

7-1993

## **An Economic Analysis of Waterfowl Hunting in Louisiana (Bulletin #841)**

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July 1993

No. 841

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# **An Economic Analysis of Waterfowl Hunting in Louisiana**

CHRISTOPHER EC GAN AND E. JANE LUZAR<sup>1</sup>

## **Introduction**

Waterfowl hunting in Louisiana has traditionally been an important use of Louisiana's extensive coastal and inland wetlands. Waterfowl-related activities generate millions of dollars for Louisiana's economy annually, with duck and goose hunting as one of the most significant sporting activities. However, recent declines in waterfowl populations have caused increasingly restrictive hunting regulations. This has recently been paralleled by a significant decline in the number of Louisiana waterfowl hunters (Louisiana Department of Wildlife and Fisheries, 1991).

Attempts to evaluate the economic value of waterfowl hunting are often complicated by the non-market characteristics of this outdoor recreation activity which are under-represented when considered within a conventional market framework. In addition, like many recreation activities, waterfowl hunting can be characterized as a multiattribute activity. For example, the decision to hunt waterfowl may be influenced by the composition of the hunting party, the constraints on bag limits, the number of days in the season, hunting site characteristics, or annual cost of waterfowl hunting. Economic information on the characteristics that influence the decision to hunt waterfowl can provide valuable information to resource managers faced with declining waterfowl populations as well as declining numbers of waterfowl hunters.

## **Objectives**

The general objective of this study is to provide an economic analysis of waterfowl hunting in Louisiana, focusing on the multiattribute nature of this outdoor recreation activity. Specific objectives of this study include a review of national and local trends in the status of waterfowl, and development of a socio-economic profile of a sample of Louisiana waterfowl hunters. In addition, this study employs and evaluates the appropriateness of a relatively new non-market valuation technique, conjoint analysis (CJA), for the valuation of hunting attributes influencing waterfowl hunting decisions.

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## **Trends and Status: U.S. Waterfowl and Waterfowl Hunting**

Migratory birds provide a basis for many consumptive and nonconsumptive recreational experiences, as these birds may be hunted, observed, or photographed. Unlike most consumer goods, migratory birds are a fugitive resource not priced in a market. As a result of this market failure, their value generally goes unmeasured. Another consequence of this market failure is that the value of wetlands used in supporting the birds also goes unmeasured.

Migratory waterfowl nest primarily in the northern areas of the North American continent in the summer and fly south in the fall and winter, with major wintering areas in the southern United States and Central America. The United States Fish and Wildlife Service, (USFWS, 1990) estimates that over 12 million ducks nest and breed annually in northern U.S. wetlands. This area, when combined with similar habitat regions in the Canadian prairies, accounts for over 60 percent of the continent's breeding duck population. Waterfowl banded in North Dakota have been recovered in 46 states, 10 Canadian provinces and territories, and 23 other countries. The prairie pothole farmlands of central and southern Alberta, Saskatchewan, and Manitoba, together with parts of the neighboring states of North Dakota, South Dakota, and Minnesota, provide the prime duck producing areas of the continent. The region comprises only 10 percent of the total continental breeding grounds, but produces about 55 percent of the total duck population in an average year (Hammack and Brown, Jr. 1974).

Some 2.5 million of the three million mallards in the Mississippi Flyway and nearly 100 percent of the nation's four million wood ducks spend the winter in flooded bottomland forests and marshlands throughout the South (USFWS, 1990). Mallards, wood ducks, blue-winged and green-winged teals, gadwalls, American wigeons, black ducks, pintails, and Canada geese are the most common waterfowl harvested by Mississippi and Atlantic flyways hunters (Soutiere, 1989).

In 1977, there were about 1.1 million adult waterfowl hunters in the 14 Mississippi and 17 Atlantic Flyway states. They recorded 9.4 million hunting days. A decade later, this number had decreased to about 800,000 adult waterfowl hunters (a 27 percent decrease) and a recorded 6.5 million hunting days (a 30 percent decrease), with an average of seven days per hunter (Soutiere, 1989). Soutiere suggests that the decrease in waterfowl hunting, especially goose hunting, signifies hunters' difficulty in gaining access to waterfowl hunting areas and congestion on hunting areas, particularly in the South. In addition, waterfowl hunters in Louisiana and throughout the nation are facing sharply shortened hunting seasons and bag limits due to a major decline in duck populations (Cockerham and Helm, 1985).

The wetlands upon which waterfowl depend throughout their life cycle for food, rest, nesting, and reproduction are disappearing at an increasing rate. Of the original 24.7 million acres of bottomland hardwood wetlands along the Mississippi River Deltaic Plain, only 30 percent remained unaltered in 1969 (Wesley, 1987). The annual loss of such wetlands has approached 200,070 acres per year (U.S. Department of Agriculture, 1971). Within North and South Dakota and Minnesota, which include the major breeding habitats in the U.S., 335,117 acres of prime wetlands were destroyed or lost in the 10-year period from 1964 to 1974 (Wesley, 1987). This

loss amounted to approximately 10 percent of the total area of such habitat that existed in these states.

## **Trends and Status: Louisiana Waterfowl and Waterfowl Hunting**

Historically, more than two-thirds of the Mississippi Flyway's waterfowl population and a fourth of North America's dabbling ducks have wintered in Louisiana wetlands. Louisiana has a diverse assortment of habitat types--more than any other state in the southeastern U.S. These habitats include bottomland hardwoods (5,497,000 acres), mixed pine hardwoods (2,207,000 acres), pine (5,095,000 acres), upland hardwoods (1,725,000 acres), and farmland (7,600,000 acres) which is composed of row crops, pasture, and rice. In addition, over 40 percent of the U.S. coastal marshes and a quarter of the nation's wetlands are found in Louisiana. This wetland habitat is considered to be one of the world's largest and most biologically productive wetlands (Louisiana Department of Wildlife and Fisheries, 1987).

Two types of wetlands most critical to waterfowl in Louisiana are the coastal marshes and the forested wetlands. While coastal marshes in Louisiana account for about 41 percent of the U.S. coastal marshes (excluding Alaska), they account for 96 percent of those within the Mississippi Flyway. The Louisiana coastal marshes cover approximately four million acres--over 50 percent of the marsh acreage along the Gulf and Atlantic coasts of the U.S. (Louisiana Department of Wildlife and Fisheries, 1987). These coastal marshes are an important wintering area for North America's ducks and geese. About 29 percent of these coastal marshes are freshwater marshes--the most productive habitat for waterfowl (USFWS, 1990). Brackish marshes (about 16 percent of the coastal marshes) are considered the second most productive marsh type for waterfowl.

Bellrose (1976) noted that Louisiana's coastal wetland supports over one-half of the continental mottled duck population, with fall populations of 75,000 to 120,000 birds. About three to five million waterfowl funnel into Louisiana's agricultural fields and coastal marshes every fall through the Central and Mississippi Flyways, two of the four major U.S. waterfowl routes. Louisiana coastal marshes and adjacent rice fields have supported 369,000 lesser snow geese and 55,000 white-fronted geese in recent years (Boesch, 1982). Forested wetlands also provide habitat for several duck species, including mallards and wood ducks, which account for over 25 percent of the statewide duck harvest (USFWS, 1990). Mallards, wood ducks, blue-winged and green-winged teals, wigeons, pintails, and Canada geese are some of the most common waterfowl harvested by Louisiana, Mississippi, and Atlantic Flyways hunters.

