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An analysis of the Iowan angler's fishing license renewal decision

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An analysis of the Iowan angler's fishing license renewal decision

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CHAPTER I

OVERVIEW

Objectives

The objective of this research project is to explore the demographic and geographic composition of the resident recreational angler population of Iowa and identify factors which influence the annual resident fishing license holder's renewal decision. The primary goal of the project is to develop an effective model to capture these factors as they relate to the renewal decision. The data for the model will come from the Iowa Department of Natural Resources (DNR) license database. It is expected that the amount of fishing opportunities readily available to an angler will have a positive effect on their decision to renew their fishing license. Access to fishing opportunities will be represented by the acreage of lakes and mileage of rivers within 25 miles of the angler's home. Other factors which are expected to have significance include the angler's fishing license purchase history, whether he or she additionally have purchased trout or hunting licenses, and demographic traits such as age and gender.

The number of annual resident fishing licenses sold in Iowa has declined over the past five years and the DNR is focusing resources on reversing this trend. Therefore, this project's findings will be analyzed with the interests of the DNR's marketing and fisheries management goals of the Iowa DNR in mind. The secondary goal of this project is to provide the DNR with background and recommendations for a survey to obtain Iowan angler motivations and place a meaningful economic value on the state's recreational fishing resources.

Statement of the Problem

The DNR has faced a steady decline in resident fishing license sales over the past 25 years. In recent years, annual sales fell by 51,050 licenses, a 14.4% decrease from 1999 to 2004 (see Figure 1.1). The budget of the DNR's Fisheries Bureau, which is responsible for providing access to public fishing areas, controlling species, and stocking fishing waters, is tied directly to the revenue provided by fishing license sales (Iowa DNR 2006). The resulting revenue problem for the Bureau is exacerbated by the fact that each license not only provides revenue from its sale price, but also affects the amount of money the Fisheries Bureau receives from the Federal Aid in Sport Fish Restoration Act, also known as the Dingell-Johnson Act (U.S. Fish and Wildlife Service 2006). The total revenue lost from each license unsold is about $25.

If license sales continue to decrease, projects to improve public water access and the maintain quality fish stocks will be limited, further worsening the prospects of recruiting and retaining the state's anglers. This is a main concern of DNR fisheries research supervisor, Don Bonneau, who has asserted that the stabilization and recovery the resident fishing base, and the concurrent revenue they generate for the state, is crucial for the wellbeing of recreational fishing in Iowa.

In reaction to declining fishing license sales, the DNR's marketing specialist, Julie Tack, has been working in conjunction with the Recreational Boating and Fishing Foundation (RBFF) on a joint marketing program encouraging families and lapsed anglers to go fishing. The *Take Me Fishing* campaign in Iowa has been focused in the Eastern Iowa "Technology

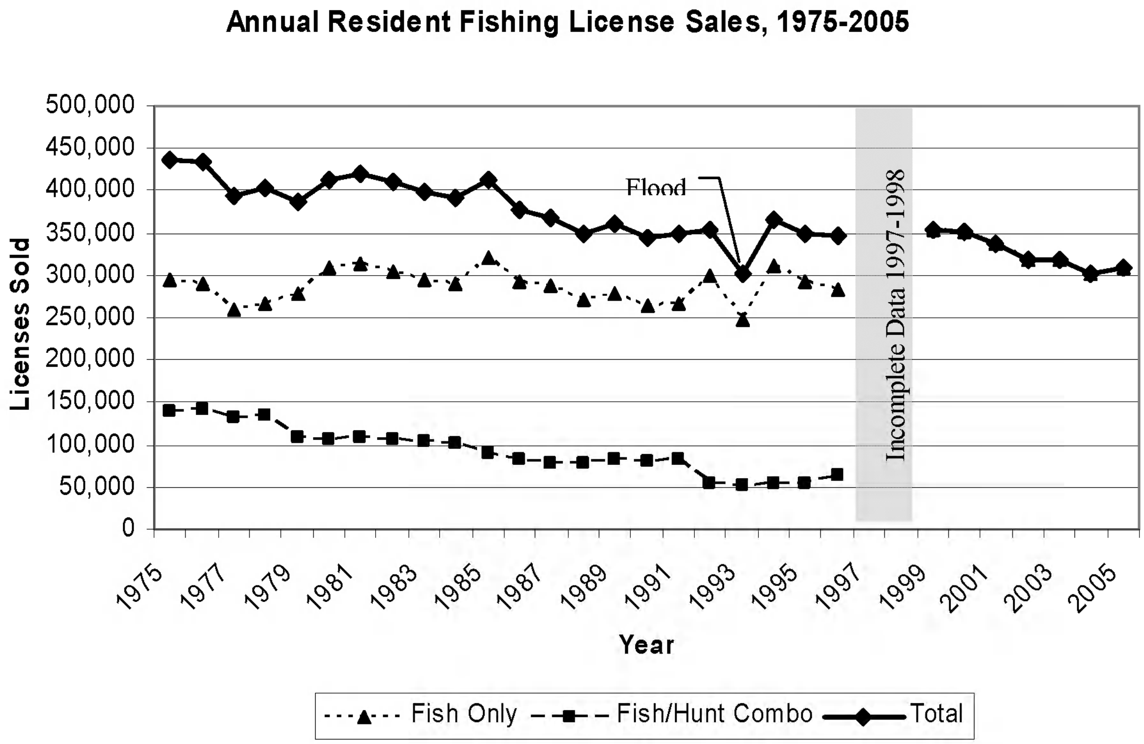

Figure 1.1. Resident Fishing License Sales, 1975-2005

Corridor" comprising of Black Hawk, Linn, and Johnson counties. The campaign has utilized direct mail, radio, and retail advertising, in addition to national cable television spots. To investigate the effectiveness of the campaign, license sales of targeted anglers were tracked and customers were grouped by the angler's license purchasing habits over the previous three years (i.e. a group may comprise of those who purchased a license in 2003 and 2004 but not 2005).

The renewal rates of groups in the targeted counties were compared to those in control counties of similar demographic makeup that were not exposed to *Take Me Fishing* advertising. Analysis of the campaign's effectiveness yielded reports of mixed results. License sales in the targeted counties did increase but campaign awareness surveys reported that the campaign did not significantly affect the decision of targeted anglers to purchase a fishing license (Fedler 2006). The Iowa DNR's Communications Bureau is in charge of marketing fishing licenses and would like to acquire a better understanding of the factors which affect the fishing license renewal decision so they can execute efficient marketing campaigns with their limited resources.

The research that the DNR has conducted with regard to angler preferences and demographics is relatively sparse and outdated. Iowan anglers were surveyed in studies funded by the DNR in 1986 (IMR Systems 1987) and 1994 (Center for Social and Behavioral Research 1995) but more recently the DNR has relied on third-party sources such as the U.S. Department of the Interior's National Survey of Fishing, Hunting, and Wildlife Associated Recreation (2003) for angler data. While national studies, research done by consulting firms for fishing lobbyists, and academic recreational fishing literature all have value and can be generalized to the Iowa angling experience, a detailed new study of Iowan anglers is badly needed.

Identification of Possible Solutions

There are a number of immediate actions the DNR could take to stabilize revenue including: [1] changing the price of the resident annual fishing license, [2] lobbying for alternative sources of government funding, or [3] expanding the range of marketing communications to the entire state. Unfortunately, the first two options are not viable in the short-term given political constraints. Tack believes a price increase on fishing licenses [1] would be difficult to execute given that fishing license prices were last increased in 2003 and changes in license prices must be approved by the state legislature. However, in May 2006 the

Iowa General Assembly passed a mandate in the appropriations bill that created a Sustainable Natural Resources Funding Advisory Committee (2006). The committee is exploring the viability of different methods of sustainable funding in order to provide a main source of funding for the DNR outside of the state's general budget. They are expected to present their findings and recommendations to the state appropriations committee during the next legislative session in January 2007. This leaves the possibility for alternative sources of fisheries funding [2] lying in the future rather than the present.

The other option for stabilizing falling fishing revenues is expanding marketing communications [3] in an effort to increase the angler base. Tack notes that the DNR is already operating under a strained marketing budget, so they must efficiently target customers with the highest probability of renewing their fishing license. In order to accomplish this, the DNR must reevaluate their approach to customer analysis. Therefore, I will present in this paper three distinct levels of analysis. Given existing data obtained from the DNR, I am able to carry out a basic analysis of the population, as well as development of a probability model for the license renewal decision. However, I can only make recommendations for the deepest level of analysis presented, a detailed survey of both anglers and non-anglers in Iowa.

Basic Analysis of Present Fishing Population

A basic analysis of the customer is a clear place to start when dealing with declining sales in a market. As I've cited, the state lacks recent data on the motives or preferences of anglers, so analysis of the fishing population must be based on the demographic data that is readily available. The DNR maintains an extensive license transaction database of individual-level customer data including address, sex, and date of birth. This demographic data can be matched up with each customer's purchasing history for all DNR privileges back to 2002, including hunting licenses and trout stamps. This will prove to be very useful later in this project when I develop a model to predict the license renewal decision.

A portion of the demographic data contained in this database can be compared with data collected by fishing surveys commissioned by the DNR in 1986 and 1994. Since the current database contains individual data for the state's entire licensed fishing population, there is a negligible amount of error in our current data compared to the 1986 and 1994 surveys in which each survey respondent represented 130 and 117 state anglers, respectively. A frequency analysis of updated angler data will allow us to make some general qualitative observations about changes in the demographic structure of state's angling population.

In a basic analysis of the Iowan angler will also want to review government and academic publications for studies that develop our knowledge of angler motivations. Many articles in this line of interest are available that may be applied to Iowa's anglers in general and I will refer to some of them in the next chapter. I will perform the basic analysis described above as part of this project but it is an incomplete resolution to our problem. There is much more we can do to investigate the data and provide recommendations with a solid statistical foundation.

Model for the fishing license renewal decision

Even without having all of the relevant data to model the demand for fishing licenses we can study the data we do have to see how demographic factors relate to a customer's license purchasing history. From this type of analysis it will be possible to identify groups of customers who may be more or less likely to renew their license based on their shared characteristics. These groups can then be targeted with customized marketing materials tailored to these significant traits.

Going one step further, a model can be developed to predict the probability of a given angler renewing their license based on demographic variables. To provide more explanatory variables for our model, we can utilize the customer address data to capture geographic factors such as the mileage of rivers and acreage of lakes within a short-drive for the customer. The DNR could use this type of model to predict how the amount of annual fishing license renewals may change given an addition to the State of Iowa's inventory of Class B Non-Limited Resource Lakes or the successful recruitment of a given number of anglers from a given demographic.

Conduct a detailed survey of Iowans angling motivations

Calvert's (2002) motivation model for sport fishery management tells us that angler motivations drive their behavior and satisfaction of these motivations will increase demand for licenses and trips for fishing. For the DNR, a big step in the process of turning around the declining fishing license sales trend would be to gather more information about the angling population's motivations for fishing in Iowa. It will only then be possible to develop marketing materials and fish management plans in accord to the recreational demands of Iowa's anglers.

Besides asking for angler motivation data, a well-timed, in-season survey could capture site visit and catch data, as well as determine willingness to pay values. From this the DNR could develop welfare calculations (Phaenuf *et al.* 2000), site choice models for water quality advisories (Jakus *et al.* 1998), or an optimal license pricing model. This type of survey with the appropriate accompanying analysis would not only be a valuable tool for marketing and fisheries management but also as support for the DNR to leverage their political wills. Statewide value and willingness-to-pay statistics are far more likely to drive political action than qualitative assertions, according to the DNR's Communications Bureau Chief, Kevin Baskins.

CHAPTER II

BACKGROUND AND REVIEW OF CONCEPTS

Fishing in Iowa

History of Fishing and Fish Management

Iowa has a rich heritage of outdoor recreation, especially in the activity of sport fishing. Its importance is illustrated in the state's history of fisheries management (See Figure 2.1). The state government has had laws and regulations in place to protect the quality of fishing since the 9th General Assembly passed the first season limits law in 1862 (Harlan *et al* 1987). In 1874, the legislature appointed a Fish Commissioner and formed a joint standing committee to oversee fish and game issues. It was this same year that the state's first hatchery near Anamosa, Iowa. Management practices were fairly simple from this time up until the depression-era and consisted of removing competitive species from the waters and stocking hatchery-grown species that Iowans preferred.

