution (sales/output, income, employment) of both resident and visitor uses of the Florida Keys and Florida Bay to the Monroe County economy and the South Florida (Broward, Dade and Monroe Counties) regional economy.
- Estimation of the net economic user value of marine resources in the Florida Keys and Florida Bay.
- Importance and satisfaction ratings with respect to natural resources, facilities, and services and an assessment of the importance of water quality and abundance and diversity of sealife as attractions for visitors to the area.

The project is being conducted through a unique partnership between federal and local agencies and a private nonprofit organization. Two offices within the National Oceanic and Atmospheric Administration (NOAA): The Office of Ocean Resources Conservation and Assessment, Strategic Environmental Assessments Division and the Office of Ocean and Coastal Resource Management, Sanctuaries and Reserve Division, Florida Keys National Marine Sanctuary; The Nature Conservancy, Florida Keys Initiative (TNC); and The Monroe County Tourist Development Council (TDC) have entered into a cooperative agreement. These are the “funding partners.”

The actual conduct of the project is done by the “working partners”. NOAA’s Strategic Environmental Assessments Division is the lead working partner and has an interagency agreement with the U.S. Forest Service’s Southern Forest Research Station, Outdoor Recreation and Wilderness Assessment Group to conduct the survey of visitors to the Florida Keys and Florida Bay area, and to jointly conduct economic analyses of the data. The U.S. Forest Service has a cooperative agreement with the University of Georgia’s Environmental and Resource Assessment Group and the Department of Applied and Agricultural Economics to conduct the visitor survey and to provide an economist to assist in estimating the economic contribution of both resident and visitor uses of the Florida Keys and Florida Bay Area. The University of Georgia has a cooperative agreement with the Bicentennial Volunteers, Inc. to conduct all on-site interviews in the visitor survey. Florida State University’s Policy Sciences Program, Survey Research Center conducted the survey of residents of Monroe County under contract to NOAA’s Strategic Environmental Assessments Division.

This report is more technical than the previous fact based reports. The Overview: Summary and Conclusions is a stand alone section and is directed at nontechnical audiences. The report's key findings and conclusions are summarized here. The remaining portion of this report provides the theory and methods used to derive study findings and conclusions. Here we also attempted to lay out a simple conceptual model of the links between the economy and the environment, showing the theoretical relationships between environmental quality, use, and market and nonmarket economic values. We also provide our own view of how we think these concepts relate to this issue of sustainable development in the Florida Keys/Key West. We follow this with a discussion of what are nonmarket economic use values and how they are measured. We then present the results from the estimated travel cost models and how we estimated nonmarket user values from these models as well as how we calculate the asset value of natural resources using these values. We close with a section summarizing the uses of nonmarket economic values and attempt to put the projected costs of wastewater and storm water plans into perspective by comparing them with the annual user values and the asset values of the natural resources of the Florida Keys/Key West.

This report, as well as the other reports in this series, are intended for all people involved in planning, managing or providing natural resources, facilities and services to residents and visitors of the Florida Keys/Key West. A great deal of information is presented in these reports. Despite the enormous extent of information available in the reports, the data bases from which these reports were generated are much richer in content. We encourage users to explore further these rich sources of information by making special requests or obtaining the data bases and documentation themselves. The visitor data and documentation are already available on CD-ROM. The resident data and documentation will be available in November 1997.

Other Reports Available

Visitor Profiles: Florida Keys/Key West
Economic Contribution of Recreating Visitors to the Florida Keys/Key West
Importance and Satisfaction Ratings by Recreating Visitors to the Florida Keys/Key West
Technical Appendix: Sampling Methodologies and Estimation Methods Applied to the Florida Keys/Key West Visitors Survey
A Socioeconomic Analysis of Recreation Activities of Monroe County Residents in the Florida Keys/Key West
Technical Appendix: Sampling Methodologies and Estimation Methods Applied to the Survey of Residents of Monroe County

World Wide Web Site

A world wide web site has been established that contains a project background along with all the reports generated in the project in PDF file format. The site address is

http://www-orca.nos.noaa.gov/projects/econkeys/econkeys.html

The site also provides links to the Monroe County Tourist Development Council site where information can be obtained on lodging, restaurants, and recreation facilities and services. There is also a link to the Florida Keys National Marine Sanctuary site. You can also place orders for any of the project reports from this site.

For further information about this project, contact:

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Overview: Summary and Conclusions

The objective of this review is to provide the results of the study and their implications with a minimum of technical detail. Those who wish to simply review the results and understand their general application need not read the remaining portion of the report. All the main conclusions and important study measurements are summarized here. For those that want to learn more about the underlying theory and methods used, we encourage you to read on. For more technical audiences, we have attempted to provide as much of the technical details as is practical in the main body of the report and in report appendices. **The results of this report are limited to visitors (nonresidents of Monroe County) to the Florida Keys/Key West that engaged in at least one natural resource-based activity on their visit to the area.** This group of visitors accounted for 72 percent of the total annual person-trips made by recreating visitors to the Florida Keys/Key West. In addition, they accounted for 85 percent of the total annual person-days and 95 percent of the total annual activity-person days.

It is unfortunate but true that the nature of nonmarket economic valuation is such that the methods used to estimate such values are more technical and the underlying economic theory on which nonmarket economic valuation is based is not as easy to understand compared with market values such as sales/output, income, employment, and tax revenues. These market economic values are more familiar as we are exposed constantly to reports on the status of our economy, through newspapers, television, radio, magazines and other media, as it relates to these measures. With every report of either upturns or downturns in any one these measures, the inferences are that we are either better off or worse off.

For at least 100 years, economists have recognized the deficiency of market economic values as indicators of social or economic welfare or well-being. The reason is that market economic values do not fully account for the values of resources not traded in markets. We have polluted our air and water because the lost values from polluting these resources are not included in the costs of producing products. We harvest our renewable natural resources such as fish, wildlife, and timber beyond their abilities to replenish themselves because many of these resources are held in common and they too go unpriced in markets. But property rights aren't the only problem. Many wetlands are privately owned. However, all the public benefits that wetlands generate (e.g. habitat for fish and wildlife, water recharge to aquifers, storm and flood protection, etc.) cannot be captured by the wetland owner i.e., there is no way the owner can figure out what or who to charge and collect the charges. Therefore, the public benefits of wetlands are not considered by developers in a free market economy. Consequently, most of the nation's wetlands have disappeared and are continuing to disappear despite the "no net loss" policy fostered during the Bush Administration.

There are real economic values associated with the environment and natural resources. Economics now includes a separate discipline of environmental and natural resource economics. One of the main thrusts of this field of economics is how to measure the nonmarket economic values of the environment and natural resources. In recent years, the field of environmental and natural resource economics has expanded to include ecological economics. Ecological economics attempts to integrate the methods of ecology and economics. Terms such as ecosystem management, sustainability and sustainable development are the subjects of ecological economics.

We attempted to bring together the concepts from environmental and natural resource economics and ecological economics to show the relationships between environmental quality and tourist/recreational use of the Florida Keys/Key West and how environmental quality and tourist/recreational use are related to market and nonmarket economic values. We present a simple conceptual model of how the economy and environment are linked (See Figure 1, pg 7). We also provide our own definition of sustainable development as we see it relating to practical application in the Florida Keys/Key West. The inset box on page 2 contains a summary of the lessons on the relationship between environmental quality and the economy.

Environmental Quality and the Economy

- Sustainable development in the Florida Keys/Key West is dependent on maintaining or increasing the natural capital stock of the area. The natural capital stock is represented by the quality of the environment and abundance & diversity of the natural resources of the area.

- In the long-run, market and nonmarket economic values will decline if environmental quality declines.

- Market economic values (sales/output, income, employment, tax revenues) are not good l*eading indicators* of the long term health of the natural resource dependent portion of the economy, because market economic values can increase in the short-run if natural capital is sacrificed.

- Theoretically, nonmarket economic values (consumer's surplus, see definition on page 2) are a better *leading indicator* of the long term health of the natural resource dependent portion of the economy, but suffer the same problem, in that, nonmarket values can continue to increase in the short-run if natural capital is sacrificed.

- Levels of sustainable use are a function of technologies, individual behaviors and institutions.

- Economic opportunities can be expanded by investments in technologies, changes in individual behaviors, and changes in institutions that alter the relationship between environmental quality and use.

- Environmental indicators can be better *leading indicators* of the long term health of the natural resource dependent economy.

Travel Cost Demand Model Results

Travel cost demand models were estimated for both the summer and winter seasons. The models relate the number of trips (visits) per year to the Florida Keys/Key West to travel costs (price) and other socioeconomic factors such as age, household income, race/ethnicity, years experience visiting the Keys, forgone earnings to make the trip, length of stay, and whether the visitor visited other sites. Travel cost demand models allow for the estimation of how visitors would respond to price increases and their nonmarket economic user values per person-trip.

Key Definitions

- **Price elasticities.** For estimated travel cost models, price elasticities provide a prediction of the percentage change in the number of trips (visits) for a given percentage change in price, holding all other factors constant. Elastic demands mean a more than proportional reduction in the number of trips for a given change in price, while inelastic demands mean a less than proportional reduction in the number of trips for a given change in price.
- **Consumer's Surplus or Nonmarket Economic User Value.** The value a consumer receives from a good or service over and above what they have to pay to consume the good or service.
- **Asset Value of the Resources.** This represents the price one would be willing to pay for the resources today based on the flow of annual user values that the resources could generate into the indefinite future.

Visitor Responses to Prices. Price elasticities provide a prediction of the percentage change in the number of trips (visits) for a given percentage change in price, holding all other factors constant. Significant differences were found between summer and winter season visitors. Significant differences were also identified for Hispanic visitors during the summer season and day trip visitors during the winter season. The details of these findings are summarized below.

- Price elasticities for visitors to the Florida Keys/Key West vary with the level of prices and become more "elastic" as the level of prices rise. In other words, a higher percentage response in trips for a given percentage change in prices.
- Generally, visitor demands are price "inelastic," which means a less than proportional change in trips (visits) for a given change in price. This means that price increases will result in increases in total revenue.
- Generally, winter season visitors are more responsive to prices than summer season visitors.
- During the summer season, Hispanic visitors had more elastic demands than all other visitors. At overall sample mean levels of travel cost, Hispanic's price elasticity was -1.15 versus -0.30 for all other visitors. This would mean that for a 10 percent increase in price, Hispanics would reduce their number of trips (visits) by 11.5 percent, while other visitors would reduce their visits only 3.0 percent. However, Hispanic visitors generally come from South Florida and have, on average, lower costs. At the Hispanic group mean level of travel costs, Hispanic visitor's price elasticity was equal to -0.30. And, at the all other visitors group mean level of travel cost, the price elasticity for all other visitors was -0.34.
- During the winter season, no difference in price elasticities were found for Hispanic visitors. However, they were a smaller proportion of winter season visitors.
- During the winter season, day trip visitors had more elastic demands than all other visitors. At overall sample mean levels of travel cost, day trip visitors price elasticity was -0.71 versus -0.44 for all other visitors. However, as with the Hispanic visitors during the summer, winter season day trip visitors primarily come from South Florida and have, on average, lower costs. At day trip visitors' group mean level of travel costs, day trip visitor's price elasticity was -0.30. And, at the all other visitor's group mean level of travel costs, the price elasticity for all other visitors was -0.46.

Per Person-trip User Values. Separate travel cost demand models were estimated for summer and winter season visitors that participated in natural resource-based activities. The travel cost demand models were then used to derive estimates of the nonmarket economic user values on a per person-trip basis. The estimated models yielded not only different values by season but also significantly different values for Hispanic visitors during the summer season and day trip visitors from South Florida during the winter season. The estimated values are summarized below.

Summer Season (June - November, 1995)

- Hispanic visitors had a per person-trip user value of about $201 versus $790 for all other summer season visitors.
- The weighted average per person-trip user value for all summer season visitors was about $740.

Winter Season (December 1995 - May 1996)

- Hispanic visitors did not have significantly different per person-trip values during the winter season. However, Hispanic visitors were a much smaller proportion of winter season visitors.
- Day trip visitors from South Florida had a per person-trip user value of about $289 versus $594 for all other winter season visitors.
- The weighted average per person-trip user value for all winter season visitors was about $561.

Annual Weighted Average

- The average annual weighted per person-trip user value was about $654.

Annual User Value

Annual user values were estimated by multiplying estimates of the total number of person-trips, by group, by the per person-trip user values, by group, presented above. Estimates of the total number of person-trips, by group, can be found in Table 1 of the main body of this report. The estimated annual user values are summarized by season and group below.

Summer Season. Hispanic visitors had a total user value of about $16 million while all other visitors had a value of about $689 million for a total summer season value of about $705 million.

Winter Season. Day trip visitors had a total user value of about $28 million, while all other visitors had a value of about $471 million for a total winter season value of about $499 million.

Total Annual Value. All visitors that engaged in natural resource-based activities had a total annual user value of about $1.2 billion.

Activity-based User Values. Visits to the Florida Keys are a complex mix of recreation activities and most often visitors do not think of any one activity as being either the main activity on the visit or the main reason for making the visit. However, for many purposes activity-based user values are desired. The authors generated estimates of user values by activity and season using the distribution of estimated person-days by activity and season. This method produces a first approximation for the estimated values by activity because the method assumes a constant per activity-day value for each activity i.e., that the value of a snorkeling day is the same as a scuba diving day or a fishing day. Using this method, the estimated value of snorkeling is different from scuba diving or fishing simply by the relative amount of days visitors spent doing each activity. The method also allows for differentiating the proportion of value assigned to non natural resource-based activities (e.g. swimming in outdoor pools, visiting historic areas, or visiting museums) and therefore provides a conservative estimate of the proportion of value assigned to the natural resources of the area.

- The constant per person-day values were about $97 for the summer season and about $77 for the winter season with an annual weighted average of about $87.
- Natural resource-based activities accounted for about 76 percent of the activity-days and total annual user value of $1.2 billion, or about $910 million, while non natural resource-based activities accounted for about 24 percent of the $1.2 billion, or about $294 million.
- Beach activities accounted for about $233 million in annual user value, viewing nature and wildlife about $224 million, fishing about $171 million, snorkeling about $156 million, and scuba diving about $49 million.

Asset Value of the Resources

The natural resources of the Florida Keys/Key West are represented by the environment as a tourist destination and abundance & diversity of specific usable resources. The asset value of the resources of an area represents the price one would be willing to pay for the resources today based on the flow of annual user values that the resources would generate into the indefinite future. This value can be approximated using a couple of conservative assumptions. First, the annual values (net of inflation) remain constant in all future years. This means that combination of total person-trips and value per person-trip do not change in the future. Second, the interest rate that converts future dollars to current dollars (net of inflation) i.e. the real discount rate, ranges between 3 and 5 percent. Based on the findings in this study, the following asset values are estimated.

- The total asset value of all natural resource-based trips is $24.1 billion at a 5 percent interest rate and $40.2 billion at a 3 percent interest rate.
- Using only the natural resource-based activity component of value, the asset value of the resource is $18.2 billion at a 5 percent interest rate and $30.4 billion at a 3 percent interest rate.

Uses of Nonmarket Economic Values

- Natural Resource Damage Assessment
- Restoration of Natural Resources
- Public Investments in facilities and land acquisition
- Public Investments in environmental protection
- Investments in education and enforcement efforts
- Green Accounting

Uses of Nonmarket Economic Values

Nonmarket economic use values now have a long tradition of use in benefit-cost analyses for public projects that either benefit or have adverse impacts on natural resources. We expect that the greatest benefits will be had in applying the results in evaluations of many public projects that will be required to fully implement the FKNMS Management Plan and the Monroe County Comprehensive Plan and Development Regulations (Florida Department of Community Affairs, 1996). Other uses include natural resource damage assessments, restoration of natural resources, investments in education and enforcement efforts, and “green accounting”. Nonmarket economic user values found in Leeworthy (1991) have been used in several damage assessment cases brought against owners of vessels that have grounded on and damaged the coral reefs in the Florida Keys. Millions of dollars have been recovered and these funds are being used to help restore the corals in the area. Attempts are underway by the U.S. Department of Commerce, Bureau of Economic Analysis to expand the Nation’s economic accounts to include the nonmarket economic values of the Nation’s natural resources (Green Accounting). The values estimated in this project could provide important information to this effort.