Waterfowl are considered an economically important natural resource in Louisiana. Recent national expenditure information provides some insight regarding the impact of waterfowl hunting on local communities. Waterfowl-related activities can generate millions of dollars for a state's economy, with duck and goose hunting one of the most significant sporting activities. These revenues benefit hotels, restaurants, gas stations, clothing merchants, recreational vehicle and equipment merchants, as well as other sectors of the economy. Based on data gathered by the U.S. Fish and Wildlife Service in a 1980 national survey, 33,774,000 hunter-days

and \$500 million was spent annually in pursuit of ducks and geese (USFWS and U.S. Bureau of Census, 1982).

Louisiana has approximately 4,001,400 acres of marshlands, with substantial acreage planted in rice (Wesley, 1987). Together, these lands yield enormous recreational revenues for the state, as most of these lands were leased for duck hunting. Hunters in Louisiana bagged 2.8 million ducks in the 1977-78 season, with the coastal marshes contributing about 63 percent of the total state waterfowl harvest (Boesch, 1982). The Louisiana Department of Wildlife and Fisheries (LDWF) estimated that \$145 million was spent annually for sport hunting in Louisiana during the 1984-85 hunting season, with waterfowl hunting generating an estimated total value of \$21 million.

An estimated 96,109 adult hunters harvested 1,215,392 ducks with an average bag of 12.02 ducks per hunter during the 1985-86 season in Louisiana. Goose hunters harvested 92,207 birds, with an average bag of 1.03 bird per hunter. Each goose hunter spent an average of 7.95 days in the field, while duck hunters spent an average of 12.5 days in the field. In the same season, the LDWF estimated that some 34,000 hunters harvested 263,000 woodcock (LDWF, 1987).

In the 1987-88 season, 97,000 hunters bagged 1.2 million ducks, primarily in Louisiana's coastal marshes (Van Sickle, 1988). These figures represent an eight percent reduction in the number of hunters, with the duck harvest basically unchanged from the previous hunting season. The goose harvest increased by 16 percent in 1987, approaching 60,000. White-fronted geese comprised 53 percent of the harvest, with blue and snow geese accounting for the remainder. Other species harvested include the green-winged teal (21 percent), mallard (20 percent), blue-winged teal (19 percent), wood duck (10 percent), gadwall (9 percent), with pintails, shovelers, wigeons, and ring-necked ducks accounting for the remainder.

For the 1990 season, LDWF reported that 66,000 hunters bagged 635,000 ducks, with an average bag of 9.6 ducks per hunter, a decrease of 14 percent from the previous season. The harvest composition included 18 percent green-winged teal, 20 percent mallard, 8 percent blue-winged teal, 16 percent wood duck, 13 percent gadwall, with pintail, shoveler, wigeon, and ring-necked ducks accounting for the remainder. The goose harvest increased by 29 percent, with white-fronted geese accounting for 50 percent of the goose harvest (LDWF, 1991).

Van Sickle (1989) noted that 252,000 Louisiana and nonresident waterfowl hunters spent 2,118,000 hours hunting waterfowl. This total is based on the 537,000 hunters who hunted all types of game. By comparison, at the national level, there were 75 million hunters who hunted all types of game, with four million hunters spending an average of 35.4 days per year hunting waterfowl. The average number of days spent hunting waterfowl in Louisiana in 1989 was 12 days, with total expenditures of \$21 million, compared to eight days per year with total expenditures of \$1.1 billion at the national level.

Over 90 percent of migratory bird hunters report hunting only in their state of residence (USFWS, 1988), with 68 percent hunting on private land (Langner, 1987). In a 1980 national hunter survey, 3.1 percent of migratory bird hunters paid an average of \$61 private land access fees to hunt (Langner, 1987). In an earlier survey of only waterfowl hunters, 13.8 percent and 8.7 percent of the hunters in the Mississippi and Atlantic Flyways, respectively, paid a private property fee or leased land. Hunters paid a fee most commonly in the southern, Gulf Coast, and Chesapeake

Bay region states (Soutiere, 1989).

Fees charged for waterfowl hunting vary considerably, depending on the services provided, the perceived quality of the hunting opportunity, the value of the duck, and hunter's demand, which is influenced by the availability of public and private hunting areas. In the southern states, waterfowl leases ranged from \$4 to \$50 per acre for choice areas (Shelton, 1987). Commercial guides and hunters in Delaware and Maryland paid annual leasing fees of \$4,000 to \$40,000, but the common fee in 1988 was \$10,000 per farm. These annual fees for hunting rights reflect the perceived quality of the hunting opportunities, and had no association with the size of the hunting area.

Questions arise as to whether waterfowl hunters can play a role in influencing the demand or supply for recreation land. According to a 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (USFWS and U.S. Bureau of Census, 1982), over 35 percent of the respondents made \$25,000 or more per year. More than 10 percent of those responding to the survey reported incomes of over \$40,000. In a 1984 Ducks Unlimited survey of its own members, it was reported that over 53 percent had incomes of over \$35,000 annually, and over 32 percent disclosed incomes greater than \$50,000 (Wesley, 1987). These figures suggest that waterfowl hunters have the financial resources to support a recreational demand for wetland-related activities.

The following section describes a survey of Louisiana waterfowl hunters who purchased duck stamps through the LDWF in 1990-91. Survey responses are categorized and discussed by three major classifications of waterfowl hunting experiences. Empirical and economic models based on conjoint analysis are then used to estimate Louisiana waterfowl hunters' rating preferences for hunting trips.

## **Survey Design and Data Collection Procedures**

A mail survey pertaining to the major attributes and socioeconomic factors of waterfowl hunting trips that can influence trip preference for Louisiana waterfowl hunters was conducted in the spring of 1991 with the cooperation of the Louisiana Department of Wildlife and Fisheries. The questionnaire was designed to obtain information about the socio-economic characteristics of Louisiana waterfowl hunters, including age, income, residence, ethnic background, employment status, and education. Information on hunting experiences, including use of public and fee-based access, costs, hunting trip frequency, and hunting party composition was also elicited in the survey. In addition, a major component of the questionnaire was developed describing hypothetical waterfowl hunting trips in which the respondents were asked to rate hunting trip attributes, including site characteristics, hunting party composition, costs (travel distance and expenditures), and regulatory considerations such as bag limits.

Names and addresses of waterfowl hunters surveyed were obtained from the annual duck stamps sold in 1990-91 by the Louisiana Department of Wildlife and Fisheries. After pre-testing, the questionnaire was mailed in May, 1991 to a randomly selected sample of 7,500 individuals who purchased Louisiana duck



stamps. Dillman's Total Design Method (TDM) was employed in designing and conducting the mail survey. Dillman (1978) developed the TDM as a means of improving mail survey response rates as well as the quality of responses.

Implementation of the TDM involved the mailing of a series of three packages of materials to individual waterfowl hunters randomly chosen for participation. The initial mailing contained an explanatory cover letter, a questionnaire, and a postage paid return envelope. A postcard reminder was mailed to all participants in the sample 10 days after the initial mailing. Two weeks after mailing, the postcards, another cover letter, questionnaire, and return postage envelope were sent to 4,500 individuals in the sample who had not yet responded. A total of 478 incorrect addresses were generated from the sample of 7,500, leaving a total of 7,022 usable addresses. The overall response rate for the waterfowl hunting survey was 48.78 percent, yielding a final total of 3,319 usable surveys (a 47.26 percent response rate).

