Applying Human Dimensions Information to Recreational Fisheries Management in the Gulf and Caribbean

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The growth in human dimensions of fisheries research over the past decade has resulted in a growing understanding of the impacts of recreational fisheries management regulations on the angling public. This paper examines the use of strategic choice modeling for analyzing regulatory alternative impacts on recreational angler behavior.

Strategic choice modeling employs an experimental design to manipulate and evaluate the independent effects of length, size, season, bag limits, and other factors on anglers decisions to fish and the number of trips taken. Since the choice modeling process is similar to the decision process of anglers, strategic modeling has the potential to provide reasonable assessments of impacts on angling behavior. Fisheries management applications of strategic choice modeling will be presented.

KEY WORDS: Modeling, Recreational Fisheries, Regulations

INTRODUCTION

expectations, and the acceptance of angling regulations. Management agencies recognize that some angling regulations can stimulate fishing effort while others may severely reduce it, and that a decline in fishing activity can have serious implications for license sales, agency revenues, public support and the important social and economic benefits provided by fisheries. This realization has led to a growing concern that regulatory alternatives be thoroughly evaluated in terms of their impacts on the fishery, anglers, and the recreational fishing industry prior to implementation. However, over the years little research has been conducted to determine what role regulatory changes and other factors have played in angling participation.

Despite recent growth in the human dimensions of fisheries research, to date neither basic nor applied fisheries research has contributed significantly to identifying the relationships among fisheries regulations and angling behavior. Only a few studies have attempted to analytically identify the essential attributes and services that account for angler's attitudes, preferences and satisfaction

(Graefe and Fedler, 1986). Few experimental studies have been conducted which identify the independent effects of regulations and other factors on angling behavior. In one of the few studies of this nature, Milon *et al.* (1994) examined the relationship between improvements in bag limits, size limits and catch rates, and angler willingness to pay for the improvements. Their study found that some anglers were willing to pay for incremental improvements, although nearly 70% of the survey respondents reported they would not pay for these improvements. Whether or not increased value translates into more trips taken is unknown. Further, this type of research does not address the effects of more restrictive regulations or reductions in catch rates on angler behavior.

Most applied angler behavior research contains little more than an aggregate analysis of angling frequency, attitudes toward regulations (support or non-support), or level of satisfaction with the current or recently completed fishing experience (e.g., Dewees *et al.*, 1988; Ditton et al., 1988; Loomis and Ditton, 1987; Wilde and Ditton, 1994; Riechers *et al.*, 1993). When truly behavioral issues are addressed, such as individual angler behavior and experiences during and satisfaction following a fishing trip, research has focused on the observation of actual (revealed) behavior. Researching revealed behavior is a legitimate procedure for monitoring the acceptance and success of existing policies and programs, and for detecting attitudinal changes. But one should be conscious of the fact that the subject's responses are based on a limited choice set that makes projections to new alternatives or policies difficult.

Fisheries managers, for example, often conclude that new regulation research is not possible because of the intangibility of the regulation. Thus, they tend to assess the impact of a regulatory change in one fishery based on similar changes in other fisheries, through hearing input, or through informal evaluation.

This pragmatic and conservative orientation to management is detrimental to the short- and long-term interests and needs of the angler, the recreational fishing industry and the management agency. Fishery managers need evidence that program changes under consideration will not unnecessarily reduce fishing activity levels, will be supported by anglers, and will minimally effect communities. Actions that result in significant negative changes in angling behavior can result in profound effects on local economies and engender animosity toward the agency by the fishing public and communities (Matlock *et al.*, 1987).

Data from typical attitude surveys are insufficient to determine angler responses to new or changed management programs and/or fishing regulations. The importance that anglers place on the attributes of different fishing sites and on different types of fishing will determine their support for or resistance to proposed changes. In other words, fishery managers need objective indications as to how the angling public might react to program and regulation changes deemed necessary to protect fishery resources while maintaining or enhancing the social and economic benefits of fishing. This can be a difficult goal for fisheries managers to achieve given the growing political involvement of fisheries user groups (Gale, 1992; Barber and Taylor, 1990). The challenge for fisheries managers then becomes one of anticipating the intended and unintended effects of their management actions before going "public" with the regulations in order to help avoid unnecessary controversy. The Matagorda Bay case discussed by Matlock *et al.* (1987), Ditton and Fedler (1988) and Payton and Gigliotti (1988) provides a good example of this need for better decision making information.

