RECREATIONAL VISITOR ATTITUDE AND SELECTED LIMNOLOGICAL MEASUREMENTS OF RECREATIONAL IMPACT AT LAKE CARL BLACKWELL

By

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

If it were possible to enter a time machine and travel backward to the beginnings of humankind, eventually a period would be reached in the past where the human species was in balance with the environment. This does not mean it was a good time for humanity. On the contrary, it was a time before agriculture, an extremely difficult time when the survival of humans as a species was in question. Yet it was the last time humanity existed within the boundaries of the natural environment. From the time agriculture was discovered, humans embarked on the path of modifying, rather than adapting to, the world. Human precursors turned their backs on nature-provided food bases, ignored the cycles of established ecosystems, and began the process of engineering the environment to their own specifications (DiSilvestro, p. 3.). Terra forming the planet, humans rarely considered the possible consequences to the natural world. This approach was singularly successful, and humans have dominated both the planet and the life forms upon it.

While agriculture freed humans from their hunter-gatherer mode of life, it also provided a commodity rarely seen before, time for leisure. At first leisure was for only a few, for farming was still labor intensive. However, as time progressed, more and more hours were available for the pursuit of such ephemeral things as art, music, and sports. Recreation was invented, or more likely, was stumbled upon as an instinctive reaction to the stress of living. The leaders of early societies sought relief from the burdens of rule. The need for a "place" to recreate grew, and humans, ever the changer, engineered their playgrounds as they did their farm fields. The environment continued to be changed, not this time for sustenance of the body, but for sustenance of the mind and soul. This subversion of nature and the environment for ephemeral pleasures continues today.

People seek unspoiled natural areas in which to conduct their recreation. Most are unwilling, however, to separate themselves from their technology even for a short visit to a park or lake. They bring their cars, power boats, recreation vehicles, off road vehicles and jet powered skis with them. Park and recreation professionals consent, and even provide special access to their resource for this techno-leisure invasion and its potential degradation of the environment. Caneday asserts that recreation professionals pay attention to the impact of their management upon the environment only when forced to do so.

> If environmental concerns are present in the minds of park and recreational professionals, they exist because of laws and their effect on our operations. The laws have become a nuisance in our daily work (p. 90).

Research has shown that the very act of recreating has a detrimental effect on the environment that has far reaching consequences for the flora and fauna of our recreation areas as well as their very physical makeup. Resource managers attempt to protect and preserve parks, lakes, forests and deserts from outside pollution and exploitation and yet allow it to go on under the guise of recreation, in the very bowels of the areas we would preserve. These factors must be taken into consideration by resource managers if recreational areas are to be preserved for the future. The more that is known about the attitudes of recreational visitors and their effect on the resources they visit, the better recreation professionals can make decisions that not only provide a complete recreational visit, but protect and preserve the resource for wildlife, plantlife, and the humans that rely on them.

Need for the Study

Much is known about the causes of pollution from outside protected areas and the detrimental effects it has upon them. Less is known about the pollution and overall degeneration of protected areas by the recreational visitors that use them. There is a lack of research into recrea-

tional visitor's attitudes and actual effects on the environment of specific recreational areas. This study is to determine what, if any, relationships exist between visitor attitudes and limnological measurements of recreation upon a managed recreational lake. This information is valuable in assessing the impact of recreational visitors upon a lake environment, their knowledge of such impact, and their attitude concerning those impacts.

The need for this study is: (1) to expand the knowledge of research on recreational visitor's attitudes toward the environment; (2) assess the limnological impact of such visitors on a lake environment; (3) identify relationships between visitor's attitudes and their limnological impact; (4) identify aspects of recreation that require additional resources and management emphasis; and, (5) Identify actions needed to provide a quality recreational experience while conserving and protecting animal and vegetative life as well as the unique physical characteristics of recreational resources.

Purposes of the Study

This study was conceived to determine the attitudes of recreational visitors to Lake Carl Blackwell concerning the effect different forms of outdoor recreation has upon a lake environment. The study was meant to discover whether such effects could be measured through limnological observation,

and to ascertain if the effects are detrimental. Further, the study was designed to identify visitor's opinions on whether adverse environmental effects are acceptable as a trade-off for recreation.

The specific purposes of this study are:

1. To determine if recreational visitors to Lake Carl Blackwell have knowledge of the environmental effects of their recreation.

2. To identify different recreational group's attitudes toward adverse environmental effects of recreation.

3. To determine what specific demographics, if any, have a relationship to the vistor group's attitude concerning the environmental effects of recreation.

4. To determine, by visitor group, whether adverse environmental effects are an acceptable consequence of recreation.

5. To determine if the environmental effects of recreation upon an aquatic environment can be measured.

6. To determine if the environmental effects of recreation are adverse to an aquatic environment.

Of these purposes, the emphasis of this study was to determine the attitudes of recreational visitors toward the environmental effect of recreation, whether such effects are measurable, and whether visitors believe that adverse environmental effects are acceptable as a consequence of their recreation.

Statement of the Problem

Adverse environmental effects of human activity is not a recently discovered problem, our ability to generate pollutants exceeds our ability to control them. The invasion of recreational areas by new techno-leisure vehicles in ever increasing numbers generates physical impacts never seen before and poses a serious threat to entire ecosystems. This study focuses on this growing problem and seeks to answer questions regarding what category of outdoor recreation visitor is causing the most impact, their attitudes about such impact, and whether such impact could be measured in a lake environment.

To determine these questions, an instrument for measuring human data was developed and answers to the following queries measured:

1. Do recreation visitors have knowledge of the effect their recreation has upon a lake environment?

2. If informed their recreation has an adverse effect on the lake environment, do they find such effect acceptable as a consequence of recreation?

3. If adverse environmental effects are a result of specific outdoor recreation, is such effect measurable in a lake environment?

The following null hypotheses were developed:

1. There is no significant differences of knowledge of, or attitude toward, the effects of recreation upon a

lake environment regardless of; gender, type of visitor, age level, formal education, knowledge base of respondents, transportation of visitor, or membership in an outdoor recreation group.

2. There is no significant difference in limnological measurements regardless of where or when the measurements are taken.

3. There is no significant difference in limnological measurements taken in 1992 and past limnological data.

Limitations of the Study

Several factors limited this study. First, the human data collection instrument was developed by the researcher and the reliability of the measure is, therefore, directly related to the instrument content. A comparable instrument was used with apparant success by Reynolds in his dissertation regarding off road vehicle users.

Second, the study was limited to one recreational area in Oklahoma. However, with approximately 29.0 percent of Oklahoma's population within sixty miles of Lake Carl Blackwell, the surveyed lake visitors should represent a cross-section of Oklahoma outdoor enthusiasts.

Third, the survey instrument was administered for one recreational season from May 22, 1992 to September 7, 1992.

Fourth, this study left out one important group of lake visitors whose season is other than the summer, hunters.

Most hunting takes place, however, away from the lake proper and during the fall season. The deletion of this group should have minimal impact upon the findings of the study.

Fifth, horsemen, a group that has a pronounced effect on the recreational environment, refused to participate in the survey.

Sixth, the group of lake visitors who did not fit into any of the visitor categorys and indicated their status as "other", was too small for meaningful analysis.

Seventh, limnological observations were limited to four days a month, taken just prior to and after weekends, and restricted by available funds to only certain types of measurements.

Assumptions of the Study

It was assumed that the central location of Lake Carl Blackwell to three of Oklahoma's major population centers (Oklahoma City, Tulsa, and Enid) would provide a cross section of visitors from the general population of recreation area visitors.

The assumption was made that a representative sample of recreational visitors were selected during the time frame of May 22, 1992 to September 7, 1992. This assumption was based upon the premise that random sampling produces a representative sample.

It was assumed that the use of a survey type question-

naire was an appropriate method of obtaining data for the human part of the study.

The assumption was made that respondents answering the questionnaire would do so in an honest and forthright manner.

It was assumed that accurate limnological samples were obtained from the waters of Lake Carl Blackwell and correctly analyzed.

Delimitations of the Study

This study was targeted to study the recreational visitors to Lake Carl Blackwell, a recreational lake managed by Oklahoma State University and the conclusions are therefore applicable to public resource managers, particularly those dealing with aquatic environments.

Definition of Terms

Lake visitor: Any individual that visits the recreational area comprising Lake Carl Blackwell for the purpose of recreation.

Casual visitor: Any individual that visits Lake Carl Blackwell with no particular outdoor sport in mind, or who intends to spend but a brief period of time in the lake area. Examples are day visitors, picnickers and swimmers.

User visitor: Any individual that visits Lake Carl

Blackwell with a particular outdoor sport as his goal, or who intends to spend more than a brief period of time in the lake area. Examples are fishermen, boaters and campers.

Limnological measurements: Field sample analysis of dissolved oxygen, pH levels, alkalinity levels, transparency levels, and the temperature of lake water.

Littoral zone: That region of the lake where rooted plants grow and hence where light penetrates to the bottom.

Benthic: Relating to the bottom of a body of water.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

A literature review was conducted on the environmental effects of recreation. This review included literature over the limnological aspects of outdoor recreation, its interpretation, and data collection procedures.

Literature Related to the Environmental Effects of Outdoor Recreation

Recreation, particularly recreation that takes place outdoors, has an effect on the environment. This is particularly true where an area is set aside specifically for recreation such as a state or municipal park. These effects take on many forms, and the more variety of recreational pursuits available, the more prominent the environmental results. Advancing recreational technology continues to mount a growing assault on the land, air, and water of our recreational areas. The use of vehicles and animals in recreation causes soil compaction and erosion, loss of vegetation and degradation of water quality. The exhaust of land and water vehicles contributes heavy metals and other pollutants to the air and water. Watercraft leak oil and

fuel directly into water sources, and can cause damage to shoreline vegetation through direct physical impact. Recreational vehicles have the added ability of releasing grey water and raw sewage directly onto the land and into the water. All these activities result in detrimental effects to wildlife, from the loss of food sources, to the destruction or disturbance of habitat. Nesting sites of waterfowl can become damaged, eggs destroyed, and breeding grounds disrupted by fishermen, boaters, water skiers, and horsemen. Noise pollution generated by jet boats, jet skis, and other motorized water and land vehicles disrupt the normal behavior patterns of wildlife and adversely effect their hearing. Dust, raised by land vehicles drifts over vegetation and water sources, disrupting the photosenthesis of plants on land and water.

Literature Related to Water Based Activities

The physical impact on water of recreation is primarily caused by the operation of water craft. M. J. Liddle and H.R.A. Scorgie, in The Effects of Recreation on Freshwater Plants and Animals state that watercraft's wash, turbulence, propeller action (cutting effect), direct contact, and disturbance by sight and sound are some of the more apparent effects of recreational watercraft. They described these effects and their consequences:

Wash: Forces generated to propel boats may be

> considerable. This force is dissipated to the surrounding water which directs it to the beds and banks of water bodies, and can cause severe erosion. Motor boats are often high powered and the wash they create can cause considerable erosion of plant roots (p. 185).

Although jet skis are not specifically mentioned, their effects on the water and shoreline is very similiar and perhaps even more disruptive than power boats. Generally smaller than motor boats in both size and power, their ability to maneuver close to shore and remain in one area for a great length of time suggests they can produce the same or even greater amount of disruption. The numbers of these relatively cheap and easy to operate vehicles on recreational waters will undoubtedly grow in the future. Liddle goes on to add:

> Propeller action: The edges of propellers can act as a set of rotating knives, as demonstrated by the effect of the occasional collisions with swimmers (p. 185).

Boats or jet skis moving along the shoreline in the plant bearing littoral zone can uproot vegetation needed for food by aquatic animals. This can be especially devastating in a lake as turbid as Lake Carl Blackwell where the littoral zone is small to begin with. Additionally, in some freshwater habitats such as the Everglades in Florida, propeller caused injuries to animals contribute to their direct endangerment. A primary example of this is the manatees, or seacows of Florida.

> Direct contact: Boats may also dissipate their kinetic energy by direct collision with the marginal vegetation or bank (Liddle, p. 189).

Direct contact with the shoreline can cause erosion of the bank through impact and the destruction of littoral zone and bank vegetation. This is particularly true of shallow rooted plants. Erosion caused in this manner contributes to the turbidity of the water body and subsequently adversly effects aquatic life. The advent of the jet ski has multiplied this particular effect. These direct contact problems are not limited to inland freshwater lakes but also includes coastal estuaries and reefs. John C. Sawhill in Last Great Places, addressed direct visitor impact upon the Florida Keys.

> The estimated one million tourists who scuba, snorkel, or fish off the Keys often damage the fragile coral by accident or through ignorance. As the popularity of the Keys has boomed, the quality of both surface and ground water has decreased dramatically. In many places the reefs have begun to turn white and die (p. 7).

This damage is caused by direct physical contact of boats with the coral. Most damage is done by watercraft running aground on the reef, yet turbulence and turbidity from prop action is also a contributing factor. This turbidity has detrimental effects that can spread beyond the immediate wash area of powered watercraft. In freshwater lakes turbidity can also have negative effects.

> Inert solids make water opaque to light and render all plant and algal growth impossible. Additionally, suspended solids make it difficult for fish to feed. Suspension of solids can eliminate or reduce life forms or reduce its amount without greatly altering the composition of its environment, simply by shading out plant life (Hynes, p. 87).

H.B.N. Hynes continued his indictment of turbidity in The Biology of Polluted Waters by stating:

> Upon settling, inert solids smother algal growth, kill rooted plants and mosses, and alter the nature of the lakebed. The effect of settling solids is to destroy or alter the vegetation and produces a corresponding change in the fauna, including fish. Sediments, filling spaces between stones deprive animals of their hiding places. They also coat rock surfaces, depriving animals that live on their surfaces any handholds (p. 88).

In their edited work entitled Pollution Ecology of Freshwater Invertebrates C.W Hart and Samuel L. H. Fuller note the effects of oil on an aquatic environment.

> Oil can form films on the surface and thus interfere with gaseous exchange, photosynthesis, and a multitude of other phenomena. It may coat bottom surfaces, substrate surfaces, or protozoans themselves and lead to death (p. 16).

Liddle indicted the two stroke engines of outboard power boats. He stated that two stroke engines may discharge up to 40% of their fuel directly into the water. This fuel is mixed liberally with an oil additive required for operation. He estimated that the total discharge of hydrocarbons from one outboard engine running for one day is equivalent to the sewage produced by a population of 400 people (p. 192). The oil from outboard motors can lower oxygen content of the water and reduce the production of phytoplankton.

Literature Related to Shore Based Activities

Activities conducted along the shoreline of water bodies directly effect the flora and fauna of an aquatic environment. These include physical impacts such as walking in and out of the water by swimmers, waders, and anglers (Liddle, p. 194). Even this seemingly innocuous activity can crush water plants and benthic animals, both of which make up the food chain of larger fish. In a shore area heavily frequented by human activity, this can cause extensive damage to the ecosystem, especially that of a small lake or pond. This disruption can have far reaching consequences, this is particularly so in a lake as turbid as Lake Carl Blackwell, where the littoral zone is already quite thin. The shore disruption of a swimming area or boat ramp represents a break in the continuous habitat and a block to the reproduction of benthic animals.

Liddle states that marginal vegetation, so vital to oxygen and food production, is also damaged by people walking parallel to the water's edge or seeking access to the water for activities such as fishing or swimming (p. 195). The loss of such vegetation facilitates shoreline erosion which is a serious problem at Lake Carl Blackwell. Increasingly, the important role that margins play as transition areas between salt and fresh water, forest and grassland, as well as land and water is becoming evident. At Lake Carl Blackwell, these margins are under constant

assault from the wave actions of watercraft and shoreline human activity as well as the forces of nature.

Grey water discharge by recreational visitors can clearly cause serious water quality problems. The extent of this damage is determined by the nature of the lake's buffering system. Liddle and Scorgie called this the "natural" nutrient status of the water body. They continued :

> Any increase in the nutrient status of a body of water, particularly with respect to nitrogen and phosphorus, will tend to increase algal production. This in turn leads to an increase in turbidity in the water (due to phytoplankton), and rooted macrophytes may become shaded and...eventually killed (p. 200).