During the 1930's Iowa experienced what DNR Fisheries Management Supervisor, Marion Conover, described as a breakthrough modernization of fish management (Harlan *et al.)*. In 1932, the nation's first Cooperative Fish and Wildlife Research Unit was established at Iowa State University (then Iowa State College). One year later, a Twenty-Five Year Conservation Plan was presented to state congress by the Fish and Game Committee. The plan recommended statewide surveys of fish species and habitat, improvement of 60 lakes statewide, and the construction of 30 man-made recreational lakes in southern Iowa. The author of the plan, Jacob R. Crane Jr., recognized the importance of geographic location in recreational access planning. He suggested that the artificial lakes be spaced 40 miles apart "in a fairly even geographic distribution, and the distribution must also recognize the prospective tributary population, the present fisheries situation, and a proper relationship to other project such as existing lakes, state parks, and preserves, etc." (Crane Jr. and Walcott 1933)

In 1935, the State Conservation Commission (SCC), a precursor to the DNR, was founded and proceeded to carry out the proposals from Crane Jr.'s Twenty-Five Year Plan. The execution of the plan shared many of the same funding concerns that the DNR faces today. There were ideas put forth of raising license and state park user fees or using gasoline tax money to support the plan but in the end the proposal was primarily financed out of the state budget. Crane Jr. estimated it to be completed in whole "if once a year each family in Iowa contributed 50 cents… a most reasonable figure." The accomplishment of the Twenty-Five Year Plan and the formation of the SCC has easily been the most ambitious and successful conservation initiative in the history of Iowa. It transformed the way that fish populations were managed in Iowa, using sound biological principles in the place of indiscriminate fish stocking and species removal. This initiative has helped conserve the quality of fishing to present day. Following this advancement in state recreation, the SCC wanted to inform Iowans about their new fishing resources. The 1951 publication of the extensive fishing handbook, *Iowa Fish and Fishing*, represented a unique venture for a public conservation entity. Jim Mayhew, former chief of the Fisheries Bureau at the DNR and co-author of the 1987 edition of the book, said its principal aim was to "help our citizens enjoy more fully the fishing opportunities offered in this state and to understand more about our aquatic environment." The book featured chapters

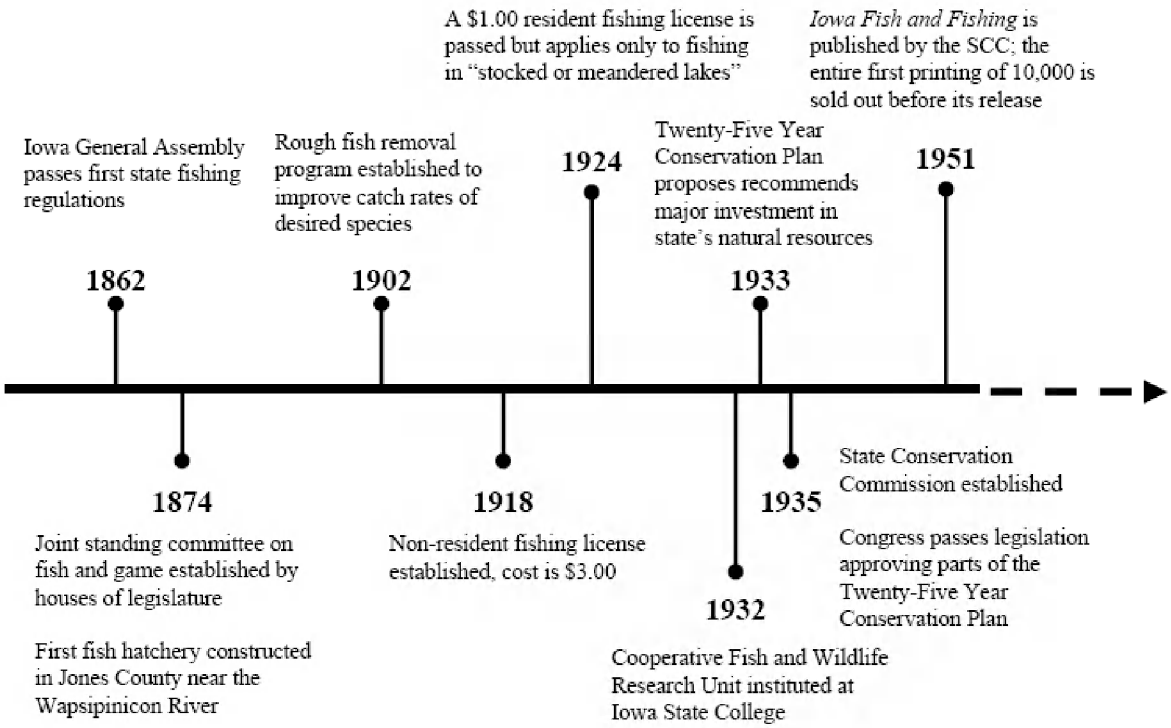

Figure 2.1. History of State Fisheries Management, 1862-1951*

about places to fish in the state, species-specific fishing techniques, and 63 illustrations of species for identification.

The publication was very well received by anglers and fish scientists alike. In the ichthyology journal *Copeia*, Raymond E. Johnson from the Minnesota Department of Conservation reviewed the book and noted the quality of its species illustrations as "excellent reproductions" (1951). He also called the color illustrations of black bullhead and channel catfish "nearly perfect reproductions of the fish in prime condition." Although the landmark

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* Sources: Crane Jr. ; Harlan and Speaker, 1951; Comparative Fish and Wildlife Research Unit, 2006

publication is now out of print, selected parts of the book are reprinted on the DNR's website (2006).

Since the establishment of the SCC in 1935, fish management in Iowa has been focused on angler education, appropriate stocking practices, and improving access and water quality at lakes and rivers throughout the state. In 1986, The SCC was reorganized to its current form as the DNR and has not strayed from these goals. The DNR has tracked anglers by using instruments such as surveys, creel counts, and focus groups. They have also relied on third-party sources for information about anglers. From an analytic perspective, these sources of data are not sufficient for developing an econometric model, however these data give us background knowledge for model development.

Background from Surveys of Iowan Anglers

Five surveys of Iowans over the past 23 years give us insight into the factors driving angling participation in Iowa:

- A mail survey conducted in 1983 in a communications thesis by Karen Babcock Grimes at Iowa State.
- Two phone surveys conducted in 1986 and 1994 specifically to gather data about fishing. Both were funded by the DNR.
- A 2001 national wildlife-related recreation phone survey conducted by the U.S. Department of the Interior, with isolated statistics for Iowa.
- The Iowa Survey for the State Comprehensive Recreation Plan (SCORP) phone survey conducted in 2006 by Responsive Management for the DNR.

While these surveys were not carried out using identical methods, the authors of each make claims to using universally accepted contemporary practices for data collection and analysis. We can then make some cautious observations from a comparison of these surveys.

Demographic and resource usage estimates may be simplistic figures but they tell us some of the most important facts the DNR wants to know: how many people are fishing, who are they, and how often they are doing it. We compare this data from the DNR's fishing surveys in 1986 and 1994 and the 2001 U.S. Department of the Interior survey in Table 2.1. I have also included survey estimates for the number of fish caught in Iowa as well as the estimated expenditures by anglers in inflation adjusted dollars, which was calculated in two of the three surveys.

From the survey data it is confirmed that the number of anglers in Iowa is declining, but slowly. The 2001 U.S. Department of the Interior estimate is much higher than license sales indicate because it includes all anglers age 15 and older. Annual license sales in Iowa do not account for anglers who do not require a license or lifetime license holders. It also fails to capture those who fish illegally, which has been estimated at 19% of anglers in Alabama (Hyde *et al.* 1998). If we take non-licensed anglers in to account, the 2001 estimate by the U.S. Department of the Interior is probably accurate. Angler demographics show that the disproportionate amount of men to women anglers has not receded in the past twenty years. Age distribution has also held fairly steady with half the anglers falling in the 30-49 age group. All of these measures will be updated in this project using the 2002 and 2005 licensed angler populations, which will give us the true demographic distributions, as opposed to survey sample estimates.

Table 2.1. Comparison of Iowa Angler Surveys

Year	1986	1994	2001
Administrator	IMR Systems, LTD.	CSBR, University of Northern Iowa (UNI)	U.S. Dept. of Interior, FWS
Sample Size	3000	3104	792
	Resident Anglers (* Licensed Only)		
Total	389,000 *	364,246 *	471,000
	Sex		
Men	70%	78%	75%
Women	30%	22%	25%
	Age Distribution		
16-29	22%	16%	23%
30-49	50%	54%	49%
50-64	26%	24%	17%
65+	2%	6%	11%
	Days Fished		
Total	11,878,647	8,726,770	7,048,000
Angler Mean	30	24	15
	Fish Caught		
Total	34,181,662	39,835,081	NR
Angler Mean	88	109	NR
	Expenditures (inflation adj. 2006 $)		
Total	$115,940,000	NR	$172,290,000
Angler Mean	$298.05	NR	$365.80

The resource usage statistics indicate a strong trend of anglers spending less days fishing but catching more fish on each trip. With improvements being made to fishing stocks, water quality, and availability of resources (access and man-made lake construction), the increased catch rate makes sense with improvements in fishing technology and less quantity demanded for days fishing. However, we might suspect that increased annual catch rates may not necessarily equate to a significantly higher median individual catch as both the 1986 and 1994 surveys indicated found that 50% of the population caught 25 or less fish, though 5% more anglers caught 100 or more fish in 1994 compared to 1986.

Grimes' 1983 survey, the two DNR-funded fishing surveys, and Responsive Management's 2006 survey all give us indicators of fishing motivations and preferences for Iowans. Some of the basic preferences of Iowans we are concerned with are preferred species of catch and body of water. These are important for proper management of the state's fisheries. We also want to look at motivations or social preferences for fishing that could be utilized for marketing or public education. Trip-related decisions such as how often anglers decide to fish, how far they travel, and whether they use a boat have relevance in both fishery management and marketing.

The 1986 and 1994 surveys reported that lakes are the most preferred fishing resource in Iowa by about 40% of anglers, followed by inland rivers and streams at about 20%, farm ponds at 15%, and the Mississippi River at about 15%. Federal reservoirs, trout streams, and the Missouri River are all preferred by less than 5% of anglers. The types of fish most preferred by anglers in these surveys included catfish, largemouth bass, walleye, crappie, and bluegill.

Grimes found in her survey that Iowans overwhelmingly prefer to fish with a social group such as friends or family, with 42% of men preferring the former and 80% of women preferring the latter. Only 12% of men and 2% of women preferred to fish alone. She also found a positive correlation between frequency of fishing license purchasing and whether a respondent fished when they were a child. These results reaffirm the strategy of the DNR's current marketing campaign, *Take Me Fishing*, which encourages family fishing.

The number of fishing trips taken within state boundaries gives us a general idea of how much demand there is for fishing. As mentioned earlier, the annual amount of days fished by Iowans has been decreasing. In the 1994 survey, 42% of all anglers said they are fishing less often than 10 years ago, 72% of these anglers reasoned that the decline in fishing activity was because they "don't have enough time." Responsive Management's 2006 survey found that 48% of respondents who wanted to participate in river fishing in the previous two years but did not chose "not enough time" as their main constraint. Thirty percent of those who wanted to participate in lake fishing but did not used the same reason. Clearly, recreational fishing is losing demand to time constraints though we do not know if Iowans are substituting other recreational activities or simply have less leisure time available.

The U.S. Department of the Interior's survey found that 95% of fishing trips within the state are one-day outings. This corresponds with the 1994 survey finding that 93% of trips are within 100 miles of home and 66% are within 25 miles. The same survey reported that 52% of fishing days are by boat and 61% of anglers fished at least once by boat in the previous year. This was a significant increase from the 1987 survey which found that 35% of fishing days were by boat. Fishing by boat is arguably more time-intensive than finding shoreline water access, so it may be that anglers are taking longer trips less often, such as a full weekend day fishing from boat as opposed to fishing from local stream bank after work. This would be a valuable item to investigate as part of a recreation demand survey.

The motivations and expectations of Iowan anglers have not been extensively studied but some data were collected to this regard in the CSBR survey of 1994. The respondents were asked how important a particular outcome was to fishing on a one-to-five scale, with one being very unimportant and five being very important. Catching and releasing fish (3.57) was found to be more important than keeping and eating fish (2.98). Actually catching fish was moderately to very important for 76% of anglers but slightly less were concerned with catching a particular species of fish (63.2%) or size of fish (68.8%). This is an area where more information needs to be gathered to, at the very least, compare Iowans motivations and expectations to those found in other surveys and academic literature.