Putting the Cost of Water Quality Improvement and Protection into Perspective

The Monroe County Comprehensive Plan and Land Development Regulations includes estimates of the five-year costs of implementation of all aspects of the water quality protection plan. The total costs of this plan range from about $251 million to $283 million. However, implementation of all aspects of the water quality plan could push costs to as high as $500 million.

The above costs do not include annual operating costs. On the other side, the large up-front investment costs would be expected to have some useful life (usually 20 to 30 years). But even if we accept the $500 million estimate, it still pales in comparison to the $1.2 billion in nonmarket use values we estimated for one year. This conclusion still holds if we limit the comparison to only the natural resource-based activity component of the annual nonmarket economic user value ($910 million). In addition, the five-year investment estimated for wastewater and stormwater protection is only about 2.7 percent of the conservatively estimated natural resource-based component of the asset value of the area’s natural resources at a 5 percent discount rate and only 1.6 percent of the natural resource-based component of the asset value of the area’s natural resources at a 3 percent discount rate. Although this simple comparison does not meet the rigorous requirements of a benefit-cost analysis, it does suggest that the costs of water quality protection are a relatively small proportion of the total nonmarket economic user value of the resources they are designed to protect. In addition, the investment would have looked even more favorable if the other components of nonmarket values (e.g. economic rents, nonuse values, and passive use values) could have been included. Given the area’s recognition internationally as a biosphere reserve, the nonuse and passive use values are potentially large, possibly equal to or exceeding the use values of the area.

Limitations

As with most studies there are many limitations. Even though we explain the definitions of all types of nonmarket economic values, in this study, we were only able to estimate the nonmarket economic user values related to tourist/recreational uses of the natural resources of the Florida Keys/Key West. Nonmarket values such as “economic rents” to producers and nonuse or “passive use” values were not estimated as part of this project. These values may be very important components of the total economic value of the area’s natural resources, but they must be left for future research. We were also not able to estimate relationships between environmental quality or the abundance & diversity of natural resources and tourist recreational uses in order to estimate the “marginal benefits” of investments to improve or protect the environment. We cannot answer the question “What are the benefits to recreating visitors of investments that reduce nutrient loads by either 10, 20, 50 or even 100 percent ? We can however estimate the total value of the resources that are negatively impacted by nutrients and place this against the total cost of protection efforts. This would not be a legitimate comparison in a formal benefit-cost analysis, but would allow decision-makers to formulate benchmarks for deciding the level of investment. For example, would it be reasonable to spend an amount equal to 3 percent of the total value of the resource if the investments reduced nutrients 50 percent ? Other studies and other experiences might be drawn upon to aid in this decision making. What we have provided is simply one piece, albeit an important piece, of the puzzle.

The travel cost models that we presented are only a small subset of what was estimated. The models incorporate many judgments. Instead of presenting many different models incorporating many different modeling choices and judgments, we chose to present what ,in our judgment, were the best results based on our own extensive experience and the latest findings in our scientific journals. We have carefully documented each of the modeling choices and judgments made and have made the data and documentation available to other researchers. Rather than a limitation, we believe this to be a strength of our work.

A major limitation to all economic valuation work is our inability to forecast very far beyond current baselines. When calculating the asset value of the resources, the formula used required the assumption that the total annual user value in real terms (net of inflation) and the real discount rate (interest rate net of inflation) were constant into perpetuity. Assuming that the quality of the resources of the area do not decline and increased use does not result in negative reactions because of crowding, we called these conservative assumptions (i.e., assumptions that would produce the smallest values). We would predict that the demand for trips (visits) to the Florida Keys will increase in the future, and because of increasing scarcity of good recreation opportunities in the future (i.e., that demand will increase relative to total supply) nonmarket economic user values per person-trip will also increase. The combination of both would mean increases in the total annual user value in future years versus our assumption of constant annual value. This is simply a limitation of economic science and a limitation that will not likely be overcome by future research.

Linking the Economy and Environment

There are many factors that determine the demand for recreation/tourism in the Florida Keys/Key West. The overall economic conditions of the U.S. and other countries (close to 20 percent of the recreating visitors to the Florida Keys/Key West are foreign visitors, see Leeworthy and Wiley, 1996a) play a major role, as do exchange rates, energy costs, the relative prices of goods and services provided in the Keys, and various socioeconomic factors (e.g. household income, age, race/ethnicity, years of experience visiting the Keys, etc.). Other determinants of demand include the nature of supply in terms of the quantity and quality of facilities and services and the quality of the environment and the abundance and diversity of natural resources.

Figure 1 is a simple conceptual model that shows the link between the economy and the environment. In this model, actual conditions with respect to the quantity and quality of facilities & services, the quality of the environment and abundance & diversity of natural resources, and the degree of crowdedness are important factors in determining peoples' perceptions of these conditions.

How peoples' perceptions are actually determined is complex. Other important factors are peoples' frames of reference and their experiences. For example, people from highly developed places of residences with no prior experience with tropical or coral reef environments will have quite different perceptions of environmental quality than people from less developed places and extensive experience with visiting tropical or coral reef environments. Peoples' perceptions determine their behaviors and thus their demands and their nonmarket economic values. Nonmarket economic values then determine the market economic values. The level of demand for recreation/tourism uses may then have a feedback effect on the actual conditions of facilities & services and environmental quality, the abundance & diversity of natural resources, and the degree of crowdedness.

Nonuse Values. Note that, in our simple conceptual model, nonmarket economic values are divided into nonmarket user values and nonuse or "passive use" values. Nonuse values, by definition, involve no direct uses of the environment by the individuals expressing their values. Part of the population may not currently be users, but may be willing to pay an amount to have the option of visiting sometime in the future. This willingness to pay would be like purchasing an insurance policy to preserve actual conditions for possible future visitation. Economists call this "option value".

Another nonuse value is called "bequest value". Some people that have never visited the Florida Keys/Key West and may never plan to make a visit, may still be willing to pay an amount to ensure that their children or grandchildren have the opportunity to visit sometime in the future. Still others, who also have never visited or plan to visit the area, may also be willing to pay an amount simply to ensure the existence of the place, in a certain condition. Economists call this "existence value".

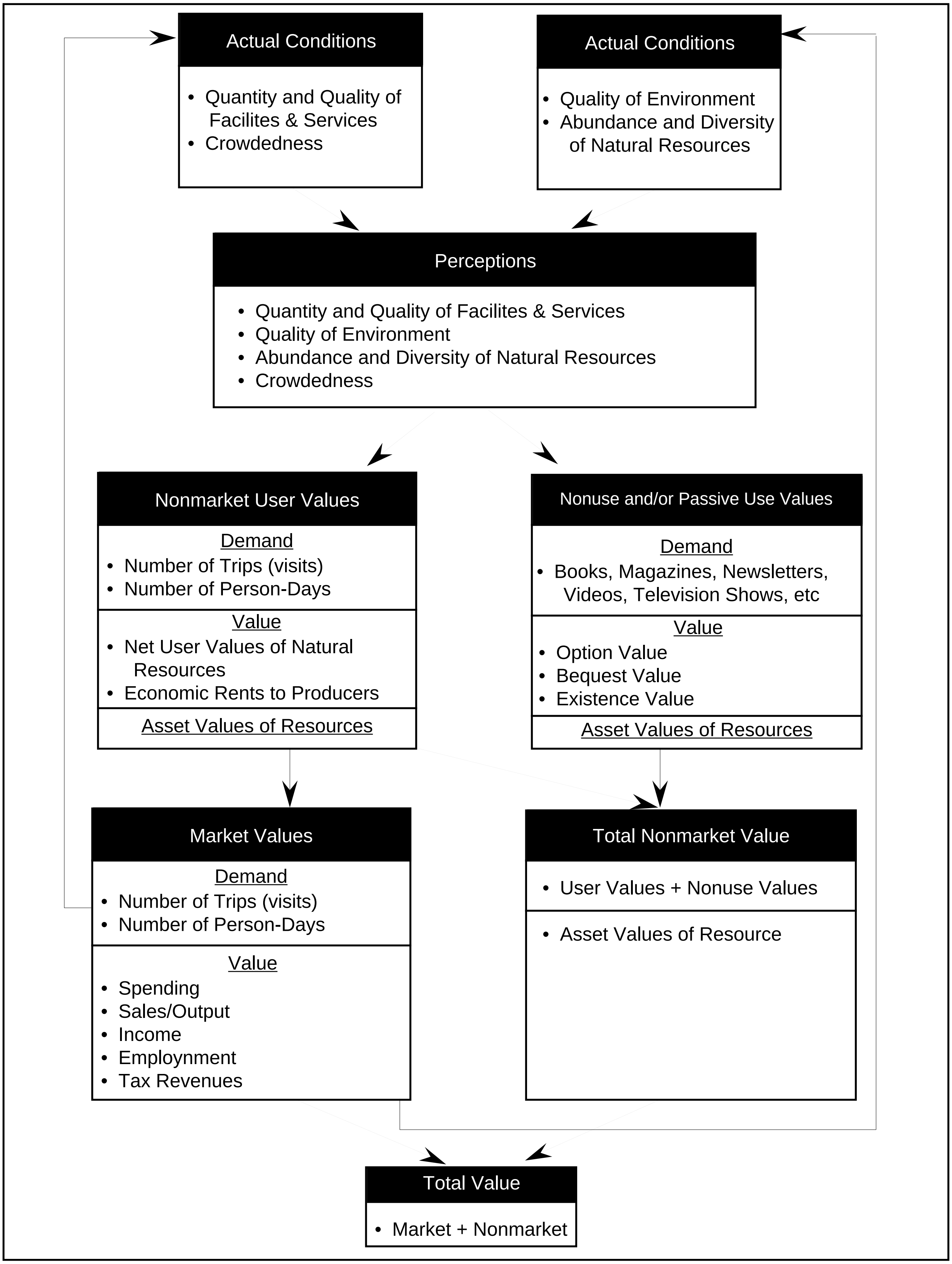
Nonuse values are increasingly being referred to as "passive use values". The reason is that to have value for something requires knowledge of what is being valued. People learn about natural resources and their conditions through a variety of media including books, magazines, newsletters, videos, television shows, etc. Through this passive use (e.g. reading a book or watching a television show), people develop real economic values for resources. Thus the term "passive use value".

Market and Nonmarket Use Values. When people think of the economy, they usually think of it in terms of market economic values such as spending, sales/output, income, employment, and tax revenues generated. But as described in our simple conceptual model, the market economic values are driven by nonmarket user values. But what are nonmarket user values and how are they measured ?

Nonmarket values can be broken down into two categories according to the group receiving the value. Generally, they have been referred to as consumer' surplus and producer's surplus. In economic welfare theory, consumer's surplus and a special sub-category of producer's surplus, economic rents, have relevance in the context of economic efficiency arguments. The concepts are related to efficiency because they represent a net gain from the utilization of a certain amount of society's available resources. They are the values that are incorporated in benefit-cost analyses which attempt to determine what is the best use of society's available resources i.e., which uses yield the greatest net gain.

Economic rents are a return on investment above "normal" returns on investment. Normal meaning the amount that could be earned elsewhere. In an open and competitive environment, economic rents will not exist for long as new entrants will be attracted to the relatively high rates of return

Figure 1. Conceptual Model Linking the Economy and Environment



on investment. Economic rents can however persist when, for example, governments pass regulations that limit entry. If, for example, the government passes a regulation that prohibits further dredging of wetlands to build or expand marinas, this may limit the supply of marinas relative to the demand for marinas resulting in returns on investment to existing marinas above the normal rate of return. These higher than normal rates of return on investment increase the asset value of existing marinas. They therefore could command a higher price to a potential buyer.

When economists estimate consumer's surpluses for outdoor recreation/tourism, they have used the term nonmarket economic user values or sometimes simply use values. *Consumer's surplus* is an amount of value that a consumer of a good or service receives over and above what they pay to get the good or service. Figure 2 illustrates the concept of consumer's surplus. Figure 2 shows a hypothetical demand curve. A demand curve shows the maximum amount a consumer would be willing to pay for each quantity of the good or service per time period. The demand curves shows the relationship between prices and quantities holding all other factors that determine demand constant (e.g. income, taste & preferences, and environmental quality).

At price, P_1, the consumer would buy Q_1 units/time period. That is, P_1 is the maximum the consumer would be willing to pay in order to get Q_1 units/time period. The consumer pays an amount equal to P_1*Q_1 which is equal to the area $P_1 AQ_1Q_6$. This area is equal to the total sales or revenue from the consumer's purchase of Q_1 units/time period at price, P_1. Similarly, the consumer would be willing to pay P_2 for Q_2, P_3 for Q_3, etc. But what the consumer is willing to pay and what they have to pay are determined by both the demand and supply of goods and services. If the market demand and supply are such that the consumer gets to purchase Q_1 units/time period at P_1, the consumer only pays the amount equal to the area $P_1AQ_1Q_6$. But according to the demand curve, the consumer's total willingness to pay for Q_1 would be equal to the area $Q_6P_6AQ_1$. The area P_1P_6A is the consumer's surplus or the amount of value the consumer receives from the amount of goods and services consumed over and above what the consumer was required to pay.

Nonmarket User Values and Environmental Quality.
Nonmarket user values for visits to the Florida Keys/Key West are determined, in part, by environmental quality. Increases in environmental quality would increase the demand for recreation/tourism. This would result in an upward shift in the demand curve and a resulting increase in both use and consumer's surplus (nonmarket economic use value). Figure 3 illustrates this effect.

In Figure 3, D_1 is the demand for recreation/tourism at the original

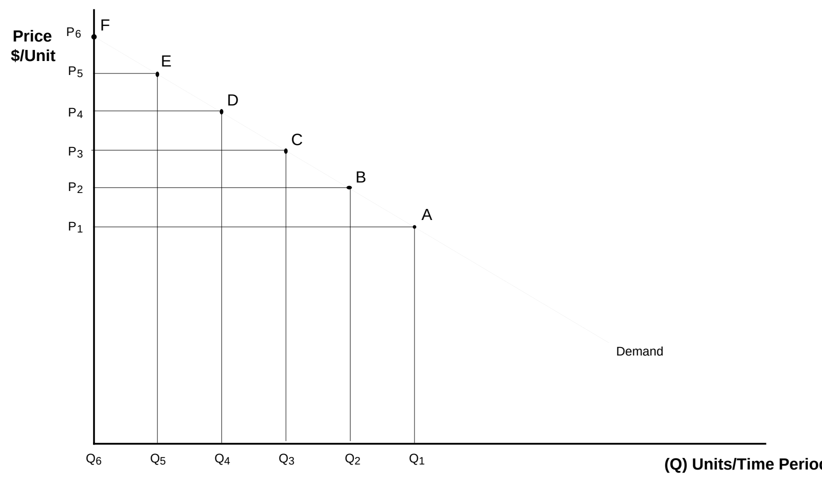


Figure 2. Hypothetical Demand Curve

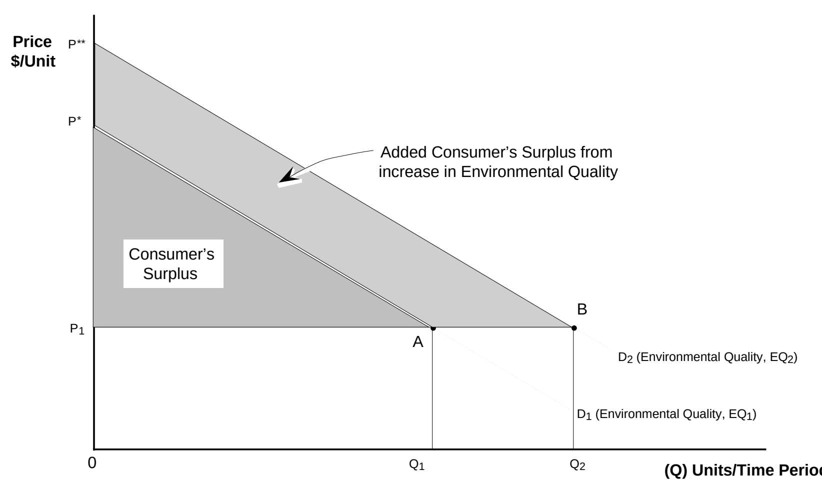


Figure 3. Changes in Environmental Quality and Changes in Consumer's Surplus (Nonmarket User Value)

environmental quality (EQ_1). At price, P_1, visitors make Q_1 visits to the Florida Keys/Key West. Visitors spend an amount equal to the area $0P_1AQ_1$ and receive a consumer's surplus equal to the area P_1P^*A. When environmental quality increases to EQ_2, the demand for recreation/tourism increases to D_2. At price, P_1, visitors will now make Q_2 visits, spend an amount equal to the area $0P_1BQ_2$, and receive a consumer's surplus equal to the area $P_1P^{**}B$. Market spending increases by the amount Q_1ABQ_2 and consumer's surplus increases by the amount equal to the area $AP^*P^{**}B$. Thus both the market and nonmarket economic use values increase with increases in environmental quality.