MODELING ANGLER BEHAVIOR

Little is known about the salient attributes of recreational fishing trips and how these are combined by the angler in trip decision making. This is particularly true with regard to the role regulations play in this decision process. Most previous studies have asked anglers about their support or non-support of various regulation alternatives. None of these studies have examined the potential impacts on angling behavior, such as whether or not the angler will continue to fish, change the frequency of fishing, target other species, or change fishing locations. Recent developments in the application of choice modeling techniques to natural resource management has resulted in the capability to evaluate the relationship of regulatory alternatives and other managerially relevant variables to angler behavior.

The Strategic Choice Model is built on the evaluation of several crucial attributes of the fishing experience in connection with each other, including the estimation of trade-offs between these attributes. The results of such an analysis can be readily adopted into a decision support system which permits managers to simulate the effects of certain changes in the management system on specific user groups. A brief overview of this methodology follows.

A fishing experience can be considered as a bundle of several tangible and intangible components. Tangible components consist of equipment, fishing site characteristics, access facilities, support facilities and services, and regulations while intangible components consist of fishing quality, social interaction, ambience of the environment, and remoteness among other factors. These elements combine to form a particular "fishing product" which anglers translate into fishing experiences. Before the experience can be enjoyed, the angler is faced with the task of selecting one "product" among many. In other words, the angler is faced with a multi-attribute decision-making task, which can be examined in the same manner as consumer choice behavior for other more traditional consumer products. An improved understanding of the preferences and choice behavior of angler groups is equally important for resource management, because this kind of information is a prerequisite to forecasting the likely impacts of policy decisions and regulations, and assessing the feasibility of implementation.

In preference and choice behavior research, two important distinctions need to be made:

i) research can be based either on revealed or stated preferences
ii) within stated preference research, a fundamental distinction exists between compositional and decompositional approaches (Timmermans, 1984). Revealed preference research infers preference from direct observation of behavior, the physical manifestation of choice. Stated preference research on the other hand relies on individuals to express preference or choice directly.

More sophisticated revealed preference models, such as the discrete choice model (McFadden, 1974; Ben Akiva and Lerman, 1985) estimate utility functions from observed choices. Theoretically, the discrete choice model can be linked to the theory of consumer behavior (Rosen, 1974) , according to which a product or service consists of a bundle of objective characteristics, and consumers choose that product or service which combines the maximum utility of all these characteristics. The discrete choice model adds that instead of the objective characteristics of these goods, it is the characteristics, as perceived by the consumer, which actually determine utility. Therefore, the discrete choice model reflects individual utility rather than aggregated demand (Hensher and Johnson, 1981). Further, products (choice alternatives) are discrete rather than continuous entities, and it is assumed that an individual will choose the alternative with the highest overall utility (Ben Akiva and Lerman, 1885).

A major criticism of discrete choice models is the difficulty associated with isolating the actual determinants of choice, especially if they relate to environmental or resource attributes. This is because explanatory variables are highly multicolinear, the researcher lacks perfect information about all alternatives, and/or there are different spatial combinations of alternatives (or competitors) in different destination areas (Louviere and Timmermans, 1990a). Furthermore, many other attributes are either unmeasurable, or will enormously inflate the number of parameters that need to be estimated.

Experimentally based stated preference methods can avoid or minimize many of these difficulties by designing data collection appropriately. Any type of experimental research which "...provides a quantitative measure of relative importance of one attraction as opposed to another... (has become known as) conjoint analysis" (Aaker and Day, 1986). It is useful to distinguish between the trade-off (compositional) approach and the full-profile (decompositional) approach to conjoint analysis (Timmermans, 1984) because each provides a different perspective on understanding behavior.