**Table 1. - Profile of all waterfowl hunters who hunted in Louisiana during the 1990-91 waterfowl hunting season**

Variable Description	Mean	Std. Dev.	Min.	Max.
Percent of hunters who hunted during the 1990-91 waterfowl hunting season	75.30	43.12		
Total numbers of waterfowl shot:				
Ducks	21.24	18.75	0	99
Geese	5.65	12.55	0	99
Total numbers of waterfowl hunting trips taken by hunters	11.35	9.30	1	80
Percent of other wildlife hunted	60.70	48.88		
Percent of hunters indicating type of other wildlife hunted:				
White-tailed-deer	39.15	48.81		
Turkey	7.16	25.79		
Rabbits	32.44	46.81		
Squirrels	38.33	48.62		
Other migratory birds	41.51	49.27		
Others	4.18	21.13		
Percent of hunters who are a member of either a club/lease	25.42	43.54		
Percent of hunters who hunted on either a National Wildlife Refuge or the Louisiana Wildlife Management Area	14.15	34.85		
Percent of hunters who hunted on a commercial hunting site	9.97	29.97		
Total cost of waterfowl hunting for the 1990-91 waterfowl hunting season	763.39	1,640.14	5	50,000
Cost at which hunters stop hunting	3,232.59	45,763.95	1	1,000,000
Willingness-to-pay of waterfowl hunters not to hunt for one season	31,909.54	184,621.7	1	4,000,000
Minimum days in a duck hunting season	22.83	8.29	1	5
Minimum daily bag limit of ducks	2.20	0.74	1	33
Total numbers of years respondent has been a waterfowl hunter	21.55	12.24	1	70
Age of waterfowl respondents	38.57	12.57	13	82
Percent gender of respondents:				
Male	95.57	2.02		
Female	20.54	14.09		
Percent of respondents:				
Living in cities of at least 50,001	35.43	47.83		
White	96.50	18.39		
Black	0.54	7.36		
American Indian	0.33	5.76		
Hispanic	0.12	3.47		
Oriental	0.00	0.00		
Employed	79.87	40.10		
Completed high school	92.32	26.62		
Income of at least \$35,000/year	57.16	49.48		

This response rate exceeded prior expectations of a relatively low response rate due to the length and detail of the questionnaire.

## **Profile of Survey Respondents**

Based on survey responses, an average of 75.30 percent of the sample of waterfowl respondents hunted waterfowl in Louisiana during the 1990-91 waterfowl hunting season. The hunters took an average of 11.35 waterfowl hunting trips at an average hunting cost of \$763.39 per season. The average hunting cost includes hunting related expenses such as lease, gas, food, shells, overnight lodging, and duck stamp. The hunters shot and retrieved an average of 21.24 ducks and 5.65 geese during the season. Apart from hunting ducks and geese, hunters indicated that, on the average, they hunted other wildlife 60.70 percent of the time. Other migratory birds (for example, dove and woodcock), white-tailed deer, and squirrels were hunted most frequently (Table 1).

The average reported age of the waterfowl hunters was 38.57 years. The average hunter was Caucasian with a high school degree, was employed, and had an average total annual household income of at least \$35,000. On the average, 97.57 percent of these respondents were male, consistent with the typical gender bias evident in most hunting-related recreation (Henderson, Stalnaker, and Taylor, 1988). Over 25 percent of the respondents indicated they were members of a hunting lease, and 14.15 percent reported hunting on some sort of publicly provided site. Only 9.97 percent of the sample respondents indicated they hunted at a commercial day hunt site during the 1990-91 season.

During the 1990-91 waterfowl hunting season, Louisiana had a season length of 30 days and a maximum daily bag limit of three ducks. In order to address the effect of increasingly restrictive regulations on waterfowl hunters, the hunters were asked at what level of regulation they would cease hunting Louisiana waterfowl. Survey respondents indicated that on average, they would stop hunting ducks in Louisiana if the number of hunting days were reduced to 22.83, and the bag limit reduced to 2.20 ducks.

## **Waterfowl Site Leasing**

Of particular interest in Louisiana is the opportunity for landowners to earn additional income by leasing land for recreation access. As a multiple land use option, recreation leasing for waterfowl hunting is very complementary to existing forestry and agricultural land uses. Based on the waterfowl survey responses, 840 waterfowl hunters indicated that they were members of a waterfowl lease, an average of 25.42 percent of the survey respondents. Survey respondents indicated that the waterfowl lease had an average of 13.48 members who leased an average of 1,428.17 acres of waterfowl hunting land. The average distance (one way) of the waterfowl lease from the members' homes was 51.28 miles. The waterfowl lease members paid an average of \$3,938.73 for leasing the land. On a per acre per member basis, each member paid an average of \$467.66 to be a member of a waterfowl lease, at an average of \$20.60 per acre for the leased land.

The respondents on average rated the quality of the leased land as fair (32.46 percent). Leased land was typically described as mainly marsh (52.31 percent). The

waterfowl lease members also reported leasing land for other recreational activities. These hunters indicated that on average, 56.84 percent of the leased land was used for other recreational activities, with fishing being the predominant other recreational activity (37.45 percent), followed by other types of hunting (28.89 percent), and wildlife viewing (20.19 percent).

Respondents who were members of a lease reported that they had leased the waterfowl hunting land for an average of 12.76 years. On average, 58.50 percent of the waterfowl lease members reported that no services were provided by the owners of the leased land. Limited services reported as provided by landowners include land preparation and flooding (13.44 percent), provision of blinds and pits (11.18 percent), improved access, including roads and launches for boats (13.67 percent), and liability insurance (3.92 percent). The average cost of waterfowl hunting per season for respondents who leased recreation access was \$1,371.93, including hunting-related expenses such as lease price, gas, food, clothing, shells, overnight lodging, and duck stamp.

## **Public Hunting Sites**

In addition to accessing waterfowl through privately leased land, Louisiana waterfowl hunters have access to a publicly provided system of management areas and wildlife refuges. A total of 468 of the survey respondents (14.15 percent) reported hunting on either a National Wildlife Refuge (NWR) or a Wildlife Management Area (WMA) in Louisiana during the 1990-91 waterfowl hunting season. For the purpose of this research, the NWR and WMA hunting sites are both referred to as public hunting sites. These public site hunters reported shooting and retrieving an average of 24.88 ducks and 4.86 geese during the 1990-91 waterfowl hunting season. In addition to ducks and geese, an average of 85.90 percent of those who hunted on the public land reported hunting other wildlife, with squirrels (69.02 percent) hunted most frequently, followed by white-tailed deer (61.53 percent), and other migratory birds, including doves and woodcock (60.68 percent).

The hunters who hunted on public land took an average of 5.50 hunting trips to the NWR and an average of 7.08 hunting trips to the WMA. The average one-way distance from the hunters' homes to the NWR was 43.47 miles and to the WMA, 38.68 miles. On average, the hunters rated the quality of the public land for waterfowl hunting as fair to good.

The average hunting cost for waterfowl hunters who hunted on public land was \$640.32. Respondents who hunted on public lands such as the NWR or the WMA were, on average, 34.69 years old and had hunted on these public lands for an average of 19.61 years. The average hunter in this category was a white male who had completed high school, was employed, and had an average total household income of \$35,000 to \$39,999.

## **Commercial Hunting Sites**

A third means of accessing the waterfowl in Louisiana is offered through commercial establishments offering day or weekend hunts. A total of 328 of the survey respondents indicated that they hunted on a commercial hunting

establishment in Louisiana during the 1990-91 waterfowl hunting season, an average of only 9.97 percent. These hunters reported shooting and retrieving an average of 23.4 ducks and 8.4 geese while hunting on the commercial hunting site during the 1990-91 waterfowl hunting season. In addition to ducks and geese, an average of 78.18 percent of the hunters indicated that they hunted other types of wildlife. On average, other migratory birds, including doves and woodcock, (58.18 percent), dominated this subset of other wildlife hunting, followed by white-tailed deer (46.65 percent) and squirrels (40.30 percent).