Sustainable Development

One of the overall objectives of this project was to provide a practical demonstration of how market and nonmarket economic values of an ecosystem could be considered an integral component of an economy when formulating sustainable development projects and policies. Defining sustainable development in a manner that has practical application has been, and continues to be, a challenge. Defining sustainable development for the planet, for a nation, for a county, and for a particular reef area may all involve significantly different considerations. But one thing that seems to be common among all definitions of sustainable development and one that has practical value for application to the Florida Keys/Key West is the idea of increasing or maintaining the natural capital stock. By this we mean the environmental quality and abundance & diversity of natural resources as presented in our simple conceptual model of how the economy and environment are linked.

Figure 4 shows the relationships between environmental quality, use, and market and nonmarket economic values under existing technologies, individual behaviors, and institutions. The top part of Figure 4 shows the relationship between environmental quality and level of use. This relationship remains constant up to the sustainable level of use depicted as point A. Up to this point, wastes from use activities, harvest of resources, and other use related damages are such that the natural stock of capital remains intact. That is, the environment is able to assimilate the amount of wastes without declining environmental quality. Fish harvests do not exceed the population's ability to replenish itself. Damages to other resources like seagrasses and corals are at a rate not exceeding the replenishment rates of these resources.

The bottom portion of Figure 4 shows the relationship between market and nonmarket economic values and use for different amounts of environmental quality

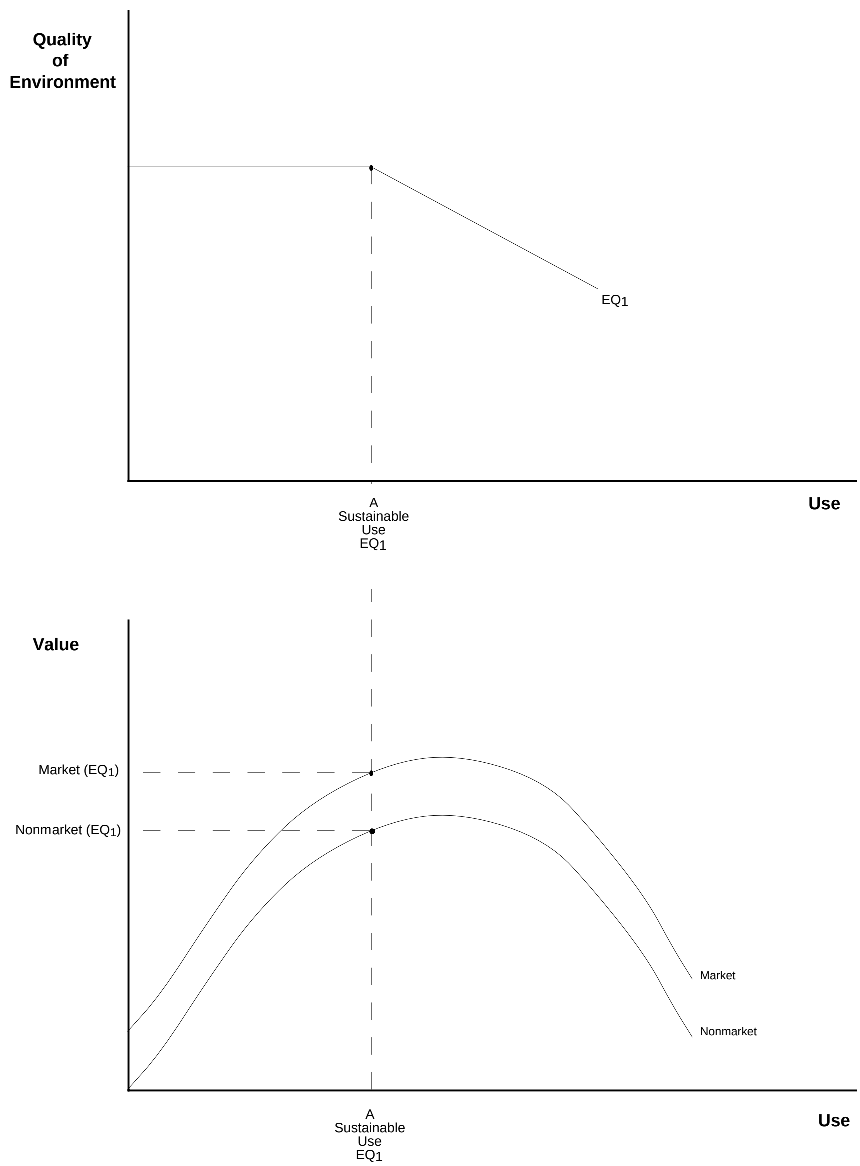


Figure 4. Sustainable Use, Environmental Quality and Market and Nonmarket Use Value under Existing Technologies, Individual Behaviors and Institutions

under existing technologies, individual behaviors, and institutions. Note that up to the level of sustainable use both market and nonmarket economic values are increasing. In the short-run, it is possible that market and nonmarket economic values can continue to increase with use levels above the sustainable level. For this to occur requires the short-run sacrifice of natural capital for short-run gain. But as Figure 4 shows, this situation cannot persist (is not sustainable). Using up the natural capital stock will eventually lead to downturns in both market and nonmarket economic values.

Role of Technologies, Individual Behaviors, and Institutions. The relationships between environmental quality, use, and market and nonmarket economic values, as depicted in Figure 4, were defined under existing technologies, individual behaviors, and institutions. Changes in any of these could shift these relationships. Different technologies (advanced wastewater treatment) and individual behaviors (prop scaring and buoyancy control) can change the relationship between environmental quality and use. Changes in technologies and individual behaviors can expand the market and increase the sustainable level of use. This essentially is the idea behind sustainable development and what differentiates it from simple economic growth. ***Sustainable development recognizes the inherent limits of the natural environment but also recognizes that it's not simply how much or often something is done but how it is done that determines economic value***. It may be true, for example, that given currently applied technologies and individual behaviors, Monroe County's economic growth is limited (cannot increase tourist visitation or number of residents without decreasing environmental quality). However, a sustainable development plan would change how things are done, by encouraging investment in redevelopment and changes in individual behaviors that would expand economic opportunities without declines in environmental quality (would be sustainable).

Recent changes have been made to the institutions in the Florida Keys/Key West. The Florida Keys National Marine Sanctuary (FKNMS) was created along with the Sanctuary Advisory Council representing a broad cross-section of stakeholders. This change in institutions is an attempt at integrated coastal management. The recently approved FKNMS Management Plan contains many management strategies, most of which have been organized into action plans. This set of institutional changes can be viewed as an attempt to shift the relationship between environmental quality and use and thus raise the long-term sustainable level of use through investments in new technologies (advanced wastewater treatment, mooring buoys, channel markers) and changes in individual behaviors through education and enforcement efforts. Figure 5 illustrates the role

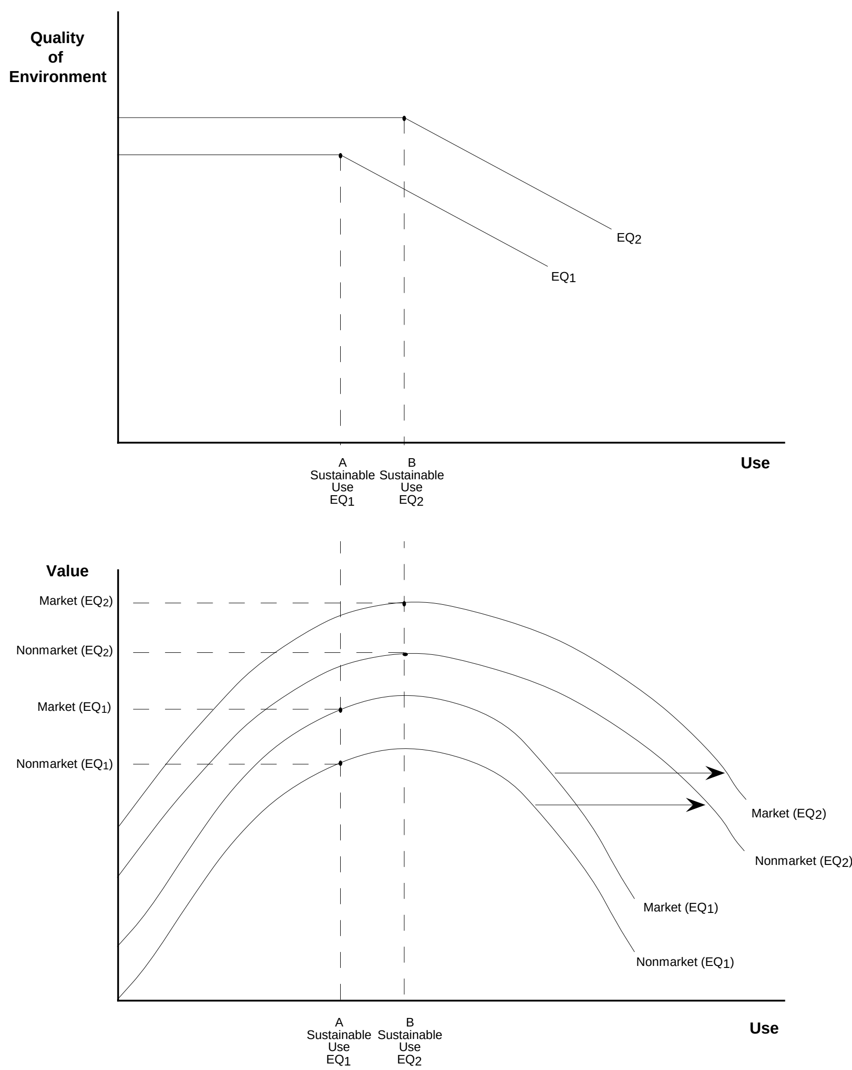


Figure 5. Sustainable Development under Changing Technologies, Individual Behaiviors and Institutions

of changing technologies, individual behaviors, and institutions in raising the levels of sustainable use thus expanding economic opportunities.

Lag Between Actual Environmental Conditions and User Perceptions - An Opportunity

In our simple conceptual model of the link between the environment and the economy, a crucial link was between actual environmental conditions and people's perceptions of those conditions. People do not always have complete and/or accurate information about environmental conditions. This is made worse by either great uncertainty of actual environmental conditions or disagreement among scientists over the state of environmental conditions. These problems aside, there usually is a time period between actual changes in environmental conditions occur and when they are perceived by users (lag period). This lag period presents an opportunity to correct the problems causing the adverse environmental conditions before they have negative impacts on nonmarket and market economic values.

During the lag period, cash flow to businesses and governments may be relatively high and thus provide the wherewithal and thus opportunity to make the necessary investments in new technologies, change individual behaviors, and make any necessary changes in institutions to improve actual environmental conditions. If one waits until perceptions of adverse environmental conditions catch-up with actual environmental conditions, the risk is that nonmarket and market economic values will already be on the decline and remove the necessary cash flow to effectively correct the problems. This could lead to the spiraling down in both nonmarket and market economic values.

Another potential adverse impact is that it may become more costly to attract visitors, so this warrants further discussion. Usually the most sensitive and active users recognize the changes in environmental conditions first. Sometimes the majority of users are unaware of adverse changes in environmental conditions because they either have had no or little previous experience with the resources of the area or their frames of reference (i.e. where they live or other places they have visited) are such that the resources in the Keys are by comparison much better or worse. A key element in assessing this situation is the distribution of the most sensitive and active users relative to those with little experience or frames of reference of places with lower environmental quality than the Keys.

First time visitors to the Florida Keys/Key West made up 32 percent of the summer season visitors and 40 percent of the winter season visitors. Overall, 42 percent of visitors had visited the Florida Keys/Key West at least five years ago. In Leeworthy and Wiley (1996b), it was found that visitors who had visited the Keys at least five years prior to the current visit had significantly lower satisfaction scores for eight of eleven natural resource attributes, facilities, and services they were asked to rate (e.g. clear water, amount of living coral on the reefs, opportunity to view large wildlife, uncrowded conditions, shoreline access, parks and specially protected areas, and value for the price).

Changes in perceptions of the quality of the natural resource attributes, facilities, and services of the area by the most experienced users may result first in declines in nonmarket economic use values which may result in declines in use (e.g. trips or visits). Reductions in the number of trips (visits) will lead to reductions in market economic values (e.g. sales/output, income, employment, and tax revenues) and thus negative impacts on the local economy. To off-set this negative impact, local government and business may be forced into a costly strategy of continually attracting first-time visitors.

What Kind of Economy ?

The relationships between the environment and the economy discussed above are predicated on the assumed desire for a certain type of economy. There are many different types of economies in the U.S. New York City currently has a vibrant economy based on the usual measures (e.g. sales/output, income, employment). In addition, other social indicators of well-being such as crime are on the decline. But the economy of New York City is not based on quality snorkeling, scuba diving, or fishing experiences nor on the opportunities to view and study an abundance and diversity of wildlife and nature.

Monroe County has faced and will continue to face the choice of what kind of economy it wants. Many development choices will not be consistent with maintaining the kinds of opportunities that currently exist. There might be just as many jobs and just as much income to be made by changing to a non-environmentally based economy, but it would indeed be a totally different place.

Given the recent changes in the Monroe County Comprehensive Plan and Land Development Regulations and the FKNMS Management Plan, Monroe County is moving towards an economy based on a high quality

Environmental Quality and the Economy

- Sustainable development involves maintaining or increasing the natural capital stock of the area. The natural capital stock is represented by the quality of the environment and abundance and diversity of the natural resources of the area.
- In the long-run, market and nonmarket economic values will decline if environmental quality declines.
- Market economic values (sales/output, income, employment, tax revenues) are not good leading indicators of the long term health of the natural resource dependent portion of the economy because market economic values can increase in the shortrun if natural capital is sacrificed..
- Theoretically, nonmarket economic values are a better leading economic indicator of the long term health of the natural resource dependent portion of the economy than market economic values, but suffer from the same problem, in that, nonmarket values can continue to increase in the short-run if natural capital is sacrificed.
- Levels of sustainable use are a function of technologies, individual behaviors and institutions.
- Economic opportunities can be expanded by investments in technologies, changes in individual behaviors, and changes in institutions that alter the relationship between environmental quality and use.
- Environmental indicators can be better leading indicators of the long term health of the natural resource dependent economy.

environment and high quality natural resource-based activities. But all of the efforts outlined in both referenced plans will have costs as well as benefits. Some of these costs may seem quite high. Further, costs are usually well defined, while the benefits are usually stated only qualitatively. This imbalance in information can lead to less than optimal investments.

In English et al., 1996, we presented estimates of the market economic values associated with recreating tourists to the Florida Keys/Key West. Here we add estimates of the nonmarket user values of the natural resources of the area. In the last section of this report, we attempt to put some of the projected costs of implementing the water quality and growth management plans into perspective by relating them to the annual user values generated by recreating visitors that participate in natural resource-based activities and the asset values of the resources the programs are designed to protect.

Nonmarket Economic User Values: Natural Resource-based Trips

Travel Cost Demand Models. The travel cost method (TCM) is one of the most popular means of nonmarket valuation used over the past 30 years. The theoretical basis for TCM derives from the basic notion of economic utility maximization subject to budget and time constraints. The method is predicated on a number of assumptions, foremost of which is that individuals perceive and respond to changes in the travel-related component of cost of a trip or visit to a recreation site in the same way they would respond to a change in admission price (Freeman, 1993). In its various forms (see Fletcher, Adamowicz, & Graham-Tomasi, 1990: Smith, 1989: or Ward & Loomis, 1986), TCM has generally been preferred to estimate economic values derived from site use over other nonmarket methods because of its behavioral basis.