Literature on Angler Motivations, Behavior, and Expectations

In Calvert's sport fishing dimensions model (see Figure 2.2), an angler's motives for fishing drive their behavior, which can be interpreted as their demand for fishing in the form of purchasing a license, number of trips, etc. Their experiences from their behavior and resultant fulfillment of expectations determine some arbitrary level of satisfaction. The angler then adjusts their motivations for fishing and the cycle is renewed.

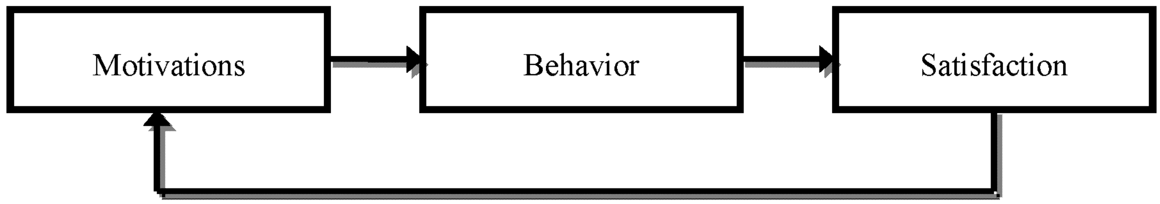

Figure 2.2. Calvert's Sport fishing Dimensions Model (2002)

Calvert argues that angler motivations can be broken down into catch and non-catch factors. Catch motives include simple fishing outcomes such as testing new gear or improving skills, as well as catching fish to keep for food or trophy. Non-catch motives can be broken down into personal factors like relaxation and companionship, or environmental factors such as water quality, access, and weather. The DNR can control the sources of some of these motivational factors like water quality and fish availability and can promote others like family closeness and relaxation. However, they will inevitably have no control over the weather or the intrinsic value from the thrill one feels when their line pulls taut.

Interestingly enough, a portion of the literature suggests that avid anglers are more motivated by non-catch aspects of the fishing experience than catching certain types or sizes of fish. Bryan (1977) noted in his study that novice anglers are generally unconcerned with the environmental setting and more focused on catching fish. An important study conducted in 1986 by Fedler and Ditton reinforced Bryan's findings. They classified anglers in as low-, mid-, or high-consumptive based on their daily take. They found that low-consumptive anglers were primarily concerned with non-fishing aspects of their trips and were more satisfied with their trips than mid- and high-consumptive anglers who placed a much higher priority on catching fish.

A review conducted by Holland and Ditton (1992) of eleven different studies on angler satisfaction found that in general, appreciation of nature, relaxation, and escape are more valued than catching fish.

Calvert and Williams (1999) studied anglers vacationing in British Columbia and found low-consumptive anglers to have more fishing experience, take longer vacations, spend more money on their trip, and be more satisfied than high-consumptives. These anglers also were more likely to support strict fishing regulations. The idea to take from these numerous studies is that novice or high-consumptive anglers are more likely to be frustrated and dissatisfied by their fishing experience if their catch quantity or size doesn't meet expectations. Graefe and Fedler (1986) support this notion as they found that catch in relation to expectations is extremely important to the satisfaction of the angler.

To relate findings of academic literature to the Iowa experience, we can refer to Baskins, who sat in on focus groups comprised of lapsed anglers which was administered in Eastern Iowa in 2006 by the DNR. The focus group participants repeatedly claimed that they felt fishing in Iowa was subpar and that they were disappointed with how many fish they caught, or rather, did not catch. The misalignment in motivations and satisfaction of consumptive anglers in Iowa may explain the high lapsed license purchasing rates that the Iowa DNR presently faces, though this remains to be tested.

Since an angler's behavior, including the purchase of a fishing license, is reinforced by satisfaction of one's motives, the DNR should pay close attention to how sated Iowan anglers are. Recent data shows that satisfaction is high but has some room for improvement. The SCORP survey in 2006 found that 57% of anglers were very satisfied with lake fishing and less than 7% of anglers were dissatisfied with any given fishing activity. A slightly different measure used in the 1987 and 1994 surveys of Iowan anglers found that roughly 80% felt they were "getting their money's worth" from their fishing license. With 183,599 lapsed anglers in 2005, that is, anglers who purchased a license in 2003 and/or 2004 but not in 2005, a marginal increase in angler satisfaction and retention would translate into a significant increase in license revenue.

Literature on Resource Value and Recreation Demand

Types of Value

When analyzing license data with regard to lapsed anglers and license renewals, we begin to start thinking about the true demand for recreational fishing. While the data utilized in this project alone is not enough to derive a model for fishing demand, it does give us some background for execution of a study that may appropriately do so. Deriving the demand for fishing, as opposed to the demand for renewing fishing licenses, allows us to make an estimation of the value of Iowa's fisheries beyond that of angler expenditures. However, there are many ways to measure resource values so we will first review how the economic and ecological literature has addressed the concept of value.

Pitcher and Hollingworth (2002) capture the fundamental duality of the value problem with respect to recreational fishing. They stress that it is important to distinguish between values obtained by summing the various market transactions that are connected to recreational fisheries and value as perceived by the angler. The former can be measured by simply summing market transactions from license fees, travel costs, fishing equipment sales, etc.

Perceived angler value can be measured from revealed (observational) or stated preference (hypothetical) studies that estimate social welfare obtained from the existence and use of fishing resources. Welfare measures incorporate market values and nonmarket values alike, including value from the social aspects of fishing (family building, camaraderie) and ecological protection of the resource.

These different measures of value also have different applications. A transactional measure of value may be utilized for evaluating policy or measuring the impact of recreational fishing on the local economy. An example of this could be using transactional value to evaluate excise taxes from fishing equipment or recreational vehicles, such as those in the Dingell-Johnson Act and the Wallop-Breaux Amendment. Alternatively, social welfare estimates are more useful in evaluating management decisions such as choosing where to make access or water quality improvements.

Economic Foundation for Measuring Welfare

In order to determine the appropriate demand and values for environmental resources we must employ some commonly accepted methods from the economic literature. These resource evaluation techniques are grounded in basic economic theories of welfare measurement. Our treatment of these theories comes from Varian (1992) and Freeman III (2003) but many other acceptable sources are available. The framework of welfare measurement is developed around a relatively simple set of assumptions about an individual's preferences:

- An individual who prefers one bundle of goods over another will receive more utility from the bundle he or she prefers.
- An individual knows their own preferences for goods and services and can rank these preferences accordingly.
- Individuals exhibit non-satiation of goods; more of any good or service is always better.
- Individuals exhibit substitutability between goods. That is, if an individual has x apples and y bananas and we take away some of the apples, there will be some number of bananas that the individual can add to his or her bundle to keep his or her welfare the same. Money can act as a proxy for this trade-off ratio.

From our assumptions we can construct a basic model for utility. In our model we will include three variables that determine an individual's welfare: market services and goods (X), a fixed bundle of public services and goods including environmental and resource goods (Q), and time spent in utility-generating activities (T). Utility is a function of these three variables and is increasing under partial differentiation with respect to each variable.

$$u = u(X, Q, T), \tag{2.1}$$

where $\frac{du}{dX} > 0, \frac{du}{dQ} > 0, \frac{du}{dT} > 0.$

This equation is maximized by the individual subject to his or her fixed income of M, requiring chosen quantities of each individual good x_i, contained in the vector X, and the given prices p_i

for each good, contained in the vector *P*. By substituting in expressions for the x_i*'s* as functions of *P* and *M* we obtain the indirect utility function (equation 2.2). In using this substitution, we are still able to obtain each x_i expression by using Roy's Identity, shown in equation2.3.

$$u = v(P, M) \tag{2.2}$$

$$x_i(P, M) = -\left.\left(\frac{dv}{dp_i}\right)\middle/\left(\frac{dv}{dM}\right)\right. \tag{2.3}$$

At this point it is useful to construct the dual of utility maximization under an income constraint. This is the minimization of expenditures, *e*, under utility constraint, u^0, shown in equation 2.4 and it allows us to derive what it called the Hicksian or compensated demand h_i for x_i (equation 2.5).

$$e = \sum_{i=1}^{n} p_i \cdot x_i \equiv e(P, u^0) \tag{2.4}$$

$$h_i = \frac{de}{dp_i} \equiv h_i(P, u^0) \tag{2.5}$$

The Hicksian demand equation essentially gives us the quantity consumed by an individual at different prices, where income is adjusted to maintain constant utility. We now have developed a way to measure how an individual will adjust demand in response to changes in price and income. Since this has been derived from our ordinary demand equation for utility in equation 2.1, we are able to calculate measures of welfare change for any number of scenarios where an individual's circumstance is adjusted.

The measures of welfare we are interested in are *compensating variation* (CV) and *equivalent variation* (EV). Compensating variation measures the amount of income needed to prevent a utility change, that is, to make one indifferent to a price change in some good *x*. Our measure of CV is equivalent to the minimum amount of money the individual is *willing to accept* (WTA) in order to take a price increase in *x*. Alternately, CV is also the maximum amount of money the individual is *willing to pay* (WTP) in order to obtain a price decrease in *x*.

$$u^0 = v(P', M) = v(P'', M - CV) \qquad (2.6)$$

$$CV = e(p_1', p2, u^0) - e(p_1'', p_2, u^0) = M - e(p_1'', p_2, u^0) \qquad (2.7)$$

Equivalent variation places a dollar value on a change in utility. EV is the amount of income we must give a person in order to reach an increased utility level u^1 that may otherwise be obtained by a price decrease for some good. This can also be expressed using our indirect utility function from equation 2.2.

$$u^1 = v(P'', M) = v(P', M + EV) \qquad (2.8)$$

$$EV = e(p_1', p2, u^1) - e(p_1', p2, u^0) = e(p_1', p2, u^1) - M \qquad (2.9)$$

Another way we can measure welfare changes is to employ quantity or quality changes as opposed to price changes for some good. This is relevant for our situation because it provides a value for non-market goods such as public recreation sites. When referring to a quantity change situation we use measures of *compensating surplus* (CS) and *equivalent surplus* (ES) which are derived in a similar fashion as CV and EV but with changes in quantity substituted in for changes in price. CS is essentially the maximum WTP for a change in quantity while ES is the WTA compensation to avoid a change in quantity. Quality changes may serve a role in the demand equation but only when we take care in the way that it is measured. Quantitative measures of quality such as dissolved oxygen levels for water quality or number of access points along a river segment are preferred for legitimate computation of CS and ES. These are important details that must be attended to when conducting studies to capture welfare values.

Obtaining Recreation Demand and Value

Estimation of the increased well-being that anglers derive from the fishing experience can be inferred either from observing actual behavior or by conducting a survey of angler preferences. The former method, labeled revealed preferences (RP), collects real-world data on property values or trips and expenditures to recreation sites and incorporates the information in to an appropriate demand model. The latter method of surveying anglers is known as stated preferences (SP) and involves asking questions carefully constructed to reveal information about the respondent's values. There are a number of models that use either RP or SP data to obtain a user's utility from recreation but we will focus on two of the more commonly used ones, the *travel cost model* and the *random utility model*. We will review these utility models in a simplified form as presented by Freeman III so that we have some exposure to the economic framework behind recreation demand research.

A typical study for determining existing demand for a fishing site might utilize the travel cost model. In this method, the number of visits to a recreation site is paired with the costs of traveling to the site and the opportunity costs of visiting the site. When expanding to a multiple site model, attributes of each site included in the model are collected to represent the quality of the site. Vaughn and Russell (1982) provide a list of defining site attributes that they argue should be included in any cross-sectional site analysis. These attributes include the type of water body, accessibility of the site, acreage of fishable waters, average number of fish caught per day, average total weight of fish caught per day, and a number of other lesser factors. The resulting multiple site model is a system of equations all individuals *i* and each site *j*, where for each site the demand equation is specified as

$$r_{ij} = r_j\left(p_{r_{ij}}, p_{r_{ik}}, M_i, q_j\right) \tag{2.10}$$

where *k* indicates alternatives to site to *j* and q_j serves as a value for the quality of site *j*. Freeman III notes that it is difficult in a travel cost model to separate the effect of differences in travel costs to each site from the effect of the different levels of quality attributed to each site. This has led to the use of random utility models for multiple site analysis though the travel cost method is an acceptable choice when simply valuing existing sites.