In the compositional approach it is assumed that individuals can directly express the importance of each attribute (factor) and the relative and absolute position of each attribute of each alternative. Such evaluation typically relies on questionnaire techniques where respondents rate or rank independently listed attributes. Then overall evaluations or preference scores are "composed" by the researcher who combines, according to some a priori assumed algebraic function, the measured importance weights and attribute positions of alternatives. The best known method of this family of approaches is the Fishbein and Ajzen (1975) model.

In the decompositional approach, instead of measuring weights of attributes separately, the preference for complete attribute profiles (scenarios) is measured. The construction of such profiles is based on the principles of multivariate statistical experiments, i.e., factorial or fractional factorial designs. Respondents evaluate the entire alternative (scenario) only. The resulting overall preference scores for such synthetically designed choice alternatives can be decomposed statistically into the weights and evaluations of attribute positions, given a priori specified combination rules (Louviere and Timmermans, 1990b). In this case, respondents typically evaluate alternatives in a ranking or rating procedure.

Thus, stated preference research makes inferences from behavioral antecedents (preferences) to actual choice behavior. New developments in behavioral research have made it possible to shorten this conceptual distance further by having respondents state a choice instead of a preference. This is the major accomplishment of the Strategic Choice Model (SCM).

The SCM combines the concepts of discrete choice modeling with the flexibility of experimental designs. In a first experimental design, scenarios are generated as described above. Then a second experimental design is used to combine these scenarios into choice sets, so that the respondent is forced to select between discrete, but hypothetical, alternatives (Louviere and Woodworth, 1983; Louviere, 1988; Louviere and Timmermans, 1990a). Thus an experimental setup analogous to the discrete choice model is designed and analysis can be based on a multinomial logit model (Ben Akiva and Lerman, 1985; Wrigley, 1985). The advantages of the Strategic Choice Model can be summed up as follows:

i) It allows the design of experiments in which a large number of salient attributes can be combined to describe a hypothetical scenario in which research subjects evaluate the alternative as a whole instead of rating attributes singly;
ii) It allows attributes to be uncorrelated, obviating the problem of multicolinearity often encountered in observational studies;
iii) It allows the researcher to control the alternatives and choice sets presented to the respondent;
iv) Truly different alternatives, some of which may not exist presently, can be designed and presented to the respondent for evaluation;

v) The intangibility of the angling experience makes recreational fishing particularly appealing to experimental research; it places the respondent in a situation very similar to that faced by an angler when selecting a fishing location.

THE EXPERIMENTAL DESIGN

The three major steps in the design process are as follows:

i) specification of attributes
ii) selection of a design plan for scenarios
iii) design of choice sets.

Attributes of the fishing experience are developed through reviewing the literature, consultation with angling organizations and anglers. An initial review of the angling literature suggests several categories of attributes are important components of fishing experience. For example, distance traveled to the fishing site, target species, regulations (size, harvest, season), catch expectations (size and quantity), social group, fishing mode (boat, shore, pier, etc.), and location, among other factors, have been identified as important factors contributing to fishing trip satisfaction (Graefe and Fedler, 1986). A panel of recreational fishing experts from academic institutions, fisheries management agencies, and angling organizations can also assist in identifying the saliency of each attribute and in determining the appropriate measurement levels for use in the study.

From this list of attributes, different hypothetical scenarios can be designed by selecting one particular level of each attribute and combining it with selected levels of each of the other attributes. Using a factorial design containing all possible combinations would result in several thousand scenarios, thus making a survey application completely unfeasible. By selecting an appropriate fractional factorial design, a much smaller number of scenarios are needed for the design of a survey instrument. This type of design still permits the estimation of main effects, and in most cases of selected two-way interactions. Orthogonal attribute designs can be constructed to describe species or area scenarios. Orthogonality implies that all the attributes in the design are uncorrelated with each other. This assumption can be tested prior to administration of the survey.