In Engineering and the Environment, Martin Wanielista et al observed that:

> Nutrients stimulate the growth of algae and waterweeds. These nutrients accelerate the process of eutrophication in lakes (p. 131).

Although off road operation of vehicles is prohibited at Lake Carl Blackwell, horseback riding is permitted almost any place a horse can go. The only restrictions on horse riders are to stay out of the campgrounds and away from heavily populated human activities such as swim areas and outdoor games. In their article "Trampling Effects of Hiker, Motorcycles and Horses in Meadows and Forests" T. Weaver and D. Dale observed:

> No significant difference [in the effects] between motorcycles and horses in shrub sites. Horses cause wider paths because

> of greater widths and tendencies to wander from the path. Trail depths were greatest under horse use. Horses produce a plowing effect. Compaction is greatest under horses, because horses exert the greatest downward pressure on the soil (p 453).

This compaction of the soil and destruction of covering vegetation causes the erosion of soil, formation of washouts, and adds to the eutrophication of the lake. Horse droppings contribute to the influx of nutrients and thus the growth of algae and water weeds.

Literature Related to Limnological Data Collection

There is a vast amount of literature pertaining to the collection of limnological data. The problem lies in discovering literature that outlines collection and analization techniques that a researcher with limited funding can utilize. A Guide to the Study of Freshwater Ecology edited by William A. Andrews was very valuable in this regard. Its simplistic approach to what can be a complex and involved task was most helpful. The researcher had to be very selective in what limnological measurements were pursued, not only considering what was affordable, but what was readily adaptable to attempting to discern recreational impact on the lake. Andrews stated that the dissolved oxygen test is probably the most important test for determining water quality (p. 89). He goes on to add that temperature also effects dissolved oxygen and determines what species of organisms can live in a particular body of water (p.98).

Using a Secchi disc to determine transparency and therefore an indication of suspended matter, was a simple but effective way to check for changes in water turbidity.

In determining what chemical analysis to carry out on water samples, the author consulted the Diagnostic Study of Lake Carl Blackwell compiled and published by Gregory L. Howick et al of the Zoology department of Oklahoma State University. Staying with what was affordable and documented historically, the researcher followed their lead in testing for dissolved oxygen, pH content, and alkalinity (pp. 32-70). Also consulted was The Practice of Water Pollution Biology written for the U.S. Department of the Interior by Kenneth M. Mackenthun. This volume also listed essentially the same constituents as Howick for testing water quality (pp. 19-31). Mackenthun was found equally useful in the analysis and reporting of limnological data in his Department of the Interior booklet titled Biological Associated Problems in Freshwater Environments which he co-authored with William M. Ingram (pp. 51-82).

Other possible research choices included testing for metals in lake waters, requiring the use of equipment and technicians at Oklahoma State University's water quality laboratory, an expense the author could not afford. Another possible avenue of approach in the study was the collection, observation and analysis of biological specimens, an approach considered beyond the author's current abilities. Both approaches may have yielded valuable information on the

environmental effects of recreation.

Historical limnological data from the 1940s was extracted from data tables compiled by Edgar M. Leonard in his dissertation Limnological Features and Successional Changes of Lake Carl Blackwell, Oklahoma.

CHAPTER III

METHODS AND TECHNIQUES OF THE RESEARCH

Introduction

This study was designed to determine recreation visitor's attitudes about the effects of recreation upon resources, and to ascertain what effects, if any, are actually occurring at Lake Carl Blackwell. To facilitate the stated research objectives, a data collection instrument was developed and administered to visitors, and principles of limnology were applied in collecting physical samples. Sites for sampling both visitors and the gathering of water samples were selected. Appropriate statistical procedures were applied to the collected data.

Development of the Human Data Collection Instrument

The data collection instrument for this study was a questionnaire developed by the researcher. The questionnaire was divided into five sections to correspond with the visitor's primary recreational activity.

The questionnaire opened with a consent statement informing the subject that participation was voluntary, that no penalty existed for refusal to participate, that input

could have an effect on future lake managment decisions, and that their help with the survey was very important to the study.

The first portion of the survey asked demographic questions pertaining to their gender, type of recreation, age, formal education, the number of vehicles brought onto lake property, and whether or not the subject was a member of an organized outdoor recreation group.

The remainder of the questionnaire was divided into five sections numbering seven statements each (except for horse riding statements which only numbered six). The subject was asked to respond to the statements on a Likert Scale by indicating whether they strongly agreed, agreed, are undecided, disagreed, or strongly disagreed with each statement.

Section I of the questionnaire formed the "default" portion of the instrument and was used for the "casual" lake visitors such as swimmers, picnickers, and day visitors. It was also used for all "other" visitors that did not fit into any of the nine categories of visitors. The categories consisted of day visitors, picnickers, hikers, swimmers, fishermen, motor boaters, jet/water skiers, campers, horse riders, and "others". This "default" section made statements regarding the effects of vehicle operation, noise generation, and littering, on the wildlife and environment of Lake Carl Blackwell.

Section II of the questionnaire directed statements

toward the effects of fishing in lake waters. These statements addressed the consequences to aquatic life of abandoned fishing line, catch and release of fish, the use of lead weights, returning dead fish or entrails to lake waters, fishing without catch limits, and abandoned jug lines.

Section III of the questionnaire pertained to operators of motorized watercraft and asked them to respond to statements about the impact of their activity on wildlife and the environment of Lake Carl Blackwell. Specific statements dealt with gasoline and oil spills, motoring close to the littoral zone (shoreline) of the lake, littering of lake waters, and the muddying of lake waters.

Section IV of the questionnaire was directed at campers and their attendant recreational activities. Specific statements surveyed their attitudes toward off road vehicle operation, destruction of groundcover, littering, erosion due to campsite over use, discharge of grey water, and the effects of campfires on trees.

Section V of the questionnaire addressed horse rider attitudes toward the effects on soil erosion of riding several horses single file and their willingness to pay fees to facilitate soil recovery. It also surveyed their attitudes about the effects of horse manure in the lake's watershed, and their willingness to be regulated as to the size of horse groups using the resource at one time.

Limnological Data Collection Instruments

Field and laboratory sample collection and analysis of lake water samples was conducted in four recreation intensive areas of the lake. The purpose of these procedures was to determine, within narrow perimeters, whether the effects of recreation on lake waters could be detected through chemical analysis and physical measurement. The procedure consisted of five tests to determine water transparency, temperature, pH, alkalinity, and dissolved oxygen content of the waters of Lake Carl Blackwell. These tests were chosen because of their importance to the survival of aquatic life, ease of implementation, and compatability with the amount of funds available for research.

Transparency, an indication of the amount of suspended matter in water, was determined by the use of a Secchi disc. This is a metal disc, 20 cm in diameter and divided into four quarters, two of which are white and two black. Several types of information may be gathered with the disc; a rough measure of suspended matter, the depth of reflected light penetration, and a rough estimate of the extent of the littoral zone. The disc is lowered into lake waters in a shaded area until it just disappears. It is then raised until it just reappears and the two measurements are averaged. This process is repeated three times and the overall average is considered to be the proper Secchi disc

reading. The reading corresponds closely to the depth limit of the littoral zone, the area of rooted plant growth. Thus, the contour of the lake's littoral zone will correspond closely to the Secchi disc reading. Readings taken should show any increase in turbidity that may be generated by boat and jet ski traffic.

Temperature is closely correlated to the amount of dissolved oxygen the water can hold. The colder the water, the more gas it can dissolve. Water temperature will point out changes in the water caused by climatic changes that affect the entire lake, and factors that may affect only a small area. Since one of the major factors acting on the lake is the climate, it is fundamentally important for the research to rule out changes not caused by recreational actitivity. The tracking of temperature change will help to do that.

A limiting factor which has a maximum and minimum value above or below which life for many aquatic species cannot survive is pH. The content of pH in lake waters can be affected by the presence of humans, their machines, chemicals, and refuse. It is also an expression of the concentration of hydrogen ions present in lake waters. Organic materials released into lake waters causes a rise in acidity and a subsequent lowering of the pH level. Recreational visitors releasing organic materials into the lake can possibly be detected through this analysis. pH content is measured using two simple HACH chemical tests that

provide a narrow pH reading of from 5.5 to 7.5, and from 6.5 to 8.5

Closely allied with pH and in many ways determining it is alkalinity. Alkalinity is a limiting factor that is dependent upon the alkalies and basic salts that are present in lake waters. Alkalinity analysis was conducted using HACH test kit model AL-AP MG-L. All samples were measured using high range testing procedures, with a range of 5-400 mg/L using a sulfuric acid drop count titration method.

Dissolved oxygen content (D.O.) is the single most important test for determining water quality, especially as far as aquatic life is concerned. The amount of oxygen dissolved in lake waters and available for the respiration of fish and their prey directly effects recreation at Lake Carl Blackwell. Regardless of whether the visitor is a skilled bass fisherman complete with boat, depth finder, and the latest rod and reel, or just a boy with a cane pole, fishing is the single greatest draw to the lake.

D.O. was measured using HACH test kit model OX-2P with a range of 1-20 mg/L. Sample size measured was 60 mL and used a sodium thiosulfate drop count titration/modified Winkler method to determine D.O. content of the sample.

The Process of Human Sampling

Lake Carl Blackwell is a busy recreational area during the summer months. Initially, it was thought that patrons could be stopped on the way out of the lake and surveyed in

their cars. This proved to be impractical and possibly dangerous because of the amount of traffic. Instead, patrons were approached on foot as they recreated. All surveys were conducted in the afternoon to allow those surveyed to have experienced some recreational activity at the lake before answering the survey. Visitors were approached in a random manner, without regard to the nature of their recreation. If the recreation being pursued was a group activity, only one individual from the group was questioned. Input from other group members to the individual being surveyed was discouraged. Surveys were conducted in all five campgrounds (see figure 1), at the boating facilities, and at the Ski Point recreational area. Campers were surveyed at every other site and only once per weekend to keep from surveying any one individual group of campers more than once. After the initial survey, all patrons approached were questioned concerning previous participation so as not to survey any person more than once. Later, as it was determined by reading surveys that samples of certain types of visitors were low, those engaged in that particular recreation were sought out. Those found to be recreating in the manner needed to be sampled were then approached using the methods previously outlined.

The Process of Limnological Sampling

Limnological sampling was conducted at four recreationally intense areas, each selected to measure a slightly