Hunters who hunted on a commercial hunting site averaged 3.37 hunting trips per season. The average one-way distance from the hunters' homes to the commercial hunting site was 105.68 miles, with an average total hunting cost of \$1,446.69. The average overall rating quality of the commercial hunting site was fair (24.24 percent) to good (34.24 percent). An average of 96.06 percent of the commercial site hunters reported owners of the commercial hunting site provided blinds and decoys, and 86.36 percent of the hunters reported guide services being provided. An average of 28.77 percent reported that owners provided liability insurance. The average price charged for a commercial day hunt was reported as \$153.48 per day.

The average commercial site hunter reported being a waterfowl hunter for 22.38 years. The average age of these hunters was 40.08 years. The average hunter who hunted on the commercial hunting site was a white male who had completed high school and was employed. Over 78 percent had an average total annual household income of \$35,000 to \$39,999.

## **Non-Hunters**

An average of 23.36 percent of the survey respondents purchased duck stamps during the 1990-91 waterfowl hunting season, but indicated that they did not hunt during that season. For descriptive purposes, this group was identified as stamp collectors or individuals who chose not to hunt. The average age of this group was 38.55 years, with socioeconomic characteristics similar to survey respondents who hunted. The average nonhunting respondent was a white male who completed high school, was employed, and had an average total household income of \$35,000 to \$39,999.

Given the decline in waterfowl hunting participation in Louisiana, factors which influence a hunter's decision to hunt or not hunt during a given season after purchasing a duck stamp are of interest. The following sections therefore report a series of survey respondent rankings of factors which may influence participation decisions, including waterfowl species preferences, and a number of hunting season characteristics. Seven potentially influential hunting characteristics were chosen based on consultation with a focus group composed of members of LDWF Waterfowl Division personnel. Information from these rankings later form the basis for the conjoint analysis design of waterfowl hunting experiences in Louisiana.

## **Waterfowl Species Ranking Preferences**

Respondents who had purchased a 1990-91 duck hunting stamp and who hunted in Louisiana during the 1990-91 waterfowl hunting season were asked to indicate the type of waterfowl species they preferred to hunt. Hunters were asked

to rank their waterfowl species preferences on a scale of one to nine, with one being the most preferred and nine being the least preferred.

From the 3,319 usable responses, a total of 2,503 responded to the question pertaining to ranking waterfowl species preferences. Eight hundred and sixteen of the remaining respondents did not attempt to rank any of the waterfowl species preferences, with the majority of these respondents indicating that they have no preferences in terms of a waterfowl species, as long as they could hunt. Over 58 percent of the hunting respondents ranked mallard as their first preference. Following mallards, 14.29 percent ranked wood ducks as their second preference, and 12.32 percent ranked pintails as the third preference.

## **Hunting Trip Features and Season Ranking Preferences**

In addition to species preferences, hunters were asked to indicate the features that most influenced their decision to hunt waterfowl. The features offered in the survey--travel time to hunting site, site congestion, type of hunting party, type of hunting areas, length of the hunting season and the daily duck bag limit, total cost per season, and other related trip hunting factors--were chosen based on the focus group input. Hunters were asked to rank these features on a scale of one to ten, with one being the least influential and ten being the most influential. Respondents indicated that type of hunting party (hunting with family, hunting with friends, or hunting alone or with strangers) was the most important feature. Site congestion was ranked second, followed by the maximum duck bag limit and length of the hunting season. Total cost per season was not reported as a major influence.

Respondents were also asked to rate 20 hypothetical waterfowl hunting trips, with ten being the ideal hunting conditions for a trip and one being the least satisfactory conditions. Each hypothetical hunting trip featured seven combinations of factors, such as daily duck bag limit, travel time, site congestion, type of hunting party, type of hunting area, total cost, and length of hunting season. Each factor was given at three different levels, such as a daily bag limit of two ducks, three ducks, or seven ducks, or hunting season length of 20 days, 30 days, or 40 days. The levels for each of these factors were again determined through consultation with the LDWF focus group.

Respondents consistently rated one hypothetical trip as the most satisfactory. This trip featured a travel time of 1.5 hours one way, low site congestion, and a total hunting cost of \$1,500 per season. In addition, it featured a duck bag limit of seven ducks per day, a hunting season of 40 days, site access through leasing and hunting alone or with a party of friends.

Important factors that appear to have influenced respondents' choice of this particular hunting trip as typical of the most ideal hunting season were the daily duck bag limit and the length of the hunting season. This scenario has the least restrictive hunting institutional constraints--a traveling time of only 1.5 hours per way and a total cost of \$1,500 per season.

The hypothetical hunting scenario rated the least satisfactory by survey respondents had a longer one-way travel time of five hours. This scenario has more restrictive hunting institutional constraints, including a 20-day hunting season and

a duck bag limit of two ducks per day. The type of hunting area described in this scenario was public land (NWR or WMA), with low site congestion.

## **Hunter Choice Process: An Economic Perspective**

One perspective on the decision-making process of waterfowl hunters suggests that they evaluate each available hunting alternative in terms of its attributes, assessing the relative importance of the attributes, ultimately choosing the hunting alternative with the greatest weighted aggregate score. Waterfowl hunters are assumed to maximize their underlying utility functions, based on the attributes and characteristics of the hunting trips as well as their individual socio-economic attributes. Although hunting trip attributes will differ among available alternatives, an individual hunter's attributes would remain constant.

The decision to rate or rank different hunting trips reflects the multiple choice combination of hunters' socio-economic attributes, hunting trip attributes and characteristics that yields the greatest utility to the hunters. Viewed within this decision framework, evaluation of a recreationist's choices can be improved by development and use of a conceptual and empirical framework which explicitly recognizes the multiattribute nature of the good as well as the consumer's process of ranking these characteristics. The following section provides an overview of conjoint analysis theory, including an empirical and economic model of conjoint analysis for waterfowl hunting in Louisiana.

## **Conjoint Analysis: A Multiattribute Decision-Making Process**

Social scientists, especially in the fields of economics, sociology, and psychology, have traditionally focused systems of thought around a single attribute that was considered to be the most significant factor in explaining decision-making among sets of alternatives. Recent theoretical and empirical studies on modeling consumer and executive decision-making processes acknowledge that individual, organizational as well as institutional decision-making, involves complex multidimensional goals, often with competing or conflicting objectives. This decision process cannot be defined within a traditional economic framework by a single objective function such as cost minimization or profit maximization.

Decision-making processes are inherently multidimensional. For example, customers differentiate and evaluate stores and brands with respect to many alternatives and different types of attributes. The purchaser of a durable good may have an opinion of the durability of alternative brands, attitudes with regard to the importance of durability, preferences among specific brands, and models to maximize preference, taking into account the opportunity cost of the outlay for the product, and a behavioral intention to choose a specific brand (Green, Wind and Jain, 1972). Current studies of consumer behavior acknowledge and emphasize the importance of multiattribute alternative problems in decision theory (Halbrendt, Wirth, and Vaughn, 1991).

Conjoint analysis has become an increasingly popular approach to modeling

consumer preferences for multiattribute choices. For example, over a decade ago, Cattin and Wittink (1982) estimated that more than 1,000 CJA applications had been reported. CJA has been employed extensively in the marketing literature where it has proven especially useful in analysis of new products, market segmentation, or product differentiation (Green, 1974; Green and Srinivasan, 1978; Green et al., 1981; Wittink and Cattin, 1989; Hair, et al., 1990; Halbrendt, Wirth, and Vaughn, 1991). CJA measures the joint effect of two or more independent variables on the ordering of a dependent variable (Green and Srinivisan, 1978; Cattin and Wittink, 1982). Hair, et al. (1990) suggest that CJA is especially suited for understanding consumers' reactions to predetermined attribute combinations as CJA relates an individual's preferences to a set of prespecified attributes.