Additional choice sets can be constructed by the researcher in which most attributes will be favorable with only two or three variables being manipulated. The purpose of these scenarios is to observe the trade-offs respondents make between regulations and one or two selected other variables. For example, the relation between harvest limit and size, or slot size and harvest limit. These scenarios can be common to all questionnaires and used to test the reliability and consistency of responses.

MODELING RECREATIONAL FISHERIES

Adamowicz *et al*. (1994) provide the first application of choice modeling to recreational fisheries. They used a stated preference model to examine angler choices between lake and stream fishing in northern Alberta based on ten attributes which included terrain, fish size, catch rate, fish species, water quality, facilities, distance, swimming and beach opportunities, and type of water. Each attribute had from two to four levels. The final design consisted of 64 choice sets blocked into four sets of 16 choices and place into a mail survey format. The response format requested anglers to choose between lake and stream settings with attribute levels being manipulated in each choice set. While the study did not specifically examine angling regulations, the independent effects of catch rates, fish size, and species were estimated. Anglers were asked to make a choice among three alternatives based on the attribute level mix; fish at the lake, fish at the stream, or choose not to fish.

The results of this study (Adamowicz *et al*., 1994) indicated that larger fish (size), and higher catch rates were highly significant predictors of choice between lake and stream fishing areas. Species was also a significant factor in angler choice decisions. Choice sets which included mountain whitefish singly were less desirable than choices which included whitefish and rainbow trout; cutthroat trout, bull trout and whitefish; or rainbow trout, brown trout and whitefish. Clearly, these three variables were important determinants of angling choice. The independent effects of size, catch rates and species also indicate that anglers evaluate each of these attributes separately in the overall decision process.

Results of stated preference studies can be used to develop management decision support systems. Coefficients from these studies can be incorporated into simulation models to examine the effects of various management alternatives included in the choice sets. The following example illustrates the use of a simulation model for inshore species in Florida.

Red drum (*Sciaenops ocellata*), spotted seatrout (*Cynoscion nebulosus*), and snook (*Centropomus undecimalis*) are popular species recreational anglers pursue throughout the coastal areas of Florida. For this example, we will use six attributes which the literature supports as being salient to this type of fishing. These attributes and their measurement levels are shown in Table 1. A survey would be designed similar to that reported by Adamowicz *et al.* (1994) which varied attribute levels across scenarios for each species of fish.

Table 2 shows the base case which reflects existing management conditions and apportions fishing participation across the three species. The fourth column represents the choice of anglers to "not fish" for any of the three species, given the choice profiles, or fish for other species. In this example, the current case is the existing management condition.

Table 1. Recreational fishing experience attributes and measurement levels

Attribute	Measurement Levels		
Travel Time	Twice as Long	Same as Today	Half as Long
Boats	None	1-2 Boats	3-5 Boats
Size Regs.	Slot 18-28"	22" Minimum	28" Minimum
Limits	5 Fish	2 Fish	1 Fish
Expectations	Many	Average	Few
Size of Fish	Many Over Slot	Most in Slot Some Over	Mostly Below Slot Trophy Rare

When management conditions change, as shown in Table 3, the model can account for these changes and calculate changes in participation. In this example, the redfish bag limit is raised from one to two fish per day while the spotted seatrout bag limit is reduced from 10 to five fish per day. A corresponding decline in the expectations of anglers from catching many to a moderate number of seatrout is also included in the management scenario to be evaluated. The change from current conditions under the new managed conditions resulted in a 12% increase in fishing participation for redfish and a 14% decline in angling for seatrout. Even though snook regulations stayed the same, anglers would reduce their effort by about three percent. Anglers choosing to not fish or fish for other species would increase by five percent. The result of this simulation would clearly show that increasing the redfish bag limit by one fish, reducing the seatrout bag limit, and moderating catch expectations would have significant effects on angler effort. All these factors together would result in a five percent drop in overall angling participation.