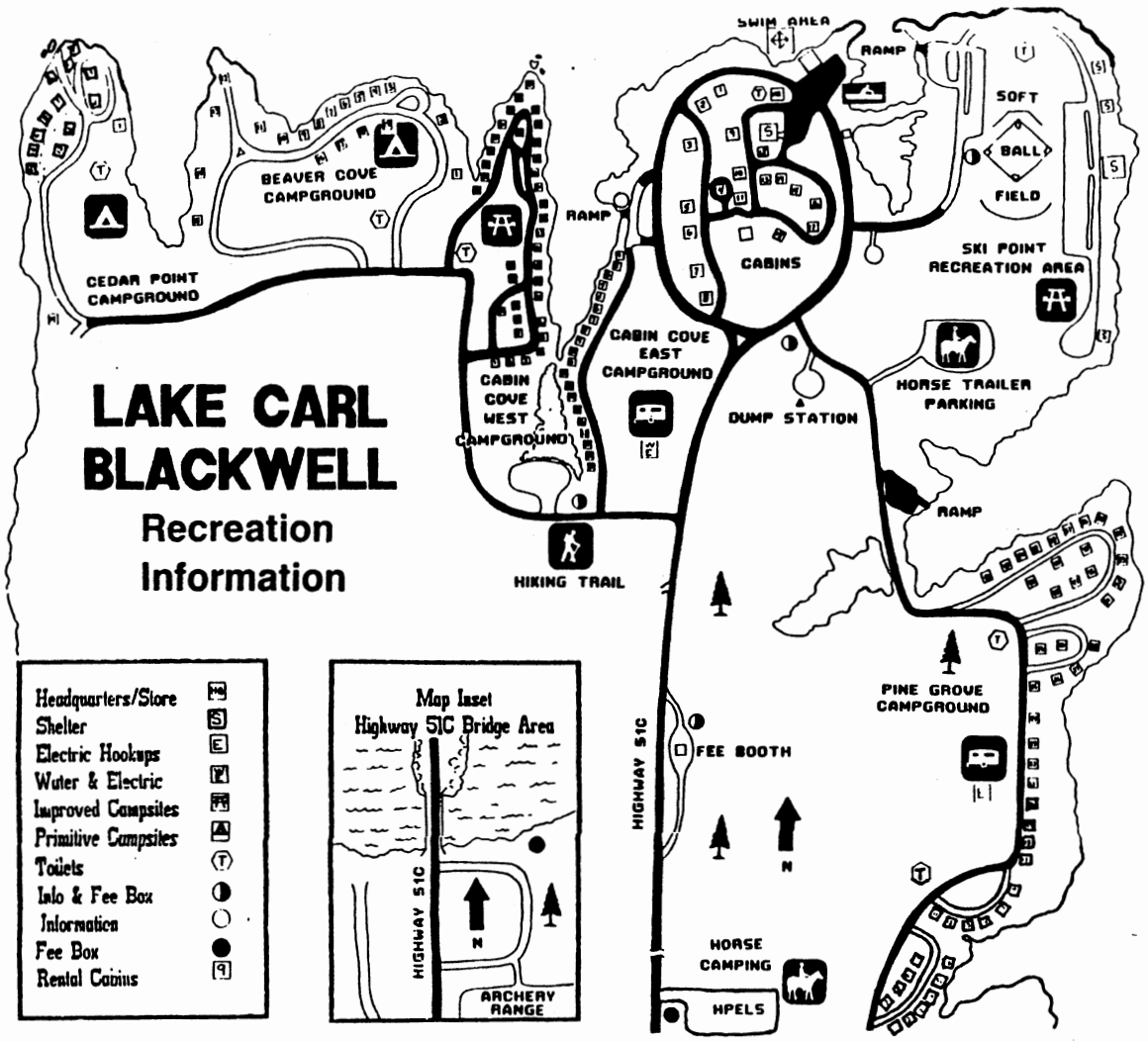

Figure 1. Lake Carl Blackwell Recreational Area

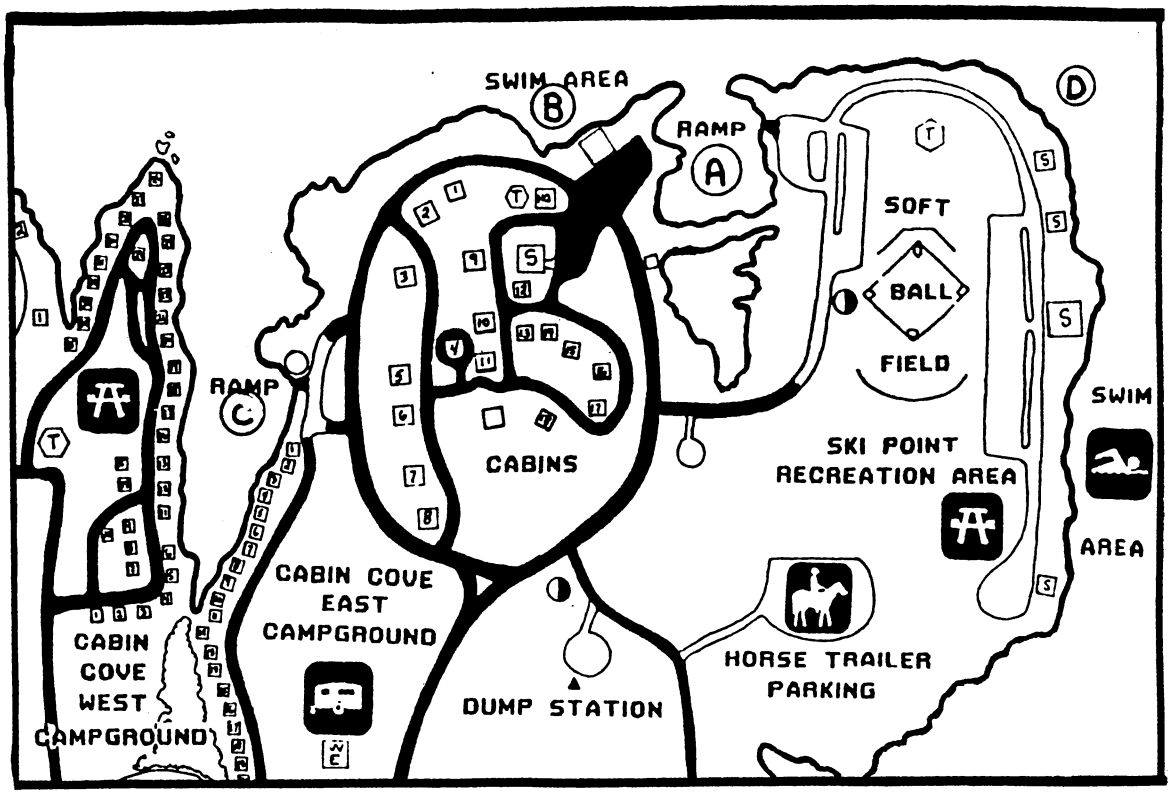

Figure 2. Limnological Test Sites Lake Carl Blackwell

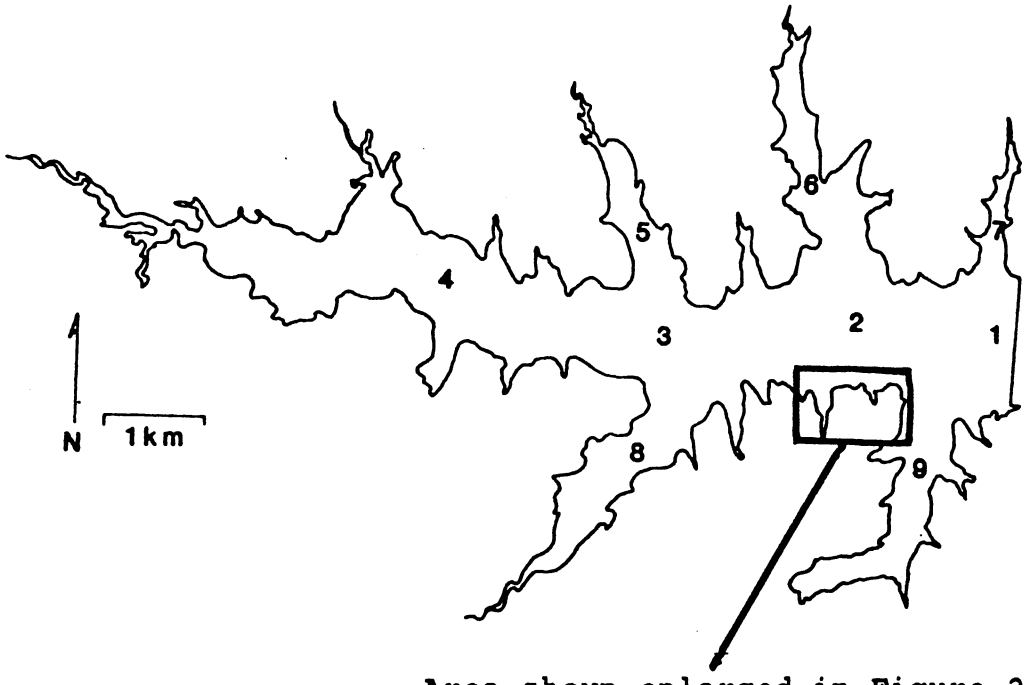

Figure 3. Sampling Sites for 1981 Diagnositic Study

different activity (see figures 2 and 3).

Station A: Ski Point Boat Dock

Ski Point boat dock is located on the south side of the lake and adjacent to the lake store. It is enclosed by two earthen jettys that form a horse shoe shaped harbor about the three docks, boat ramp, and boat house located in this area. The docks are used primarily by motorized watercraft, although one is for the exclusive use of sailboats. All measurements were taken at the end of the east boat dock. Temperature and all water samples for analysis, as with all stations, were taken at the surface of the water. Analysis of deeper waters was beyond the scope of this study. This dock is serviced by a dirt road and a dirt parking area. Recreation in this area consists of fishing and the loading/unloading of watercraft.

Station B: Swim Area

This station is a designated swim area located north of the lake store and separated by an earthen jetty from Station A which lies to the east of the swim area (see figure 2). This station is an unprotected cove that faces north and on days when the wind is out of the north, suffers from wind generated wave action. All samples were taken along the shore or from a watercraft inside the swim area. As its name implies, recreation in this area is primarily swimming with some sunbathing. Boats and fishing are prohibited in

this area. This area is serviced by a paved highway. Visitors to the area park in a small public parking area located to the east and along the highway shoulder. On very hot days, this relatively small swim area is used extensively.

Station C: Cabin Cove Dock

This station is a southern arm of the lake and is bordered by two campgrounds. Cabin Cove West campground, located on the west side of the arm is an improved campground with several sites on the arm. These sites have pump water, but no electricity. The area is serviced by a paved road and an outside toilet facility. During heavy use times such as holidays, portable latrines are brought in to supplement the toilet.

Cabin Cove East campground, located on the east side of the arm is occupied by year-around campers with built up areas, running water, and electricity. Sewage is captured in various styled holding tanks and transported to the lake dump station. The dock area and campground are serviced by both paved and dirt roads/parking areas. Recreation in this area consists of fishing, boating, water skiing, swimming, sunbathing, and camping.

All samples and temperatures were taken at the end of the dock or on watercraft near the end of the dock.

Station D: Ski Point, Point

This area, located at the entrance to the eastern most south-pointing arm of the lake (see figure 2) is the most open of all the test stations. It is a primary turning point for boats towing water skiers and for jet ski operators. Besides the use of watercraft, other recreation in this area includes fishing, swimming, and sunbathing. The area is serviced by a dirt road and receives wave action both from the wind and the operation of watercraft. There are no utilities in this area, and the outdoor toilet is located well away from the shore. On heavy use days, portable latrines are brought in to supplement the toilet. The dirt road is subjected to heavy vehicular use, not only from the recreational visitors to the area, but from casual "drive through" vehicles.

Samples and temperatures were taken from the shore and from watercraft just off the shore.

Methods for Reporting Data

Parametric inferential statistical procedures were applied to the collected human data. Responses are reported as frequencies, percentages, and cumulative percentages. The responses are then regrouped to reflect agreement or non-agreement with current literature. Two tables are reported for knowledge and one table for attitudes toward the environmental effects of recreation.

Analysis of variance procedures were applied to limno-

logical data to determine any significant variation between current and historical data.

CHAPTER IV

ANALYSIS AND SYNTHESIS OF DATA

Introduction

Data for this study was gathered using the measuring instruments outlined in Chapter III and consisted of a survey questionnaire as well as chemical analysis of water samples and physical measurements of transparency and temperature. The data provided by the questionnaire consists of basic demographics about recreational visitors to Lake Carl Blackwell. Additionally, their knowledge and attitudes concerning the effects of recreation on a lake environment was determined.

Limnological data was gathered using physical measurements and chemical analysis of water samples. This data was compared with the lake's historical limnology and effects thought to be the direct result of recreational pursuits isolated for scrutiny. All data were analyzed using inferential statistical procedures. Frequencies of response, percentages, and variances between current and historical data were determined. Reported percentages may not total 100 percent due to rounding of figures.

Frequency tables and measurements related to respond-

ent's demographics, knowledge, and attitudes are shown in Tables I through XXXVII. The tables are broken down to correspond with the groups surveyed.

The summer season of 1992 beginning with the Memorial Day weekend (May 22 - 24) and ending with the Labor Day weekend (September 5 - 7) was allocated to on site sampling of recreational visitors as well as the gathering and analysis of limnological field samples. Two hundred and thirty two respondents from 10 different recreational groups were sampled during this period. Thirty six physical measurements of water temperature and Secchi disk readings were taken, and fifty four chemical analysis of water samples to determine pH, total alkalinity, and dissolved oxygen content, were conducted during this same time frame. Measurements were taken on Friday and Sunday afternoons two weekends per month. The range of the pH test (5.5 -7.5) was determined to be too low as most readings consistently came out at the upper end of the test range. New chemicals allowing a range of test from 6.5 to 8.5 was obtained and used in the latter part of the study period, from August 21 through September 7, 1992.

On two occasions (19 and 21 June), Secchi disk readings were not taken at two of the sampling stations due to inclement weather. One designated recreational group, horse riders, were for the most part unresponsive and refused to participate in the survey in any meaningful numbers. Out of thirty contacts, only three horse riders

agreed to participate in the survey. Their lack of participation seems to stem from a fear of increased regulation of their sport by Lake Carl Blackwell management if they participated in the survey. This attitude, in and of itself, says something about the perception by horsemen of the effect of their sport on the recreational environment. Two other groups, hikers and the default group of "others", did not have enough respondents for statistical analysis.

All surveys were taken in the afternoon between 1:00 p.m. and 6:00 p.m.. This allowed the respondents a period of time to experience the recreational setting prior to being surveyed. Limnological readings were also taken during this time frame on Fridays before the onset of the recreational period of the weekend, and on Sundays after most recreation had taken place.

Data Related to Visitor's Knowledge and Attitudes Concerning Recreational Impact

Recreational visitors were asked to respond to statements in five separate sections of the questionnaire related directly to the type of activity they were engaged in.

Section I of Questionnaire

Section I was the default section, visitors that fit no other category automatically answered section I. Responses

to statements and frequency measures are shown in TABLE I through TABLE XXId. There are two tables for each knowledge statement and one for each attitude statement. The first table shows frequency measures for the responses to a statement. The second table combines the "Strongly Agree" and "Agree" responses, and the "Strongly Disagree", "Disagree" and "Don't Know/No Opinion responses. Then frequency measures are shown for "Match" and "No Match". "Match" indicates that the response to the statement correspondes to the position taken in the current literature. "No Match" indicates that the response to the statement did not correspond with the position taken in current literature. Being subjective, attitudes do not have a corresponding Match/No Match table.

Statement #1 of Section I was, "Driving on the roads of Lake Carl Blackwell does not effect the lake environment." Eisler states that amounts of lead in roadside soils increase as a direct result of the combustion of gasoline containing organolead additives and reaches the aquatic environment through highway runoff (p. 22). The effect of this lead contamination is highly detrimental to lake wildlife. Lead additives to gasoline are being phased out by government regulation, so a lack of knowledge in this area may not be as important as it was at one time. Swimmers demonstrated the most concern in this area with a thirty seven percent "match" of current literature.

TABLE Ia

STATEMENT #1, SECTION I "DRIVING ON THE ROADS OF LAKE CARL BLACKWELL DOES NOT EFFECT THE LAKE ENVIRONMENT."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.3	6.3
Agree	12	37.5	43.8
Don't Know/No Opinion	8	25.0	68.8
Disagree	8	25.0	93.8
Strongly Disagree	2	6.2	100.0
Total	32	100.0	

TABLE Ib

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	10	31.2
No Match	23	68.8
Total	32	100.0

TABLE Ic

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	11	36.7	40.0
Don't Know/No Opinion	7	23.3	63.3
Disagree	5	16.7	80.0
Strongly Disagree	6	20.0	100.0
Total	30	100.0	

TABLE Id

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	11	36.7
No Match	19	63.3
Total	30	100.0

TABLE Ie

PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	5	15.6	15.6
Agree	10	31.2	46.8
Don't Know/No Opinion	7	21.9	68.7
Disagree	7	21.9	90.6
Strongly Disagree	3	9.4	100.0
Total	32	100.0	

TABLE If

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	10	31.2
No Match	22	68.8
Total	32	100.0

Statement #2 of Section I was, "Driving off road causes no environmental harm." Studies by Weaver and Dale (p. 453) and Webb and Wilshire (p. 87) have shown that operating

vehicles off road does damage the environment. In a similar survey question asked by Reynolds (p. 65) of off road vehicle operators, 58.4 percent of the respondents agreed that off road vehicle operation caused no harm to the environment, while 21.8% disagreed. In the "Match/No Match" category, 71.1% of the respondents were "No Match" for the current literature. In the LCB survey, day visitors showed the way with the highest understanding of the environmental hazards of off road vehicle operation.

TABLE IIa

STATEMENT #2, SECTION I
"DRIVING OFF ROAD CAUSES NO ENVIRONMENTAL HARM."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.3	6.3
Agree	3	9.4	15.7
Don't Know/No Opinion	5	15.6	31.3
Disagree	14	43.7	75.0
Strongly Disagree	8	25.0	100.0
Total	32	100.0	

TABLE IIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	22	68.8
No Match	10	31.2
Total	32	100.0

TABLE IIc

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.7	6.7
Agree	4	13.3	20.0
Don't Know/No Opinion	4	13.3	33.3
Disagree	10	33.3	66.6
Strongly Disagree	10	33.3	99.9
Total	30	100.0	

TABLE IId

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	20	66.7
No Match	10	33.3
Total	30	100.0

TABLE IIe

PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	4	12.5	12.5
Agree	1	3.1	15.6
Don't Know/No Opinion	7	21.9	37.5
Disagree	10	31.2	68.7
Strongly Disagree	10	31.2	99.9
Total	32	100.0	

TABLE IIf

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	20	62.5
No Match	12	37.5
Total	32	100.0

Statement #3 of Section I was, "Parking on grass causes no environmental harm." Running over the stems and roots of vegetation has been shown by Wilshire, Shipley, and Nakata (p. 136) to cause the destruction of the effected plants. Additionally, Webb and Wilshire (p. 87) have shown the subsequent compaction of the soil effects its ability to absorb water. Reynold's similar question produced a matching response to current literature of 56.5 percent (p. 70). Swimmers demonstrated their perception of this environmental hazard by scoring a "match" percentage of 67 percent, five percent higher than their closest competitors.

TABLE IIIa

STATEMENT #3, SECTION I
"PARKING ON GRASS CAUSES NO ENVIRONMENTAL HARM."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.1	3.1
Agree	6	18.7	21.8
Don't Know/No Opinion	5	15.6	37.4
Disagree	14	43.7	81.1
Strongly Disagree	6	18.8	99.9
Total	32	100.0	

TABLE IIIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	20	62.5
No Match	12	37.5
Total	32	100.0

TABLE IIIc

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	4	13.3	13.3
Agree	5	16.7	30.0
Don't Know/No Opinion	1	3.3	33.3
Disagree	13	43.3	76.6
Strongly Disagree	7	23.3	99.9
Total	30	100.0	

TABLE IIId

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	20	66.7
No Match	10	33.3
Total	30	100.0

TABLE IIIe

PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.2	6.2
Agree	4	12.5	18.7
Don't Know/No Opinion	7	21.9	40.6
Disagree	11	34.4	75.0
Strongly Disagree	8	25.0	100.0
Total	32	100.0	

TABLE IIIf

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	19	59.4
No Match	13	40.6
Total	32	100.0

Statement #4 of Section I was, "Noise from loud car stereos drives wildlife from the area." Loud noises, whatever their origin, do drive animals away from the source of noise. Car stereos outfitted with the large boom-boxes of

today are quite capable of effecting animals. Hope points out that many animals depend on their hearing for survival (p. 56). A rabbit, hidden in the brush near a car with a loud bass stereo could have its hearing impaired and thus become an easier target for predation. Additionally, many animals, especially nocturnal ones, depend upon their hearing to locate potential reproductive partners. In this particular area, perhaps because loud speakers also bother them, picnickers scored the highest "match" percentage with 75%, a formidable 23% over the second highest percentage scored by the swimmers.