The objective of conjoint analysis is to decompose a set of responses to factorially designed stimuli in which the utility of each stimuli attribute can be inferred from the respondents' evaluations of the stimuli (Green, 1974; Green et al., 1988; Halbrendt, et al., 1991). CJA models are decomposition models as the technique involves surveying respondents regarding their relative preferences for alternative bundles of goods when multiple attributes are varied simultaneously. Empirical estimates of an indirect utility index from which the marginal rate of substitution between attributes and marginal willingness-to-pay estimates for attributes can then be derived.

CJA involves measuring consumer utilities associated with various combinations of products or service offerings (Sands and Warwick, 1981). The approach is based on the economic theory of consumer choice in which consumer preferences can be measured in terms of utilities for individual attributes or components of the product offering. When added together, the utility values for the components of the product offering can then measure the total preference for various combinations of the product or service. The conceptual and empirical strength of CJA lies in information gained from analysis of the trade-offs made among product attributes that can be used to establish the perceived preference or utility of various product offerings.

Given the multiattribute nature of wetland-based recreation experiences such as waterfowl hunting, conjoint measurement offers an attractive technique in estimating waterfowl hunters' part-worth utilities (i.e. consumer's utility preference for different levels of the alternative attributes) for different hunting attributes and levels. CJA decomposes the overall evaluations into implicit utilities for components of the multiattribute alternatives.

CJA can also be characterized as an extension of the referendum closed-end contingent valuation method (CVM) in which large numbers of attributes and levels can be included in the analysis without overwhelming the respondents. For example, this technique can be employed to construct hypothetical hunting trip choice sets, estimate the form of an indirect utility index for a single hunting trip, and derive willingness-to-pay (WTP) measurements for individual hunting trip attributes. Respondents are often more comfortable providing qualitative rankings and ratings of a given set of attributes which include prices rather than offer dollar valuations of the same bundle of goods without prices.

One fundamental assumption underlying CJA is that an individual's preference for a good can be decomposed into preference scores for components or characteristics of the good. These preference scores can in turn be revealed through surveying

individuals regarding their relative preferences for alternative attribute bundles. Responses can then be quantified in terms of marginal rates of substitution between attributes (Mackenzie, 1990). By using different attributes and levels for different respondents, a larger number of attributes and levels can be included in the analysis without overwhelming the respondents. The technique is advantageous because a researcher is able to limit the number of choices to which a subject is required to respond, while at the same time permitting computation of a preference measure for choices that are both explicitly and implicitly implied by the research design.

A commonly used technique for such a purpose is the fractional factorial (FF) design (Petersen, 1985; Green, 1974; Winer, 1971). The FF design allows a researcher to evaluate some of the combined effects of two or more experimental variables when used simultaneously. For example, a CJA of a product involving four factors, each with five levels, would involve ranking 625 ( $5^4$ ) possible combinations of factor levels, a task recognized as well beyond the capability of respondents. Therefore, a subset of all possible combinations is selected to permit the estimation of the main factors (McLean and Anderson, 1984; Green, 1977). By using the FF design involving four factors, each with five levels, the respondent would only have to evaluate 25 responses. This design allows the researcher to estimate the main effects of the factor levels as well as some interaction effects, if desired. An interaction effect involves the effect of variables above and beyond that which can be attributed to the variables operating independently (Green, 1974; Winer, 1971).

For example, let  $Z$  represents a composite good with  $N$  attributes in which  $Z = (z_1, \dots, z_N)$  where  $z_i$  ( $i = 1 \dots N$ ) refers to the quantity of the  $i^{\text{th}}$  constituent attribute. Assuming utility  $U[Z(z_1, \dots, z_N); D]$  is additively separable in  $Z$  and its component attributes, then the marginal rate of substitution between any pair of attributes is independent of the level of any other goods  $D$ . Let consumers compare two bundles of good  $Z^0(\dots z_i^0, z_j^0 \dots)$  and  $Z^1(\dots z_i^1, z_j^1 \dots)$  in which the consumers are left indifferent between bundles  $Z^0$  and  $Z^1$  and the attributes between  $z_i$  and  $z_j$  be varied in proportion across the two bundles  $Z^0$  and  $Z^1$ . Holding all other attributes constant, the implied marginal rate of substitution between attributes  $z_i$  and  $z_j$  is  $U_{z_i}/U_{z_j}$  (Mackenzie, 1990; Goodman, 1989).

The marketing applications of CJA generally employ an indirect utility function approach incorporating price into the analysis (Mackenzie, 1990; 1991). For example, if  $Z$  is a marketed composite good and its price  $P_z$  is incorporated into the attribute, then the indirect utility function can be expressed as  $U(z_1, \dots, z_N, P_z, Y)$ , where  $Y$  represents consumers income. The consumers will be comparing bundles between  $Z^0(\dots z_i^0, \dots P_z^0)$  and  $Z^1(\dots z_i^1, \dots P_z^1)$ . If only  $z_i$  and  $P_z$  are varied and consumers are indifferent between bundles  $Z^0$  and  $Z^1$ , then the marginal WTP for attribute  $z_i$  is given by the ratio -  $U_{z_i}/U_{p_z}$ , a compensated measurement with utility held constant.

The indirect utility function  $U(Z)$  has a systematic component  $u(Z)$  and a random unobservable component  $\epsilon^i$ , so that the utility from any bundle  $Z^i$  is given as

$$U(Z^i) = u(Z^i) + \epsilon^i \quad (1)$$

where  $u(Z)$  represents a specified functional form and  $\epsilon^i$  represents a random



disturbance term (Mackenzie, 1990; McFadden, 1974). If a consumer preferred  $Z^1$  to  $Z^0$ , this implies  $u(Z^1) > u(Z^0)$ . Therefore, the probability that the consumer will choose  $Z^1$  over  $Z^0$  is given as:

$$\text{Prob}[u(Z^1) > u(Z^0)] = \text{Prob}[(\epsilon^0 - \epsilon^1) < \{u(Z^1) - U(Z^0)\}] \quad (2)$$

Assuming that the  $\epsilon$ 's are independently and identically distributed, the appropriate functional form (for example normal or logistic) for the cumulative distribution of  $(\epsilon^1 - \epsilon^0)$  can then determine the type of indirect utility model to be estimated (for example probit or logit).

In summary, conjoint analysis offers a potentially useful perspective on decision analysis, a perspective capable of capturing the complexities of multiattribute decision-making such as that evident in recreation choices. While CJA is an established technique in the field of marketing, it is still relatively new in the area of conventional economics and natural resource economics. In the following section, empirical and an economic models are developed using CJA to estimate Louisiana waterfowl hunters' rating preferences for hunting trips.

## **Conjoint Analysis of Waterfowl Hunting**

The objective of CJA analysis is to decompose a total evaluation score into components imputed to each attribute or to decompose a set of overall responses to factorially designed stimuli so that the utility of each stimulus component can be inferred from the respondent's overall evaluations of the stimuli and to measure these components (Green and Tull, 1978; Green and Wind, 1973). The stimuli in CJA analysis are designed beforehand according to some form of factorial structure dealing with preference judgments rather than similarities. The attractiveness of CJA as a technique in the field of consumer research is due to the ability of consumers to order preferences, combined with the fact that although only rank order data are required as inputs, the output consists of a measurement of the utility value to a consumer of each product attribute.