The random utility model uses an indirect utility function which includes travel cost to site *j*, an individual's income *M*, and vectors of socioeconomic characteristics for the individual S_i and site quality Q_j but also includes an error term that is independently and identically distributed among all individual and site combinations.

$$u_{ij} = v_i\left(M_i - C_{ij}, Q_j, S_i\right) + \varepsilon_{ij} \tag{2.11}$$

This specification of utility allows us to determine the probability that an individual with certain characteristics, costs, and income will visit a site with certain quality characteristics out of their entire choice set of sites to visit. It also allows us to estimate the CS value of a change in site quality. A limitation of the random utility model comes from dealing with uncertainty in regard to the random component of the utility equation. For this reason it may not be as well suited as the travel cost model for capturing value of an existing site.

In contrast to the complicated but robust methods of estimation described above, a very simple and direct method of valuation is available by using *contingent valuation*. This SP method simply asks respondents of a survey their maximum WTP for an improvement of a specific environmental resource. This is usually stated either as an open-ended question ("How much would you be willing to pay…?") whose values are directly interpreted as measures of CS, or as referendum-styled question ("Would you be willing to pay $X…?") from which a WTP or indirect utility function can be constructed. The validity of values obtained from these contingent valuation methods are a source of controversy, as survey credibility, compatibility with economic theory, and competing methods of data analysis all major points of contention. Hanemann (1994) provides a review of the issues surrounding contingent valuation and outlines steps that researchers can take to acquire reliable survey results.

We've covered a wide array of models and methods for measuring recreational demand. The measures we can now obtain go beyond simply summing up an angler's receipts from fishing expenditures; they take in to account an individual's values for the sport, nature, and social interaction as well. Contingent valuation studies are used by governments all over the world, the U.S. military, and the World Bank (Hanemann). Travel cost models provide an excellent measure of how anglers choose and value different recreation sites and random utility models give insight into how changes in resource or site quality affect demand and value. While the model developed in this paper focuses on license purchasing and derives no measures of utility, understanding how Iowans value resource availability and quality will allow the DNR to manage resources more efficiently and may be a key driver for license demand. We will investigate how availability of quality resources affects license demand in this paper's model but let us first review some recently completed and continuing research on recreation demand and valuation in Iowa.

Research on Recreation Demand in Iowa

Kearney (2002) suggests that "if the real value of fisheries is social then management should reflect social benefits." Therefore, the DNR should study the social welfare derived from the state's fisheries. They should also measure the willingness to pay for increased quality of fishing at different public sites throughout the state. The Center for Agricultural and Rural Development at Iowa State University has recently conducted a number of studies with respect to these measures, including surveying recreational use of Iowa wetlands (Azevedo *et al.* 2000), examining the role of water quality in recreation demand at Iowa lakes (Egan *et al.* 2004), and measuring WTP values for preservation and quality improvements at Clear Lake (Azevedo *et al.* 2001). A large portion of this research has stemmed from the Iowa Lakes Valuation Project, a current five-year venture which is jointly funded by the Environmental Protection Agency and the DNR.

There have been many encouraging findings from this recent body of research on Iowa lakes. For our purposes, the preliminary results from the 2004 working paper by Egan *et al.* are of the greatest interest. These researchers developed a random utility model using the mixed logit statistical procedure. The model estimates are derived from recreational trip and socio-demographic data collected from 3,859 households in the 2002 Iowa Lakes Survey along with individual lake attributes and water quality measures collected by Iowa State University biologists. Two scenarios compared in the paper include improving all 128 lakes in the study to a superior quality baseline (West Okoboji Lake) and improving nine major lakes distributed fairly equally throughout the state to the quality baseline. The scenarios chosen remind us of the Twenty-Five Year Conservation Plan of 1933's suggestion to attempt to equally space newly created artificial lakes in order to give Iowans a short commute to the closest public recreational site (Crane Jr. and Wolcott). Preliminary findings suggest that the average WTP of the second, more realistic scenario of water quality improvement for nine major lakes is estimated at nearly $40 per household. They also estimate that this quality improvement would increase the average lake recreation trips taken per household to increase by 2.65%. I must stress that this paper has not yet been published and much more survey data has been collected since this preliminary analysis but the initial findings suggest that this research will yield very practical results for the proper management of Iowa's lakes.

A fishing-specific social valuation of Iowa's water resources has not been attempted but may be possible for the lakes included in the Iowa Lakes Valuation Study. For the DNR, inclusion of fishing as part of total recreational demand is acceptable given the department's mission to "enhance natural resources… and improve quality of life for Iowans." (Iowa DNR

2006) Major problems with regard to site choice sets would result from a statewide valuation of fisheries due to the significant amount of fishing done on rivers, streams, and farm ponds. It would be a costly and formidable task to collect the trip and resource attribute data necessary to carry out a study of this magnitude. There would also be problems with regard to breaking up rivers into different segments based on geographic location and changes in quality.

A valuation of the Iowa fisheries is not impossible to estimate but the validity or usefulness of simplified attempts to measure valuation may be trivial. By using a CV survey to estimate WTP for a fishing license, we could obtain the value of recreational licensed fishing for the state. However, this estimate would undervalue the state's resources because of the many demographic groups that are not required to purchase a fishing license such as those under the age of 16, disabled persons, and those who fish on their own private farm ponds. Additionally, the responses from anglers may not be valid, as Kearney has found that many anglers assume they have a right to fishing and that a recreational fishing license infringes on their right to access fishing resources. This view would certainly affect a respondent's WTP for a fishing license though they may have a very high value for fishing in the state.

If we were to complete a study that estimates a total dollar value for the state's fishery, the results may not be very useful to the DNR in its management of state resources. Since we are obtaining our economic values from a utility model that contains market goods, public and resource goods, time spent in utility-bearing activities subject to income and prices, the only items the DNR has control over is the price of a fishing license or the quality of resource goods. An across the board increase or decrease in fishing quality is unreasonable given the separation of resources and the limited range of travel for most anglers, so the DNR cannot truly affect the quantity and quality of fishing resources uniformly on a statewide basis. Therefore, the only rational uses for valuation of state's fishing waters are for setting the price of a fishing license and as a metric for how well the DNR is managing the fisheries.

It is my opinion that it would be extremely valuable for resources management purposes for the DNR to commission single site studies on a case-by-case basis, when it is economically feasible and the decision has extensive consequences on recreation in the area. An example of this is the 2001 Clear Lake study done by Azevedo *et al*. They surveyed residents and visitors to the lake, gathering data on activities and spending with regard to recreational activities at the lake. They then measured the WTP of two different quality improvement levels to the lake for each group of lake users (residents and visitors). The results showed that, on average, respondents would take 6% more trips to the lake with a low quality improvement and 55% more trips with a high quality improvement. WTP levels were also high for this type of study, though there were large margins of error involved in the point estimates. The DNR has been able to use this analysis as part of a larger diagnostic study of Clear Lake, integrating environmental science and ecology with economics to make informed decisions about quality improvements at the lake (Downing *et al.* 2001).

Recreation demand and resource values can be costly and difficult to capture but they give DNR officials an invaluable tool in making resource management decisions. There are positive externalities from these studies as demographic, resource usage, and spending data is collected and can be used for marketing purposes or by local conservation boards in their own planning. In the summary chapter I will provide some recommendations for the DNR to consider for future research.

CHAPTER III

METHODS AND PROCEDURES

Data Collection and Extraction

For our analysis of Iowan anglers we will use the DNR's license database, which includes demographic information and license purchase history for every unique DNR customer from 2002 to present. This effectively gives us the entire residential license purchasing population of 506,956 unique customers from 2002 through 2005. For each customer we have address, sex, and age data in addition to which years they have purchased residential fishing, hunting, and trout licenses. With this primary data we will create secondary variables to identify avid and lapsed anglers. These variables are defined in the next section.

At this point, a simple organization of the data set gives us everything we need to complete a basic audience analysis of Iowa anglers. These results can be compared to the 1986, 1994, and 2001 surveys we have reviewed above. The updated analysis has the advantageous property of representing the entire population of licensed anglers, as opposed to a sample of them as in the previous studies. This limits our sources of error to data entry and forged or invalid license applications.

In order to develop a license renewal decision model that incorporates resource availability, further extraction of information from our dataset is needed. To accomplish this, ArcGIS, a geographic information systems (GIS) software program, was utilized to map customer locations. This process, called *geocoding*, involves matching database addresses to a geographic layer of street addresses (Crosier 2004). Our customer data was geocoded based on an address locator from a layer of Iowa roads created by the U.S. Department of Commerce. The Iowa roads layer comes from the year 2000 and was assembled from county road data extracted from each of Iowa's 99 counties. The geocoding process yielded a 78% match rate, with many of the failures resulting from customer's who used P.O. Box addresses or live on newer roads constructed since 2000. The geocoded customer layer contains 440,367 points, each representing a customer's home addresses.

The newly formed geocoded customer layer gives us a geographic set of data to extract our resource data from. The first action taken with the new set of data was to pair it with a layer created by the U.S. Census Bureau that represents areas classified as "urban" under the Bureau's year 2000 *urban area* and *urban cluster* definitions. These areas include "core census block groups or blocks that have a population density of at least 1,000 people per square mile and surrounding census blocks that have an overall density of at least 500 people per square mile" (2002). ArcGIS allows us to select only points from our geocoded set that lie within the layer's polygons represent urban areas (see Figure A.1). This allows us to create a discrete variable classifying geocoded customers as urban (1) or rural (o). This will be used as an additional demographic variable in our model.

To extract resource access data from the geocoded layer, we recall previous Iowa fishing surveys which found that over 60% of fishing trips are within 25 miles of home. Using this fact, each geocoded customer point is "buffered" with a circle of 25 miles in diameter. While this does area does not bound all fishing trips taken by an angler, it is important to remember that we want to model the decision to renew a fishing license, so the availability of resources which allow an angler to take a short fishing trip at any time is more important to us than trying to include all resources an angler may use during an entire fishing season. A technique called *spatial joining* is used to acquire data from features that fall within each customer's travel buffer.

The Iowa DNR maintains two layers of hydrological surface data that are needed for our spatial analysis. One layer is a 2004 set of geographically referenced Iowa lakes and reservoirs designated as "Class B" under the Code of Iowa's water quality standards. The second layer contains 2004 Iowa river segments that carry same Class B designation. Class B waters are designated by law "to be protected for wildlife, fish, aquatic, and semi-aquatic life uses" and must meet criteria for dissolved oxygen and pH levels, as well as general chemical constituents, toxic chemical levels, and temperature (Iowa Administrative Code Sec. 567.61 2006). Maps of these layers are provided in Appendix A.

We must address a few issues when using these resource layers. To begin, they are an incomplete catalog of resources as they leave out smaller bodies of water such as farm ponds, streams, and smaller lakes that many Iowans enjoy for fishing. Additionally, DNR fishery research specialist Jeff Kopaska stresses that the designation of each water body's quality standards does not necessarily pertain directly to the fishing quality of each resource at any given time (2006). These limitations are countered by the fact that the layer is a pre-existing source of water quality data that pertains to fishing and that the DNR already is required to maintain. The *designated lakes* and *designated rivers* layers act as both cheap and verifiable sources of otherwise resource-intensive data to collect.

The two resource layers were first screened so that they only contained Class B waters and did not include any water bodies classified as a "limited resource." They were then each spatially joined with customer buffer layers; a computationally demanding process. The resource access data is captured in the variables for count of lakes, acreage of lakes, and miles of rivers within the 25 mile buffer of each individual customer. The extracted data will give us the ability to measure the significance and weight of these resource variables in the fishing license renewal decision.

The entire customer data set used in this project was extracted in Microsoft Access and ArcGIS 9 and then exported to SAS 9.1 for statistical analysis. Steps were taken along the way to ensure the integrity of the data and the data set was cleansed to remove incomplete observations before analysis. The final geocoded customer data set contained 440,367 observations (unique customers) and 21 variables. A description of each of the variables is included in the next section.

Measurement of Variables

Below is an overview of each of the variables that are included in our master data set. Many of these variables will not be used in our model in order to keep it parsimonious. Additionally, variables from the year 2005 will also not be included in our model, except for our dependent variable identifying customers who renewed their license in 2005. These variables will be left out because DNR will not have this data for the year in which they are estimating predicted outcomes from the model (see Figure 3.1). However, data from the year 2005 will be used in our basic demographic customer analysis. A table of descriptive statistics for the variables in our data set is provided in Appendix B.