TABLE IVa

STATEMENT #4, SECTION I "NOISE FROM LOUD CAR STEREOS DRIVES WILDLIFE FROM THE AREA."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	8	25.0	25.0
Agree	6	18.7	43.7
Don't Know/No Opinion	7	21.9	65.6
Disagree	7	21.9	87.5
Strongly Disagree	4	12.5	100.0
Total	32	100.0	

TABLE IVb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	14	43.8
No Match	18	56.2
Total	32	100.0

TABLE IVc

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	5	16.7	16.7
Agree	9	30.0	46.7
Don't Know/No Opinion	6	20.0	66.7
Disagree	7	23.3	90.0
Strongly Disagree	3	10.0	100.0
Total	30	100.0	

TABLE IVd

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	14	46.7
No Match	16	53.3
Total	30	100.0

TABLE IVe

PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	13	40.6	40.6
Agree	11	34.4	75.0
Don't Know/No Opinion	2	6.2	81.2
Disagree	3	9.4	90.6
Strongly Disagree	3	9.4	100.0
Total	32	100.0	

TABLE IVf

RESPONSES VS LITERATURE

Response	frequency	Percent
Match	24	75.0
No Match	8	25.0
Total	32	100.0

Statement #5 was, "Assuming cars have a negative effect on lake environment and wildlife, this is an acceptable consequence of recreating." Fully 44 percent of day visitors, 37 percent of picnickers, and 36 percent of swimmers feel that the negative consequences of vehicles on wildlife and the environment is an acceptable price to pay for their recreation. This is an area that must be addressed by resource managers. Visitors to recreational areas have to be educated as to the hazards posed to parks, lakes, refuges and even desert areas by motor vehicles. There are few, if any, recreational areas that are not threatened by the need

to bring vehicles wherever humans venture.

TABLE Va

STATEMENT #5, SECTION I "ASSUMING CARS HAVE A NEGATIVE EFFECT ON LAKE ENVIRONMENT AND WILDLIFE, THIS IS AN ACCEPTABLE CONSEQUENCE OF RECREATING."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.3	6.3
Agree	12	37.5	43.8
Don't Know/No Opinion	5	15.6	59.4
Disagree	10	31.3	90.7
Strongly Disagree	3	9.3	100.0
Total	32	100.0	

TABLE Vb

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	10	33.3	36.6
No Opinion/Don't Know	10	33.3	69.9
Disagree	4	13.3	83.2
Strongly Disagree	5	16.7	99.9
Total	30	100.0	

TABLE Vc

PICNICKERS

Response	Frequency	Percent	Cumuative Percent
Strongly Agree	0	0	0
Agree	12	37.5	37.5
Don't Know/No Opinion	9	28.1	65.6
Disagree	8	25.0	90.6
Strongly Disagree	3	9.4	100.0
Total	32	100.0]	

Statement #6 was, "Litter, such as six pack rings, cause damage to wildlife and the environment." All three groups scored a high "match" percentage, with swimmers scoring the highest with 87 percent. The detrimental effects of litter is the most emphasized and visible environmental effect of human activity. Yet, thirteen to nineteen percent of these groups did not see litter as a threat to wildlife, the environment, humans, or their recreation.

TABLE VIa

STATEMENT #6, SECTION I "LITTER, SUCH AS SIX PACK RINGS, CAUSE DAMAGE TO WILDLIFE AND THE ENVIRONMENT."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	16	50.0	50.0
Agree	10	31.3	81.3
Don't Know/No Opinion	3	9.4	90.7
Disagree	1	3.1	93.8
Strongly Disagree	2	6.2	100.0
Total	32	100.0	

TABLE VIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	26	81.3
No Match	6	18.7
Total	32	100.0

TABLE VIc

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	20	66.7	66.7
Agree	6	20.0	86.7
Don't Know/No Opinion	2	6.7	93.4
Disagree	0	0.0	93.4
Strongly Disagree	2	6.7	100.0
Total	30	100.0	

TABLE VId

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	26	86.7
No Match	4	13.3
Total	30	100.0

TABLE VIe

PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	17	53.1	53.1
Agree	10	31.2	84.3
Don't Know/No Opinion	1	3.1	87.4
Disagree	0	0.0	87.4
Strongly Disagree	4	12.5	99.9
Total	32	100.0	

TABLE VIf

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	27	84.4
No Match	5	15.6
Total	32	100.0

Statement #7 was, "If litter causes damage to wildlife and the environment, this is an acceptable consequence of recreating." Even more disturbing than the "no match" scores of question six, is the high percent of all three

groups that are willing to accept damage to wildlife and the environment for the sake of their recreation.

TABLE VIIa

STATEMENT #7, SECTION I "IF LITTER CAUSES DAMAGE TO WILDLIFE AND THE ENVIRONMENT, THIS IS AN ACCEPTABLE CONSEQUENCE OF RECREATING."

DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	7	21.9	21.9
Agree	5	15.6	37.5
Don't Know/No Opinion	2	6.3	43.8
Disagree	5	15.6	59.4
Strongly Disagree	13	40.6	100.0
Total	32	100.0	

TABLE VIIb

SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	7	23.3	23.3
Agree	5	16.7	40.0
No Opinion/Don't Know	1	3.3	43.3
Disagree	3	10.0	53.3
Strongly Disagree	14	46.7	100.0
Total	30	100.0	

TABLE VIIc

PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	3	9.4	9.4
Agree	7	21.9	31.3
No Opinion/Don't Know	2	6.2	37.5
Disagree	6	18.7	56.2
Strongly Disagree	14	43.8	100.0
Total	32	100.0	

Demographics of Section I Responders

TABLES VIIIa through VIIIo show the demographics of those subjects responding to Section I of the questionnaire.

TABLE VIIIa

FORMAL EDUCATION COMPLETED BY SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Less than 12 years	2	6.7	6.7
12 years	17	56.7	63.4
Some College/No Degree	7	23.3	86.7
Associate Degree/Acad	1	3.3	90.0
Associate degree/VoTech	2	6.7	96.7
Bachelors Degree	1	3.3	100.0
Masters Degree+	0	0.0	100.0
Total	30	100.0	

mode = 12 years

TABLE VIIIb

AGE IN WHOLE YEARS OF SWIMMERS

Response	Frequency	Percent	Cumulative Percent
15-19	6	20.0	20.0
20-24	5	16.7	36.7
25-29	7	23.3	60.0
30-34	4	13.3	73.3
35-39	5	16.7	90.0
40-44	2	6.7	96.7
45-49	0	0.0	96.7
50-54	0	0.0	96.7
55-59	0	0.0	96.7
60-64	1	3.3	100.0
Total	30	100.0	

median = 28.0

TABLE VIIIc

GENDER OF SWIMMERS

Response	Frequency	Percent	Cumulative Percent
Male	12	40.0	40.0
Female	18	60.0	100.0
Total	30	100.0	

TABLE VIIId

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY SWIMMERS

Response	Frequency	Percent	Cumulative Percent
0	2	6.7	6.7
1	23	76.7	83.4
2	4	13.3	96.7
3	1	3.3	100.0
Total	30	100.0	

mean = 1.13

TABLE VIIIe

NUMBER OF SWIMMERS WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency	Percent	Cumulative Percent
Member	1	3.3	3.3
Non-member	29	96.7	100.0
Total	30	100.0	

TABLE VIIIf

FORMAL EDUCATION COMPLETED BY PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Less than 12 years	3	9.4	9.4
12 years	11	34.4	43.8
Some college/no degree	8	25.0	68.8
Associate degree/acad	0	0.0	68.8
associate degree/Votech	0	0.0	68.8
Bachelors degree	5	15.6	84.4
Masters degree+	5	15.6	100.0
Total	32	100.0	

mode = 12 years

TABLE VIIIg

AGE IN WHOLE YEARS OF PICNICKERS

Response	Frequency	Percent	Cumulative Percent
15-19	2	6.3	6.3
20-24	4	12.5	18.8
25-29	2	6.3	25.1
30-34	7	21.9	47.0
35-39	3	9.4	56.4
40-44	4	12.5	68.9
45-49	1	3.1	72.0
50-54	4	12.5	84.5
55-59	3	9.4	93.9
60-64	1	3.1	97.0
65-69	1	3.1	100.0
Total	32	100.0	

median = 35.0

TABLE VIIIh

GENDER OF PICNICKERS

Response	Frequency	Percent	Cumulative Percent
Male	18	56.0	56.0
female	14	44.0	100.0
Total	32	100.0	

TABLE VIIIi

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY PICNICKERS

Response	Frequency	Percent	Cumulative Percent
0	7	21.9	21.9
1	24	75.0	96.9
2	0	0.0	96.9
3	0	0.0	96.9
4	1	3.1	100.0
Total	32	100.0	

mean = 0.88

TABLE VIIIj

NUMBER OF PICNICKERS WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency	Percent	Cumulative Percent
Member	1	3.1	3.1
Non-member	31	96.9	100.0
Total	32	100.0	

TABLE VIIIk

FORMAL EDUCATION COMPLETED BY DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Less than 12 years	2	6.3	6.3
12 years	5	15.6	21.9
Some college/no degree	15	47.0	68.9
Associate degree/acad	1	3.1	72.0
Associate degree/votech	2	6.3	78.3
Bachelors degree	5	15.6	93.9
Masters degree	2	6.3	99.9
Total	32	100.0	

mode = Some college/no degree

TABLE VIIIl

AGE IN WHOLE YEARS OF DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
15-19	2	6.3	6.3
20-24	11	34.4	40.7
25-29	6	18.8	59.5
30-34	2	6.3	65.8
35-39	4	12.5	78.3
40-44	4	12.5	90.8
45-49	1	3.1	93.9
50-54	1	3.1	97.0
55-59	0	0.0	97.0
60-64	0	0.0	97.0
65-69	0	0.0	97.0
70-74	1	3.1	100.0
Total	32	100.0	

mean = 30.40 median = 25.50

TABLE VIIIm

GENDER OF DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
Male	17	53.1	53.1
Female	15	46.9	100.0
Total	32	100.0	

TABLE VIIIn

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY DAY VISITORS

Response	Frequency	Percent	Cumulative Percent
0	3	9.4	9.4
1	24	75.0	84.4
2	3	9.4	93.8
3	1	3.1	96.9
4	1	3.1	100.0
Total	32	100.0	

mean = 1.16 vehicles per day visitor

TABLE VIIIo

NUMBER OF DAY VISITORS WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency	Percent	Cumulative Percent
Member	2	6.3	6.3
Non-member	30	93.7	100.0
Total	32	100.0	

Section II of Questionnaire, Fishermen

Section II addressed fishermen and their fishing habits which effect both the lake environment and its animal inhabitants. Statement 1 of Section II was, "Abandoned fishing line causes no damage to wildlife or the environment." Monofiliment fishing line easily entangles wildlife and can cause death through strangulation. A slower but just as lethal hazard is entanglement to the point that the animal starves to death due to restricted movement. The most visible victims of abandoned fishing line are waterfowl, especially the wading birds. As indicated in the tables below, most fishermen recognize the threat abandoned fishing line has for wildlife and the environment. Yet the 33 percent that do not, pose a continuing problem for Lake Carl Blackwell in particular and the environment in general.

TABLE IXa

STATEMENT #1, SECTION II "ABANDONED FISHING LINE CAUSES NO DAMAGE TO WILDLIFE OR THE ENVIRONMENT."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	5	16.7	16.7
Agree	3	10.0	26.7
Don't Know/No Opinion	2	6.7	33.4
Disagree	7	23.3	56.7
Strongly Disagree	13	43.3	100.0
Total	30	100.0	

TABLE IXb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	20	66.7
No Match	10	33.3
Total	30	100.0

Question #2 of Section II was, "Catch and release of game fish such as bass, is not damaging to the fish." The jury seems to be still out on this question, although Shultz (pp. 158-162) and Hope (pp. 54-59) indicate that catch and release programs are doing well at Nueltin Lake near Manitoba, Canada. The catch and release program is well supervised and care is taken not to damage the fish. Local bass organizations at Lake Carl Blackwell provide similar release programs for their members. However, only 10 percent of the surveyed fishermen were members of an organized outdoor recreation club.

TABLE Xa

STATEMENT #2, SECTION II "CATCH AND RELEASE OF GAME FISH SUCH AS BASS, IS NOT DAMAGING TO THE FISH."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	9	30.0	30.0
Agree	9	30.0	60.0
Don't Know/No Opinion	5	16.7	76.7
Disagree	7	23.3	100.0
Strongly Disagree	0	0.0	100.0
Total	30	100.0	

TABLE Xb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	18	60.0
No Match	12	40.0
Total	30	100.0

Question 3, Section II was, "If catch and release is damaging to fish, this is an acceptable consequence of fishing." There is no doubt that damage is done to fish when caught. The use of hooks guarantees that injury will occur, not always fatal and not always serious damage, but damage none the less. Damage to fish already weakened by a polluted environment or susceptibility to infection would

increase the likelihood of death. Damage to mouth parts could also reduce the ability of fish to feed. Statement 3 was to ascertain the fisherman's view of fish as a living creature. Not cute and cuddly like mammals, would the fisherman still feel compassion for this animal that provides his recreation? The following tables seem to indicate that fishermen are about equally divided on the question.

TABLE XI

STATEMENT #3, SECTION II "IF CATCH AND RELEASE IS DAMAGING TO FISH, THIS IS AN ACCEPTABLE CONSQUENCE OF FISHING."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	3	10.0	10.0
Agree	6	20.0	30.0
Don't Know/No Opinion	7	23.3	53.3
Disagree	8	26.7	80.0
Strongly Disagree	6	20.0	100.0
Total	30	100.0	

Statement #4, Section II is, "Lead weights left in fishing areas do pose a threat to aquatic animals and waterfowl." Eisler indicated that waterfowl have been poisoned through the ingestion of discarded fishing sinkers, the major cause of death of the mute swan. Eisler also

stated that lead toxicosis caused by ingestion of shot and other lead objects to include sinkers, has been reported for sandhill cranes, mourning dove, and wild turkey (p. 2). Lead is toxic to all aquatic biota, and at low pH and alkalinity levels is soluble in water (p. 3).

TABLE XIIa

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	9	30.0	30.0
Agree	8	26.7	56.7
Don't Know/No Opinion	8	26.7	83.4
Disagree	2	6.7	90.1
Strongly Disagree	3	10.0	100.0
Total	30	100.0	

TABLE XIIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	17	56.7
No Match	13	43.3
Total	30	100.0

Statement #5, Section 2 was, "Returning dead fish or entrails to Lake Carl Blackwell waters is harmful to the environment." Any healthy body of water with decomposers,

scavenger fish species and predators should have no problem with absorbing the remains of cleaned fish thrown back in by non-commercial fishermen. The practice of returning remains to lake waters is preferable to burying, burning, or disposal in waste containers. It also allows nutrients to remain in the natural environment. The following table indicates that the majority of fishermen lack knowledge of the ecology of lakes.

TABLE XIIIa

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	6	20.0	20.0
Agree	8	26.7	46.7
Don't Know/No Opinion	2	6.7	53.4
Disagree	7	23.3	76.7
Strongly Disagree	7	23.3	100.0
Total	30	100.0	

TABLE XIIIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	14	43.7
No Match	16	53.3
Total	30	100.0

Statement #6, Section II was, " "Fishing with no estab-

lished limit is not detrimental to the fish population." As in any pursuit, no restraint on individual sportsmen can result in actions detrimental to both wildlife and their environment. Assuming all life is interdependent, how much more so are the creatures of closed finite ecosystems such as lakes? The unlimited removal of a species such as bass can have a wide effect on an aquatic environment. McClanahan stated:

> Current research suggests that a number of fish, particularly top carnivores, play important ecological roles within aquatic ecosystems. Often these same species are the focus of fishing efforts. Bass, an example from freshwater lakes, can directly and indirectly affect an array of community structure variables, including zooplankton and phytoplankton abundance as well as ecological processes such as nutrient dynamics and productivity. Changes in abundance of these top predators can have unexpected consequences that can effect the entire ecosystem (p. 13).