CJA typically involves two basic design procedures. First, the attributes and attribute levels which form the design provisions must be identified. For example, in waterfowl hunting, these attributes might reflect important hunting characteristics in which hunters can engage to assess hunting quality and various sites. Attribute levels correspond to points along these design specifications and should cover the entire range of representative levels (Cattin and Wittink, 1982).

In the application presented in this study, the selection of waterfowl hunting trip attributes and attribute levels drew upon a survey of waterfowl hunters' hunting characteristics and habits as well as input from focus groups conducted with Waterfowl Game Division personnel in the Louisiana Department of Wildlife and Fisheries. The selected attributes for this study are travel time, site congestion, type of hunting party, total cost, duck bag limit, type of hunting area and length of season. Once the attributes and attribute levels were identified, they were combined into hypothetical waterfowl hunting trip vignettes. Based on mail survey responses, a preference rating scale of one to ten was assigned to each hunting trip vignette with

one as completely unsatisfactory season and ten as the ideal season.

CJA assumes that an individual's rating are systematic and consistent so that the ratings provide at least as much information concerning individuals' preferences for recreation attributes as ordinal rankings since they also provide some indication of the magnitude of the preference. The utility function of the hypothetical waterfowl hunting trip can, as a result, be estimated by means of traditional binary choice techniques such as logit, probit or tobit, using  $n*(n-1)/2$  pairwise choice observations per respondent, or using  $n$  rank observations per respondent via the rank-order logit estimation technique (Harrell, 1980).

If rankings are used in the binary choice model, the conventional intercept term is then replaced by  $n-1$  separate dummy variables  $a_1, a_2, \dots, a_{n-1}$ , accounting for  $n-1$  rank intervals, where  $a_j = 1$  for an observation rating  $j$  and  $a_j = 0$  otherwise. If a  $k$  level rating scale is employed, the intercept term is substituted by  $k-1$  separate dummy variables. This ordinal logit transformation collapse the rankings or ratings to define an indirect utility index normalized to a one unit rank or rating interval (Mackenzie, 1990).

While it is a common practice to regress ratings against attributes by means of the OLS technique, the results of OLS estimation violate classical utility theory because ratings have only ordinal significance. For example, if a respondent gives bundle  $Z^0$  a rating of 10 and bundle  $Z^1$  a rating of 3, this does not imply that the respondent is indifferent between one bundle  $Z^0$  and two bundles of  $Z^1$  (Mackenzie, 1990). Furthermore, the rating variables are discrete instead of continuous and its variation is bounded by a defined set of rating scales. Consequently, OLS estimation will yield inconsistent and inefficient estimators.

## Stimuli Design

A substantial amount of literature has been developed addressing the efficient design of CJA questions using fractional factorial designs (Green, 1974; Adelman, 1962). In this application, the hypothetical waterfowl hunting trip vignettes are described according to seven different attributes, with each attribute varying across three levels. The set of all possible waterfowl hunting trip vignette attributes includes  $3^7$  or 2,187 different trip combinations or profiles. If preferences are assumed to be transitive and do not reflect significant jointness between attributes from the perspective of information content, most of these trip vignettes then become redundant (Mackenzie, 1990). A design algorithm, fractional factorial, was used to identify 20 parsimonious sets of vignettes which permitted development of marginal valuations of each level of each attribute (Saxton, Frederick, and Wright, 1991; Green and Wind, 1975; Green, 1974). Additionally, informational efficiency could also be improved by eliciting simultaneous rankings of multiple vignettes rather than pairwise comparisons. A respondent's rankings of  $n$  bundles then implies  $n*(n-1)/2$  non-redundant pairwise comparisons.

Additional informational efficiency gain is conceivable through the use of a rating scale  $1, \dots, k$  ( $k > n$ ). Assuming each respondent's ratings are fairly consistent, the ratings provide at least as much information about the respondent's preferences for attributes as ordinal rankings. Indifference between bundles can be indicated by equal ratings, while rating intervals between different vignettes can provide some

information on the intensity of preferences which is not revealed in rankings or binary choice techniques (Mackenzie, 1990).

Conjoint designs are orthogonal as the variation of each attribute is completely independent of the variation of all other attributes. This orthogonality implies that specifications of the utility function in which the attributes are entered in linear form on the right-hand side yields unbiased estimates of the “main effects” (i.e. obtaining marginal estimation of each level of each attribute without separate joint effects of the attribute) of those attributes on the utility. The estimation results from such models imply constant marginal rates of substitution between attributes, or constant WTP measurement. For example, let

$$\text{RATING} = F(\text{ZB}), \quad (3)$$

where Z is defined by N attributes with each attribute,  $z_i$  ( $i=1, \dots, N$ ) varying across discrete levels of  $j$  ( $j=1, \dots, M$ ), F is a transformation function such as the logistic and ZB is the linear combination of attributes:

$$\text{ZB} = \dots + b_i z_i + b_j z_j + \dots, \quad (4)$$

Setting the total differential of equation (4) equal to zero (i.e. no change in the rating) yields the following:

$$d\text{ZB} = \dots + b_i dz_i + b_j dz_j + \dots = 0 \quad (5)$$

Holding all other attributes constant except  $z_i$  and  $z_j$ , the marginal rate of substitution  $dz_i/dz_j$ , i.e. a given change in  $z_i$  to offset a given change in  $z_j$ , would change by  $-b_j/b_i$  so as to leave ZB unchanged, and hence the rating. If the price  $P_z$  is included as an attribute, the compensated marginal WTP for  $z_i$  is  $dP_z/dz_i = -b_i/b_{pz}$ , which will be valid over the mid-ranges of the attribute levels offered in the conjoint design. However, its linear integral does not necessarily provide plausible welfare measures for large changes in  $z_i$  (Mackenzie, 1990, 1991).

In this application, the stimuli or vignettes used a rating scale with ten levels, econometrically estimated with the ordinal logit procedure estimating a separate constant to account for each rating level ( $\text{ALPHA}_1, \dots, \text{ALPHA}_{w-1}$  as specified below). The specification for the general rating model using ALPHA ratings is then given as:

$$\text{RATING} = 1 / [1 + \exp^1(\text{ZB})] \quad (6)$$

where

$$\begin{aligned} \text{ZB} = & \text{ALPHA}_1 + \dots + \text{ALPHA}_{w-1} + \beta_1(\text{TIME}) + \beta_2(\text{LENGTH}) + \beta_3(\text{COST}) \\ & + \beta_4(\text{DUCKBAG}) + \beta_5(\text{ALONE}) + \beta_6(\text{FRIEND}) + \beta_7(\text{STRANGER}) \\ & + \beta_8(\text{CONGEST1}) + \beta_9(\text{CONGEST2}) + \beta_{10}(\text{CONGEST3}) + \beta_{11}(\text{LEASE}) \\ & + \beta_{12}(\text{PUBLIC}) + \beta_{13}(\text{COMMERCIAL}) + \epsilon \end{aligned} \quad (7)$$

and

ALPHA <sub>w</sub>	= rating interval dummies (w = 10)
ALPHA <sub>i</sub>	= 1 if the rating is i, and = 0 otherwise
TIME	= total travel time (1.5, 3, 5 hours one way)
LENGTH	= length of hunting season (20, 30, 40 days)
COST	= total cost of duck hunting per season
DUCKBAG	= daily duck bag limit (2, 3, 7 ducks) per day
ALONE	= 1 if waterfowl hunter hunted alone; 0 otherwise
FRIEND	= 1 if waterfowl hunter hunted with friends; 0 otherwise
STRANGER	= 1 if waterfowl hunter hunted with strangers; 0 otherwise
CONGEST1	= 1 if no reported congestion at hunting site; 0 otherwise
CONGEST2	= 1 if low reported congestion at hunting site; 0 otherwise
CONGEST3	= 1 if high reported congestion at hunting site; 0 otherwise
LEASE	= 1 if waterfowl hunter belongs to a lease or hunting club; 0 otherwise
PUBLIC	= 1 if waterfowl hunter hunted on a public hunting site; 0 otherwise
COMMERCIAL	= 1 if waterfowl hunter hunted on a commercial hunting site; 0 otherwise
ε	= error term