The most frequently used TCM empirical approaches are the zonal approach and the individual approach. The zonal approach (ZTCM) was the first developed and is still widely used (English & Bowker, 1996; Hellerstein, 1991; Richards et al., 1990). It is based on establishing a relationship between per capita participation rates at a site from various geographic origin zones and the costs incurred in travel from the origin zone to the given site. The individual travel cost model (ITCM) is conceptually similar to the zonal model, however, the travel cost/ trip relationship is based solely on individual observations. Another important distinction between the ZTCM and the ITCM is that with the ZTCM one estimates the total population of users using the model. The ITCM requires an independent estimate of the number of users. Examples of ITCM applications in recreation include Adamowicz, Fletcher, & Graham-Tomasi (1989); Creel & Loomis (1990); Englin & Shonkwiler (1995); and Leeworthy (1991).

Currently, ITCM seems preferred over ZTCM for reasons such as (a) statistical efficiency, (b) theoretical consistency in modeling individual behavior, (c) avoiding arbitrary zone definitions, and (d) increasing heterogeneity among populations within zones. In addition, statistical methods are now available for dealing with the integer nature of individual trip demand and zero truncation common to choice-based samples (Creel & Loomis, 1990 and Yen & Adamowicz, 1993) and endogenous stratification commonly associated with on-site survey data collection (Shaw, 1988). Both of these problems have been shown to effect a bias in regression-based demand models which do not take them explicitly into account (Hellerstein, 1992).

Another distinction in applying the ITCM is the choice between multiple-site models and single site models. The most popular multiple-site choice model is the random utility model (RUM). RUMs focus on site choice and therefore substitution across sites. RUMs also allow for the inclusion of site attributes in the model. Attribute values are derived from these models by deducing their value based on people's choices among sites with different attributes.

Although RUMs have several desirable properties, the use of this type of model for estimating nonmarket user values was rejected for several reasons. First, trips to the Florida Keys/Key West are characterized by visitors engaging in a variety of activities, and most often, none of the activities is considered either the main activity or the main reason for visiting the area (see Appendix 2 for a set of activity matrices showing the complex patterns of activities participated in by visitors). RUMs are usually activity specific in order to relate specific site attributes to specific activities. Second, the Florida Keys/Key West is a unique place. It is the only place in the U.S. that can be accessed by automobile with an expansive tract of coral reefs within a short distance from shore. Specifying a reasonable set of alternative sites for the site selection choice set is problematic. Third, most of the trips to the area are longer than one day. RUMs do not handle multiple-day trips very well. But probably the most important reason has to do with the nature of the nonmarket user values estimated from a RUM.

The RUM is focused on site substitution. The main reason for using this type of model is that it addresses the biases inherent in ignoring substitution across sites. For example, if an oil spill occurs on a beach, users can usually go to another beach thereby mitigating losses in nonmarket economic user values. A RUM model would account for this whereas the simple single site model would not. Values derived from a single site model would have an upward bias because they would not account for this type of substitution. However, when addressing the long-run sustainability of an environment, the RUM would over adjusts for substitution when applied to a resource characterized by the unique resources of the Florida Keys/Key West. Even the single site model is not completely able to capture long-run values. We are very limited in our abilities to project such values very far into the future. In our judgment, the single site ITCM is more appropriate for estimating the nonmarket economic use values for the Florida Keys/Key West.

Sample Data. The data used for estimating travel cost demand models came from a sub-sample of the CUSTOMER Survey conducted during the July-August, 1995 period and during the January-April, 1996 period. The July-August, 1995 period data were used to estimate models for the June-November, 1995 season (summer) and the January-April, 1996 period data were used to estimate models for the December 1995 - May 1996 season (winter). [See Leeworthy (1996) for a complete description of the sampling methods and for estimates of the total population of users (person-trips and person-days) for each season.] Leeworthy and Wiley (1996a) gives detailed profiles of the visitors and Leeworthy and Wiley (1996b) provides importance-satisfaction ratings for 25 natural resource attributes, facilities, and services.

The sub-sample used for estimating the travel cost demand models only included those who participated in natural resource-based activities. This included all water-related activities (except swimming in a pool) and viewing wildlife or other nature study from land. Complete information was provided by 1,608 respondents during the summer season and by 2,427 respondents during the winter season. Table 1 provides a summary comparison of all recreating visitors with the sub-population of those visitors that participated in natural resource-based activities for person-trips, person-days and activity person-days, by season.

Natural resource-based trips accounted for 72.5 percent of the total person-trips (81.3% summer and 65.0% winter) made to the Florida Keys/Key West by recreating visitors during the year June 1995 - May 1996. However, natural resource-based visitors accounted for much larger shares of the person-days. They accounted for 85.4 percent (90.4% summer and 82.5% winter) of the total annual number of person-days.

The third measure in Table 1 requires further explanation. Activity person-days are used in this report to provide a first order approximation of activity-based user values by distributing the total estimated value for each season by the distribution of days across activities. Activity person-days are derived by adding up days of recreation activity reported and estimated for 39 different activities (see Leeworthy, 1996 Chapter 4). Since any part of a day was counted as a whole day, visitors could have participated in multiple days of activities in a single day of visitation in the Keys. So activity person-days could potentially exceed the total number of person-days in the Keys. This was true for the summer season. However, during the winter season, activity person-days were less than total person-days in the Keys. The reason for this is that the winter season is characterized by seasonal visitors that are on extensive stays. Many do not participate in outdoor recreation activities every day they are in the Keys.

Table 1. Person-trips, Person-days, and Activity Person-days: All Recreating Visitors versus Natural Resource-based Visitors

	June - Nov. 1995		
	Person-trips (Thousands)	Person-days (Thousands)	Activity[1] Person-days (Thousands)
All Recreating Visitors	1,172.0	4,889.4	7,613.8
Natural Resource-based Visitors	952.9	4,421.7	7,307.5
Percent Natural Resource-based	**81.3**	**90.4**	**96.0**
	Dec. '95 - May '96		
	Person-trips (Thousands)	Person-days (Thousands)	Activity[1] Person-days (Thousands)
All Recreating Visitors	1,368.5	8,409.2	6,972.8
Natural Resource-based Visitors	889.7	6,939.3	6,481.5
Percent Natural Resource-based	**65.0**	**82.5**	**93.0**
	June 1995 - May 1996		
	Person-trips (Thousands)	Person-days (Thousands)	Activity[1] Person-days (Thousands)
All Recreating Visitors	2,540.5	13,298.4	14,586.6
Natural Resource-based Visitors	1,842.6	11,361.0	13,789.0
Percent Natural Resource-based	**72.5**	**85.4**	**94.5**

1. Activity person-days include double-counting since a visitor can do multiple activities in a day. During the winter season, activity person-days are less than total person-days in the Keys because of seasonal visitors that do not participate in outdoor activities on every day of their visit.

Estimated Models. As mentioned above, the on-site sampling format leaves us with a sample that is zero truncated because only participants are sampled and might be endogenously stratified because the probability of being chosen in an on-site sample is not independent of the frequency of usage.[1] To overcome estimation biases caused by these two problems, we employ a truncated negative binomial regression model which accounts for the truncation problem while retaining the property of an integer-based trip distribution.[2] Within this structure individual trip demand is generally specified as:

(1) $$\mathrm{Ln}\,(TRIPS_i) = \beta_0 + \beta_{tc} TC_i + \beta_{sb} SB_i + \beta_m M_i + \beta\, SE_i + \mu_i$$

where, for the i^{th} individual Ln (TRIPS) is the natural log of the quantity of recreation trips, TC is the travel cost per trip, M is income, SB is a substitute variable, SE represents a vector including other relevant socioeconomic and site attributes, the β's are regression parameters and exp (μ) is assumed to follow a gamma distribution with mean 1.0 and variance α (Greene, 1995).

Seasonal Models. In Leeworthy and Wiley (1996a), it was shown that there are statistically significant differences between visitors by season. This also proved true with respect to the estimated travel cost models. So we estimated separate models for the summer and winter seasons. These will be discussed below.

Variable Definitions. Table 2 provides definitions of all the variables used in estimating the final models presented here.[3] Several of the variables in Table 2 require further explanation. We followed Bowker, English & Donovan (1996) and defined the dependent variable as a person-trip. Hence a family of four visiting the Keys once per year would account for four person-trips as would an individual visiting the Keys four different times in one year. However, given the same origins and travel modes, the price per person-trip would differ as the single visit cost for the family of four would be apportioned to four person-trips. While intuitively appealing, this construction of the dependent variable is practical for situations where group travel by car is common as in the Florida Keys. As well, it helps to avoid the empirical malady of low dispersion of the dependent variable (Ward & Loomis, 1986) which was espe-

Table 2. Definitions for Variables in the Travel Cost Demand Models

Variable	Definition
TC2PPTH	Travel cost per person-trip in hundreds of dollars. Based on round-trip distance from home to the interview site for those where the Keys was the primary destination of the trip and from either a temporary residence or last place visited to the interview site for those on multiple destination trips. Mileage cost is the round-trip distance times $0.14/mile for auto only mode and $0.30/mile for multiple modes.
HISPANIC	Binary variable representing ethnicity (1=Hispanic, 0=non Hispanic)
HISPINT	Hispanic-travel cost interaction (HISPANIC * TC2PPTH)
DDAY	Binary variable for single day trips (1=day trip, 0=multiple day trip)
INTDAT	Single day trip-travel cost interaction (DDAY * TC2PPTH)
DSUB1	Binary substitute variable (1=would travel to alternative site, 0=no alternative site)
YRKEYS	Number of years experience visiting the Florida Keys/Key West
DTRIP	Average number of days per trip
DTIME	Binary variable (1=income forgone by taking trip, 0=no income forgone)
AGEH	Age of person interviewed divided by ten.
AGESQ	Age of person interviewed squared in hundreds of years.
INC	Household income (in 10,000 of $)
INCSQ	Household income (in 10,000 of $) squared
α	Overdispersion parameter. A significant parameter indicates the presence of overdispersion and that the negative binomial is the preferred model.
NTRIPS	The annual number of person-trips to the Florida Keys/Key West for natural resource based activities (uncorrected).

cially true for the winter season sample. Appendix 1 reports the details of how NTRIPS was constructed.

Travel Costs. TC2PPTH is the travel cost per person-trip scaled in hundreds of dollars. [4] We call this the marginal mileage cost because we only assign a portion of the total mileage costs to trips where the Keys was not the primary destination of the trip. We also differentiated between modes of travel used in calculating travel costs. Mileage costs were equal to $0.14/mile for those that used auto mode only and $0.30/mile for those that used multiple modes. These per mile costs were calculated using information obtained from an expenditure mail back survey from the Auto, Air & Cruise Ship Survey component of the project (See Leeworthy and Wiley, 1996a). Appendix 1 details how the travel cost variables were constructed. An important point here is that travel costs and trips were constructed to be internally consistent and thus yield proper measurements for estimating the relationships between the annual number of person-trips and the travel cost per person-trip.

Time costs. The inclusion of time costs, both in-transit and on-site is subject to considerable debate. Theoretically, Freeman (1993) demonstrates that both kinds of time costs should be included. However, he points out a number of problems which continue to plague applied researchers. One is the inability of a large portion of the population to easily substitute between working increased hours at their normal (or overtime) wage rate and leisure time. Another is the possibility of utility or disutility resulting from work, travel, or on-site time, hence rendering the full wage rate a potentially poor measure of the shadow cost of time. He points out that while most surveys elicit a pretax income measure, a more realistic wage rate would be derived from after tax income. McConnell (1992) states that judgments about time and the cost of time have been dominated by theoretical considerations rather than empirical results and that a measure of the cost of time may be considered “good” when it yields an “appropriate” measure of consumer’s surplus. Interestingly, overall about 85 percent of those surveyed reported that they lost no opportunity to earn income during their visit(s) to the Keys. Hence, we chose to avoid the common but arbitrary practice of factoring a percentage of the household wage rate into mileage costs opting instead for a binary variable (DTIME) to indicate the group for which income was forgone to partake of the trip. We also constructed an interaction variable between DTIME and TC2PPTH. Neither variable was statistically significant in any model specifications.

Length of trip. It is important in travel cost modeling to control for the length of trip. Trips to the Florida Keys/Key West are characterized by a wide range of trip lengths. Again, there are significant differences between the length of trips during the summer and winter seasons. DTRIP is the average number of days per trip calculated as the annual number of trips to the Keys divided by the annual number of days in the Keys. This is different from the length of the trip on which the interview took place but not significantly different. Summer season visitors average trip length was 4.9 days, while winter season trips were on average 7.6 days. We also constructed a binary variable for single day trips since these trips might be significantly different (DDAY). We also constructed an interaction variable between DDAY and TC2PPTH (INTDAY). Both DDAY and INTDAY were statistically significant in the winter season model but were not statistically significant in the summer season model.

Substitution. As discussed in the previous section of this report, ignoring substitution can lead to biases. We include a binary variable (DSUB1) which indicates whether the visitor would travel to an alternative site. We also constructed an interaction term (DSUB1 * TC2PPTH) but this term was not statistically significant in any specifications of the models.

Race/Ethnicity. For race/ethnicity, we originally constructed separate binary variables for each racial/ ethnic classification. However, only the binary variable for Hispanics (HISPANIC) entered any of the models as statistically significant. We also constructed an interaction term between HISPANIC and TC2PPTH (HISPINT). HISPANIC was statistically significant in both season models, but HISPINT was only significant in the summer season model. This is an important finding and will be discussed further below.

Other Socioeconomic Factors. Age, household income, and years of experience visiting the Keys were also included in the travel cost models. Age and household income were included along with their squared values. This yields parabolic relationships between the number of trips and each of these variables. However, we found exactly opposite relationships for the summer and winter season models. This will be discussed further below. It is important to note that these variables have been scaled down. This is necessary when estimating count data models that have difficult time reaching convergence in maximum likelihood estimation.

Also, the original household income variable was obtained in the survey using income categories or ranges of income and many visitors did not provide their income. We estimated household income for those that did not provide income with household income models and converted the values to a continuous variable using the mid point of each interval. The details for this can be found in Appendix 4.