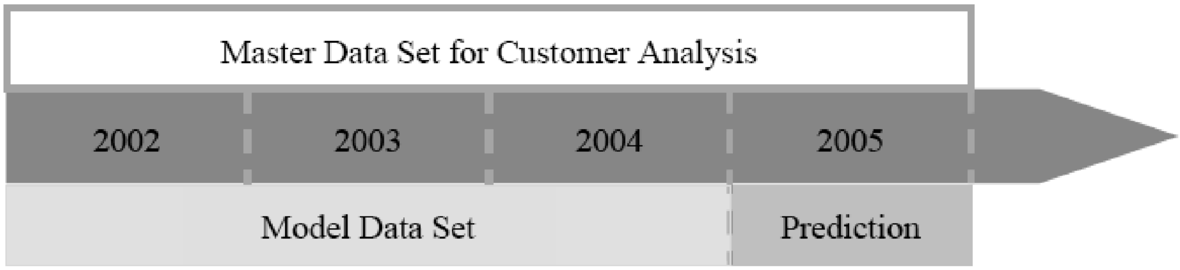

Figure 3.1. Data and Model Timeline

Customer ID

Customer ID was included in the data set for tracking purposes only. It is used by the DNR to follow purchasing habits of their customers and each person has a unique ID that stays with them. All of the other variables attributed to an individual observation are tied to this number.

Address

For each customer an address was collected by the DNR in the form of a street, city, and zip code. Addresses were used in this project to create geographic variables in ArcGIS but were dropped from the final data set.

Gender

Gender is measured as a dichotomous variable for being male, with males coded as a one and females coded as a zero. Gender may play an important role in our license renewal model as females have been historically underrepresented in the fishing population and continue to be so today. Grimes' 1983 thesis at Iowa State provided insight into the motivations of women anglers and made suggestions to the DNR on how to attract more women to fishing. However, preliminary data analysis shows that over 73% of present customers are male. Due to these difficulties recruiting women anglers I hypothesize that a customer being male will have a positive marginal effect on the probability of license renewal.

Age and Age Group

Each customer's birth date is included in the DNR's license database. A continuous variable for age was obtained from this birth date for January 1, 2005, the most recent year of data that is used in the project. Age will be included in the license renewal model and I hypothesize that it will have a positive marginal effect on the probability of license renewal. Additionally, a discrete variable for age group has been created from the age variable. This will be used in our audience analysis to compare the current license population to the reviewed surveys. The age groups are 16-29, 30-49, 50-64, and greater than 65 years old.

Geocoded

This variable is a dichotomous indicator of whether or not the customer's address was able to be geocoded using ArcGIS. A problem that arises from our failure to geocode a considerable amount of the population is that there might be significant differences in demographics or purchase history between those who were geocoded and those who were not.

In comparing the difference in means of each variable for those *geocoded*=1 against those *geocoded*=0, we want to test the hypothesis that the difference in means is equal to zero. This hypothesis was tested for each variable in our data set using Student's t-test. The comparison showed that there are small but statistically significant differences between the two groups for every variable but *fish03*. This is not surprising due to the extremely large size of our samples which resulted in extremely small standard errors for each variable.

All of the variables had less than a 5% difference in the means except for the hunting license purchase variables which showed that customers that were not able to be geocoded were about 10% more likely to purchase a hunting license in any given year. We will proceed with using variables created from our geocoding because geocoded customers make up a bulk of our license purchasing population but we must recognize that there are differences between the two groups.

Urban

The urban variable is dichotomous and indicates whether the customer lives in a designated urban area or urban cluster as defined by the U.S. Census Bureau (2002). Kearney noted the conflict anglers in urban areas may find with respect to competition with others for fishing resources. This could be especially relevant around Des Moines and Iowa City where large reservoirs serve multiple recreational activities for the population of the area. For this reason, I hypothesize that urban will have a small but significant negative marginal impact on the probability of license renewal.

License Purchasing History

Our model will be anchored on a dependent variable for the renewal decision, *renewal05*, which includes all unique customers who purchased a fishing license in the previous three years. If one of these customers purchased a fishing license in 2005, then they are coded as a renewal (1). If they did not purchase a fishing license in 2005 they receive a zero. Notice that the term "renewal" is used loosely here and is contingent not on owning a Iowa resident annual fishing license the previous year but just sometime in the previous three years. If a customer's first fishing license purchase was in 2005, then they will are not included in *renewal05* because their decision was not based on previously owning an Iowa resident annual fishing license.

Annual license purchases are represented in our data set as a dichotomous variable for a customer's purchase of a resident fishing license, hunting license, or trout stamp. We must note that owning a fishing license is a prerequisite to purchasing a trout stamp. There are a total of 12 primary purchase variables in our data set, one for each type of license for year from 2002 to 2005. These variables are named *fish02, fish03, fish04, fish05, trout02, trout03, trout04, trout05, hunt02, hunt03, hunt04,* and *hunt05*. Dichotomous variables named *huntany* and *troutany* were created from these primary variables and are scored as a one for any customer who had purchased a hunting or trout license, respectively, anytime in the previous three years and zero otherwise. These additional variables were formed so that we have more options for independent terms in testing different license renewal models.

Until the late 1990's the DNR offered hunting and fishing combo license that was fairly popular, with anywhere from 15 to 25 percent of total anglers opting to purchase this combination license each year. Therefore, it is reasonable to assume that prior purchase of a hunting license or trout stamp indicates a stronger tie to outdoor recreation and a higher probability of license renewal.

Avid and Lapsed

Related to license purchase history are two dichotomous variables that classify an angler's longer-term purchasing habits. *Avid* anglers are defined by Fedler (2006) as customers who have purchased a fishing license for at least three consecutive years. He also defines *lapsed* anglers as those who have purchased sometime in the previous three years but did not in the most recent year. Fedler used these definitions to create sub-groups for tracking the success of the DNR's 2005 and 2006 marketing campaigns.

For our purposes we will classify an avid angler as a customer for which *fish02, fish03,* and *fish04* are each scored as a one. If an angler was not in the database in 2002 or 2003, then they are not counted as part of the *avid* variable because they haven't developed enough of a license history to correctly identify their avid status. A lapsed angler is classified as a customer who did not purchase a license in the previous year but had sometime in the two years before that. The *lapsed* variable for us identifies those who purchased a license in 2002 and/or 2003 but not 2004. Fedler has found that in Iowa avid anglers renew their licenses around 75% of the time and lapsed anglers renew their license only 21% of the time. By including these variables in our model, we should see a very significant marginal effect on an angler's probability of license renewal; positive for avids and negative for lapsed.

Resource Availability

Our resource availability data was collected using ArcGIS methods described in the previous section. The *lkcount* variable simply sums the number of lakes within 25 miles of a customer. The variable *lkacre* is the sum of lake acreage within the 25 mile buffer and will be transformed by the log function in order to obtain a variable *llkacre*. We take this transformation because the *lkacre* variable exhibits a distribution with a very long upper tail. It is not necessarily the case that a person with 12,500 acres of lake water within 25 miles has five times better availability of lake resources than somebody with 2500 acres in their buffer. The log distribution of lake acreage gives us a more evenly spaced distribution (see Figure 3.2). I hypothesize that more lakes and log acreage of lakes within a customer's 25 mile buffer will result in a higher probability of license renewal simply because of lessened travel costs and less competition for fishing resources.

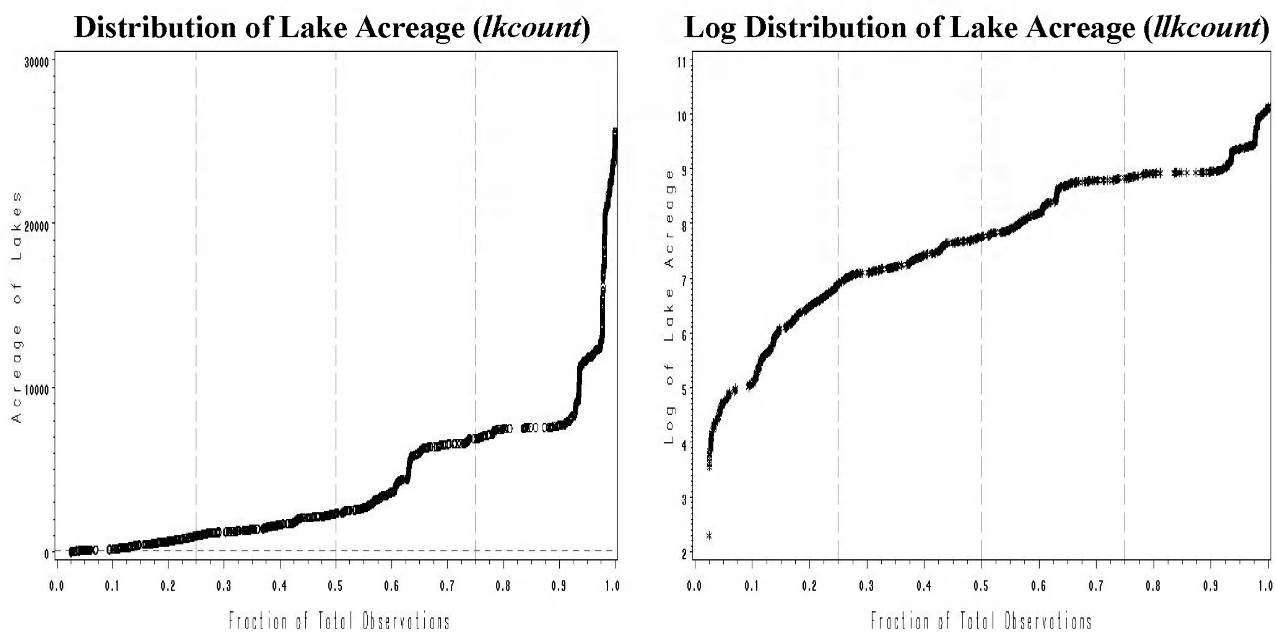

Figure 3.2. Comparison of the Distributions of lkcount and llkcount

River segment mileage within customer buffers (*rvmile*) was also collected in ArcGIS and displays a fairly even distribution across the range of the variable. In this case no transformation seems needed. In accordance with the reasoning provided for lake counts and log acreage, I believe river mileage will exhibit a positive marginal effect on license renewal probability.

Models and Analysis

Remembering our initial problem of declining license sales and revenue, we concluded that the DNR should commit itself to a full evaluation of the angling population. This evaluation can be broken down into three levels of analysis. Our first level was to produce a basic investigation of present customers. The second was to develop a model for license renewal so that the DNR can understand how demographic traits and license purchasing habits affect the license renewal decision. The deepest level of analysis is a full survey of Iowa anglers to gather input on motivations and expectations. Contingent valuation methods may be used in the survey to develop WTP for an annual fishing license. We will cover this in the final chapter of the project but for now let's look at how we'll approach the basic analysis of customers and development of a license renewal predictive model.

Our basic analysis of the present customer base is relatively straight forward and involves only elementary statistics. We will use our data set to produce a summary of annual license sales for 2002 and 2005 and present percentage breakdowns by gender, age groups, and urban classification. Unfortunately, we do not have matching data related to number of fishing trips or number of fish caught, as in previous surveys of Iowan anglers. However, for 2005 we can identify whether an angler is avid or lapsed, which may serve a metric for the health of recreational fishing. This basic analysis will be presented in the results section with comments about trends that may be important for marketing or fisheries management at the DNR.

For the second part of our analysis we will focus on the development of a model for license renewal. In this model we want to predict the probability that a person will renew their license given their demographic characteristics, license purchasing history, and access to recreational waters. Probability of such an event is bounded from 0 to 1, with 0 representing the event definitely not occurring and 1 representing certainty that the event will occur. Since we have a single dichotomous dependent variable for which we want to predict probability of occurrence, we will need to use a discrete model such as the logit or probit. The logit model is a good choice for our analysis because it is simple to understand, easy to estimate using statistical packages like SAS, and provides intuitive results when odds-ratios are derived for the explanatory variables.