The vignette ratings were then fitted to a logit transformation of a linear combination of right-hand side variables ZB. For example, let Q represent a respondent rating n vignettes on a rating scale of k levels, and  $q_{ij}$  represent the number of respondents giving hunting trip vignette i a rating of j or higher. The indirect utility function can be estimated directly, with nQ original rating observations collapsed into  $n*(k-1)$  cell observations. The dependent variable  $Y_{ij}$  in equation (6) then takes the following form:

$$ZB = \text{Log}_e [q_{ij} / (Q_i - q_{ij})] \quad (8)$$

where  $q_{ij}$  = cumulative number of respondents giving trip vignette i a rating of j or higher, and  $Q_i$  = total number of rating observations for trip vignette i.

A further adjustment suggested by Cox (1970) and Pindyck and Rubinfeld (1976), adding 0.5 to  $q_{ij}$ , was employed to improve the model efficiency given by equation (8) since some of the data were somewhat sparse for some cells. The dependent variable in the rating model (6) is given as:

$$ZB = \text{Log}_e [(q_{ij} + 0.5) / (Q_i - q_{ij} + 0.5)] \quad (9)$$

The rating model (6) is then estimated in linearized logistic form with the intercept term decomposed into ALPHA-1 separate intercept dummies to account for the intervals between ALPHA rating levels (Mackenzie, 1990; Maddala, 1983; Chapman and Staelin, 1982).

Travel time (for example 1.5, 3, or 5 hours, one way) was included in the

questionnaire to obtain valuations of travel time. The need for including time in recreation demand analysis has been discussed in the literature (Knetsch, 1963; Clawson and Knetsch, 1966; Cesario and Knetsch, 1970). Neglecting to account for the cost of time in estimating a recreation framework will result in a demand curve that will be biased from the true demand curve. In this survey, lower ratings were expected from trips requiring longer travel time.

Trip cost per season (for example, \$500, \$1,000, or \$1,500) was included to capture the valuation of the other attributes. Theoretically, a hypothetical site fee would have been preferred to an overall total cost per season, since respondents might identify more costly hunting trips with omitted attributes such as more guide services, meals, or lodging. This effect would reduce the variance of the trip ratings with respect to the total trip cost, thereby biasing the regression coefficient on trip cost downward and increasing the valuation estimates for other trip attributes.

An important determinant of trip enjoyment includes the composition of the hunting party, here presented as hunting with close friends, or with family members, hunting alone or hunting with strangers. It is generally perceived that there are strong preference for hunting with close friends or family members who reflect friendship and safe hunting partners. A lower rating would be expected if hunting were with strangers.

Site congestion (none, low, or high) was hypothesized to influence trip ratings. A heavily congested site could reduce trip ratings due to the nature of waterfowl hunting. Waterfowl hunters can be sensitive to the number of hunters present on a site because the larger the number of hunters hunting on a given site, the greater the distraction and noise. In addition, congestion could decrease the number of ducks present on a site and increase competition for those on a site.

Waterfowl hunters in Louisiana (and throughout the nation) are facing restrictive hunting seasons and reduced duck bag limits. The hunting season is the number of hunting days that may occur within the total season. The daily bag limit is the number of birds of a specie or group that may be taken in one day. A lower rating will hypothetically be given to a more restrictive hunting regulation. In this survey, a length of hunting season of 20, 30, or 40 days and bag limits of two, three, or seven ducks were specified.

Three types of hunting areas (lease, public lands, and commercial hunting sites) are generally available to waterfowl hunters in Louisiana who do not hunt on their own land. Commercial sites can provide extensive packages of services including room, board, a guide, and a blind. Leased acreage typically has few owner-provided services. Public land, including Wildlife Management Areas or Federal Wildlife Refuges, typically offers limited services specifically to waterfowl hunters.

## **Empirical Results**

Table 2 presents the coefficient estimates resulting from the rating model of waterfowl hunters who hunted in Louisiana during the 1990-91 waterfowl hunting season. The rating model was estimated by means of weighted least squares in SHAZAM to correct for problems of heteroscedasticity (White and Horsman, 1986). The survey yielded a total of 3,319 usable surveys from the waterfowl hunters who hunted in Louisiana during the 1990-91 waterfowl hunting season. Of these 3,319

**Table 2.- Coefficient estimates resulting from the rating model of the sample of Louisiana waterfowl hunters**

Variable	Parameter	Standard	t-statistic	Coeff/(COST) Error
Alpha <sub>0</sub>	-33.044	4.42277	-7.4630	
Alpha <sub>2</sub>	-0.69833	0.059101	-11.816	
Alpha <sub>3</sub>	-0.52807	0.040818	-12.937	
Alpha <sub>4</sub>	-0.37150	0.037661	-9.864	
Alpha <sub>5</sub>	-0.23282	0.034636	-6.721	
Alpha <sub>6</sub>	-0.92791	0.053981	-17.190	
Alpha <sub>7</sub>	0.13486	0.027735	4.862	
Alpha <sub>8</sub>	0.34046	0.026643	12.779	
Alpha <sub>9</sub>	0.61084	0.027002	22.622	
Alpha <sub>10</sub>	5.6487	0.40087	14.091	
TIME	-0.14454	0.0064259	-12.493	(\$687.47)
LENGTH	0.0064478	0.00085520	7.539	\$30.67
COST	-0.00021025	0.00001931	-10.887	\$1.00
DUCKBAG	0.083211	0.0041993	19.815	\$395.77
FRIENDS	0.14420	0.019651	7.338	\$685.85
STRANGER	-0.10601	0.025030	-4.235	(\$504.09)
CONGEST2	-0.0035773	0.020796	-0.172	(\$17.01)
CONGEST3	-0.20816	0.021784	-9.556	(\$990.06)
LEASE	0.15452	0.021220	7.281	\$734.93
PUBLIC	-0.066875	0.020720	-3.227	(\$318.07)
n	3,283			
df	199			
R <sup>2</sup>	0.92			
F-value	112.242			

waterfowl hunters, 3,283 provided usable hunting trip vignette ratings of the conjoint question. Thirty-six (1.096 percent) of the 3,319 respondents did not rate any of the presented 20 waterfowl hunting trip vignettes. The total number of rating observations of hunting trip vignettes is thus slightly lower than the number of usable surveys. The estimated coefficients of TIME, LENGTH, COST, DUCKBAG, FRIEND, STRANGER, CONGEST2, CONGEST3, and LEASE have the expected sign and are statistically significant at a five percent (1.65) level of confidence. These variables appear to significantly affect the ratio of respondents' rating of trip preferences.

The slope coefficient of TIME (-0.14454) gives the change in the log ratio of a waterfowl hunter giving trip *i* a rating of *j* or higher per total decrease in TIME for a particular hunting season. Likewise, the slope of LENGTH (0.0064478) and DUCKBAG (0.083211) gives the change in the log ratio of a waterfowl hunter giving trip *i* a rating of *j* or higher per total increase in LENGTH and DUCKBAG for a particular season (Table 2).