The tables below indicate that most fishermen also view unlimited fishing as detrimental to the fish population.

TABLE XIVa

STATEMENT #6, SECTION II "FISHING WITH NO ESTABLISHED LIMIT IS NOT DETRIMENTAL TO THE FISH POPULATION."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	4	13.3	16.6
Don't Know/No Opinion	3	10.0	26.7
Disagree	9	30.0	56.7
Strongly Disagree	13	43.3	100.0
Total	30	100.0	

TABLE XIVb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	22	73.3
No Match	8	26.7
Total	30	100.0

Statement #7, Section II was, "Abandoned jug lines do not pose a threat to the environment." Jug lines are nearly always attached to plastic bottles of some kind. The resistance of plastic to natural decomposition is well known. Combined with monofiliment fishing line and a metal hook, jug lines become a formidable environmental hazard. With an ability to last literally for years, abandoned jug lines have the potential of killing and maiming animals below water as well as above long after the fisherman has abandoned it. The table below indicates that most fishermen

are well aware of the problems abandoned jug lines present.

TABLE XVa

STATEMENT #7, SECTION II "ABANDONED JUG LINES DO NOT POSE A THREAT TO THE ENVIRONMENT."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	3	10.0	10.0
Agree	3	10.0	20.0
Don't Know/No Opinion	1	3.3	23.3
Disagree	6	20.0	43.3
Strongly Disagree	17	56.6	99.9
Total	30	100.0	

TABLE XVb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	23	76.7
No Match	7	23.3
Total	30	100.0

Demographics of Surveyed Fishermen

TABLE XVIa through TABLE XVIe shows the demographics of the fishermen surveyed at LCB.

TABLE XVIa

FORMAL EDUCATION COMPLETED BY FISHERMEN

Response	Frequency	Percent	Cumulative Percent
Less than 12 years	2	6.7	6.7
12 years	12	40.0	46.7
Some college/no degree	8	26.7	73.4
Associate degree/acad	1	3.3	76.7
associate degree/votech	2	6.7	83.4
Bachelors degree	3	10.0	93.4
Masters degree +	2	6.7	100.0
Total	32	100.0	

Mode = 12 yrs

TABLE XVIb

AGE IN WHOLE YEARS OF FISHERMEN

Response	Frequency	Percent	Cumulative Percent
20-24	4	13.3	13.3
25-29	5	16.7	30.0
30-34	8	26.7	56.7
35-39	4	13.3	70.0
40-44	6	20.0	90.0
45-49	1	3.3	93.3
50-54	0	0.0	93.3
55-59	0	0.0	93.3
60-64	2	6.7	100.0
Total	32	100.0	

median = 32.67

TABLE XVIc

GENDER OF FISHERMEN

Response	Frequency	Percent	Cumulative Percent
Male	25	83.3	83.3
Female	5	16.7	100.0
Total	30	100.0	

TABLE XVId

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY FISHERMEN

Response	Frequency	Percent	Cumulative Percent
1	14	46.7	46.7
2	6	20.0	66.7
3	6	20.0	86.7
4	3	10.0	96.7
5	0	0.0	96.7
6	1	3.3	100.0
Total	30	100.0	

mean = 2.06 vehicles per fisherman

TABLE XVIe

NUMBER OF FISHERMEN WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency/Percent		Cumulative Percent
Member	5	16.7	16.7
Non-member	25	83.3	100.0
Total	30	100.0	

Section III of Questionnaire, Boaters and Jet/Water Skiers

Section III was directed toward boaters (powered), water skiers, and jet skiers. Statement #1 of Section III was, "Minor gasoline or oil spills cause no real harm to the environment." Spillage of gasoline fuels and oils, even in small amounts into an aquatic environment can have detrimental effects that become compounded over time as the recreation season advances and more spills take place. The number of spills possible increases as the number of watercraft operating on the lake increases. Hart and Fuller noted:

> Oil can form films on the surface and thus interfere with gaseous exchange, photosynthesis, and a multitude of other phenomena. It may coat bottom surfaces, substrate surfaces, or protozoans themselves and thus lead to death (p. 16).

TABLE XVIIa

STATEMENT #1, SECTION III "MINOR GASOLINE OR OIL SPILLS CAUSE NO REAL HARM TO THE ENVIRONMENT."

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	4	13.3	16.6
Don't Know/No Opinion	6	20.0	36.6
Disagree	5	16.7	53.3
Strongly Disagree	14	46.7	100.0
Total	30	100.0	

TABLE XVIIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	19	63.3
No Match	11	36.7
Total	30	100.0

TABLE XVIIc

JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	4	13.3	13.3
Agree	3	10.0	23.3
Don't Know/No Opinion	7	23.3	46.6
Disagree	7	23.3	69.9
Strongly Disagree	9	30.0	99.9
Total	30	100.0	

TABLE XVIId

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	16	53.3
No Match	14	46.7
Total	30	100.0

Statement #2 of Section III was, "Should gasoline and oil spills cause harm to the lake environment, this is an acceptable consequence of recreating." This statement is a

personal decision oriented question and is not addressed in literature. It was included to gauge the willingness of visitors to accept environmental damage as a consequence of their recreation.

TABLE XVIIIa

STATEMENT #2, SECTION III "SHOULD GASOLINE AND OIL SPILLS CAUSE HARM TO THE LAKE ENVIRONMENT, THIS IS AN ACCEPTABLE CONSEQUENCE OF RECREATING."

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	0	0.0	0.0
Agree	6	20.0	20.0
Don't Know/No Opinion	5	16.7	36.7
Disagree	12	40.0	76.7
Strongly Disagree	7	23.3	100.0
Total	30	100.0	

TABLE XVIIIb

JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.7	6.7
Agree	6	20.0	26.7
Don't Know/No Opinion	6	20.0	46.7
Disagree	11	36.7	83.4
Strongly Disagree	5	16.7	100.0
Total	30	100.0	

Statement #3 of Section III was, "Motoring close to the shoreline harms wildlife and their sources of food." The wash, turbulence, and propeller action (cutting effects), direct contact, as well as sight and sound of watercraft all have negative effects on aquatic flora and fauna. Liddle and Scorgie addressed the wash of motor boats thusly:

> Motor boats are often high powered and the wash they create can cause considerable erosion of plant roots (p. 187).

Plants may also be uprooted by propeller action as boats move along the shoreline. This includes the electric motors often attached to the front of bass boats as well as the main propeller. Boats moving close to shore stir bottom sediments and add to the turbidity of lake waters. Prolonged use of an outboard motor boat, operating in shallow water, can remove all plants in its path and wash silt from the lake bed leaving only the heavier sand and gravel (p. 187). Direct contact by boats with the shoreline results in the disturbance of nesting waterfowl and the destruction of marginal vegetation through collision. Heavy use of shoreline areas for the berthing and launching of boats can eliminate extensive areas of emergent vegetation (p. 187). This destruction of the vegetation in what is already a shallow littoral zone at Lake Carl Blackwell, can only have a negative impact on aquatic life forms to include game fish.

Problems similiar to those of Lake Carl Blackwell have been observed elsewhere. For example, fragile cane beds in

Wisconsin lakes have been heavily damaged by power boats and the water left so turbid as to not allow their regrowth. The cane beds are habitat for walleye and other game fish. Damage has also been caused by electric motors, and even poles and paddles have been shown to damage the cane (Husar, p. 12).

TABLE XIXa

STATEMENT #3, SECTION III "MOTORING CLOSE TO THE SHORELINE HARMS WILDLIFE AND THEIR SOURCES OF FOOD."

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	5	16.7	16.7
Agree	8	26.7	43.4
Don't Know/No Opinion	10	33.3	76.7
Disagree	6	20.0	96.7
Strongly Disagree	1	3.3	100.0
Total	30	100.0	

TABLE XIXb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	13	43.3
No Match	17	56.7
Total	30	100.0

TABLE XIXc

JET/WATER SKIERS

Responses	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.7	6.7
Agree	8	26.7	33.4
Don't Know/No Opinion	12	40.0	73.4
Disagree	4	13.3	86.7
Strongly Disagree	4	13.3	100.0
Total	30	100.0	

TABLE XIXd

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	10	33.3
No Match	20	66.7
Total	30	100.0

Statement #4 of Section III was, "Shoreline motoring does harm wildlife and habitat, however, this is an acceptable consequence of boating." The purpose of this question was to determine the acceptability of damage to wildlife and the environment by boaters and skiers as the cost of pursuing their respective recreation. Boaters and skiers showed a high "Don't Know/No Opinion frequency of response to this statement.

TABLE XXa

STATEMENT #4, SECTION III "SHORELINE MOTORING DOES HARM WILDLIFE AND HABITAT, HOWEVER, THIS IS AN ACCEPTABLE CONSEQUENCE OF BOATING.

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	0	0.0	0.0
Agree	7	23.3	23.3
Don't Know/No Opinion	13	43.3	66.6
Disagree	7	23.3	89.9
Strongly Disagree	3	10.0	99.9
Total	30	100.0	

TABLE XXb

JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	6	20.0	23.3
Don't Know/No Opinion	10	33.3	56.6
Disagree	9	30.0	86.6
Strongly Disagree	4	13.3	99.9
Total	30	100.0	

Statement #5, Section III was, "Litter thrown into lake waters cause no real harm to the environment." Litter in an aquatic environment causes problems for many animals. Plastic six pack rings and monofiliment fishing line strangle waterfowl. Bits of styrofoam floating in the water is often mistaken for food, consumed by animals, and is the cause of internal injury and death.

TABLE XXIa

STATEMENT #5, SECTION III "LITTER THROWN INTO LAKE WATERS CAUSE NO REAL HARM TO THE ENVIRONMENT."

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.73	6.7
Agree	0	0.0	6.7
Don't Know/No Opinion	4	13.3	20.0
Disagree	4	13.3	33.3
Strongly Disagree	20	66.7	100.0
Total	30	100.0	

TABLE XXIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	24	80.0
No Match	6	20.0
Total	30	100.0

TABLE XXIc

JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	3	10.0	10.0
Agree	1	3.3	13.3
Don't Know/No Opinion	3	10.0	23.3
Disagree	5	16.7	40.0
Strongly Disagree	18	60.0	100.0
Total	30	100.0	

TABLE XXId

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	23	76.7
No Match	7	23.3
Total	30	100.0

Statement #6, Section III was, "Disturbing the nesting sites of waterfowl is an acceptable consequence of boating or water skiing." Disturbance of waterfowl results in redistribution on, or movement away from, the lake (Liddle, p. 190). This can result in the abandonment of nests and subsequent death of nestlings or eggs. Movement of adult birds to unfamiliar surroundings can leave them open to predation or death by hazard. Disturbance of a large area could conceivably determine the success or failure of the breeding cycle for an entire flock of waterfowl. Boaters seemed much more aware and/or concerned about the effect on waterfowl than skiers.

TABLE XXIIa

STATEMENT #6, SECTION III "DISTURBING THE NESTING SITES OF WATERFOWL IS AN ACCEPTABLE CONSEQUENCE OF BOATING OR WATER SKIING."

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.7	6.7
Agree	3	10.0	16.7
Don't Know/No Opinion	2	6.7	23.3
Disagree	11	36.7	60.0
Strongly Disagree	12	40.0	100.0
Total	30	100.0	

TABLE XXIIb

JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	0	0.0	0.0
Agree	9	30.0	30.0
Don't Know/No Opinion	5	16.7	46.7
Disagree	5	16.7	63.4
Strongly Disagree	11	36.6	100.0
Total	30	100.0	

Statement #7 Section III was, "Muddying lake waters with boats or jet skis causes no harm to the lake environment." Rooted, suspended, and floating aquatic plants which provide oxygen to aquatic organisms require light for photosynthesis (Mackenthun, p. 19). The disruption of available light has far reaching effects on the lake's environment. Boats and jet skis adversely affect light penetration by

stirring up bottom and shoreline sediments.

TABLE XXIIIa

STATEMENT #7, SECTION III "MUDDYING LAKE WATERS WITH BOATS OR JET SKIS CAUSES NO HARM TO THE LAKE ENVIRONMENT."

BOATERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	7	23.3	26.6
Don't Know/No Opinion	9	30.0	56.6
Disagree	5	16.7	73.3
Strongly Disagree	8	26.7	100.0
Total	30	100.0	

TABLE XXIIIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	13	43.3
No Match	17	56.7
Total	30	100.0

TABLE XXIIIc

JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	2	6.7	6.7
Agree	2	6.7	13.4
Don't Know/No Opinion	16	53.3	66.7
Disagree	9	30.0	96.7
Strongly Disagree	1	3.3	100.0
Total	30	100.0	

TABLE XXIIId

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	10	33.3
No Match	20	66.6
Total	30	100.0

Demographics of Section III Responders

TABLE XXIVa

FORMAL EDUCATION COMPLETED BY BOATERS

Response	Frequency/Percent	Cumulative Percent
Less than 12 years	2 / 6.7	6.7
12 years	10 / 33.3	40.0
Some college/no degree	9 / 30.0	70.0
Associate degree/acad	1 / 3.3	73.3
Associate degree/votech	0 / 0.0	73.3
Bachelor degree	4 / 13.3	86.6
Masters degree	4 / 13.3	99.9
Total	30 / 100.0	

mode = 12 years

TABLE XXIVb

AGE IN WHOLE YEARS OF BOATERS

Response	Frequency/Percent	Cumulative Percent
20-24	8 / 26.7	26.7
25-29	4 / 13.3	40.0
30-34	7 / 23.3	63.3
35-39	3 / 10.0	73.3
40-44	5 / 16.7	90.0
45-49	2 / 6.7	96.7
50-54	1 / 3.3	100.0
Total	30 / 100.0	

median = 31.17

TABLE XXIVc

GENDER OF BOATERS

Response	Frequency	Percent	Cumulative Percent
Male	19	63.3	63.3
Female	11	36.7	100.0
Total	30	100.0	

TABLE XXIVd

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY BOATERS

Response	Frequency	Percent	Cumulative Percent
0	2	6.7	6.7
1	6	20.0	26.7
2	12	40.0	66.7
3	7	23.3	90.0
4	3	10.0	100.0
Total	30	100.0	

mean = 2.1 vehicles per boater

TABLE XXIVe

NUMBER OF BOATERS WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency	Percent	Cumulative Percent
Member	4	13.3	13.3
Non-member	26	86.6	100.0
Total	30	100.0	

Jet and water skiers, the youngest recreation visitors to LCB, hold the most bachelors degrees of all categories of recreation users. They also brought the most vehicles onto

lake property per individual and had the highest frequency of answers in the Don't Know/No Opinion section of the survey questionnaire. TABLE XXIVf through TABLE XXIVj shows the demographics of jet and water skiers.