The logit model essentially transforms the probability of some event into an *odds ratio*, so that instead of measuring the probability of some even happening, we measure the ratio of the probability it will occur to the probability that it will not occur (see equation 3.1) (Allison 1999). By transforming our dependent variable's measurement from a probability to odds we remove the measurement's upper bound of one. We can then take the natural logarithm of the odds to remove the lower bound of zero. If we define our probability of license renewal for customer i as p_i, our model with k independent variables can be derived as shown in equation 3.2. There is no random error term in the model, however that doesn't mean the equation is deterministic because of the inherent random variation in the relationship between p_i and license renewal.

$$Odds = \frac{p}{1-p} = \frac{probability\ of\ license\ renewal}{probability\ of\ no\ license\ renewal} \tag{3.1}$$

$$log\left[\frac{p_i}{1-p_i}\right] = \alpha + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + +\beta_k x_{ik} \tag{3.2}$$

The coefficients of the explanatory variables in the logit model can be estimated using maximum likelihood estimation (MLE), which will be our method of choice because it is built-in to many statistical packages and it is efficient in large samples (Hensher *et al.* 2005). Once the coefficients are determined we can revert back to the simple calculation of renewal probability by solving for p_i using the logit model in equation 3.2.

$$p_i = \frac{1}{1+exp(-\alpha-\beta_1 x_{i1}-\beta_2 x_{i2}-\cdots-\beta_k x_{ik})} \tag{3.3}$$

<u>*Examination of Explanatory Variables*</u>

Before we specify our models for estimation we need to decide which explanatory variables will be incorporated. A straightforward way to determine this is by calculating the appropriate correlation statistics for each of our data set's variables with respect to our dependent variable, *renew05*. Correlation coefficients were calculated using Kendall's Tau b method for dichotomous explanatory variables and using the point biserial method for the others (Hensher *et al* 2005). These correlation statistics are provided in Appendix B as Table B.2. Variables with positive correlation should have a positive effect on license renewal and those with negative correlation should have a negative effect on renewal. By intuition we should expect that the variables with a higher correlation to license renewal will have a stronger effect on the probability of renewal in our model.

We can see in the correlation table that a number of variables exhibit fairly high correlation to license renewal. All of these variables highly correlated with license renewal represent license purchase history. As expected with our extremely large sample, nearly every variable has a statistically significant correlation coefficient except for *lkcount* whose correlation is not significantly different than zero at the 95% level. Because of this, we will leave this variable out of our analysis. One surprising result from our examination of the correlation coefficient is that there is negative correlation with respect to license renewal for both *llkacre* and *rvmile*. This means we should reject the hypothesis that more resources would reduce travel costs and competition, thereby increasing license renewal. The correlation coefficients of the interaction terms for *urban*llkacre* and *urban*rvmile* show that the placement of water resources in an urban area intensifies this result. We might want to test a model that includes these interaction terms to see if they add any significant predictive power.

Model Specification

Since we have many variables that represent license purchase history we can be selective with respect to which explanatory variables will be included in our model. We did not include the variables for 2002 or 2003 purchases of fishing or hunting licenses in our correlation coefficient analysis because the variables *avid* and *lapsed* each provide very strong correlations to license renewal and essentially represent the same information.

It will be very useful for us to test a number of different models with different informational requirements so that the DNR may make predictions from short-term (one-year) or long-term (three-year) sets of customer data. Also, we will test some models that leave out variables we that were extracted from ArcGIS including *urban*, *llkacre*, and *rvmile*. The collection of this data was the product of a significant amount of processing in ArcGIS. The DNR may not be able to commit resources to renewing this data on an annual basis as they recruit new customers or current ones update their addresses. A comparison of models derived from only license database variables with these resource-intensive models will tell us how much value these geographic variables add to our models.

We will estimate a total of seven models, with each including different explanatory variables as described above. Model 1 is a simple short-term model derived from *male, age, fish04, hunt04,* and *trout04*. The general specification for Model 1 is given in equation 3.4 below. Remember that p_i represents the probability that customer i will renew their license in 2005 (*renew05*=1).

$$log\left[\frac{p_i}{1-p_i}\right] = \alpha + \beta_1 male_i + \beta_2 age_i + \beta_3 fish04_i + \beta_4 hunt04_i + \beta_5 trout04_i \quad (3.4)$$

Model 2 is similar to Model 1 but adds the variables *urban, llkacre,* and *rvmile* from our geocoding process. These two short-term models are preferable because every customer in the database carries a value for each of the license purchasing variables. This may not be the case if a customer has not been in the database long enough to establish that they are an avid or lapsed angler. Another reason for specifying a model based on 2004 purchases is that the customers included are more likely to have up-t0-date addresses, so that postage is not wasted when sending out direct mail marketing pieces.

Models 3 and 4 are similar to Models 1 and 2 but substitute the variables *huntany* and *troutany* for *hunt04* and *trout04*. This is a more general specification than the short-term models and adds customers who may have purchased hunting and trout licenses in the past but did not in 2004. We are investigating these models to see if the inclusion of these lapsed hunters and trout anglers improves our model.

Models 5 and 6 are long-term models that capture purchase history data in the form of the *avid* and *lapsed* variables which require three years of purchase history to be relevant. The additional license history included in these models over Models 1 through 4 should give them an edge in predicting *renew05*. Again, we want to investigate if the improvements these variables make to the simpler models are worth the extra information requirements.

Finally, Model 7 will build on Model 6 by dropping *urban* in favor of the interaction terms *urban*llkacre* and *urban*rvmile*. This model will allow us to investagte if the way urban customers' resource availability affects license renewal is significantly different than rural customers. This question has implications for the DNR's marketing efforts, which are often focused on urban markets as is the current Take Me Fishing campaign.

<u>Model Analysis</u>

Table 4.2 in the next chapter reports the results from the estimation for each of the seven models. For each model we show the usual coefficient estimates for each explanatory variable, noting if the estimate falls below the 95% significance level using Wald's chi-square test. Also included are the odds ratio point estimates which tell how the marginal effect on odds of a one unit increase in the explanatory variable. For example, if *hunt04* has an odds ratio of two then a person who purchased a hunting license in 2004 will have double the odds of renewing their license compared a person who did not purchase a hunting license in 2004, all other things equal. The effect on probability for a certain variable cannot be generalized as easily as the effect on odds because it is dependent on the current probability of customer's renewal decision (see equation 3.5). However, we can calculate these elasticity effects based on the actual proportion of customers who renewed in 2005 and treating that as p_i.

$$\frac{\partial p_i}{\partial x_i} = \beta p_i(1 - p_i) \tag{3.5}$$

To evaluate our models we will use a number of diagnostic criteria suggested by Allison and Wooldridge (2003). These measures include:

- Global Wald chi-square – Is the model better than nothing?
- Akaike's Information Criterion (AIC) – a measure of model fit
- Generalized R^2 and max-scaled R^2 – measures of predictive power
- Percent of Observations Correctly Predicted – if $p_i \geq 0.5$ then $\hat{y}_i = 1$ otherwise $\hat{y}_i = 0$

We will also evaluate each model based on its resource and information requirements. Note that influence diagnostics will be ignored because our sample is so large that no one observation is able to have a significant influence on the model. From this set of analytic measures we will recommend models that the DNR should utilize for marketing or fisheries management.

CHAPTER IV

RESULTS AND DISCUSSION

Basic Analysis of Angling Population

In Table 4.1 below we provide some basic attributes of the angling population for the years 2002 and 2005. These figures attempt to replicate some of the data collected in previous surveys conducted on Iowa anglers. As with the models developed later on in this chapter, all of the data comes from the DNR's already existing resources, including the license customer database and ArcGIS layers.

A few of the trends from years past seem to have continued with the present anglers of Iowa. The one of most concern and the problem that initiated this project is the decline in resident licenses sold. The DNR is taking this problem very seriously and attempting to correct this trend. Another issue that these updated numbers raise is that men anglers continue to greatly outnumber women and it seems that the proportion of men to women anglers has slightly worsened in recent years. The DNR actively recruits women anglers with special events and marketing targeted towards family fishing activities (we saw earlier that women tend to prefer fishing with family). More investigation is needed to understand why the balance of women anglers continues to fall.

Other notable trends include the relative increase of younger anglers in the 16-29 age group and a drop off in the number of senior citizens purchasing resident fishing licenses. A reason for the latter may be the proliferation of the lifetime fishing license for senior citizens, which is not calculated into our annual resident fishing license totals.

Table 4.1. Data Analysis of Angling Population

Year	2002	2005
	Resident Annual Licenses Sold	
Total	319,555	309,991
	Sex	
Men	77%	78%
Women	23%	22%
	Age Distribution	
16-29	23%	29%
30-49	46%	45%
50-64	25%	23%
65+	6%	3%
	Customer Location	
Urban	59%	59%
Rural	41%	41%
	Purchasing Behavior	
Avid	NR	75%
Lapsed	NR	10%
Neither	NR	15%

A very interesting finding from this basic analysis is that an extremely high proportion of the angling population is made up of avid anglers. This is good in the sense that it shows that a bulk of the angling population is satisfied with Iowa's fishing offerings if they are renewing licenses on an annual basis. Also, license sales should have a limited variance since 75% of annual sales come from a group which averages an 80% renewal rate. However, this top-heavy proportion of sales may indicate difficulties in recruiting new anglers and retaining lapsed ones.

Unfortunately, we do not have access to recent statewide data on days fished, the number of fish caught, or expenditure data to compare with older surveys. These are basic but popular measures of recreational fishing. They should be collected regularly so that the data can be compared with historical records.

License Renewal Models

The results of model estimation are laid out in Table 4.2. Our first task in analyzing these results is to pick the most effective model. For this we will focus on the set of comparative statistics given at the top of the first page of the table.

The global Wald chi-square statistic tests if the specified model is better than a model where all coefficients are zero. All of the models estimated easily pass this test. The second comparative statistic, Akaike's Information Criterion (AIC), is calculated using the log-likelihood function of the model and penalizes for the number of parameters included in the model. A lower AIC indicates a model with a better "fit" to the data. As we can see models 1-4 and 5-7 each have similar AIC scores. This indicates that inclusion of the *avid* and *lapsed*

Table 4.2. Comparison of License Renewal Models

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Data	License	LD+	License	LD+	License	LD+	LD+Geo
Required	Database	Geocode	Database	Geocode	Database	Geocode	+Interact
History	1 year	1 year	Any	Any	3 year	3 year	3 year
	Comparative Statistics						
Global Chi-	76,400	76,497	75,391	75,513	70,693	70,696	70,696
AIC	443,678	443,440	445,522	445,229	252,006	251,927	251,926
Gen. R^2	0.2197	0.2202	0.2160	0.2166	0.3112	0.3115	0.3115
Scaled R^2	0.2930	0.2937	0.2881	0.2889	0.4160	0.4163	0.4163
	Predicted Probability Success						
renew=1	66.6%	66.8%	66.6%	66.8%	80.6%	80.5%	80.5%
renew=0	78.5%	78.2%	78.4%	78.2%	67.6%	67.6%	67.6%
Total	71.3%	71.4%	71.3%	71.3%	72.0%	72.0%	72.0%

Table 4.2. Comparison of License Renewal Models (cont.)

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	Coefficient Point Estimates * Not significant at 95% level						
Intercept	-1.8682	-1.8160	-1.9332	-1.8864	-0.2113	-0.1476	-0.1906
male	0.2595	0.2608	0.2460	0.2495	0.2100	0.2147	0.2148
age	0.0058	0.0055	0.0055	0.0052	-0.0020	-0.0022	-0.0022
fish04	1.7930	1.7923	1.8755	1.8744	-	-	-
hunt04	0.9379	0.9141	-	-	-	-	-
trout04	0.6171	0.6360	-	-	-	-	-
huntany	-	-	0.7743	0.7468	0.5936	0.5732	0.5733
troutany	-	-	0.5256	0.5473	0.3523	0.3647	0.3642
avid	-	-	-	-	1.3087	1.3069	01.3069
lapsed	-	-	-	-	-1.3189	-1.3181	-1.3180
urban	-	-0.0546	-	-0.0633	-	-0.0619	-
llkacre	-	0.0100	-	0.0125	-	0.0047 *	0.0087
rvmile	-	-0.0002	-	-0.0003	-	-0.0002	-0.0001
urban * llkacre	-	-	-	-	-	-	-0.0053
urban * rvmile	-	-	-	-	-	-	-0.0001

Table 4.2. Comparison of License Renewal Models (cont.)

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	Marginal Effects in Odds Ratio Point Estimates						
male	1.296	1.298	1.279	1.283	1.234	1.239	1.240
age	1.006	1.005	1.006	1.005	0.998	0.998	0.998
fish04	6.007	6.003	6.524	6.517	-	-	-
hunt04	2.555	2.494	-	-	-	-	-
trout04	1.853	1.889	-	-	-	-	-
huntany	-	-	2.169	2.110	1.811	1.774	1.774
troutany	-	-	1.692	1.729	1.422	1.440	1.439
avid	-	-	-	-	3.701	3.695	3.695
lapsed	-	-	-	-	0.267	0.268	0.268
urban	-	0.947	-	0.939	-	0.940	-
llkacre	-	1.010	-	1.013	-	1.005	1.009
rvmile	-	1.000	-	1.000	-	1.000	1.000

variables in the last three models is a better fit to the data than including variables for short-term license purchasing history. However, this criterion alone does not decide that the long-term models are significantly better.