Results. Truncated Poisson and truncated negative binomial (TNB) models were estimated. [5] Only the TNB models are reported because the hypothesis of no over dispersion was rejected based on a Wald test equivalent to the asymptotic t-ratio on the estimated dispersion parameter, α (Yen & Adamowicz, 1993). Table 3 summarizes the results for the summer season model and Table 4 summarizes the results for the winter season model. All variables included in both models were statistically significant with high levels of confidence as expressed in the column labeled, P[|z| ≥z]. This column contains the significance level for the test of whether the estimated coefficient is significantly different from zero. A value

Table 3. Travel Cost Demand Model: Natural Resource Based Trips, June - Nov. 1995

Variable (X)	Coefficient (b)	Standard Error (s.e.)	z=b/s.e.	P[|z| >=z]	Mean X
Constant	1.457700	0.2150100	6.780	0.00000	1.0000
TC2PPTH	-0.125840	0.0089661	-14.035	0.00000	2.4170
HISPINT	-0.348920	0.0706860	-4.936	0.00000	0.0896
HISPANIC	1.516800	0.1410400	10.754	0.00000	0.1393
DSUB1	-0.528870	0.1000500	-5.286	0.00000	0.2108
YRKEYS	0.043377	0.0037677	11.513	0.00000	11.0500
DTRIP	-0.052022	0.0037986	-13.695	0.00000	4.9140
AGEH	-0.477380	0.0962590	-4.959	0.00000	3.9400
AGESQ	0.045937	0.0140180	3.277	0.00105	16.8900
INC	0.129450	0.0349040	3.709	0.00021	6.0300
INCSQ	-0.005515	0.0016542	-3.334	0.00086	51.4600
α	5.341700	0.9305100	5.741	0.00000	

NTRIPS (mean) 9.531100
Log likelihood function -4291.697
Restricted log likelihood -15881.04
χ^2 23178.69
Degrees of freedom 1
Significance level 0.0000
N=1608

Table 4. Travel Cost Demand Model: Natural Resource Based Trips, Dec. '95 - May '96

Variable (X)	Coefficient (β)	Standard Error (s.e.)	z=b/s.e.	P[|z| >=z]	Mean X
Constant	-1.868900	0.3242300	-5.764	0.00000	1.000
TC2PPTH	-0.167510	0.0108620	-15.422	0.00000	2.601
INTDAY	-0.106390	0.0539390	-1.972	0.04856	0.084
DDAY	0.917130	0.1010600	9.075	0.00000	0.076
DSUB1	-0.521880	0.0547040	-9.540	0.00000	0.430
YRKEYS	0.048495	0.0025115	19.310	0.00000	9.290
DTRIP	-0.007492	0.0031228	-2.399	0.01643	7.604
HISPANIC	1.201500	0.1602100	7.500	0.00000	0.050
AGEH	1.158100	0.1506700	7.686	0.00000	4.349
AGESQ	-0.135980	0.0171170	-7.944	0.00000	20.960
INC	-0.055615	0.0199510	-2.788	0.00531	6.512
INCSQ	0.002734	0.0009947	2.749	0.00599	61.390
α	3.312800	0.4564100	7.258	0.00000	

NTRIPS (mean) 4.2662
Log likelihood function -4528.41
Restricted log likelihood -10041.70
χ^2 11026.58
Degrees of freedom 1
Significance level 0.0000
N=2427

of 0.05 would indicate significance at the 5 percent level or that we are confident at the 95 percent level. The lowest significance across both models was for INTDAY in the winter season at 0.04856 significance or about the 95 percent confidence level. So these are considered to be strong results. Below we discuss the interpretation of these results.

Table 5. Price Elasticities from the Travel Cost Demand Models

Season/Group	Price Elasticities [1] At Sample Mean Travel Cost [2]	At Group Mean Travel Cost [3]
June - Nov. 1995		
Hispanics	-1.15	-0.31
All Others	-0.30	-0.34
Dec. '95 - May '96		
Day Trippers	-0.71	-0.30
All Others	-0.44	-0.46

1. Price elasticities are calculated using the formula B_{tc} * TC, where B_{tc} is the coeffcient ont the travel cost variable (TC2PPTH) and TC is the travel cost (TC2PPTH). Elasticities vary with the level of travel cost. For Hispanics, B_{tc} is equal to the coefficient on TC2PPTH plus the coefficient on HISPINT. For Day trippers, B_{tc} is equal to the coefficient on TC2PPTH plus the coefficient on INTDAY.
2. For June - Nov. 1995, the overall sample mean for TC2PPTH was $2.417. For Dec. '95 - May '96, the overall sample mean for TC2PPTH was $2.60.
3. For June- Nov. 1995, the sample mean for TC2PPTH for Hispanics was $0.643 and was $2.704 for All Other Visitors. For Dec. '95 - May '96, the sample mean for TC2PPTH for Day trippers was $1.101 and was $2.724 for All Other Visitors.

Price Elasticities. The coefficient on TC2PPTH is negative indicating a downward sloping demand curve as presented in section one of this report. The price elasticity of demand measures how the demand for trips change with changes in prices, holding all other factors constant. Specifically, price elasticities measure the percentage change in the number of trips for a percentage change in price.

For the summer season, we were able to identify significantly different price elasticities for Hispanics, while for the winter season there were significantly different price elasticities for visitors on single day trips. Table 5 summarizes the results for both seasons. The footnotes in Table 5 describe how price elasticities are calculated using the estimated coefficients in Tables 3 and 4 and the mean travel costs. The results indicate that, during the summer season, Hispanic visitors are more sensitive to price changes than all other visitors. At the overall sample mean travel cost, demand for trips is elastic. For a 10 percent increase in price, Hispanics would reduce their number of trips by 11.5 percent. This represents a more than proportional reduction in trips for a given change in price. During the summer, the price elasticity of demand for all other visitors was only -0.30, meaning that for a 10 percent increase in prices all other visitors would reduce their number of trips by only 3.0 percent. We say that this is an inelastic price response or a less than proportional response. However, in the model specification estimated, price elasticities are variable and depend on the level of prices, that is, price elasticities vary with the level of price. Using separate group means for travel cost, Hispanics have inelastic demands. At the group mean travel cost for Hispanics ($0.643 in hundreds of dollars or $64.30), the price elasticity is only -0.31. Thus, for a 10 percent increase in the average cost to Hispanics at the current level of costs to Hispanics, they would reduce their trips only 3.1 percent. For all other visitors at their mean travel cost, a ten percent increase in prices would result in a 3.4 percent reduction in the number of trips. Using separate group means reduces the differences in price responses between Hispanic and all other visitors. However, an important point is that if prices that Hispanics experience were to rise to the overall sample mean levels, Hispanics would reduce their trips to the Florida Keys by a much higher percentage than other visitors.

During the winter season, we did not find a significant difference in the price elasticity of demand for Hispanics (HISPINT was not statistically significant). However, we did find that visitors on day trips did have significantly different price elasticities. Although day-visitors had more highly elastic demands than all other visitors, day visitor demands are still inelastic. At the overall sample mean, for a ten percent increase in prices, visitors on day trips would reduce their number of trips by 7.1 percent, but at their group mean travel cost would only reduce their trips by 3.0 percent. All other visitors would reduce their trips 4.4 percent for a 10 percent increase in travel costs at the overall sample mean travel cost and 4.6 percent for a 10 percent increase in costs at the group mean travel cost. Generally, winter season visitors are more sensitive to price increases than summer season visitors.

The importance of price elasticities for businesses has to do with projecting total sales revenues in response to different prices. Inelastic demands mean that, for price increases, total revenue will increase. That is, the increase in prices will more than offset the decrease in demand. However, for decreases in price, total revenue will decrease because demand will not increase enough to offset the decrease in price. Except for Hispanics during the summer season at sample mean levels of price, demand appears to be price inelastic for the Florida Keys/Key West.

Relationship between Age and Trips. The estimated relationships between age and the number of trips were parabolic for both seasons but with opposite relationships by season. For the summer season, the number of trips first decreases with increasing age, reaching a minimum at age 52, then increases with increases in age beyond age 52 (see Table 6 and Figure 6). For the winter season, the number of trips first increases with age, reaching a maximum at age 43, then decreases with increases in age beyond age 43 (see Table 6 and Figure 7).

Relationship between Household Income and Trips. The estimated relationships between household income and the number of trips were also parabolic for both seasons and were also characterized by opposite relationships by season. For the summer season, number of trips first increases with increases in household income, reaches a maximum at $117,368, then decreases with increases in income beyond $117,368 (see Table 7 and Figure 8). For the winter season, number of trips first decrease with increases in household income, reaches a minimum at $101,714, then increases with income beyond $101,714 (see Table 7 and Figure 9).

Relationship between Race/Ethnicity and Trips. Above we discussed the difference price responsiveness for Hispanics during the summer season. Hispanics also, on average, take more trips than all other visitors during both the summer and winter seasons. Hispanics are, however, a much smaller proportion of total visitors during the winter season. During the summer season, Hispanic visitors make, on average, 14.46 more trips than all other visitors, holding other factors constant. During the winter season, Hispanic visitors make, on average, 5.12 more trips than all other visitors, holding other factors constant.

Table 6. Relationship between Trips (Visits) and Visitor Age (holding other factors at sample means)

June - Nov. 1995		Dec. '95 - May '96	
Trips	Age	Trips	Age
15.1	16	2.2	16
11.6	25	3.7	25
9.5	35	5.2	35
8.5	45	**5.6**	**43**
8.3	**52**	5.5	45
9.0	65	3.7	60
9.7	70	2.8	65
11.9	80	2.0	70
16.2	90	0.8	80

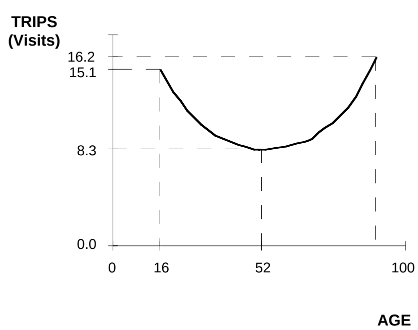


Figure 6. Trips by Age: June - Nov. 1995

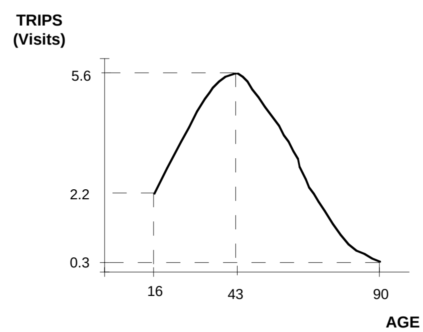


Figure 7. Trips by Age: Dec. '95 - May '96

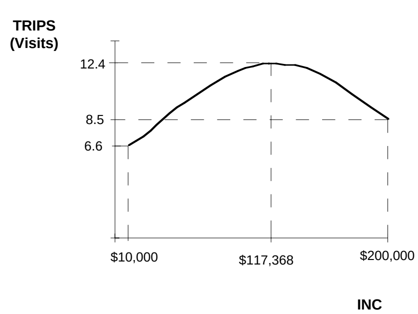


Figure 8. Trips by Income: June - Nov. 1995

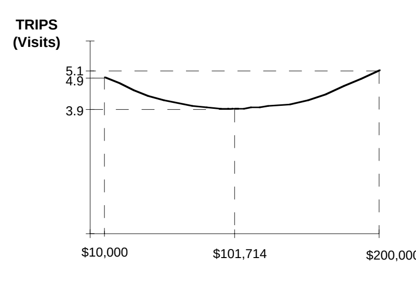


Figure 9. Trips by Income: Dec. '95 - May '96

Table 7. Relationship between Trips (Visits) and Household Income (holding all other factors at sample means)

June - Nov. 1995		Dec. '95 - May '96	
Trips	Household Income	Trips	Household Income
6.6	$10,000	4.9	$10,000
7.3	$20,000	4.7	$20,000
8.1	$30,000	4.5	$30,000
8.9	$40,000	4.3	$40,000
9.6	$50,000	4.2	$50,000
10.3	$60,000	4.1	$60,000
10.9	$70,000	4.0	$70,000
11.5	$80,000	3.95	$80,000
11.9	$90,000	3.92	$90,000
12.2	$100,000	3.91	$100,000
12.4	**$117,368**	**3.9**	**$101,714**
11.7	$150,000	4.2	$150,000
8.5	$200,000	5.1	$200,000

Relationship between Other Factors and Trips. The marginal effects are reported here. Marginal effects are the changes in the number of trips for a one unit change in a factor. Marginal effects are calculated as the mean number of NTRIPS times the estimated coefficient on a selected factor. For the summer season, increases in the average length of trip by one day results in a reduction in the number of trips of 0.50 trips. For the winter season, increases in the average length of trip by one day results in a reduction in the number of trips by 0.03 trips. During the winter season, day trip visitors make, on average, 3.9 more trips than all other visitors. For those that have substitute sites (DSUB1=1) the results were different by season. During the summer, those with substitute sites take, on average, 5.0 less trips than those that do not have substitute sites. During the winter season, those with substitute sites take, on average, only about 2.23 less trips than those that do not have substitute sites. The relationship between years of experience visiting the Keys and number of trips was significantly different between seasons. During the summer season, a one year increase in experience results in about 0.41 more trips. During the winter season, the estimate is 0.21.

Annual User Values

From the estimated travel cost models, we can estimate the per person-trip nonmarket economic user values. The formula is simply $1/\beta_{tc}$ or one divided by the absolute value of the estimated travel cost coefficient[6]. To obtain estimates of total annual user values, we multiply the estimated per person-trip values by the total number of person-trips made to the Florida Keys/Key West by those on trips where they participated in natural resource-based activities. These calculations were made by season then added across seasons to get an annual total.

User Values Per Person-trip. As discussed in the previous section on estimated price elasticities, we found different price responsiveness for Hispanics during the summer season and visitors on day trips, during the winter season. The differences in estimated price coefficients also has implications for estimated user values as well. According to the formula above, the higher the absolute value of the travel cost coefficient, the lower the per person-trip use value. During the summer season, Hispanics had an estimated per person-trip use value of $201.30 versus $790.61 for all other visitors. The weighted average per person-trip value for all visitors, during the summer, was $740.52. During the winter season, those on day trips had a per person-trip value of $289.16 versus $594.47, with a weighted average for all visitors of $561.19. The summer season per person-trip values were significantly higher than the winter season values. This is true even though trips are of significantly longer length during the winter. Part of this difference is probably due to the greater share of activity in water related activities during the summer, especially snorkeling and scuba diving. The overall weighted annual average for per person-trip user values was $653.94. Table 8 summarizes these results[7].

Annual User Values. Table 1 of this report contains the estimated total number of person-trips to the Florida Keys/Key West made by those that participated in natural resource-based activities. Table 8 provides a breakdown of these estimates by group and season so we can calculate total annual user values using our estimates of per person-trip values by group and season. Table 8 shows that summer season visits were worth almost $706 million, while winter season visits were worth about $499 million for a total annual value of about $1.2 billion.

Total Market and Nonmarket Value. Referring back to our simple conceptual model linking the economy and environment, the

Table 8. Annual User Values: Natural Resource Based Trips

June - November 1995

Group	User Value Per Person-trip ($)	Person-trips	Annual User Value ($)
Hispanics	$201.30	81,001	$16,305,501
All Others	$790.61	871,955	$689,376,343
Total	$740.52	952,956	$705,681,844

Dec. '95 - May '96

Group	User Value Per Person-trip ($)	Person-trips	Annual User Value ($)
Day trippers	$289.16	96,972	$28,040,424
All Others	$594.47	792,679	$471,223,885
Total	$561.19	889,651	$499,264,309

June '95 - May '96

Group	User Value Per Person-trip ($)	Person-trips	Annual User Value ($)
All Natural Resource	$653.94	1,842,607	$1,204,946,153

Table 9. Activity Based Annual User Values: Natural Resource Based Trips, June - Nov. 1995

Activity	Person-days (Thousands)	% of Days	Annual User Value (Millions $)
All Snorkeling	1,261.0	17.26	121.801
All Scuba Diving	408.8	5.59	39.448
All Fishing	1,055.1	14.44	101.900
Personal Watercraft Use	238.0	3.26	23.005
Sailing	80.6	1.10	7.763
Other Boating	190.6	2.61	18.418
Viewing Nature & Wildlife	1,031.8	14.12	99.642
All Beach Activities	1,321.9	18.09	127.658
Windsurfing	8.0	0.10	0.706
Natural Resource-based sub-total	**5,595.8**	**76.57**	**540.341**
Swimming in Outdoor Pools	1,169.7	16.01	112.980
Visiting Historic Areas	369.5	5.06	35.708
Visiting Museums	172.5	2.36	16.654
Non Natural Resource-based sub-total	**1,711.7**	**23.43**	**165.341**
Total	**7,307.5**	**100.00**	**705.682**

Table 10. Activity Based Annual User Values: Natural Resource Based Trips, Dec. '95 - May '96

Activity	Person-days (Thousands)	% of Days	Annual User Value (Millions $)
All Snorkeling	441.5	6.81	34.000
All Scuba Diving	126.0	1.94	9.686
All Fishing	894.7	13.80	68.898
Personal Watercraft Use	140.4	2.17	10.834
Sailing	137.1	2.12	10.584
Other Boating	70.1	1.08	5.392
Viewing Nature & Wildlife	1,613.4	24.89	124.267
All Beach Activities	1,366.7	21.09	105.295
Windsurfing	16.4	0.25	1.248
Natural Resource-based sub-total	**4,806.3**	**74.15**	**370.204**
Swimming in Outdoor Pools	1,056.1	16.30	81.380
Visiting Historic Areas	409.3	6.31	31.504
Visiting Museums	209.8	3.24	16.176
Non Natural Resource-based sub-total	**1,675.2**	**25.85**	**129.060**
Total	**6,481.5**	**100.00**	**499.264**

estimated annual nonmarket economic use value of $1.2 billion would be added to the market economic values estimated at about $1.33 billion for Monroe County or $2.94 billion for all of South Florida to obtain total market and nonmarket economic use values. The total would be about $2.5 billion if we count only the market output in Monroe County and over $4.1 billion if we count the total market output to South Florida (Broward, Dade, and Monroe Counties). Details on the market economic values were reported in English et al. (1996). However it is important to note that only the nonmarket economic value portion of total economic value is appropriate to use in benefit-cost analyses.