The estimated coefficients of LENGTH (0.0064478) and DUCKBAG (0.083211) are positive and significant, implying that as the length of the hunting season and the daily duck bag limit increase, a waterfowl hunter would give a higher rating to a trip reflecting these characteristics. It also suggests the increasing marginal utility of hunting success. The estimated PUBLIC (-0.066875) and CONGEST3 (-0.20816) coefficients were negative and significant, implying that within this choice

framework, hunters do not prefer to hunt on public lands. The estimated coefficient CONGEST2 (-0.0035773) with a t-ratio (-0.17202) is not significant at the five percent level of significance, implying that the effect of low site congestion on trip ratings is negligible. The estimated coefficient on COST (-0.00021025) suggests an increasing marginal disutility of rating trips with a high COST, consistent with diminishing marginal utility theory. Hunters are, as hypothesized, reluctant to continue hunting waterfowl if the total cost of waterfowl hunting increases (Table 2).

Marginal valuations of various trip attributes can be derived from the rating model in equation (6). The marginal WTP for attributes is given by the negative of the ratios of the coefficient on each attribute divided by the coefficient on COST. Negative ratio values represent attributes that reduce utility (for example, travel time and hunting with strangers). Positive ratio values represent attributes that increase utility (for example, length of hunting season, hunting with friends, and duck bag limit per day). For example, the marginal valuation of TIME, the responsiveness of the respondent's marginal willingness to incur a higher total cost to have travel time decreased, is the constant (in absolute value)

$$\begin{aligned} \text{WTP}_{\text{Time}} &= -b_1/b_3 = -(-0.14454)/(-0.00021025) & (10) \\ &= -\$687.47 \text{ per season hour of travel time} \end{aligned}$$

as derived from the linearized logistic rating model. Since TIME is measured in hours,  $b_1$  represents logistically-transformed ratings points per season hour, while COST, given in dollars,  $b_3$ , represents logistically-transformed rating points per season dollar. Therefore, the ratio  $-b_1/b_3$  expresses the time valuation in dollars per season hour. The value of \$687.47 per season hour of travel time is the mid-range values for COST (\$1,000), LENGTH (30 days), DUCKBAG (4 ducks), and TIME (3 hours) from the CJA design.

This valuation of travel time in general is high relative to traditional time valuations derived from hourly wages which are typically employed in conventional travel-cost and hedonic analyses (Cesario, 1976; Farber 1985). In addition, this valuation reflects the implicit cost of displaced time at the hunting site more than the opportunity cost of work time (Mackenzie, 1990). The high valuation of travel time also demonstrates the brevity of waterfowl hunting seasons which can include substantial hunting expenses as reported by many respondents in the survey.

The marginal valuations of LENGTH and DUCKBAG are similarly derived as a constant from the linearized logistic rating model:

$$\begin{aligned} \text{WTP}_{\text{Length}} &= -b_2/b_3 = -(0.0064478)/(-0.00021025) & (11) \\ &= \$30.67 \\ \text{WTP}_{\text{Duck}} &= -b_4/b_3 = -(0.083211)/(-0.00021025) & (12) \\ &= \$395.77 \end{aligned}$$

This value implies that the hunters are willing to pay \$426.44 to have the number of hunting days extended and the daily duck bag limit increased from the mandated three ducks per day.

Similarly, the implied willingness to pay for the composition of a hunting party and degree of site congestion can be derived, but are not meaningful because these

attributes were not quantitatively defined. These values are given by the constant

$$\begin{aligned} \text{WTP}_{\text{Friend}} &= -b_5/b_3 = -(0.14420)/(-0.00021025) & (13) \\ &= \$685.85 \end{aligned}$$

$$\begin{aligned} \text{WTP}_{\text{Stranger}} &= -b_6/b_3 = -(-0.10601)/(-0.00021025) & (14) \\ &= -\$504.09 \end{aligned}$$

as derived from the linearized logistic rating model. The average hunter implicitly is willing to pay \$1,189.94 per season to hunt with close friends rather than with strangers. The hunter is also willing to pay \$990.06  $[-(-0.20816)/(-0.00021025)]$  per season to have site congestion reduced from high to low. The hunter implicitly is willing to spend \$318.07 more  $[-(-0.066875)/(-0.00021025)]$  to lease land for hunting rather than to hunt on a public hunting site.

## Summary and Conclusions

Efforts to value many resource based recreation activities are complicated by the non-market characteristics inherent in these goods as well as variation in the bundling of these goods for consumers. In the case of waterfowl hunting, in addition to valuing a fugitive resource, demand may be influenced by the attributes of the experience, including party composition, site characteristics, cost considerations, and institutional restrictions. Conjoint analysis appears to offer a valuable theoretical and empirical perspective for this form of multi-attribute decision-making process.

The ability to decompose consumer recreation choices into relevant components and assign values to these components offers valuable information to public as well as private resource managers. Private landowners seeking to package or bundle a product offering such as a waterfowl hunting weekend at a commercial site can benefit from additional information on preferred bundles. Likewise, landowners hoping to offer land for lease to waterfowl hunters can benefit from this level and form of new product information. Public land managers are often cast as managers of the most convenient recreation site, not necessarily the most preferred site. Information obtained through conjoint analysis offers some insight to public land managers on factors such as site congestion, hunting party composition, demand for services, and location of public lands which may influence future managerial decisions.

Although well established in field of marketing, conjoint analysis appears to offer new information to recreation analysts seeking to understand increasingly sophisticated consumer decisions. However, conjoint analysis is especially sensitive to design, implementation, and interpretation. Component attributes or factors selected for inclusion in a treatment or vignette must be reasonably representative of the composite good and be clearly defined. The number of attributes varying across plausible levels (or ranges) must also be well defined. Focus groups knowledgeable of the good prove invaluable at this point of the design process. The conjoint design questions should be pre-tested extensively and revised as necessary to resolve any doubts or ambiguity that respondents might face in the survey process. Finally, the practical application of the conjoint method should be clearly



identified. More extensive use of this technique by resource and environmental economists will undoubtedly refine and define its applicability to non-market valuation.

This research has addressed the economic value and impact of waterfowl hunting in Louisiana. In addition to providing survey-based socio-economic information about Louisiana waterfowl hunters, this study has provided an economic analysis of the multiattribute characteristics of waterfowl hunting using conjoint analysis. Combined with research focusing on other types of hunting, recreational land use information, and alternative waterfowl management scenarios, this study can contribute significantly to Louisiana waterfowl resource management.

The empirical results derived from the survey and the rating model indicated that the variables reflecting daily bag limit and the length of the hunting season have the greatest impact on the respondents' rating preferences for a particular hunting trip vignette. Respondents were very sensitive to the restrictive factors that were affecting their hunting opportunities.

One reason for the decline in the number of duck hunters appears to be the restrictive institutional factors that hamper hunters' hunting opportunities. In addition, the cost of duck hunting has increased, further discouraging hunters. Of particular interest to landowners is the income potential from leasing land for waterfowl hunting. With a decline in duck hunter population, less land may be leased for recreation access. Landowners may lose incentives to invest in improving wetlands as waterfowl habitat which in turn may cause further damage to wetlands. The congestion factor estimated in this model also indicated that respondents, in general, are willing to pay more to hunt on private lands and clubs compared to open access public lands. The survey responses also indicated that respondents preferred to hunt on lands with low congestion rates and with friends.

Results from this study should provide public waterfowl managers and private resource managers information concerning the demand for services at private and public sites. The congestion factor evaluated in this analysis indicated that duck hunters preferred to hunt on hunting sites that are less congested. Survey respondents reported a willingness to pay more to have a lower congestion rate. Also, the results of this study provide valuable information concerning travel time and cost for

representative hunters. This information may be useful to decision makers considering further acquisition of land for waterfowl hunting or private landowners considering leasing forest or agricultural land for recreation access.

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