Two measures for each model's predictive power are given as well. The generalized R^2 statistic is based on the likelihood ratio chi-square for testing a global null hypothesis which is similar to the Wald chi-square we used to test this same assumption earlier. The generalized R^2 is identical to the formula that is used for linear regression but cannot be interpreted quite in the same way. We can only use it as a general measure of a model's predictive power (Allison). The max-scaled R^2 corrects for the fact that the upper bound of our discrete variable R^2 is less than one. The formula for max-scaled R^2 takes R^2 and divides it by R^2_{max} to obtain this additional measure. Again, models 4-7 have significantly better values for both R^2 measures.

One more statistic that that can be used to represent a model's predictive power is the success in which the model predicts a correct outcome. Models 4-7 prove to be extremely good at predicting that a person will renew their license, estimating the correct outcome over 80% of the time. However, models 1-4 are nearly just as good at predicting when a customer won't renew their license, with about a 78% success rate. Strangely enough, every model falls between 71.3% and 72.0% overall prediction success rate. This suggests that if we know more about a person's license purchasing history we can better predict if they will renew their license. However, when estimating outcome's using only one year's worth of license purchase history we are more apt at predicting if an angler will *not* renew their license. This implies that different models may serve the DNR's marketing efforts in different situations depending on which customers they are trying to reach.

The coefficient estimates can also inform us about each model's efficacy. We can see that every variable in each model is significant using Student's t-test at the 95% level, except for *llkacre* in Model 6. We also see that the coefficients are pretty similar across models with the same license history requirements. Looking at the odds ratios for each model, which are calculated from coefficient estimates, we can get a clearer picture on how each variable affects the customer's choice for license renewal. Some of the effects of explanatory variables are fairly constant, such as being male, which increases the odds of renewing a license by 25-30%. Models with geographic information show that being from an urban address reduces the odds of renewal by about 5% and that a 1% increase in accessible lake acreage yields around a 1% increase in the odds of renewal. Though the *rvmile* coefficients are statistically significant in each model they do not yield much of an effect on license renewal.

The variables with the highest effect on odds in the models are those which represent license purchase history, with the variables that capture fishing license purchases carrying the most weight. This outcome was expected but the magnitude that these variables bear is surprisingly high. The variable representing purchase of a fishing license in the previous year, *fish04*, predicts a six fold increase in the odds ratio. It is important to remember that we are talking about odds and not probability. However, we can calculate this effect on an individual basis by entering typical values in for each variable. In the simplistic Model 1, using the example of a 40 year old male who does not hunt, the purchase of a fishing license in 2004 (*fish04*=1) represents an increase from a 20% chance of license renewal to a 60% chance of license renewal. This model outcome reinforces the findings of Fedler (2006) with recent DNR campaigns.

Now that we've examined how these models compare with one another, which ones should we choose to keep? Foremost, it seems that our geographic data does not add much to our prediction abilities. While all of the models that include this information have slightly better measures for AIC and R^2 the difference is trivial and not worthy of the time and resources needed to collect this information. We can do nearly just as well with simpler models based on the existing and continually updated license database. This does not necessarily mean that resource availability has no effect on the license renewal decision; it may just be that there are other measures of customer location that we have omitted from the models that capture this effect better. Either way, we should ignore these models for applied use because of the comparative quality of Models 1, 3, and 5, all of which have lesser information requirements.

Out of the remaining models we might pick Model 5 to use based on the comparative statistics reported. This model uses *avid* and *lapsed* as variables for license purchase history and provides the best model fit and highest prediction success of these remaining choices. However, Model 5 requires three years worth of data to determine its license history measures, which rules out a number of customers in the DNR database. We should not dismiss this model because it may be helpful in occasions where we are concerned with the behavior of anglers that are avid, lapsed, or simply have been in the license database for three years. This model could be useful for tracking long-term trends or surveying long-term anglers who have become lapsed.

This leaves us with Model 1 and Model 3 to choose from. They are very similar models in terms of AIC, R^2, and prediction success but Model 1 only requires one year of data so we are inclined to choose this as the most effective model for applied use. Unfortunately, this model has a limited number of applications since there is no incorporation of resource availability data. It will be important for the DNR to use the findings from this project as part of a greater set of past studies, current expertise, and future research in implementing a plan for responding to the problem of declining fishing license sales. Essentially, this project should be part of a greater road map for incorporating scientific analysis into fisheries management and marketing at the DNR. We will discuss the implications of this project and present some recommendations in the final chapter.

CHAPTER V

SUMMARY AND PROPOSITIONS

The objective of this research project was to provide an analysis on Iowa's angling population given the current data available. The DNR needs to understand the motivations and behaviors of its customers so that they can reverse the recent trend of declining license sales and revenue. This study provides results that should be useful for both marketing and fisheries management efforts. Recommendations for action based on the findings of this study are provided hereafter.

There were three parts to our analysis which were divided by depth and resources needed for completion. The first part of our analysis was to simply extract some basic demographic and license sales statistics from the DNR's license database. We then derived a model to predict the probability of a customer renewing their license based on data from past license purchases, customer demographics, and geographic proximity to fishing resources. The deepest level of analysis was to complete a survey of the angling population in order to extract fishing motivations and a recreational value for the state's fisheries. However, due to limited resources and time we were not able to conduct this survey. In lieu of this, a review of current economic valuation methods and recent studies on the value of Iowa's lakes was provided and recommendations for future research are to follow.

For the first part of our project, we looked at a number of past surveys of Iowa's anglers and replicated some of the same given statistics for the 2002 and 2005 license holding population. This analysis showed that males continue to dominate the sport of fishing with nearly four male anglers for every woman. We also reported the percentage breakdown of urban versus rural customers (59% and 41%, respectively) which is just slightly more weighted towards rural customers than the overall population of Iowa (U.S. Census Bureau 2002). An important new statistic gathered for 2005 was a breakdown of license sales by Fedler's designation of angler devotion. From this we found that the majority of licenses sold in 2005 (75%) were to "avid" anglers who have purchased licenses for three or more consecutive years. We suggested that many of Iowa's anglers are satisfied with the Iowa fishing experience to the point of purchasing a license every year. However, this also means that recruiting lapsed or new anglers will need to be the focus of the DNR in order to increase license sales.

The main focus of our project's analysis is on our models for fishing license renewal that were developed. We used maximum likelihood estimation of a simple logit model as our framework for testing seven different models, each with a different structure of explanatory variables. The variables came from the DNR's license database but also from a spatial analysis of each customer's address in relation to lakes and rivers designated as protected for recreational fishing by state law. We found that these geographic variables did not add a significant amount of predictive power to our models and were not worth deriving given the high cost of time and computational resources needed in order to acquire the measures. However, the models we choose to keep have very good predictive abilities and may be utilized in many different ways by the DNR.

Table 5.1. Contingent Probability of *renew05* using Model 1, *age*=40

male	fish04	hunt04	trout04	P(renew05)
1	1	1	1	0.8778
			0	0.7948
		0	1	0.7376
			0	0.6026
	0	1	1	-
			0	0.3920
		0	1	-
			0	0.2015
0	1	1	1	0.8471
			0	0.7493
		0	1	0.6844
			0	0.5391
	0	1	1	-
			0	0.3322
		0	1	-
			0	0.1630

We chose Model 1 and Model5 as the most effective models for predictive analysis. Using model 1 we can develop a contingency table that captures the probability of renewal for different hypothetical customers to see how different variables affect the probability of renewal for a 40-year old customer (see Table 5.1). These types of tables are a standard technique of studying the effects of a logit model.

From Table 5.1 we can calculate the probability license renewal for a 40-year old customer based on gender and license purchasing history. The probability of renewal is given on the far right and is calculated using equation 3.3. Omitted values for the probability column indicate a combination of traits that is not possible, such as purchasing a trout stamp without purchasing a fishing license. Comparing these groups could be valuable for developing customer lists for direct mail campaigns that would target customers with a given probability of license renewal. As an example, we can see that males who purchased fishing and hunting licenses but no fishing trout stamp have a 79% chance of license renewal compared to 60% for similar customers who didn't buy a hunting license. It may be cost effective to only include the lower probability customers of the two groups in a direct mail campaign as it is very likely that those who hunted and fished will renew their license anyway.

One other useful approach for marketing is to test different campaign strategies to see what kind of long-term effect the promotions may yield on license sales. For example, let's say a marketing campaign targets lapsed anglers with a goal of 1000 license renewals. We can use Model 5 to test the how the recruitment of these lapsed anglers affects the predicted outcome for renewal in the second year. If the DNR reaches their goal of 1000 additional licenses sold to lapsed anglers with an average mix of gender, age, and past hunting or trout license sales then in the second year these customers all have *lapsed*=0 (since they renewed in the last year). If the effects from the variables in the model hold between each year, this group of anglers' probability of renewal for the following year will jump from about 22% to roughly 52%. This coincides in to an additional 300 licenses sold the year after the campaign, worth about $7500 of revenue to the DNR. However, I will caution that this is a simplified hypothetical case and the intertemporal effects of this model have not been investigated. This example simply illustrates a method which the DNR may want to employ in a cost-benefit framework of analyzing different marketing strategies.

It is important to keep in mind that these models are statistical estimations computed from one set of limited customer data collected from 2002 to 2005. Variables not included in the model such as income, weather, price of gas, fishing expenditures, and trip data all may significantly affect a customer's estimated probability of license renewal. It would be very valuable for the DNR to develop a license purchasing model that incorporates some of these variables.

In order to gather the data necessary to incorporate motivation and behavior variables into a license purchasing model, the DNR needs to conduct a statewide survey of the angling population. It is my recommendation that the DNR commissions such a survey with the goal of collecting this type of data, as well as data on willingness-to-pay for a fishing license. A comprehensive periodic angler survey is absolutely essential for the DNR to properly attend to the demands of Iowa's anglers and effectively recruit new ones.

An in-depth survey should collect basic demographic data such as address, gender, and income from both non-anglers and anglers chosen at random. Anglers already in the license database should have their survey results linked to their customer ID so that they may be associated with license purchasing history. The survey should be conducted near the end of the normal fishing season and ask the following questions:

- How many fishing trips have you taken in the past 12 months?
- How many different in-state water bodies have you visited in the past 12 months?
- How many of your trips were within a 30-minute / 60-minute / 120-minute drive from your home?
- Have you purchased a license to fish in the past 12 months?
- Would you be willing to pay $X for a residential fishing license? (where X represents 3-5 values varied randomly across the sample)
- Many other fisheries questions related to catch, regulations, etc…

The survey should also include questions about angler motivations and expectations, as these will drive the behavior of anglers (Calvert). This survey could be conducted by a respected agency such as CARD at Iowa State University or the CSBR at the University of Northern Iowa, both of which have conducted surveys for the DNR in the past.

From this survey it is likely that we would be able to develop a superior model for license demand (not just license renewal) and even determine how changes in license price may affect Iowans' demand for fishing licenses. Additionally, we could develop a greater understanding of how angler motivations relate to outcomes such as the number of trips taken or number of fish caught. Both marketing and fisheries management personnel could find a wealth of uses from this data set with the proper set of analyses.

There should be an attempt to develop resource data that more effectively captures the value and quality of fishing in individual water bodies so that we may renew an exploration of resource availability as part of the license decision process. Types of data incorporated into a new model for license demand could include water quality, creel counts, trip data, and other similar variables for lakes around the state. Some of this data is already available as part of the ongoing Iowa Lakes Valuation Project. Additionally, limitation of the model to a specific geographic location would facilitate the inclusion of improved resource variables over the ones included in this project. I would strongly encourage the DNR to use the recommendations in this project as a road map for future angler analysis.

This concludes this project's study of Iowa's anglers. It is undeniable that a problem exists with regard to the declining number of anglers in Iowa. The high rate of license renewal by avid anglers suggests that this trend may be social and not faulty management of recreational resources. Either way, the trend must be corrected using effective marketing grounded in an understanding of the recreational demands of Iowans.