Activity-based Values. Traditionally, values for outdoor recreation have been reported on an activity basis. As was discussed earlier and presented in Appendix 1 of this report, trips to the Florida Keys are typically characterized by visitors participating in multiple activities. It is also true that not all the estimated value of even natural resource-based trips is attributable to the natural resources of the area. Therefore, we have provided a break-down of the annual value by activity for each season. We call this a first approximation set of estimates because the estimates are based only on the distribution of activity days, that is, the total user value for a season is apportioned to different activities according to the percent distribution of person-days across activities. The reason that this will only be considered a first order approximation is that it results in a constant per person-day value across activities. Thus, a snorkeling person-day has the same value, for a given season, as a scuba diving day, a fishing day, etc. Total values differ for an activity simply on the basis of the relative amount of days visitors

Table 11. Activity Based Annual User Values: Natural Resource Based Trips, June 1995 - May 1996

Activity	Person-days (Thousands)	Annual User Value (Millions $)	Percent
All Snorkeling	1,702.5	155.801	12.93
All Scuba Diving	534.8	49.134	4.08
All Fishing	1,949.8	170.798	14.17
Personal Watercraft Use	378.4	33.839	2.81
Sailing	217.7	18.347	1.52
Other Boating	260.7	23.810	1.98
Viewing Nature & Wildlife	2,645.2	223.909	18.58
All Beach Activities	2,688.6	232.953	19.33
Windsurfing	24.4	1.954	0.16
Natural Resource-based sub-total	**10,402.1**	**910.545**	**75.57**
Swimming in Outdoor Pools	2,225.8	194.360	16.13
Visiting Historic Areas	778.8	67.211	5.58
Visiting Museums	382.3	32.830	2.72
Non Natural Resource-based sub-total	**3,386.9**	**294.401**	**24.43**
Total	**13,789.0**	**1204.946**	**100.00**

spent doing those activities. Table 9 shows these calculations for the summer season, Table 10 for the winter season, and Table 11 provides an annual total by adding the values derived in Tables 9 and 10.

Natural resource-based activity values are estimated to account for about 77 percent of the summer season values and 74 percent of the winter season values with a weighted annual average of about 76 percent. The natural resource-based component of total annual value was estimated at over $910 million. The constant per person-day values were about $97 for the summer and about $77 for the winter, with a weighted annual average of about $87.

Asset Value of the Resources

The annual user values estimated and presented above are flows of benefits for a particular period of time attributable to the areas assets. The natural resource-based component of the value would be attributed to the asset represented by the environment and abundance & diversity of the natural resources of the area. The value of an asset is defined as follows:

$$V = \frac{R_0}{(1+n)^{t0}} + \frac{R_1}{(1+n)^{t1}} + \ldots + \frac{R_k}{(1+n)^{tk}}$$

where,

V = value of the asset
R = return to the asset
n = discount rate
k = number of time periods
t = time periods (years)
0, 1, 2, . . ., k

If the return, R, flows for a large number of periods ($k \rightarrow \infty$), then the formula above can be simplified where the returns are constant into the future (R1 = R2 = Rk) to the following:

$$V = \frac{R}{n}$$

Table 12 includes the asset values calculated using the above formula under alternative discount rates. A range of real discount rates (not including inflation since the returns or annual user values are not increased by projected inflation rates) from 3 to 5 percent is used. The total asset values for natural resource-based trips ranged from $24.1 billion to $40.2 billion. Including only the natural resource-based activity portion of total trip value yields a range of asset values of $18.2 billion to $30.4 billion. The asset value of the resources represent the price one would be willing to pay today based on the flow of annual user values the resource would generate into perpetuity (the indefinite future). Indeed the resources of the Florida Keys/Key West would appear to be of extremely high value even under the conservative assumptions used here.

Uses of Nonmarket Economic Values

Nonmarket use values now have a long tradition of uses in benefit-cost analyses for public projects that either benefit or have adverse impacts on natural resources. Nonmarket values are now widely used in natural resource damage assessment cases. The most widely known case in recent times was the oil spill in Alaska by the Exxon Valdez. Exxon settled out of court for $2.5 billion and this

Table 12. Asset Value of Natural Resources (Billions $)[1,2]

	Value at Various Discount Rates 3%	4%	5%
Natural resource-based component only	$30.4	$22.8	$18.2
Non Natural resource-based component	$9.8	$7.4	$5.9
Total natural resource-based trips	$40.2	$30.2	$24.1

1. Asset value is calculated using conservative assumptions. First, the number of person-trips and person-days are assumed to remain constant in the future. Second, the real value (adjusted for inflation) per person-trip or per person-day is also assumed to remain constant in the future. Finally, the appropriate discount rate (interest rate adjusted for inflation) ranges between 3 to 5 percent.
2. The formula for calculating the asset value is the annual user value divided by the discount rate. This yields an estimate of the net present value of an annual series of constant values into perpetuity.

was an amount less than the nonmarket value losses estimated. Nonmarket user values found in Leeworthy (1991) have been used in several damage assessment cases brought against owners of vessels that have grounded on and damaged the coral reefs in the Florida Keys. Millions of dollars have been recovered and are being used to help restore the corals in the area.

Uses of Nonmarket Economic Values

- Natural Resource Damage Assessment
- Restoration of Natural Resources
- Public Investment in facilities and land acquisition
- Public Investment in environmental protection
- Investments in education and enforcement efforts
- Green Accounting

But damage assessments and restoration focus on events that have happened in the past. Sustainable development also focuses on past events to the extent they can increase the natural stock of capital (e.g restoration and redevelopment projects). We expect that the greatest benefits will be had in applying the results in evaluations of the many public projects that will be required to fully implement the FKNMS Management Plan and the Monroe County Comprehensive Plan and Land Development Regulations (Florida Department of Community Affairs, 1996). Below we attempt to simply put into perspective the estimated costs for implementing the Monroe County Five Year Work Program. We do this by simply comparing the projected five year costs with the annual user values and the corresponding asset values of the natural resources the investments proposed are designed to protect.

The Monroe County Five Year Plan calls for the development of a water quality plan (Table 13). The total costs for these items range from $251 million to $283 million. The report goes on to mention full implementation of all aspects of the water quality plans could push costs to as high as $500 million.

The above costs do not include annual operating costs. On the other side, the large up-front investment costs would be expected to have some useful life (usually 20 to 30 years). But even if we accept the $500 million estimate, it still pales in comparison to the estimated $1.2 billion in nonmarket user values for one year. Even if we only count the natural resource-based activity component of $910 million per year, the $500 million seems reasonable. So just one years worth of annual user values exceed the five-year investment in wastewater and stormwater protection efforts.

If we compared the $500 million investment with the asset values of the natural resources they are designed to protect, the $500 million would only be about 2.7 percent of the natural resource-based component of the asset value at the 5 percent discount rate and only 1.6 percent of the natural resource-based component of the asset value at the 3 percent discount rate. Referring back to our discussion in the beginning of this report on the role of technology in sustainable development, we showed how both market and nonmarket economic values would increase with investments in environmental protection. The above comparisons were made assuming constant nonmarket values. If the investments in water quality protection succeed, then this would expand the market increasing the sustainable level of use and the market and nonmarket economic values making this investment seem even more favorable.

Limitations

As with most studies there are many limitations. Even though we explain the definitions of all types of nonmarket economic values, in this study, we were only able to estimate the nonmarket economic user values related to tourist/recreational uses of the natural resources of the Florida Keys/Key West. Nonmarket values such as

Table 13. Monroe County Five-Year Water Quality Plan

	Estimated Cost (millions $)
1. Preparation of a wastewater master plan	$1
2. Preparation of a stormwater master plan	$0.5
3. An environmental carrying capacity study	$1
4. Design and construction of the Marathon Wastewater Facility	$58
5. Cesspit identification and elimination	$25.7 - $48
6. Implementation of the Stormwater Master Plan	$40
7. Implementation of Wastewater Master Plan	$125 - $135
Total	$251.2 - $283

Source: An Economic Impact Statement under Chapter 120.54, F.A.C. for Rule Establishing F.A.C. 28-20, Part II: Amendment to the Monroe County Proposed Rule 28-20.1000. March 27, 1996. Florida Department of Community Affairs, Tallahassee, Florida.

"economic rents" to producers and nonuse or "passive use" values were not estimated as part of this project. These values may be very important components of the total economic value of the area's natural resources, but they must be left for future research. We were also not able to estimate relationships between environmental quality or the abundance & diversity of natural resources and tourist recreational uses in order to estimate the "marginal benefits" of investments to improve or protect the environment. We cannot answer the question "What are the benefits to recreating visitors of investments that reduce nutrient loads by either 10, 20, 50 or even 100 percent ? We can however estimate the total value of the resources that are negatively impacted by nutrients and place this against the total cost of protection efforts. This would not be a legitimate comparison in a formal benefit-cost analysis, but would allow decision-makers to formulate benchmarks for deciding the level of investment. For example, would it be reasonable to spend an amount equal to 3 percent of the total value of the resource if the investments reduced nutrients 50 percent ? Other studies and other experiences might be drawn upon to aid in this decision making. What we have provided is simply one piece, albeit an important piece, of the puzzle.

The travel cost models that we presented are only a small sub-set of what was estimated. The models incorporate many judgments. Instead of presenting many different models incorporating many different modeling choices and judgments, we chose to present what ,in our judgment, were the best results based on our own extensive experience and the latest findings in our scientific journals. We have carefully documented each of the modeling choices and judgments made and have made the data and documentation available to other researchers. Rather than a limitation, we believe this to be a strength of our work.

A major limitation to all economic valuation work is our inability to forecast very far beyond current baselines. When calculating the asset value of the resources, the formula used required the assumption that the total annual user value in real terms (net of inflation) and the real discount rate (interest rate net of inflation) were constant into perpetuity. We called these conservative assumptions (i.e., assumptions that would produce the smallest values). Assuming that the quality of the resources of the area do not decline and increased use does not result in negative reactions because of crowding, we would predict that the demand for trips (visits) to the Florida Keys will increase in the future, and because of increasing scarcity of good recreation opportunities in the future (i.e., that demand will increase relative to total supply) nonmarket economic user values per person-trip will also increase. The combination of both would mean increases in the total annual user value in future years versus our assumption of constant annual value. This is simply a limitation of economic science and a limitation that will not likely be overcome by future research.

Endnotes

1. Zero truncation occurs in the CUSTOMER Survey because only visitors to the Florida Keys/Key West are included in the sample, that is, those that did not visit the area are excluded. Endogenous stratification might occur because those that make multiple trips to the Florida Keys/Key West might have a higher probability of being selected for an interview. In the CUSTOMER Survey, visitors on longer trips, and who were not leaving the Florida Keys at the time of the interview, have a higher probability of sample selection. This would offset the endogenous stratification based on the number of trips. Because of these offsetting effects, it is not clear that endogenous stratification bias exists in the CUSTOMER Survey sample so only the truncation problem is addressed in the statistical methods employed here.

2. People cannot take fractions of a trip. It is possible to make from 0 to 366 trips per year (1996 was a leap year and contained 366 days). Count data models like the poisson and negative binomial models employ maximum likelihood statistical methods to integer-based distribution.

3. A variety of models including continuous models based on linear, semi-log, lin-log and log-log functional forms were estimated. Details of these models can be obtained from the author on request.

4. Two different travel cost variables were constructed from the survey information. Construction of both of these variables is detailed in Appendix 1. There was little difference in the model results between using the different travel cost variables.

5. Models were estimated using LIMDEP Version 7 econometric software.

6. Although estimates of β_{tc} are unbiased in estimating demand and price elasticities, they are not unbiased in estimating consumer's surplus (See Bockstael and Strand, 1987 and Zellner and Park, 1979). We multiply our estimates by the correlation factor of $1/(1+(t)^{-2})$, where t is the t-value on the travel cost coefficient (TC2PPTH). For price interaction terms, HISPINT and INTDAY, we multiply both the correction factor for (TC2PPTH) and the correction factor for the interaction terms.

7. 90 percent confidence intervals were estimated for the per person-trip user values. Variances were calculated via the delta method (Yen and Adamowicz, 1993). For the summer season, the 90 percent confidence interval for Hispanics was \$82.08 - \$320.51 and for all other visitors was \$697.66 - \$883.55. For the winter season, the 90 percent confidence interval for day trip visitors was \$-327.51 - \$905.81 and for all other visitors \$530.87 - \$658.07. The 90 percent confidence intervals were quite large for Hispanics and especially day trip visitors. For Hispanics, the estimated values were still significantly lower than for all other visitors (i.e. the 90 percent confidence intervals do not overlap). For day trip visitors in the winter, the confidence interval is extremely wide, including the value of zero and overlaps with the confidence interval of all other visitors. Although the day trip visitor value is less reliable, we use it in calculating total annual user value since we do expect day trip visitors to have lower values.

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Appendix

Appendix 1

Transformations of the Number of Trips
and
Travel Costs Consistent with this Transformation

The number of annual trips to the Florida Keys for the majority of visitors in both seasons are bunched around one trip per year. This bunching-up around one trip presents econometric problems. The continuous trips models produce extremely inelastic demand functions, while the count data models, especially the truncated negative binomial model, fails to converge or reach the function minimum.

In addition to the above problem, travel costs are defined as round-trip mileage times a cost per mile. The share of this cost attributable to the randomly selected person for the interview (person 16 years or older) is a straight forward calculation when combined with information on the number of people the person interviewed was paying for on the trip or the number of people he or she was sharing expenses. Travel cost per person per trip is the total travel cost per trip divided by either the number of people the person interviewed was paying for or the number of people that were sharing expenses. However, the number of trips this travel cost is related to is more complicated.

For purposes of illustration, assume a family of three are traveling together. The family makes two trips per year to the Florida Keys. The travel cost per person per trip is simply the total travel cost per trip divided by three. The number of trips taken at this travel cost per trip, measured in person-trips, is not two, but two times three, or six person-trips. For a group that is sharing expenses, say a group of three friends that are sharing the costs, the travel cost is the total travel cost per trip divided by three, but the number of person-trips associated with this cost is simply the number of trips taken by the randomly selected person for the interview, not the number of people in the groups times the number of annual trips.

The dependent variable transformed in the manner described above is NTRIPS. The corresponding travel cost variables are TC1PPTH and TC2PPTH. Both travel cost variables have been scaled to hundreds of dollars to resolve convergence problems in the count data models, thus the suffix “H”. The suffix “PPT” stands for per person per trip. TC1 is based on the total round-trip mileage from the respondents home to the interview site. For those that visited multiple sites and for which the Keys was not the primary destination of the trip, only the mileage from a temporary residence or the distance the Keys interview site was from the respondents primary destination was used. We call this the marginal mileage and TC2 is the marginal round-trip mileage times the costs per mile.

Mileage and Travel Cost Calculations

Method of Calculating Mileage: PC Program Prophesy Plus was used to calculate highway mileage from zip code to zip code. We obtained the zip code of the survey respondents home as well as the interview site. For foreign visitors and air or multiple mode travelers we followed steps detailed below.

Version 1. Separate Auto, Air, and Boat mileage for multiple mode travelers. Variable name HMILES1.

Auto Mode Only: From home to interview site using Prophesy Plus zip code to zip code.

All Air Mode: From home to closest airport. Road miles using Prophesy Plus (HAIRPORT). From home airport to destination airport. Straight line distance airport to airport (AIRMILES). From destination airport to interview site using Prophesy Plus (DAIRPORT).

Boat Mode Only: From home to interview site using auto mileage from Prophesy zip code to zip code.

Cruise Ship: From home to Key West using auto mileage from Prophesy zip code to zip code.