TABLE XXIVf

FORMAL EDUCATION COMPLETED BY JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Less than 12 years	1	3.3	3.3
12 years	4	13.3	16.6
Some college/no degree	10	33.3	49.9
Associate degree/acad	1	3.3	53.2
Associate degree/votech	1	3.3	56.5
Bachelors degree	10	33.3	89.8
Masters degree +	3	10.0	99.8
Total	30	100.0	

mode = some college/no degree and bachelors degree (10 each)

TABLE XXIVg

AGE IN WHOLE YEARS OF JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
10-14	1	3.3	3.3
15-19	3	10.0	13.3
20-24	8	26.7	40.0
25-29	6	20.0	60.0
30-34	5	16.7	76.7
35-39	1	3.3	80.0
40-44	1	3.3	83.3
45-49	3	10.0	93.3
50-54	1	3.3	96.6
55-59	0	0.0	96.6
60-64	0	0.0	96.6
65-69	1	3.3	99.9
Total	30	100.0	

median = 27.0

TABLE XXIVh

GENDER OF JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
Male	24	80.0	80.0
Female	6	20.0	100.0
Total	30	100.0	

TABLE XXIVi

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY JET/WATER SKIERS

Response	Frequency	Percent	Cumulative Percent
0	1	3.3	3.3
1	9	30.0	33.3
2	10	33.3	66.6
3	6	20.0	86.6
4	2	6.7	93.3
5	2	6.7	100.0
Total	30	100.0	

mean = 2.17 vehicles per jet/water skier

TABLE XXIVj

NUMBER OF JET/WATER SKIERS WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency	Percent	Cumulative Percent
Member	1	3.3	3.3
Non-member	29	96.7	100.0
Total	30	100.0	

Section IV of Questionnaire, Campers

Campers were asked to respond to seven statements designed to identify their attitudes toward, and knowledge of, the effect of camping on the recreational environment. Responses to statements and frequency measures are shown in Table XXVa through Table XXXIb. There are two tables for each statement unless the statement is purely opinion in nature, in which case there is only one table. The first table shows frequency measures for the responses to a statement. The second table combines the "Strongly Agree" with the "Agree" responses and the "Strongly Disagree" with the "Disagree" responses. These frequency responses are then shown for "Match" and "No Match" to indicate whether the response matches or does not match the position taken in current literature. The number of "Don't Know/No Opinion" are listed under the second table.

Statement #1 was, "Driving off road causes no harm to the environment." Weaver and Dale (p. 21) as well as Webb and Wilshire (p. 89) have demonstrated that operating vehicles off road does damage the environment. In a similar survey question asked by Reynolds of off road vehicle operators, 58.4 percent of the respondents agreed that off road vehicle operation caused no harm to the environment, while 23.7 percent disagreed (p. 66). In the "Match/No Match" category, 71.7 percent of the ORV users did not match the position of current literature. In contrast, fully 60.0 percent of the thirty campers surveyed at Lake Carl

Blackwell, disagreed or strongly disagreed with the statement, demonstrating a knowledge of the consequences of operating vehicles off road. This result is nearly the exact opposite of the results Reynolds obtained from ORV users.

TABLE XXVa

STATEMENT #1, SECTION IV "DRIVING OFF ROAD CAUSES NO HARM TO THE ENVIRONMENT."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	3	10.0	10.0
Agree	2	6.7	16.7
Don't Know/No Opinion	7	23.3	40.0
Disagree	7	23.3	63.3
Strongly Disagree	11	36.7	100.0
Total	30	100.0	

TABLE XXVb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	18	60.0
No Match	12	40.0
Total	30	100.0

Statement #2 was, "Camping or parking on grass causes no harm to the environment." Running over the stems and

roots of vegetation has been shown by Wilshire, Shipley, and Nakata (p. 136) to cause the destruction of the effected plants. Webb and Wilshire (p. 89) have shown the subsequent compaction of the soil negatively effects its ability to absorb water. Reynold's similar question of ORV users produced a matching response to current literature of 56.5 percent (p. 70). In TABLE XXVIa, respondents are equally divided in agreeing or disagreeing that camping and parking on grass causes no harm to the environment.

TABLE XXVIa

STATEMENT #2, SECTION IV "CAMPING OR PARKING ON GRASS CAUSES NO HARM TO THE ENVIRONMENT."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	3	10.0	10.0
Agree	7	23.3	33.3
Don't Know/No Opinion	5	16.7	50.0
Disagree	10	33.3	83.3
Strongly Disagree	5	16.7	100.0
Total	30	100.0	

TABLE XXVIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	15	50.0
No Match	15	50.0
Total	30	100.0

Statement 3 was, "Litter such as six pack rings, cause damage to wildlife and the environment." This statement, the truth of which is undeniable and well accepted in the American psyche, was overwhelmingly accepted by campers recreating at Lake Carl Blackwell. If all environmental effects of careless recreation were as well known as this, the problem would be tremendously reduced. The success of imprinting the effects of this particular behavior (littering) as being negative is a demonstration of what education of the public can accomplish. With all its success however, there are still the few who have no opinion about littering or just don't care. TABLE XXVIIa shows, surprisingly, that group to be a full 20 percent of the campers who visit Lake Carl Blackwell.

TABLE XXVIIa

STATEMENT #3, SECTION IV "LITTER SUCH AS SIX PACK RINGS, CAUSE DAMAGE TO WILDLIFE AND THE ENVIRONMENT."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	20	66.7	66.7
Agree	4	13.3	80.0
Don't Know/No Opinion	1	3.3	83.3
Disagree	1	3.3	86.6
Strongly Disagree	4	13.3	99.9
Total	30	100.0	

TABLE XXVIIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	24	80.0
No Match	6	20.0
Total	30	100.0

Statement #4 dealt with campsite management and was, "Assuming that camping causes erosion of the soil, you would be willing to pay for improved, erosion resistant campsites." Over use of campsites results in the rapid erosion of the soil caused by the weight of vehicles and equipment compacting the soil and destroying the vegetative cover. Without cover to hold the soil, it quickly washes away, leaving the compacted soil to become the streambed for channeling runoff water. TABLE XXVIII indicates that most campers at Lake Carl Blackwell are willing to pay higher camping fees for erosion resistant campsites. Only seventeen percent were opposed to such improvement.

TABLE XXVIII

STATEMENT #4, SECTION IV "ASSUMING THAT CAMPING CAUSES EROSION OF THE SOIL, YOU WOULD BE WILLING TO PAY FOR IMPROVED, EROSION RESISTANT CAMPSITES."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	11	36.7	36.7
Agree	6	20.0	56.6
Don't Know/No Opinion	8	26.7	83.3
Disagree	3	10.0	93.3
Strongly Disagree	2	6.7	100.0
Total	30	100.0	

Statement #5 addressed the problems associated with poor campfire location and was, "Building fires under trees causes damage to the trees." Besides the obvious ravages of forest fires resulting from inept campfire tending, there is the more common and insidious damage done to root and leaf systems from the thoughtless positioning of campfires. Fires built above shallow tree roots can actually cook the roots in the ground, damaging the water and nutrient gathering system of the tree. While destroying the roots below, a poorly placed fire can also destroy the leaves of low hanging limbs. Actual flaming of the leaves is not necessary for heavy damage to occur. The ignorant camper, seeing no immediate damage, may be unaware of what he has done. The damage may not be apparent for several days, by which time the camper has gone on to other pursuits. TABLE

XXIXa indicates 70 percent of campers visiting Lake Carl Blackwell agreed that damage can result from building fires under trees.

TABLE XXIXa

STATEMENT #5, SECTION IV "BUILDING FIRES UNDER TREES CAUSES DAMAGE TO THE TREES.

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	15	50.0	50.0
Agree	6	20.0	70.0
Don't Know/No Opinion	6	20.0	90.0
Disagree	3	10.0	100.0
Strongly Disagree	0	0.0	100.0
Total	30	100.0	

TABLE XXIXb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	21	70.0
No Match	9	30.0
Total	30	100.0

Statement #6 was, "If campfires cause damage to trees, this is an acceptable consequence of recreating." After having shown that fully 70 percent of campers were aware of the potential damage fires can cause trees, this statement determined, as outlined in TABLE XXX, that only 26.6 percent

of campers believed this was an acceptable consequence of recreation. However, on the other side of the coin, merely half of the campers thought that the damaging of trees was not an acceptable consequence of recreating. With fully half of the campers visiting Lake Carl Blackwell willing to accept damage to trees, shady camp sites could become a thing of the past.

TABLE XXX

STATEMENT #6, SECTION IV "IF CAMPFIRES CAUSE DAMAGE TO TREES THIS IS AN ACCEPTABLE CONSEQUENCE OF RECREATING."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	1	3.3	3.3
Agree	7	23.3	26.6
Don't Know/No Opinion	7	23.3	49.9
Disagree	8	26.7	76.6
Strongly Disagree	7	23.3	99.9
Total	30	100.0	

Statement #7 was, "Grey water discharge (sink water) on the ground causes no damage to the environment." Wanielista et al (p. 114), state that nutrients from runoff stimulate the growth of algae and water weeds. Greywater carries such nutrients in the form of nitrogen and phosphorus. These nutrients accelerate the eutrophication of Lake Carl Black-

well. The decay of the algae and weed growth stimulated by greywater discharge removes dissolved oxygen from the water and precipitates fish kills in shallow arms of the lake. This could be a part of the reason fishing along the shoreline of recreational areas drops off in the latter months of the summer season (personal observation). 63.3 percent of campers visiting Lake Carl Blackwell recognize that the discharge of grey water upon the ground does cause damage to the environment of the recreational area. The distressing number is the 23.3 percent who see no damage resulting from this behavior, and the 13.3 per cent who either don't know the effects of this behavior or just don't care enough about it to have an opinion.

TABLE XXXIa

STATEMENT #7, SECTION IV "GREY WATER DISCHARGE (SINK WATER) ON THE GROUND CAUSES NO DAMAGE TO THE ENVIRONMENT."

Response	Frequency	Percent	Cumulative Percent
Strongly Agree	4	13.3	13.3
Agree	3	10.0	23.3
Don't Know/No Opinion	4	13.3	36.6
Disagree	9	30.0	66.6
Strongly Disagree	10	33.3	99.9
Total	30	100.0	

TABLE XXXIb

RESPONSES VS LITERATURE

Response	Frequency	Percent
Match	19	63.3
No Match	11	36.7
Total	30	100.0

Demographics of Surveyed Campers

TABLE XXXIIa shows the formal education level of surveyed campers visiting Lake Carl Blackwell. Thirty percent of campers had twelve years of education, this correlates well with Reynold's 34.5 percent of ORV users who had twelve years of education (p. 60). The largest percentage of campers, 63.3 percent, were either in the "twelve year" category or the "some college/no degree" level. This also correlates well with Reynold's mean level of education of 13.2 and median level of education of 13.0 (p. 60). Edu-cationally, the same people who use ORVs are also the campers who use Lake Carl Blackwell.

TABLE XXXIIa

FORMAL EDUCATION COMPLETED BY CAMPERS

Response	Frequency	Percent	Cumulative Percent
Less than 12 years	2	6.7	6.7
12 years	9	30.0	36.7
Some college/no degree	10	33.3	70.0
Associate degree/acad	2	6.7	76.7
Associate degree/votech	2	6.7	83.4
Bachelors degree	3	10.0	93.4
Masters degree +	2	6.7	100.0
Total	30	100.0	

mode = some college/no degree

The responses for age were grouped in 11 increments of five years each. The median age for the U.S. population in 1988 was 32.3 years (U.S. Bureau of the census, p. 12). The mean age for Lake Carl Blackwell camper respondents was 38.5 years.

TABLE XXXIIb

AGE IN WHOLE YEARS OF CAMPERS

Response	Frequency	Percent	Cumulative Percent
20-24	2	6.7	6.7
25-29	5	16.7	23.4
30-34	7	23.3	46.7
35-39	5	16.7	63.4
40-44	2	6.7	70.1
45-49	4	13.3	83.4
50-54	3	10.0	93.4
55-59	0	0.0	93.4
60-64	1	3.3	96.7
65-69	0	0.0	96.7
70-74	1	3.3	100.0
Total	30	100.0	

median = 37.0

Campers surveyed were nearly evenly split between men and women. TABLE XXXIIc shows that 53.3 of respondents were female, and 46.7 males.

TABLE XXXIIc

GENDER OF CAMPERS

Response	Frequency	Percent	Cumulative Percent
Male	14	46.7	46.7
Female	16	53.3	100.0
Total	30	100.0	

One of the hardest things for Americans to part with is their vehicles. The campers surveyed at Lake Carl Blackwell proved to be no different. The term vehicles included cars, trucks, boats, jet skis, and recreational vehicles. The mean for surveyed campers was 2.2 vehicles per camper. One camper indicated he had brought as many as six vehicles.

TABLE XXXIId

NUMBER OF VEHICLES BROUGHT ONTO LAKE PROPERTY BY CAMPERS

Response	Frequency	Percent	Cumulative Percent
1	9	30.0	30.0
2	13	43.3	73.3
3	3	10.0	83.3
4	4	13.3	96.6
5	0	0.0	96.6
6	1	3.3	99.9
Total	30	100.0	

mean = 2.2

Members of organized outdoor recreation groups might reasonably be thought to be more environmentally aware than non-members. For this reason, this demographic was included in the survey. Only twenty percent of surveyed campers indicated they were a member of a recreation group.

TABLE XXXIIe

NUMBER OF CAMPERS WHO ARE MEMBERS OF AN ORGANIZED OUTDOOR RECREATION GROUP

Response	Frequency	Percent	Cumulative Percent
Member	6	20.0	20.0
Non-member	24	80.0	80.0
Total	30	100.0	

Field Observations

Field limnological observations were taken in four intensively used recreation areas of Lake Carl Blackwell. The purpose was to determine relationships between measurements taken in the lake's waters and visitor's attitudes toward the environment. The measurements yielded information valuable in assessing the impact of recreational visitors on a lake environment. TABLE XXXIII through TABLE XXXVII show the results of the measurements.

Comparisons of Field Observations to Historical Limnological Data

TABLE XXXIII

MEAN SURFACE CONCENTRATIONS OF DISSOLVED OXYGEN

Month	Year	First Observation	Diff	2nd Observation	Diff
05	41	7.70 mg/L		6.90 mg/L	
05	49	10.15		- --	
05	81	8.00		9.00	
05	92	8.25	+.25	9.25	+.25
06	41	- --		- --	
06	49	7.45		5.90	
06	81	7.25		7.00	
06	92	7.75	+.50	7.50	+.50
07	41	8.10		- --	
07	49	6.13		7.48	
07	81	6.50		7.50	
07	92	6.13	-.37	7.13	-.37
08	41	6.70		- --	
08	49	6.75		5.68	
08	81	8.50		8.50	
08	92	7.00	-1.50	6.63	-1.87

Table XXXIII (Continued)

09	41	3.20	- --
09	49	5.83	6.35
09	81	8.25	9.00
09	92	7.75	6.25

Group Means

1941 - 6.52 1949 - 6.86 1981 - 7.95 1992 - 7.36

Source	SS	DF	MS	F
Between	9.05	3	3.02	1.99
Within	45.57	30	1.52	
Total	54.63	33		

Value of F: 2.92. Not significant, p > .05.

TABLE XXXIV

MEAN SURFACE VALUES FOR TOTAL ALKALINITY

Month	Year	First Observation mg/L	Diff mg/L	Second Observation mg/L	Diff mg/L
05	41	79		---	
05	49	129		---	
05	81	134		132	
05	92	175	+41	170	+38
06	41	---		---	
06	49	---		---	
06	81	137		139	
06	92	175	+38	1675.5	+28.5
07	41	80		---	
07	49	115.5		114.5	
07	81	140		142	
07	92	147.5	+7.5	170	+28
08	41	119		---	
08	49	126		119.8	
08	81	142		143	
08	92	175	+33	142.5	-0.5
09	41	113		---	
09	49	125		125.5	
09	81	143		145	
09	92	155		150	

*Differences shown are between 1981 and 1992

Group Means

1941 - 97.75 1949 - 122.19 1981 - 139.70 1992 - 162.75

Table XXXIV (Continued)

Source	SS	DF	MS	F
Between	7029. 13	3	4794.63	41.19
Within	3143.25	27	116.42	
Total	17527.13	30		

Value of F: 2.96. Signficant, $p < .05$.

TABLE XXXV

MEAN SECCHI DISK DEPTHS

Month	Year	First Observation cm	Diff cm	Second Observation cm	Diff cm
05	81	50		25	
05	92	70	+20	84	+59
06	81	72		70	
06	92	53	-19	83	+13
07	81	82		76	
07	92	91	+ 9	87	+11
08	81	55		45	
08	92	77	+22	47	+ 2
09	81	47		42	
09	92	57	+10	38	- 4

Group Means
1981 - 56.4 1992- 68.7

Source	SS	DF	MS	F
Between	756.45	1	756.45	2.25
Within	6060.50	18	336.69	
Total	6816.95	19		

Value of F: 4.41. Not significant, $p > .05$.