Unfortunately, at this time we do not have enough knowledge of angler motivation or experiences in order to conduct highly effective marketing campaigns. Recent research by Fedler and those involved in the Iowa Lakes Valuation Project have added to the DNR's knowledge base but an in-depth survey of Iowan anglers is needed. In the meantime, the DNR may utilize the research and models presented in this paper to guide future marketing efforts.

In summary, we have learned that an angler's fishing license purchase history strongly guides their license renewal decision. His or her access to fishing resources does not seem to play a strong part in this choice but more research is needed to this end. This project may serve as guidance for a future study that incorporates more effective resource and angler data which may yield a stronger model for both management and marketing uses. Iowa has a deep heritage of public recreation and resource management with a strong commitment to research. It is my hope that the administration of the DNR reinforces these values so that the conservation of Iowa's recreational resources is guaranteed far in to the future.

APPENDIX A

MAPS

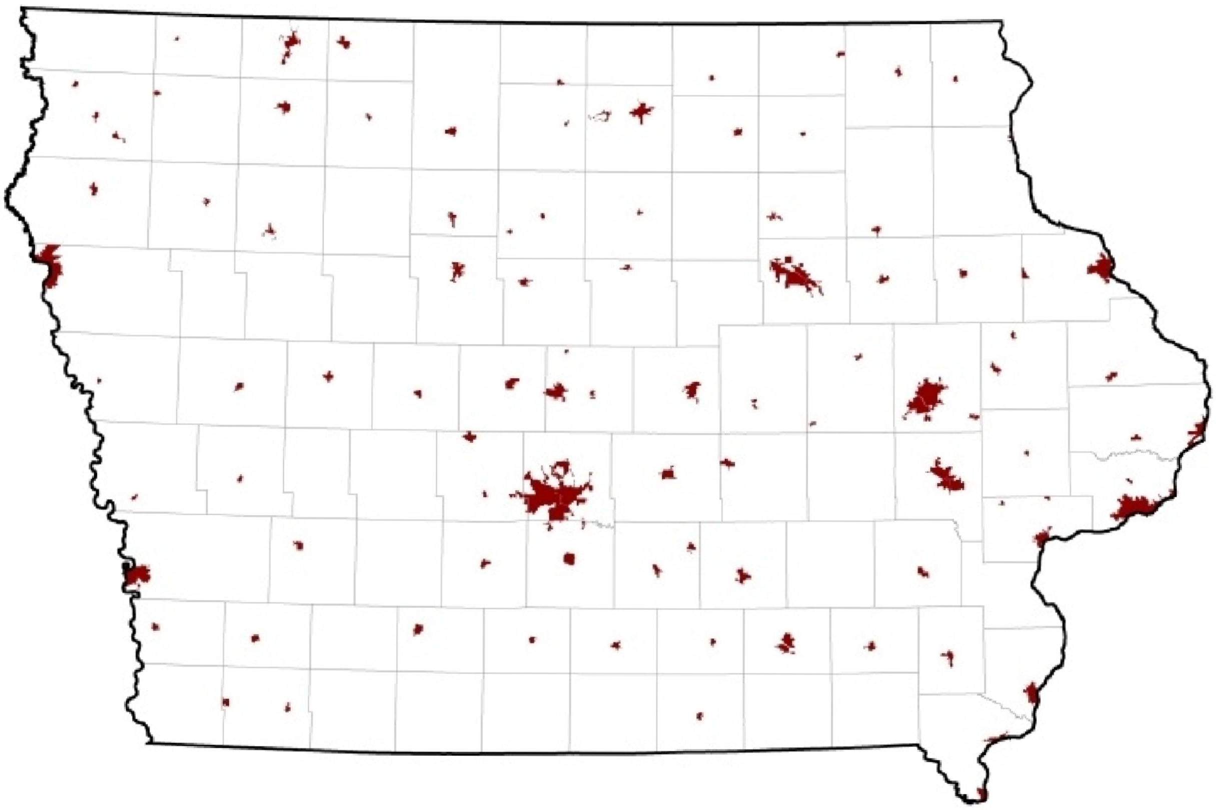

Figure A.1. Iowa Census 2000 Urban Areas and Urban Clusters

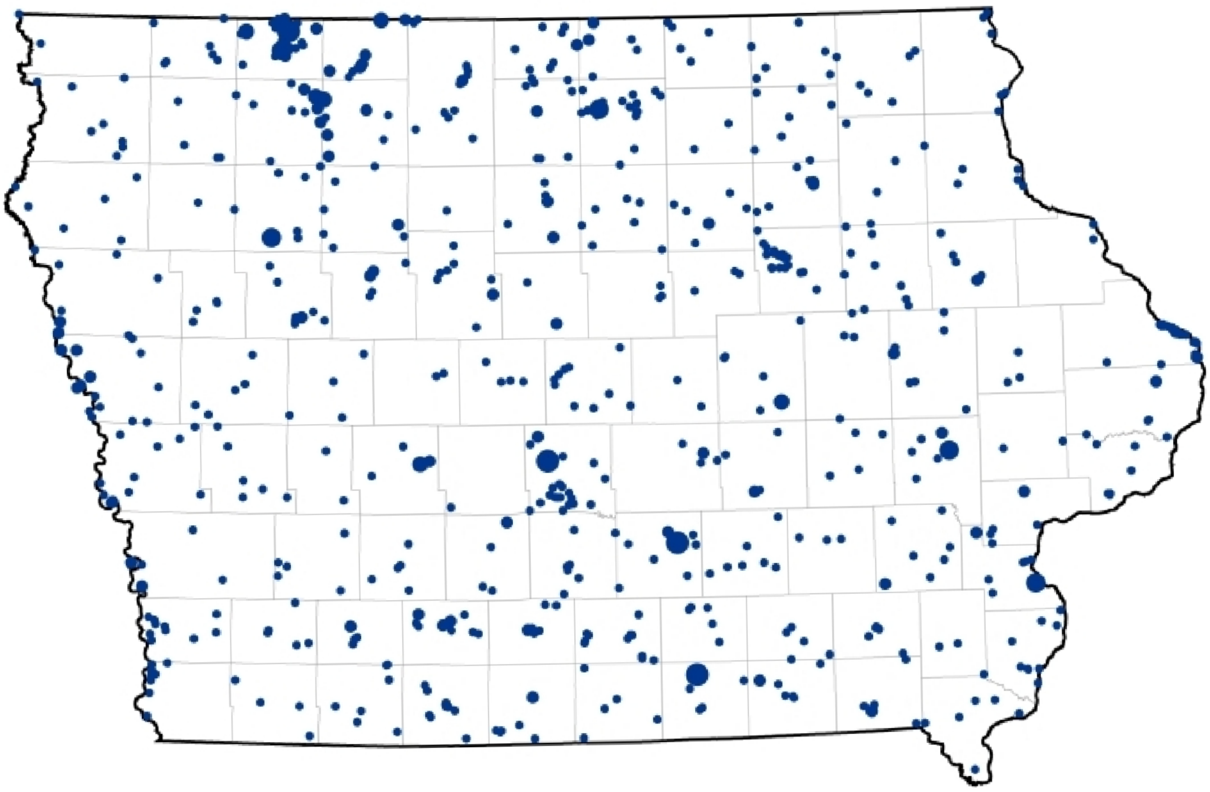

Figure A.2. Iowa 2004 Class B Non-Limited Resource Lakes

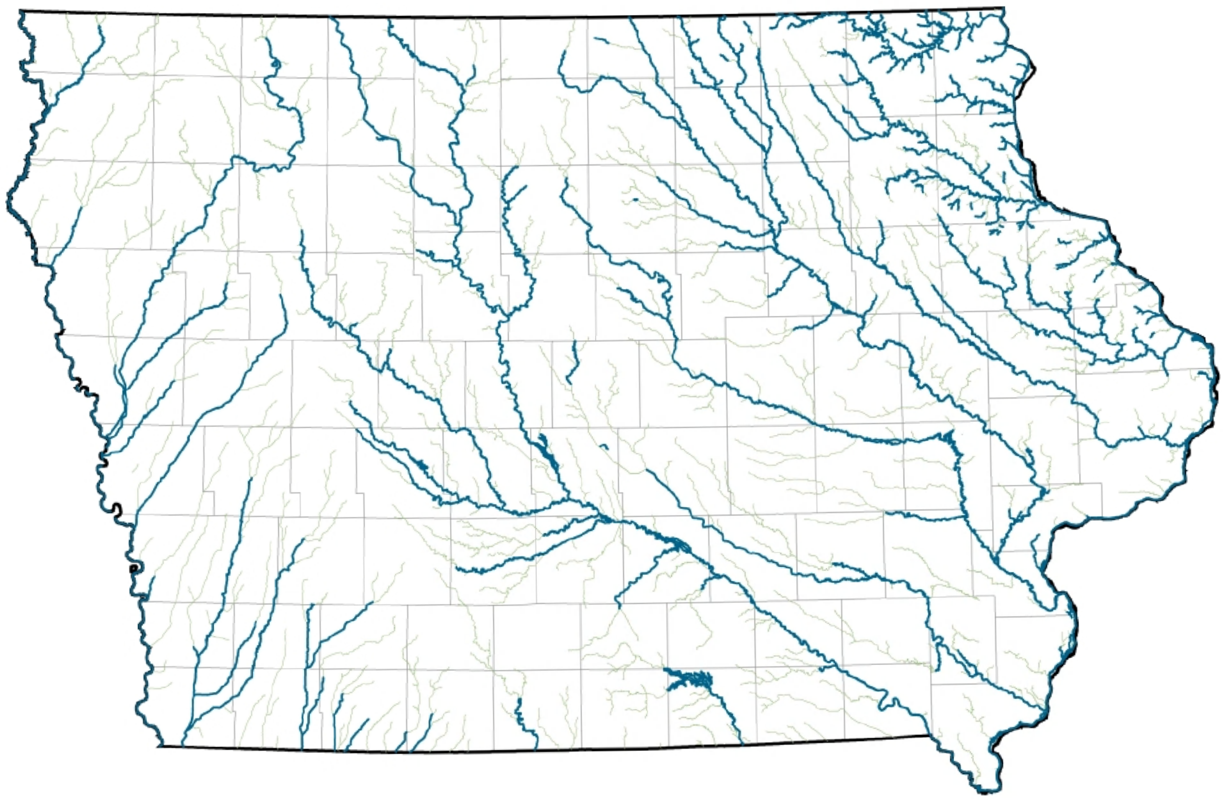

Figure A.3. Iowa 2004 Class B Non-Limited Resource Rivers

APPENDIX B

STATISTICAL TABLES

Table B.1. Descriptive Statistics for Selected Variables

Variable	Mean	Std. Dev.	Median	N
renew05	0.4885	0.4999	0	389,992
male	0.7350	0.4413	1	440,360
age	40.2085	14.6558	39.8412	440,367
urban	0.6043	0.4890	1	440,367
lkcount	21.1562	9.0442	19	440,367
lkacre	4062.99	4202.10	2346	440,367
llkacre	7.5522	1.5682	7.7605	440,367
rvmile	337.194	212.977	341	440,367
avid	0.4993	0.5000	0	250,505
lapsed	0.4596	0.4984	0	334,382
fish02	0.5689	0.4952	1	440,367
fish03	0.5643	0.4958	1	440,367
fish04	0.5366	0.4986	1	440,367
fish05	0.5471	0.4978	1	440,367
hunt04	0.2463	0.4309	0	440,367
hunt05	0.2416	0.4280	0	440,367
huntany	0.3107	0.4628	0	440,367
trout04	0.0463	0.2102	0	440,367
trout05	0.0501	0.2181	0	440,367
troutany	0.0796	0.2708	0	440,367

Table B.2. Correlation Between *renew05* and Explanatory Variables

renew05	Correlation	$P > \|\rho\|$ under H_0: $\rho=0$	N
male	0.13822	<0.0001	389,992
age	0.02568	<0.0001	389,992
urban	-0.05402	<0.0001	389,992
lkcount	0.00227	0.1558	389,992
llkacre	-0.01246	<0.0001	389,992
rvmile	-0.05752	<0.0001	389,992
fish04	0.44052	<0.0001	389,992
hunt04	0.27890	<0.0001	389,992
trout04	0.14039	<0.0001	389,992
huntany	0.24352	<0.0001	389,992
troutany	0.11523	<0.0001	389,992
avid	0.55211	<0.0001	250,505
lapsed	-0.52673	<0.0001	334,382
urban*llkacre	-0.05413	<0.0001	389,992
urban*rvmile	-0.07114	<0.0001	334,382

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