Version 2. Multiple Destination Trips - Variable (HMILES2)

Here we gathered information on whether the person was on a multiple destination trip and if so, how many days or hours they planned to spend at destinations other than the Florida Keys. We also asked if the Florida Keys was their primary destination and if not, the distance to their primary destination. We also asked if they traveled from a temporary residence outside the Florida Keys and if so, the distance from the temporary residence to the interview site.

This information allowed us to impose several rules for deciding the proportion of mileage on the trip attributed to the Florida Keys. Below is the logic employed in creating variable HMILES2.

If Fl Keys PRIMARY DESTINATION, then HMILES2=HMILES1 above.

If Fl Keys NOT PRIMARY DESTINATION, and traveled from a temporary residence outside the Keys, then HMILES2=miles from the temporary residence (TEMPMI).

If Fl Keys NOT PRIMARY DESTINATION, and NO temporary residence then HMILES2= HMILES1 * (DAYS/(DAYS + DYVISIT))

where, DAYS = length of stay in Florida Keys measured in days and
DYVISIT = days on the trip at other destinations

Calculation of Cost Per Mile

We could have used AAA estimates as have been done in other studies. However, we had access to our own separate survey using the expenditure mail back survey from the Auto, Air and Cruise Ship Survey documented in Leeworthy (1996) and Leeworthy and Wiley (1996a). Mileage was done a little differently from this sample since we did not have the details on the trip itinerary nor all the details on multiple mode use. For auto visitors, we used Prophesy Plus the distance from their home zip code to Key Largo (where they were intercepted) plus the mileage to the mid-point to the furthest region south they visited. For air visitors (Marathon and Key West airports), we used the same procedures described above for air miles and road miles from their home to the airport. For foreign visitors, we assumed they all flew to Miami and drove from there.

Travel Costs Per Mile included the following elements:

Rental Auto (Q14A)
Gas and Oil - auto/RV (Q15A)
Repair and service - auto/RV (Q16A)
Parking fees and tolls (Q17A)
Taxi fare (Q18A)

Airline fares
a) package tours (Q21A)
b) any other airline fare (Q22A)

Bus Fare
a) package tour (Q19A)
b) any other bus fare (Q20A)

Travel Cost Per Mile = (Q14A+Q15A+Q16A+Q17A+Q18A+Q19A+Q20A+Q21A+Q22A)/(Hmiles2 * 2)

We then estimate these costs for two groups. We first eliminate all cruise ship passengers since they are generally not in the CUSTOMER Survey samples. The first group includes those that had airfares. Their average costs per mile were 29.85 cents. The second group includes those with no airfares (auto use only). Their average costs were 14.32 cents per mile. We rounded the estimates to $0.14/mile and $0.30/mile, respectively and then calculated travel costs using the following logic statements. Basically what was done was to assign those that used multiple modes of travel the $0.30/mile and those that used only the auto mode $0.14/mile.

```
If AIRMILES GT 0 then TC1=(HMILES1*2*.30);
IF AIRMILES EQ 0 THEN TC1=(HMILES1*2*.14);
IF (HMILES2 LT HMILES1) AND TEMPMI GT 0 THEN TC2=(HMILES2*2*.14);
IF (HMILES2 LT HMILES1) AND TEMPMI=. AND AIRMILES GT 0 THEN TC2=(HMILES2*2*.30);
IF (HMILES2 LT HMILES1) AND TEMPMI=. AND AIRMILES=0 THEN TC2=(HMILES2*2*.14);
IF (HMILES2 EQ HMILES1) AND AIRMILES GT 0 THEN TC2=(HMILES2*2*.30);
IF (HMILES2 EQ HMILES1) AND AIRMILES EQ 0 THEN TC2=(HMILES2*2*.14);
```

These last two statements put the travel costs on a per person-trip basis and scaled them to hundreds of dollars to avoid convergence problems with the count data models.

```
TC1PPTH=(TC1/PEOPLE2)/100;
TC2PPTH=(TC2/PEOPLE2)/100;
```

Appendix 2. Matrices of Multiple Activity Participation

Attached are two matrices that summarize the extent of Multiple activity participation from the summer and winter CUSTOMER samples. The matrices include raw scores, that is, no weighting has been employed. There were 1,781 observations for the summer sample and 2,809 for the winter sample. Aggregate activities have been formed that eliminate double-counting. Thirteen (13) activities are reported in the attached two matrices.

SNORK

100 A	Snorkeling from charter/party boat (pay operation)
101 A	Snorkeling from Rental boat
102 A	Snorkeling from private boat
10 A	Snorkeling from shore

SCUBA

200 A	Scuba diving from charter/party boat (pay operation)
201 A	Scuba diving from rental boat
202 A	Scuba diving from private boat
11 A	Scuba diving from shore

FISH

400 A	Fishing from charter boat (pay operation six persons or less) - offshore
401 A	Fishing from party or head boat (charge per person) - off shore
402 A	Fishing from rental boat - offshore
403 A	Fishing from private boat - offshore
404 A	Fishing from Charter/party boat (pay operation) - flats or back country
405 A	Fishing from rental boat - flats or back country
406 A	Fishing from private boat - flats or back country
407 A	Other fishing from charter boat (pay operation six persons or less)
408 A	Other Fishing from party or head boat (charge per person)
409 A	Other fishing from rental boat
410 A	Other fishing from private boat
14 A	Fishing from shore (beach, bank, pier, bridge, jetty, dock)

BNATURE

500 A	Glass bottom boat rides (pay operation)
501 A	Back country boating excursions (pay operation/guided service/NOT FISHING)
502 A	Viewing nature and wildlife from private or rental boat

LNATURE

19 A	Wildlife observation or wildlife photography
20 A	Other nature study and observation

Appendix 2. Matrices of Multiple Activity Participation (cont.)

BEACH

15 A	Swimming at Beaches (not in pool)
44 A	All Beach Activities (other than swimming)

PWCRAFT

600 A	Personal watercraft - rental
601 A	Personal watercraft - private

SAIL

700 A	Sailing charter/party boat (pay operation)
701 A	Sailing rental boat
702 A	Sailing private boat

BOATOTH

800 A	Other activities from charter/party (pay operation)
801 A	Other activities from rental boat
802 A	Other activities from private boat

This includes activities such as water skiing, parasailing, banana boat rides, canoeing, kayaking not included in any of the other activities above.

ATTRACT

29 A	Visiting historic areas, sites, buildings or memorials
30	Attending special events (fairs, festivals, ceremonies, etc.)
31	Attending outdoor concerts, plays or other outdoor performances
32	Attending indoor concerts, plays, performances or events
33	Sight-seeing tours and tourist attractions (paid)
34	Sight-seeing (not paid tours)
35	Reading roadside exhibits or markers
36 A	Visiting a museum, educational facility or information center
37	Attending outdoor sports events (sailing or boat races; spectator at fishing tournament)

CAMP

23	Camping in developed campgrounds
24	Camping in primitive campgrounds

OUTSPORT

38	Golf
39	Tennis outdoors
40	Participation in other outdoor sports and games

ACT16A

16 A	Swimming in Outdoor pool

How to Interpret Activity Matrices

The matrices are each 13 by 13 activity matrices. They were formed by running cross-tabulations between each of the activities.

The upper left-hand corner has the total sample size for the season (1,781 for the summer and 2,809 for the winter). Reading across the top line over each variable name are the number of people in the sample that participated in the activity. The first column, on the left, repeats the variable names and the number of participants, but also includes the percent of the entire sample that participated in the activity. Thus, 712 people out of the 2,809 sampled in the winter season participated in Snorkeling (25.35 percent of the sample).

The matrices are 13 by 13 matrices and thus the diagonal values would all be equal to 100 percent. This matrix would also be symmetrical with respect to the information contained in the cells above the diagonal. There are three values in each cell above the diagonal. The top value is the number in the sample that participated in both activities. For example, during the winter season, 82 of the 2,809 sampled participated in snorkeling and scuba diving. The second number in the cell is read from left to right. Using our same example, 11.52 percent of all those sampled that did snorkeling also did scuba diving (82 divided by 712). Reading further across the SNORK row, we find that 34.41 percent of those that participated in snorkeling also participated in fishing. The third number in each cell is the percent of the entire sample that did both activities. Again using our same example, 2.92 percent of the entire sample did both snorkeling and scuba diving (82 divided by 2,809).

The values below the diagonal correspond to the second value in the cells above the diagonal. Reading the bottom row (left to right) 32.23 percent of those that participated in swimming in an outdoor pool also participated in snorkeling. 8.24 percent of those that participated in swimming in an outdoor pool also participated in scuba diving.

The attached activity matrices show that trips to the Florida Keys are a complex mix of activities.

Appendix 2. Matrices of Multiple Activity Participation (cont.)

Summer CUSTOMER Florida Keys

1,781	942 SNORK	326 SCUBA	623 FISH	395 BNATURE	153 LNATURE	906 BEACH	181 PWCRAFT	69 SAIL	119 BOATOTH	882 ATTRACT	290 CAMP	101 OUTSPORT	501 ACT16A
52.89 SNORK 942		213 22.61 11.96	366 38.85 20.55	255 27.07 14.32	107 11.36 6.01	525 55.73 29.48	121 12.85 6.79	51 5.41 2.86	78 8.28 4.38	475 50.42 26.67	218 23.14 12.24	58 6.16 3.26	296 31.42 16.62
18.30 SCUBA 326	65.34		123 37.73 6.91	75 23.01 4.21	28 8.59 1.57	108 33.13 6.06	43 13.19 2.41	10 3.07 0.56	28 8.59 1.57	137 42.02 7.69	72 22.09 4.04	13 3.99 0.73	95 29.14 5.33
34.98 FISH 623	58.75	19.74		142 22.79 7.97	59 4.47 3.31	311 49.92 7.46	61 9.79 3.43	19 3.05 1.07	43 6.90 2.41	228 36.60 12.80	165 26.48 9.26	39 6.26 2.19	163 26.16 9.15
22.18 BNATURE 395	64.56	18.99	35.95		83 21.01 4.66	230 58.23 12.91	65 16.46 3.65	26 6.58 1.46	45 11.39 2.53	239 60.51 13.42	75 18.99 4.21	27 6.84 1.52	128 32.41 7.19
8.59 LNATURE 153	69.93	18.30	38.56	54.25		102 66.67 5.73	15 9.8 0.84	10 6.54 0.56	6 3.92 0.34	91 59.48 5.11	33 21.57 1.85	7 4.58 0.39	44 28.76 2.47
50.87 BEACH 906	57.95	11.92	34.33	25.39	11.26		101 11.15 5.67	49 5.41 2.75	75 8.28 4.21	534 58.94 29.98	187 20.64 10.5	80 8.83 4.49	333 36.75 18.7
10.16 PWCRAFT 181	66.85	23.76	33.7	35.91	8.29	55.80		18 9.94 1.01	32 17.68 1.80	90 49.72 5.05	27 14.92 1.52	17 9.39 0.95	65 35.91 3.65
3.87 SAIL 69	73.91	14.49	27.54	37.68	14.49	71.01	26.09		13 18.84 0.73	51 73.91 2.86	8 11.59 0.45	7 10.14 0.39	23 33.33 1.29
6.68 BOATOTH 119	65.55	23.53	36.13	37.82	5.04	63.03	26.89	10.92		69 57.98 3.87	14 11.76 0.79	10 8.40 0.56	53 44.54 2.98
49.52 ATTRACT 882	53.85	15.53	25.85	27.10	10.32	60.54	10.2	5.78	7.82		156 17.69 8.76	69 7.82 3.87	308 34.92 17.29
16.28 CAMP 290	75.17	24.83	56.90	25.86	11.38	64.48	9.31	2.76	4.83	53.79		11 3.79 0.62	53 18.28 2.98
5.67 OUTSPORT 101	57.43	12.87	38.61	26.73	6.93	79.21	16.83	6.93	9.90	68.32	10.89		51 50.50 2.86
28.13 ACT16A 501	59.08	18.96	32.53	25.55	8.78	66.47	12.97	4.59	28.13	61.48	10.58	10.18	

Winter CUSTOMER Florida Keys

2,809	712 SNORK	210 SCUBA	810 FISH	574 BNATURE	250 LNATURE	1,502 BEACH	179 PWCRAFT	128 SAIL	121 BOATOTH	1,970 ATTRACT	730 CAMP	199 OUTSPORT	692 ACT16A
25.35 SNORK 712		82 11.52 2.92	245 34.41 8.72	188 26.40 6.69	73 10.25 2.60	476 66.85 16.95	75 10.53 2.67	62 8.71 2.21	51 7.16 1.82	457 64.19 16.27	245 34.41 8.72	64 8.99 2.28	223 31.32 7.94
7.48 SCUBA 210	39.05		44 20.95 1.57	32 15.24 1.14	11 5.24 0.39	79 37.62 2.81	23 10.95 0.82	10 4.76 0.36	12 5.71 0.43	89 42.38 3.17	33 15.71 1.17	11 5.24 0.39	57 27.14 2.03
28.84 FISH 810	30.25	5.43		177 21.85 6.30	74 9.14 2.63	395 48.77 14.06	49 6.05 1.74	32 3.95 1.14	43 5.31 1.53	464 57.28 16.52	267 32.96 9.51	74 9.14 2.63	194 23.95 6.91
20.43 BNATURE 574	32.75	5.57	30.84		76 13.24 2.71	315 54.88 11.21	57 9.93 2.03	35 6.10 1.25	45 7.84 1.60	421 73.34 14.99	153 26.66 5.45	51 8.89 1.82	151 26.31 5.38
8.90 LNATURE 250	29.20	4.40	29.60	30.40		144 57.60 5.13	14 5.60 0.50	9 3.60 0.32	13 5.20 0.46	176 70.40 6.27	102 40.80 3.63	16 6.40 0.57	48 19.20 1.71
53.47 BEACH 1,502	31.69	5.26	26.30	20.97	9.59		113 7.52 4.02	78 5.19 2.78	66 4.39 2.35	1,119 74.50 39.84	481 32.02 17.12	137 9.12 4.88	489 32.56 17.41
6.39 PWCRAFT 179	41.90	12.85	27.37	31.84	7.82	63.13		13 7.26 0.46	24 13.41 0.85	119 66.48 4.24	59 32.96 2.10	18 10.06 0.64	61 34.08 2.17
4.56 SAIL 128	48.44	7.81	25.00	27.34	7.03	60.94	10.16		14 10.94 0.50	93 72.66 3.31	38 29.69 1.35	17 13.28 0.61	51 39.84 1.82
4.31 BOATOTH 121	42.15	9.92	35.54	37.19	10.74	54.55	19.83	11.57		80 66.12 2.85	25 20.66 0.89	8 6.61 0.28	32 26.45 1.14
70.13 ATTRACT 1,970	23.20	4.52	23.55	21.37	8.93	56.80	6.04	4.72	4.06		498 25.28 17.73	164 8.32 5.84	525 26.65 18.69
25.99 CAMP 730	33.56	4.52	36.58	20.96	13.97	65.89	8.08	5.21	3.42	68.22		69 9.45 2.46	189 25.89 6.73
7.08 OUTSPORT 199	32.16	5.53	37.19	25.63	8.04	68.84	9.05	8.54	4.02	82.41	34.67		86 43.22 3.06
24.64 ACT16A 692	32.23	8.24	28.03	21.82	6.94	70.66	8.82	7.37	4.62	75.87	27.31	12.43	

Appendix 3. Derivation of Person-trips, Person-days, and Activity Person-days for Natual Resource-based Visitors

December 1995 - May 1996

	Participation Rates (%)				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	7.56	6.45	2.54	12.77	26.48
Visiting Historic Areas	5.29	3.49	2.27	22.05	31.19
Visiting Museums	3.59	3.11	0.89	13.77	19.94
Natual Resource Based	-	-	-	-	65.01

	Person-trips				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	67,258	57,382	22,597	113,608	235,580
Visiting Historic Areas	47,063	31,049	20,195	196,168	277,482
Visiting Museums	31,938	27,668	7,918	122,505	177,396
Natual Resource Based	-	-	-	-	889,651

	Average Days Per Person-trip				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	6.97	2.75	5.18	2.75	-
Visiting Historic Areas	1.51	1.10	1.36	1.41	-
Visiting Museums	1.22	1.05	1.04	1.09	-

	Total Person-days				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	468,788	157,800	117,052	312,422	1,056,062
Visiting Historic Areas	71,065	34,154	27,465	276,597	409,281
Visiting Museums	38,964	29,051	8,235	133,530	209,780
Non-natual Resource Based	578,817	221,005	152,752	722,599	1,675,723

June - November 1995

	Participation Rates (%)				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	9.44	7.95	1.39	13.21	29.64
Visiting Historic Areas	2.98	3.03	1.73	15.22	22.41
Visiting Museums	2.44	2.11	1.10	8.20	13.14
Natual Resource Based	-	-	-	-	81.31

	Person-trips				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	89,959	75,760	13,246	125,885	282,456
Visiting Historic Areas	28,398	28,875	16,486	145,040	213,557
Visiting Museums	23,252	20,107	10,483	78,142	125,218
Natual Resource Based	-	-	-	-	952,956

	Average Days Per Person-trip				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	2.27	7.37	2.13	3.01	-
Visiting Historic Areas	1.35	1.64	1.64	1.77	-
Visiting Museums	1.10	1.48	1.71	1.27	-

	Total Person-days				
Activity	Upper Keys	Middle Keys	Lower Keys	Key West	Total
Swimming in Outdoor Pools	204,207	558,351	28,214	378,914	1,169,686
Visiting Historic Areas	38,337	47,355	27,037	256,721	369,450
Visiting Museums	25,577	29,758	17,926	99,240	172,501
Non-natual Resource Based	268,121	635,464	73,177	734,875	1,711,637

Appendix 4: Creation of the Continuous Household income Variable

Predicted Income

Because a significant proportion of visitors did not answer the household income question, before creating a continuous variable for income, household income was predicted for those with missing values. This was done by modeling household income as a function of age, household type, race/ethnicity, education, employment status, sex, and whether a visitor was a foreign or domestic visitor. Separate models were estimated for the summer (Table A.4.1) and winter (Table A.4.2) seasons. The models were estimated using the demographics files. These files contain, as separate observations, each person in each recreation group. The models were estimated using only those individuals age 16 or older, thus corresponding to the same population that was selected as respondents in the CUSTOMER Survey.