Table 2. Base management case for species choice model

	Redfish	Seatrout	Snook	Would not Fish
Travel Time:	Same as Today	Same as Today	Same as Today	
Boats:	3-5 boats	3-5 boats	3-5 boats	
Size Regs:	18"-28" slot	12" min.	≥ 28"	
Limits:	1/day	10/day	1/day	
Expectations:	Many fish	Many fish	Few fish	
Size of Fish:	Most in slot 1-2 over	Many over Trophy rare	Most below Trophy rare	
Current:	40.20	30.30	22.50	7.00
Managed:	40.20	30.30	22.50	7.00
Change:	0.00%	0.00%	0.00%	0.00%

Models for single species can also be developed as shown in Table 4. In this case, testing the effects of differential regulations along the coast is the objective. Participation at the two locations has been equally weighted in order to test the effects of changing regulations. The management scenario in Table 5 reflects the anticipated response to reduced fish populations in the Area 2 of the Florida coast and improved redfish abundance in Area 1. The Area 1 bag limit for redfish is raised from one to three fish, while at Area 2 the one fish limit remaines but angler expectations and the size of fish are reduced.

Table 3. Regulation change for species choice model

	Redfish	Seatrout	Snook	Would not Fish
Travel Time:	Same as Today	Same as Today	Same as Today	↓
Boats:	3-5 boats	3-5 boats	3-5 boats	
Size Regs:	18"-28" slot	12" min.	≥ 28"	
Limits:	2/day	5/day	1/day	
Expectations:	Many fish	Moderate Fish	Few fish	
Size of Fish:	Most in slot 1-2 over	Most Small Some over	Most below Trophy rare	
Current:	40.20	30.30	22.50	7.00
Managed:	52.50	15.50	19.50	12.20
Change:	12.30%	-14.80%	-3.00%	5.20%

The increased bag at Area 1 and the reduced expectations and fish size in Area 2 resulted in the model predicting a 12% increase in redfish angling at Area 1 and a 22% reduction in fishing at Area 2. Anglers opting not to fish either of these locations or to fish elsewhere would increase by 10%.

These changes in fishing participation can be linked to community economics by calculating the change in angler trip expenditures. For example, if an economic impact study had been conducted which showed that anglers spent $500,000 annually in Area 2 communities on marine recreational fishing, then a reduction of twelve percent in fishing trips would result in a loss of $110,000 to the area. In small fishing-oriented communities this can be a very meaningful loss.

Table 4. Base management case for location choice: Redifsh

	Cedar Key	Steinhatchie	Would not Fish
Travel Time:	Same as Today	Same as Today	
Boats:	3-5 Boats	3-5 Boats	
Size Regs:	Slot 18-28	Slot 18-28	
Limits:	1	1	
Expectations:	Many	Many	
Size of Fish:	Most in slot 1-2 over	Most in slot 1-2 over	
Current:	48.22%	48.22%	3.55%
Managed:	48.22%	48.22%	3.55%
Change:	0.00%	0.00%	0.00%

Table 5. Regulation change for location choice: Redfish

	Cedar Key	Steinhatchie	Would not Fish
Travel Time:	Same as Today	Same as Today	
Boats:	3-5 Boats	3-5 Boats	
Size Regs:	Slot 18-28	Slot 18-28	
Limits:	3	1	
Expectations:	Many	Few	
Size of Fish:	Most in slot 1-2 over	Most in slot Mostly Small	
Current:	48.22	48.22	3.56
Managed:	60.85	25.45	13.70
Change:	12.63%	-22.77%	10.14%

SUMMARY

The examples above provide insights into the application of recreational fisheries modeling to management. Currently, such systems do not exist, however the application of strategic choice modeling to angler behavior will help overcome some of the impediments to assessing regulatory impacts. Current regulatory impact reviews often contain extensive information on the effects of regulations on the commercial fishing sector because economic models have been developed over the years. Impacts on the recreational sector have typically been little more than speculation. Developing a decision support system for recreational fisheries management will require the commitment of significant resources to develop the models. However, once the models are developed and compared to empirical cases, the benefits of their use could be extensive. Managers will have information to evaluate alternatives prior to the public hearing process and better anticipate the political, social, and economic impacts of their decisions.

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