TABLE XXXVI

MEAN SURFACE TEMPERATURES IN CELSIUS

Month	Year	First Observation	Diff*	Second Observation	Diff*
05	41	24.80		--	
05	49	21.00		--	
05	81	19.50		18.00	
05	92	22.75	+3.25	22.00	+4.00
06	41	--		--	
06	49	27.00		27.95	
06	81	21.00		25.25	
06	92	21.00		24.25	- 1.00
07	41	28.40		--	
07	49	28.00		28.13	
07	81	29.00		27.50	
07	92	27.13	-1.87	28.50	+1.00
08	41	27.40		--	
08	49	27.63		28.15	
08	81	26.00		26.00	
08	92	29.25	+3.25	24.75	-1.25
09	41	25.40		--	
09	49	25.00		22.20	
09	81	25.00		22.00	
09	92	24.00	-1.00	24.25	+2.25

*Differences shown are between 1981 and 1992 measurements

Group Means

1941 - 26.5 1949 - 26.12 1981 - 23.93 1992 - 24.79

Source	SS	DF	MS	F
Between	31.94	3	10.65	1.22
Within	253.11	29	8.73	
Total	285.05	32		

Value of F: 2.93. Not signficant, p > .05.

TABLE XXXVII

LIMNOLOGICAL FIELD OBSERVATIONS OF pH, TEMPERATURE, DISSOLVED OXYGEN, SECCHI DISK, AND ALKALINITY BY WEEKEND RECREATIONAL USE OF LAKE CARL BLACKWELL

Date	Location	pH	Temp (C)	DO(mg/L)	SD(cm)	Alka(mg/L)
05/22	Station A	7.5	22	6	83.76	160
05/22	Station B	7.5	23	10	55.84	180
05/22	Station C	7.5	23	9	83.76	180
05/22	Station D	7.5	23	8	86.29	180
05/24	Station A	7.5	22	9	88.83	160
05/24	Station B	7.5	21	9	91.37	160
05/24	Station C	7.5	23	9	65.99	180
05/24	Station D	7.5	22	10	91.37	180
06/05	Station A	7.5	21	9	60.91	180
06/05	Station B	7.5	20	6	65.99	160
06/05	Station C	7.5	21	7	30.46	160
06/05	Station D	7.5	21	8	55.84	160
06/07	Station A	7.5	21	8	60.91	160
06/07	Station B	7.5	21	8	55.84	180
06/07	Station C	7.5	22	8	49.49	200
06/07	Station D	7.5	21	8	48.22	200
06/19	Station A	7.5	25	7	91.37	160
06/19	Station B	7.5	25	8	*	180
06/19	Station C	7.5	25	8	76.14	160
06/19	Station D	7.5	24	8	*	180
06/21	Station A	7.0	25	7	91.37	160
06/21	Station B	7.5	23	8	*	160
06/21	Station C	7.0	24	6	73.60	160
06/21	Station D	7.5	23	8	*	180
07/03	Station A	7.5	28	7	111.68	140
07/03	Station B	7.5	28	7	101.52	140
07/03	Station C	7.5	28	8	101.52	140
07/03	Station D	7.0	28	8	118.02	140
07/05	Station A	7.5	26	5	78.68	160
07/05	Station B	7.0	27	4	71.06	180
07/05	Station C	7.0	26	6	86.29	140
07/05	Station D	7.0	26	4	88.83	140
07/17	Station A	7.5	29	8	86.29	180
07/17	Station B	7.5	29	7	86.29	160
07/17	Station C	7.5	30	9	71.07	160
07/17	Station D	7.5	28	8	83.76	180

TABLE XXXVII (Continued)

Date	Location	pH	Temp(C)	DO(mg/L)	SD(cm)	Alka(mg/L)
07/19	Station A	7.5	28	6	98.98	160
07/19	Station B	7.5	29	6	101.52	160
07/19	Station C	7.5	27	7	88.83	180
07/19	Station D	7.5	28	6	76.14	180
07/31	Station A	7.5	29	7	85.03	180
07/31	Station B	7.5	30	7	91.37	180
07/31	Station C	7.5	29	7	90.10	180
07/31	Station D	7.5	29	7	96.45	160
08/02	Station A	7.5	29	7	63.45	180
08/02	Station B	7.5	29	7	71.06	180
08/02	Station C	7.5	29	7	40.61	180
08/02	Station D	7.5	30	7	81.22	160
08/21	Station A	**8.0	22	5	43.1	120
08/21	Station B	7.0	23	9	53.3	140
08/21	Station C	8.5	23	8	45.7	140
08/21	Station D	7.5	23	7	43.1	140
08/23	Station A	7.5	25	6	45.7	160
08/23	Station B	7.5	25	6	53.3	160
08/23	Station C	8.0	24	6	48.2	140
08/23	Station D	7.0	25	6	40.6	140
09/04	Station A	7.5	24	8	55.8	160
09/04	Station B	8.0	24	8	63.5	140
09/04	Station C	7.5	24	8	66.0	160
09/04	Station D	7.5	24	7	43.1	160
09/07	Station A	7.0	24	6	21.6	140
09/07	Station B	7.0	25	6	43.1	160
09/07	Station C	7.0	24	7	48.2	160
09/07	Station D	7.0	24	6	38.1	140

See contingency tables for analysis between stations.
*Readings not taken due to adverse weather.
**Change in test kit to allow higher pH values to be determined.

CHAPTER V

SUMMARY, RESULTS, CONCLUSIONS, RECOMMENDATIONS, AND ANOMALIES

Summary

The number of visitors to our national, state, and municipal parks as well as local recreation areas such as rivers and lakes continues to grow. We have long since reached the saturation point where usage undermines preservation. A popular phrase is that we are "loving" our recreational resources to death. If we are to continue to have areas for humans to recreate and interface with nature, we must learn everything we can about our impact upon such areas and adjust our behavior to a level least destructive of recreational resources.

This study was designed to determine visitor's attitudes toward, and knowledge of, the impact of their recreation upon a lake environment. In addition, this study was designed to ascertain if such impact could be measured limnologically.

Current literature indicates that recreational visitors have an impact on the wildlife and environment regardless of the geographical setting of the recreational area. Recrea-

tional visitors damage soil, vegetation, air quality, and water environments as well as wildlife habitats and the animals that inhabit them.

The data collection instruments for this study was a questionnaire for the collection of human data, and selected limnological measurements for collection of environmental data. Some demographic information was solicited by questionnaire with emphasis placed on those most likely to have an influence on the subject's attitude toward the environmental shock of their recreation. The subjects were then asked to respond to statements in an effort to determine their opinion toward, as well as knowledge and acceptance of, the effects of their recreation upon the environment and wildlife of Lake Carl Blackwell. Limnological measurements of four heavily used areas of the lake was conducted to determine flunctuations in pH, water surface temperature, alkalinity, transparency of water, and dissolved oxygen content of the water.

After the data was collected, statistical procedures were applied. All hypotheses were tested for significance at the .05 level.

Results

Statistical analysis provided the following findings in relation to the problem statements of Chapter I.

1. Section I of the questionnaire formed the "default" portion of the instrument and was directed toward swimmers,

picnickers, and day users. Relative to the five statements on knowledge of environmental effect of recreation, these groups had a combined literature matching response of 31.9 percent to statement #1, 64.9 percent to statement #2, 60.6 percent to statement #3, 55.3 percent to statement #4, and 84.0 percent to statment #6.

2. Relative to the two statements that adverse impacts on wildlife or environment was acceptable, these groups had a combined response as follows: 3.2 percent strongly agreed and 36.2 percent agreed, 25.5 percent didn't know or had no opinion, 23.4 percent disagreed, and 11.7 percent strongly disagreed with statement #5. For statement #7 18.1 percent strongly agreed, 18.1 percent agreed, 5.3 percent didn't know or had no opinion, 14.9 percent disagreed and 43.6 percent strongly disagreed.

3. Section II of the questionnaire addressed fishermen. Relative to the six statements on knowledge of environmental effects of recreation, this group had a literature matching response of 66.7 percent to statement #1, 60.0 percent to statment #2, 56.7 percent to statement #4, 46.6 percent to statement #5, 73.3 percent to statement #6, and 76.6 percent to statement #7.

4. Relative to the one statement that adverse impacts to fish were acceptable, 10.0 percent strongly agreed, 20.0 percent agreed, 23.3 had no opinion or didn't know, 26.7 disagreed, and 20.0 strongly disagreed.

5. Section III of the questionnaire was directed

toward power boaters and jet/water skiers. Relative to the four statements on knowledge of environmental effect of recreation, these two groups had a combined literature matching response of 58.3 percent to statement #1, 38.3 percent to statement #3, 78.4 percent to statement #5, and 38.3 percent to statement #7.

6. Relative to the three statements that adverse impacts on wildlife or the environment was acceptable, these groups had a combined response of 3.3 percent who strongly agreed, 20.0 who agreed, 18.3 who didn't know or had no opinion, 38.4 who disagreed, and 20.0 percent who strongly disagreed with statement #2. Their combined response to statement #4 was 1.7 percent strongly agreed, 21.7 who agreed, 38.3 who didn't know or had no opinion, 26.6 who disagreed, and 11.7 who strongly disagreed. Combined responses to statement #6 were 3.3 percent strongly agree, 20.0 percent agreed, 11.7 percent didn't know or had no opinion, 26.7 percent disagreed, and 38.3 percent strongly disagreed.

7. Section IV of the questionnaire was directed toward campers. Relative to the five statements on knowledge of environmental effects of camping, this group had a literature matching response of 60.0 percent to statement #1, a 50.0 percent match to statement #2, an 80.0 percent match to statement #3, a 70.0 percent match to statement #5, and a 63.3 percent match with statement #7.

8. Relative to statement #4 regarding willingness to

pay for erosion resistance, this group had a 36.7 percent response in the strongly agree area, a 20.0 percent agree response, while 26.7 had no opinion or didn't know, 10.0 percent disagreed and 6.7 percent strongly disagreed.

9. Statement #6 addressed the acceptance of the adverse effects of camping on the environment, this group responded with a 3.3 percent strongly agree, 23.3 percent agree, while 23.3 did not have an opinion or didn't know, 26.7 percent disagreed, and 23.3 percent strongly disagreed.

10. There is no significant difference of knowledge of environmental effects of recreation regardless of gender, group type, education level, age of respondents, membership in organized recreation groups or whether the visitor was afoot or on a form of transportation.

11. There is a significant difference in attitudes toward the acceptance of adverse recreational effects on the environment among groups with different knowledge bases. There is a distinct break between two sets of groups. One group is composed of day visitors, swimmers, and picnickers, this group has a "casual visitor" knowledge base of the lake environment. The group means (level of acceptance) ranged from a low of 34.4 percent for picnickers, to a high of 40.6 for day visitors. The second group consisted of fishermen, power boaters, jet/water skiers, and campers. This group had a "user visitor" knowledge base of the lake environment. The means of this group ranged from a low of 20.0 for power boaters and a high of 30.0 for jet/water skiers (see

contingency tables). The difference between these two groups would suggest that those who immerse themselves more fully into the environment, such as sleeping in the woods or boating for long hours on the lake surface, have a fuller knowledge and appreciation of the effects of their recreation. It further suggests that the amount of time spent in the lake environment is a factor in determining visitor attitude. Ironically, it is this enlightened group of "user visitors" that bring most of the environmentally adverse vehicles to the recreation area.

12. Analysis of limnological observations of pH, temperature, dissolved oxygen, transparency (Secchi disk) and alkalinity showed no signficant difference between the four sampling stations.

13. Surface temperatures ranged from 20 degrees centigrade at station B on 5 June 1992 to 30 degrees at stations C on 17 July, B on 31 July, and D on 2 August 1992. Analysis of temperature observations taken in 1992 with historical temperature data showed no significant difference.

14. Surface dissolved oxygen (DO) concentrations ranged from 4 mg/L at stations B and D on 5 July 1992 to 10 mg/L at stations B on 22 May and D on 24 May 1992. Analysis of DO concentrations in 1992 with historical DO data showed no significant difference.

15. The pH at all stations exceeded 7.0. The values of pH at the surface ranged from 7.0 on twelve occasions at

all stations, to 8.5 at station C on 21 August 1992. Analysis of pH content with historical pH data showed no significant difference.

16. Secchi disk (SD) transparency ranged from 21.6 centimeters at station A on 7 September to 118.0 at station D on 3 July 1992. Analysis of SD transparency with historical data showed no significant difference.

17. The range for total alkalinity (as CaCO3) at the surface was 140 mg/L at all stations on many occasions to 200 mg/L at stations C and D on 7 June 1992. Analysis of alkalinity concentrations observed in 1992 with historical data showed a significant difference. The analysis shows a pattern of increasing alkalinity from 1941 to 1992. The mean surface alkalinity concentration for 1941 was 97.75. The mean concentration for 1992 was 162.75, an increase of 40.0 percent or 0.78 percent annually. The mean from as recent as 1981 was 139.70, and shows an accelerated growth rate of 1.27 percent annually. The reason for this increase in alkalinity could be the result of many factors and is beyond the scope of this study. Naturally occuring alkalies are present in the ZANEIS-STONEBURG-RENFROW soils with which the four sampling stations are associated. (Howick et al. pp. 14 - 15).

Conclusions

Considering the related literature as well as the limitations, delimitations and the results of this study,

the following conclusions are drawn.

1. The majority of day visitors, swimmers, and picnickers realize that their recreation has a negative effect on the environment of Lake Carl Blackwell. Despite knowing this, the majority of them have no opinion about, or are willing to inflict, damage upon the lake's environment or wildlife for the sake of their recreation.

2. The majority of fishermen realize the adverse effect on aquatic animals and the environment of the lake that their recreation activities have. Most fishermen are not willing to accept this damage as the price for their recreation.

3. Power boaters and jet/water skiers knew less about the effects of their recreation activities on the lake environment, but were even more reluctant to accept the damage than fishermen.

4. Campers demonstrated a high knowledge of the impact upon the lake environment their recreational activities have. They are also willing to pay additional fees for the lessening of the impact as it pertains to erosion. The majority of campers were unwilling to tolerate environmental damage as the price for their recreation.

5. The fact that no significant differences were noted in limnological observances between sampling stations does not put the question to rest as to whether recreational impact on the environment can be measured. The summer of 1992 was unusually cooler and wetter than in the past, in

fact the season was the coolest and wettest it has been in several decades. This suggests that observations taken during a more "normal" season may yield significantly different results.

6. For the same reasons outlined above, the lack of significant differences between 1992 and historical limnological data, except for alkalinity, cannot be ruled out. Once again, observations taken during a more "normal" summer season may yield different results. It does suggest however that Lake Carl Blackwell continues to buffer out the worst of any environmental damage that recreational visitors inflict upon its ecosystem, at least in the aquatic environment at this time. How long this positive situation will exist is unknown.

7. The rise in alkalinity over the past 51 years is interesting but probably not a reason for concern in and of itself. Indeed, waters high in alkalinity tend to be high in fish production, not withstanding past data that shows Lake Carl Blackwell's fish yield to be less than other Oklahoma lakes (Howick et al, p. 124). The reason more alkalinity is available in the aquatic environment may be more important. It suggests that soils are being absorbed at an increasing rate, thus speeding eutrophication and the ultimate environmental blow, the death of the lake. Whether this increased soil absorbtion is related to recreational use is a question for future study, however, recreational wave action by boats and jet skis is suggested as a contrib-

uting factor.

Recommendations

Based on related literature, the limitations and delimitations, and the results of the study, the following recommendations are made:

1. The current area for skiing on Lake Carl Blackwell is restricted to a section approximately one third of the lake's surface, this restriction should be maintained. Attempts to extend the skiing area to the west, most recently spear headed by the Oklahoma State University skiing team and some private individuals should continue to be resisted. The adverse impact of skiing on waterfowl, the aquatic ecosystem, and resulting lake eutrophication should be avoided. This is particularly true in the western end of the lake where waterfowl nest and whooping cranes have been observed frequenting on their spring and fall migrations (personal observation).