The Poisson model was chosen to predict household income because variable HHINCOME is in discrete categories 1-15. The sample mean and variance are very close lending further support for the use of the Poisson model. LIMDEP Version 7 was used to estimate the models. As with most project results, there were significant differences between the summer and winter season samples. AGESQ was not significant and DOMESTIC was positive, whereas AGESQ was negative and significant and DOMESTIC was negative and significant in the winter model. The signs on AGE and AGESQ are consistent with the life-cycle hypothesis where household income first increases with age, reaches an maximum, then declines in the retirement years. SEX was not significant in either season, nor was whether employment status was homemaker (HOMEMAK), so these variables were dropped from the models.

The estimated Poisson models were then used to predict household income for respondents to the CUSTOMER Survey that did not answer household income. The equations predict the household income category (1-15). Actually, the predictions take on values between categories, so they must be assigned to the closest category.

Once the household income categories were assigned, the continuous version of household income was created. This was done in the usual way by assigning a value equal to the mid-point of the income category interval. For the category 15, greater than $150,000, the value of $200,000 was assigned. The created continuous variables were then scaled to $10,000 dollars in order to avoid convergence problems when estimating the travel cost demand models with the negative binomial model.

Below we include the SAS program for the summer season data which defines the variables used in the income prediction models and documents how the above described transformations were done.

```
LIBNAME SUM ‘F:\KEYS\LF\SUM’;
OPTIONS PS=54 LS=72;
DATA SUM.LFSUM21;SET SUM.LFSUM20;
IF HHDESCRI=1 THEN SINGNC=1;ELSE SINGNC=0;IF HHDESCRI=. THEN SINGNC=.;
IF HHDESCRI=2 THEN SINGC=1;ELSE SINGC=0;IF HHDESCRI=. THEN SINGC=.;
IF HHDESCRI=3 THEN TWOADNC=1;ELSE TWOADNC=0;IF HHDESCRI=. THEN TWOADNC=.;
IF HHDESCRI=4 THEN TWOADC=1;ELSE TWOADC=0;IF HHDESCRI=. THEN TWOADC=.;
IF HHDESCRI=5 THEN MTWOADNC=1;ELSE MTWOADNC=0;IF HHDESCRI=. THEN MTWOADNC=.;
IF HHDESCRI=6 THEN MTWOADC=1;ELSE MTWOADC=0;IF HHDESCRI=. THEN MTWOADC=.;
IF EMPIN1=1 THEN UNEMP=1;ELSE UNEMP=0;IF EMPIN1=. THEN UNEMP=.;
IF EMPIN1=2 THEN FULLTIME=1;ELSE FULLTIME=0;IF EMPIN1=. THEN FULLTIME=.;
IF EMPIN1=3 THEN PARTTIME=1;ELSE PARTTIME=0;IF EMPIN1=. THEN PARTTIME=.;
IF EMPIN1=4 THEN RETIRED=1;ELSE RETIRED=0;IF EMPIN1=. THEN RETIRED=.;
IF EMPIN1=5 THEN STUDENT=1;ELSE STUDENT=0;IF EMPIN1=. THEN STUDENT=.;
IF EMPIN1=6 THEN HOMEMAK=1;ELSE HOMEMAK=0;IF EMPIN1=. THEN HOMEMAK=.;
IF EMPIN1=7 THEN EMPNONE=1;ELSE EMPNONE=0;IF EMPIN1=. THEN EMPNONE=.;
IF RACEIN1=1 OR RACEIN1=2 THEN INDASIAN=1;ELSE INDASIAN=0;
IF RACEIN1=. THEN INDASIAN=.;
IF RACEIN1=3 THEN BLACK=1;ELSE BLACK=0;
IF RACEIN1=. THEN BLACK=.;
```

```
IF RACEIN1=4 THEN HISPANIC=1;ELSE HISPANIC=0;
IF RACEIN1=. THEN HISPANIC=.;
IF RACEIN1=5 THEN WHITE=1;ELSE WHITE=0;
IF RACEIN1=. THEN WHITE=.;
IF RACEIN1=6 THEN OTHRRACE=1;ELSE OTHRRACE=0;
IF RACEIN1=. THEN OTHRRACE=.;
IF SEXIN1=1 THEN MALE=1;ELSE MALE=0;
IF SEXIN1=. THEN MALE=.;
IF COUNTRY=1 THEN DOMESTIC=1;ELSE DOMESTIC=0;
AGESQ=AGEIN1**2;
IF HHINCOME LT 1 THEN
PREDINC=1.5545 + .0041626 * AGEIN1 + .062476 * EDUCIN1 - .18658 * HISPANIC
 - .24346 * BLACK + .15914 * SINGC + .34038 * TWOADNC + .39354 * TWOADC
 + .24051 * MTWOADNC + .28578 * MTWOADC
 - .10999 * UNEMP - .11185 * RETIRED + .055323 * STUDENT
 + .04199 * DOMESTIC;
IF HHINCOME GE 1 THEN PREDINC=.;
IF HHINCOME LT 1 AND PREDINC GT 0 THEN PREDINC2=EXP(PREDINC);
ELSE PREDINC2=.;
IF PREDINC2 GT 0 AND (PREDINC2 GE 0 AND PREDINC2 LE 1.5)
 THEN PREDINC3=1;
IF PREDINC2 GT 0 AND (PREDINC2 GT 1.5 AND PREDINC2 LE 2.5)
 THEN PREDINC3=2;
IF PREDINC2 GT 0 AND (PREDINC2 GT 2.5 AND PREDINC2 LE 3.5)
 THEN PREDINC3=3;
IF PREDINC2 GT 0 AND (PREDINC2 GT 3.5 AND PREDINC2 LE 4.5)
 THEN PREDINC3=4;
IF PREDINC2 GT 0 AND (PREDINC2 GT 4.5 AND PREDINC2 LE 5.5)
 THEN PREDINC3=5;
IF PREDINC2 GT 0 AND (PREDINC2 GT 5.5 AND PREDINC2 LE 6.5)
 THEN PREDINC3=6;
IF PREDINC2 GT 0 AND (PREDINC2 GT 6.5 AND PREDINC2 LE 7.5)
 THEN PREDINC3=7;
IF PREDINC2 GT 0 AND (PREDINC2 GT 7.5 AND PREDINC2 LE 8.5)
 THEN PREDINC3=8;
IF PREDINC2 GT 0 AND (PREDINC2 GT 8.5 AND PREDINC2 LE 9.5)
 THEN PREDINC3=9;
IF PREDINC2 GT 0 AND (PREDINC2 GT 9.5 AND PREDINC2 LE 10.5)
 THEN PREDINC3=10;
IF PREDINC2 GT 0 AND (PREDINC2 GT 10.5 AND PREDINC2 LE 11.5)
 THEN PREDINC3=11;
IF PREDINC2 GT 0 AND (PREDINC2 GT 11.5 AND PREDINC2 LE 12.5)
 THEN PREDINC3=12;
IF PREDINC2 GT 0 AND (PREDINC2 GT 12.5 AND PREDINC2 LE 13.5)
 THEN PREDINC3=13;
IF PREDINC2 GT 0 AND (PREDINC2 GT 13.5 AND PREDINC2 LE 14.5)
 THEN PREDINC3=14;
IF PREDINC2 GT 0 AND (PREDINC2 GT 14.5) THEN PREDINC3=15;
IF PREDINC2 LT 0 THEN PREDINC3=.;
IF HHINCOME GE 1 THEN HHINCOM2=HHINCOME;
ELSE HHINCOM2=PREDINC3;
IF HHINCOM2=1 THEN INC=.25;
IF HHINCOM2=2 THEN INC=.75;
IF HHINCOM2=3 THEN INC=1.25;
IF HHINCOM2=4 THEN INC=1.75;
IF HHINCOM2=5 THEN INC=2.25;
IF HHINCOM2=6 THEN INC=2.75;
```

```
IF HHINCOM2=7 THEN INC=3.25;
IF HHINCOM2=8 THEN INC=3.75;
IF HHINCOM2=9 THEN INC=4.25;
IF HHINCOM2=10 THEN INC=4.75;
IF HHINCOM2=11 THEN INC=5.5;
IF HHINCOM2=12 THEN INC=6.75;
IF HHINCOM2=13 THEN INC=8.75;
IF HHINCOM2=14 THEN INC=12.5;
IF HHINCOM2=15 THEN INC=20.0;
IF HHINCOM2 LT 1 THEN INC=.;
INCSQ=INC**2;
AGEH=AGEIN1/10;
AGESQH=AGESQ/100;
LABEL PREDINC2='PREDICTED HOUSEHOLD INCOME CATEGORY 1-15'
    PREDINC='LOG PREDICTED HOUSEHOLD INCOME CATEGORY'
    PREDINC3='PREDICTED HOUSEHOLD INCOME CATEGORY 1-15'
    HHINCOM2='HOUSEHOLD INCOME-PREDICTED MISSING 1-15'
    INC='HOUSEHOLD INCOME-PRED MISSING $10,000'
    INCSQ='HOUSEHOLD INCOME SQUARED-$10,000'
    AGESQ='AGE SQUARED'
    AGEH='AGE DIVIDED BY 10'
    AGESQH='AGESQ DIVIDED BY 100'
    HISPANIC='RACE/ETHNICITY HISPANIC'
    BLACK='RACE/ETHNICITY BLACK'
    INDASIAN='RACE/ETHNICITY INDIAN-ASIAN-PAC ISL'
    WHITE='RACE/ETHNICITY WHITE'
    OTHRRACE='RACE/ETHNICITY OTHER RACE'
    SINGNC='SINGLE ADULT NO CHILDREN'
    SINGC='SINGLE ADULT WITH CHILDREN'
    TWOADNC='TWO ADULTS NO CHILDREN'
    TWOADC='TWO ADULTS WITH CHILDREN'
    MTWOADNC='MORE THAN TWO ADULTS NO CHILDREN'
    MTWOADC='MORE THEN TWO ADULTS WITH CHILDREN'
    UNEMP='UNEMPLOYED'
    FULLTIME='EMPLOYED FULL TIME'
    PARTTIME='EMPLOYED PART TIME'
    RETIRED='EMPLOYMENT STATUS RETIRED'
    STUDENT='EMPLOYMENT STATUS STUDENT'
    HOMEMAK='EMPLOYMENT STATUS HOMEMAKER'
    EMPNONE='EMPLOYMENT STATUS NONE'
    MALE='SEX IS MALE'
    DOMESTIC='1=US RESIDENT 0=FOREIGN';
RUN;
TITLE 'SUMMER CUSTOMER';
TITLE2 'PREDICTED HOUSEHOLD INCOME FOR MISSING';
DATA TEMP1;SET SUM.LFSUM21;
IF PREDINC2 GT 0;
RUN;
PROC UNIVARIATE FREQ DATA=TEMP1;
VAR PREDINC PREDINC2 PREDINC3 HHINCOM2 INC;
RUN;
TITLE2 'ORIGINAL INCOME VERSUS THAT WITH PREDICTED';
PROC UNIVARIATE FREQ DATA=SUM.LFSUM21;
VAR HHINCOME HHINCOM2 INC;
RUN;
```

Appendix 4. Derivation of Continuous Household Income Variable (Continued).

Winter

Variable	Coefficient (β)	Standard Error	z=b/s.e.	P[|z|≥ z]	Mean of X
Contant	1.3412	0.052696	25.452	0.00000	1.000
EDUC	0.04853	0.0040274	12.05	0.00000	4.398
HISPANIC	-0.1959	0.021308	-9.193	0.00000	0.0612
BLACK	-0.12794	0.046521	-2.75	0.00596	0.0113
SINGC	0.19488	0.030779	6.331	0.00000	0.03773
TWOADNC	0.34599	0.018859	18.346	0.00000	0.4560
TWOADC	0.402853	0.019743	20.404	0.00000	0.2339
MTWOADNC	0.33172	0.02156	15.386	0.00000	0.1281
MTWOADC	0.34984	0.27759	12.603	0.00000	0.04434
UNEMP	-0.15246	0.050823	-3.000	0.00270	0.01002
RETIRED	-0.13868	0.017933	-7.734	0.00000	0.1473
STUDENT	-0.12901	0.024148	-5.343	0.00000	0.0744
DOMESTIC	-0.02723	0.014916	-1.826	0.06789	0.8992
AGE	0.020692	0.0021534	9.609	0.00000	42.44
AGESQ	-0.00018073	0.000023788	-7.597	0.00000	2018.0

HHINCOME (Mean) 10.3 S.D. 3.6
Log Likelihood Function -12429.36
Restricted log likelihood -13148.79
χ^2=1438.848
Degrees of Freedom 14
Significance level 0.00000
R^2-p=0.1535
R^2-d=0.2020
N=4,691

Summer

Variable	Coefficient (β)	Standard Error	z=b/s.e.	P[|z|≥ z]	Mean of X
Contant	1.5545	0.041104	37.819	0.00000	1.000
EDUC	0.062476	0.0049107	12.722	0.00000	4.176
HISPANIC	-0.18658	0.015986	-11.672	0.00000	0.1785
BLACK	-0.24346	0.048366	5.034	0.00000	0.01849
SINGC	0.15914	0.032601	4.881	0.00000	0.05820
TWOADNC	0.34038	0.022973	14.817	0.00000	0.2980
TWOADC	0.39354	0.022504	17.487	0.00000	0.3762
MTWOADNC	0.24051	0.029657	8.11	0.00000	0.07517
MTWOADC	0.28578	0.028205	10.132	0.00000	0.09306
UNEMP	-0.10999	0.046741	-2.353	0.01862	0.01728
RETIRED	-0.11185	0.029206	-3.829	0.00013	0.05123
STUDENT	0.555323	0.024054	2.3	0.02145	0.08002
DOMESTIC	0.04199	0.019647	2.137	0.03258	0.9112
AGE	0.0041626	0.00055119	7.552	0.00000	38.10

HHINCOME (Mean) 9.9 S.D. 3.4
Log Likelihood Function -8459.707
Restricted log likelihood -8946.233
χ^2=973.0523
Degrees of Freedom 13
Significance level 0.00000
R^2-p=0.1906

N=3,299