2. Boaters and skiers, especially the growing class of jet and water bike skiers, should be informed of the adverse effect their vehicles have on aquatic environments. This study shows that boaters and skiers will not tolerate damage to the environment and so they should be receptive to such education.

3. Campsites more resistant to erosion should be constructed at Lake Carl Blackwell. This would help stem the flow of top soil into the lake and help reduce lake eutro-

phication. This study has shown the majority of campers are willing to pay higher fees for the construction of such sites.

4. Cabin Cove East, where year round permanent campsites exist and grey water discharge is a continuing problem, should be equipped with some form of sewage disposal. If cost prohibitive, the policy of allowing permanent residence should be reconsidered.

5. In parkland classification, Lake Carl Blackwell equates to a regional park reserve. In this classification 80.0 percent of the land is reserved for conservation and natural resource management with less than 20.0 percent used for recreation development. These quidelines should be considered in future management decisions.

6. An horseriding management policy, designed to accommodate the desires of horse riders while seeking to minimize impact on the lake environment should be initiated by lake management.

7. Agricultural use of lands bordering the lake, especially where cultivation runs to the lake edge, should be reviewed in light of its contribution to eutrophication. The establishment of buffer zones where natural vegetation is allowed to flourish should be considered.

8. Resource managers should be informed of the difference in attitudes of "casual visitors" and "user visitors" as it relates to their attitudes towards the recreational environment. Managers can use this information in making

decisions that effect these two very different groups.

9. The Environmental Protection Agency should be approached and lobbied to adopt an emissions testing and certification process for powered boats and skis similar to one recently enacted for lawn mowers. The damage done to water systems by two stroke engines has been overlooked to this point.

10. Due to the anomalous nature of the summer season of 1992, the limnological portion of this study should be replicated using even more varied observational techniques.

Anomalies

The first three groups of limnological sampling was taken during unusual climatic conditions that most probably affected the samples. The end of May of 1992 and during most of the month of June, the weather was cooler and wetter than is usual for this area. An overnight low record was set on June 2 when the temperature dropped to 37 degrees. The previous low had been 43 degrees set in 1919. The average for the entire month of June was nearly six degrees below the "normal" of 87.7 degrees and fell to 81.8 degrees Farenheit. The daytime low for June was 62.6 degrees, more than three degrees cooler than the "normal" low of 65.9 (Stillwater News-Press, July 10, 1992, p. 1). Rainfall for the month was 8 inches, double the "normal" 4. 1.25 inches of rain fell between readings taken on 19 and 21 June.

The months of July and August were exceptionally cool

and wet. Average temperature highs for July, August, and September were lower than the 95 year average, 2.3 degrees (F) lower in July, 8.4 degrees in August, and 2.8 degrees in September. In the past 12 months ending in September, the Lake Carl Blackwell area received 9.69 inches more rain than the yearly average. The air temperature never reached the 100 degree (F) level throughout the summer season, an unusual occurence (Stillwater News-Press, October 11, 1992, p. 1). It is probable the mild weather had a buffering effect upon any measurable recreational impact upon the waters of Lake Carl Blackwell.

The unusually cool weather undoubtedly helped keep the D.O. level higher than it would "normally" have been. Runoff from the rain may also have kept lake waters more turbulent than otherwise may have been the case. The other readings of temperature, alkalinity, and pH were most likely affected as well. These factors must be considered when looking at the readings for the entire period of the study.

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APPENDICES

APPENDIX A

RESEARCH QUESTIONNAIRE

CROSS' LAKE VISITOR SURVEY
Oklahoma State University

Your participation in this survey is appreciated. Participation is voluntary and no data collected can identify you personally. Your honest answer to the following questions will have an impact on possible lake management decisions. Your help in this survey is very important. Thank you.

Please circle or fill in the correct answer.

1. Sex: M F
(circle one)

		Answer questions in Section:
2. Type of Visit (circle one)	a. Day visit	I
	b. Picnicking	I
	c. Hiking	I
	d. Swimming	I
	e. Fishing	II
	f. Boating (motor)	III
	g. Jet/water skiing	III
	h. Camping	IV
	i. Horse riding	V
	j. Other _____ (fill in)	I

3. Age in whole years _____ (fill in)

4. Formal education completed: (circle one)

a. Less than 12 years. b. 12 years c. Some college, no degree d. Associate degree - Vocational e. Associate degree - Academic f. Bachelor's Degree g. Master's degree

5. How many vehicles (including boats, jet skis, and camping trailers) did you bring onto lake property?
_____ (fill in)

6. Are you a member of an organized outdoor recreation club?
Yes No (Circle One)

SECTION I

In the following section, you will be given a statement and asked to respond. At the end of each statement circle the response that best reflects your true feeling.

1. Driving on the roads of Lake Carl Blackwell does not effect lake environment. 1 2 3 4 5

2. Driving off road causes no environmental harm. 1 2 3 4 5

3. Parking on grass causes no environmental harm. 1 2 3 4 5

4. Noise from loud car stereos drives wildlife from the area. 1 2 3 4 5

5. Assuming cars have a negative effect on lake environment and wildlife, this is an acceptable consequence of recreating. 1 2 3 4 5

6. Litter, such as six pack rings, cause damage to wildlife and the environment. 1 2 3 4 5

7. If litter causes damage to wildlife and the environment, this is an acceptable consequence of recreating. 1 2 3 4 5

SECTION II

1. Abandoned fishing line causes no damage to wildlife or the environment. 1 2 3 4 5

2. Catch and release of game fish such as bass is not damaging to the fish. 1 2 3 4 5

3. If catch and release is damaging to fish, this is an acceptable consequence of fishing. 1 2 3 4 5

4. Lead weights left in fishing areas do pose a threat to aquatic animals and water fowl. 1 2 3 4 5

5. Returning dead fish or entrails to Lake Carl Blackwell waters is harmful to the environment. 1 2 3 4 5

6. Fishing with no established limit is not detrimental to the fish population. 1 2 3 4 5

7. Abandoned jug lines do not pose a threat to the environment. 1 2 3 4 5

SECTION III

1. Minor gasoline or oil spills cause no real harm to the lake environment.	1	2	3	4	5
2. Should gasoline and oil spills cause harm to the lake environment, this is an acceptable consequence of recreation.	1	2	3	4	5
3. Motoring close to the shoreline harms wildlife and their sources of food.	1	2	3	4	5
4. Shoreline motoring does harm wildlife and habitat, however, this is an acceptable consequence of recreation.	1	2	3	4	5
5. Litter thrown into lake waters cause no real harm to the environment.	1	2	3	4	5
6. Disturbing the nesting sites of water fowl is an acceptable consequence of boating or water skiing.	1	2	3	4	5
7. Muddying lake waters with boats or jet skis causes no harm to the lake environment.	1	2	3	4	5

SECTION IV

1. Driving off road causes no harm to the environment.	1	2	3	4	5
2. Camping or parking on grass causes no harm to the environment.	1	2	3	4	5
3. Litter, such as six pack rings, cause damage to wildlife and the environment.	1	2	3	4	5
4. Assuming that camping causes erosion of the soil, you would be willing to pay for improved, erosion resistant camp sites.	1	2	3	4	5
5. Building fires under trees causes damage to the trees.	1	2	3	4	5
6. If camp fires cause damage to trees, this is an acceptable consequence of recreation.	1	2	3	4	5
7. Grey water discharge (sink/shower water) on the ground causes no damage to the environment.	1	2	3	4	5

SECTION V

1. Riding several horses single file causes no damage to the environment.	1	2	3	4	5
2. Should horse riding cause damage to the environment, this is an acceptable consequence of recreation.	1	2	3	4	5
3. Assuming horse riding causes soil erosion, you would be willing to pay more in fees for soil recovery.	1	2	3	4	5
4. Horse manure dropped along trails in the lake's watershed causes no environmental harm.	1	2	3	4	5
5. Assuming horse manure along trails causes harm to lakewaters, this is an acceptable consequence of recreation.	1	2	3	4	5
6. If group sizes of horsemen were regulated for the sake of the environment, you would accept such regulation as necessary.	1	2	3	4	5

APPENDIX B

CONTINGENCY TABLES

THE EFFECT OF GENDER ON KNOWLEDGE OF DAY VISITORS

	Male		Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	4	23.5	6	40.0
2	10	58.8	12	80.0
3	10	58.8	10	66.7
4	7	41.2	7	46.7
6	15	88.2	11	73.3
	n = 17		n = 15	

The mean of the differences = 7.24 Standard Error = 6.22
Value of T: 2.777. T = 1.16 with 4 df. Not significant, p > .05.

THE EFFECT OF GENDER ON KNOWLEDGE OF PICNICKERS

	Male		Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	6	33.3	4	28.6
2	13	72.2	7	50.0
3	13	72.2	6	42.9
4	13	72.2	11	78.6
6	13	72.2	14	100.0
	n = 18		n = 14	

The mean of the differences = 4.39. Standard Error = 10.22
Value of T = 2.777. T = .43 with 4 df. Not significant, p > .05.

THE EFFECT OF GENDER ON KNOWLEDGE OF SWIMMERS

	Male		Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	4	33.3	7	38.9
2	9	75.0	11	61.1
3	8	66.7	12	66.7
4	5	41.7	9	50.0
6	9	75.0	17	94.4
	n = 12		n = 18	

The mean of the differences = 3.88. Standard Error = 5.45
Value of T = 2.777. T = .71 with 4 df. Not significant, p > .05.

THE EFFECTS OF GENDER ON KNOWLEDGE OF FISHERMEN

Male			Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	17	68.0	3	60.0
2	16	64.0	2	40.0
4	12	48.0	5	100.0
5	12	48.0	2	40.0
6	18	72.0	4	80.0
7	19	76.0	4	80.0
	n = 25		n = 5	

The mean of the differences = 4. Standard Error = 10.63 Value of T = 2.571. T = .38 with 5 df. Not significant, p > .05.

THE EFFECTS OF GENDER ON KNOWLEDGE OF BOATERS

Male			Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	10	52.6	9	81.8
3	8	42.1	5	45.5
5	15	78.9	9	81.8
7	7	36.8	6	54.5
	n = 19		n = 11	

The mean of the differences = 13.30. Standard Error = 6.31 Value of T = 3.183. T = 2.10 with 3 df. Not significant, p > .05.

THE EFFECTS OF GENDER ON KNOWLEDGE OF JET/WATER SKIERS

Male			Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	14	58.3	2	33.3
3	7	29.2	3	50.0
5	18	75.0	5	83.3
7	9	37.5	1	16.7
	n = 24		n = 6	

Mean of the differences = 4.17. Standard Error = 11.14 Value of T = 3.183. T = .37 with 3 df. Not significant, p > .05

THE EFFECTS OF GENDER ON KNOWLEDGE OF CAMPERS

	Male		Female	
Stmt #	Match Frequency	Percent	Match Frequency	Percent
1	10	71.4	8	50.0
2	7	50.0	8	50.0
3	10	71.4	14	87.5
5	11	78.6	9	56.25
7	10	71.4	9	56.25
	n = 14		n = 16	

The mean of the differences = 8.56 Standard Error = 7.35
Value of T = 2.777. T = 1.16 with 4 df. Not significant, p > .05.

THE EFFECTS OF GROUP TYPE BY SECTION OF QUESTIONNAIRE ON KNOWLEDGE
SECTION I

Stmt #	Day Users % Match Freq	Picnickers % Match Freq	Swimmers % Match Freq
1	31.2	31.2	36.7
2	68.8	62.5	66.7
3	62.5	59.4	66.7
4	43.8	75.0	46.7
6	81.3	86.7	84.4
Means:	57.52	62.96	60.24

Source	SS	DF	MS	F
Between	73.98	2	36.99	.0937
Within	4733.27	12	394.43	
Total	4807.25	14		

Value of F: 3.89. Not significant, p >.05

THE EFFECTS OF GROUP TYPE BY SECTION OF QUESTIONNAIRE ON KNOWLEDGE SECTION III

Stmt #	Boaters % Match Freq	Jet/Water Skiers % Match Freq
1	36.7	53.3
2	43.3	33.3
5	80.0	76.6
7	43.3	33.3
Means:	50.82	49.12

Source	SS	DF	MS	F
Between	5.78	1	5.78	1.42
Within	2437.11	6	406.18	
Total	2442.89	7		

Value of F: 5.99. Not significant, p>.05

THE EFFECTS OF GROUP TYPE ON KNOWLEDGE OF ALL GROUPS

Group 1 % Match	Group 2 % Match	Group 3 % Match	Group 4 % Match	Group 5 % Match	Group 6 % Match	Group 7 % Match
31.2	31.2	36.7	36.7	53.3	66.7	60.0
68.8	62.5	66.7	43.3	33.3	60.0	50.0
62.5	59.4	66.7	80.0	76.6	56.7	80.0
43.8	75.0	46.7	43.3	33.3	46.7	70.0
81.3	86.7	84.4	----	----	73.3	63.3
----	----	----	----	----	76.7	----
Group Means						
57.52	62.96	60.24	50.82	49.12	63.35	64.66

Source	SS	DF	MS	F
Between	1028.10	6	171.35	.5578
Within	8293.83	27	307.17	
Total	9321.94	33		

Value of F: 2.46. Not significant, p > .05

Group Identity

1-Day Users 2-Picnickers 3-Swimmers 4-Boaters 5-Jet/Water Ski 6-Fishermen 7-Campers

THE EFFECT, BY SECTION OF QUESTIONNAIRE, OF EDUCATION ON KNOWLEDGE OF RECREATIONAL IMPACT SECTION I DAY VISITORS, SWIMMERS, AND PICNICKERS

	Group 1 % Match	Group 2 % Match	Group 3 % Match	Group 4 % Match	Group 5 % Match	Group 6 % Match	Group 7 % Match
1	71.4	27.3	30.0	0.0	66.7	50.0	50.0
2	42.9	66.7	70.0	50.0	33.3	75.0	83.3
3	42.9	60.6	73.3	100.0	33.3	66.7	66.7
4	57.1	63.6	43.3	50.0	33.3	58.3	66.7
6	100.0	90.9	80.0	100.0	100.0	66.7	83.3
				Group Means			
	62.8	61.8	59.3	60.0	53.3	63.3	70.0

Source	SS	DF	MS	F
Between	757.48	6	126.24	.1974
Within	17899.42	28	639.26	
Total	18656.91	34		

Value of F: 2.45. Not significant, p >.05. Left column of numbers correspondes to statement number on section of questionnaire.

Group Identity

1-Less than 12 years 2-12 years 3-Some college no degree 4-Associate degree (academic) 5-Associate degree (Votech) 6-Bachelor's degree 7-Masters degree or higher.

THE EFFECT, BY SECTION OF QUESTIONAIRE, OF EDUCATION ON KNOWLEDGE OF RECREATIONAL IMPACT SECTION III BOATERS AND SKIERS

	Group 1 % Match	Group 2 % Match	Group 3 % Match	Group 4 % Match	Group 5 % Match	Group 6 % Match	Group 7 % Match
1	50.0	53.8	70.0	50.0	100.0	64.3	28.6
2	66.6	46.2	65.0	50.0	0.0	71.4	42.9
3	0.0	53.8	30.0	0.0	0.0	42.8	71.4
4	33.3	38.5	25.0	0.0	0.0	57.1	57.1
6	66.6	53.8	65.0	50.0	100.0	50.0	85.7
				Group Means			
	43.3	49.2	51.0	34.0	40.0	57.1	57.1

Source	SS	DF	MS	F
Between	2283.75	6	380.62	.4472
Within	23830.09	28	851.07	
Total	26113.84	34		

Value of F: 2.45. Not significant, p > .05. Left column of numbers correspondes to statement number on section of questionnaire.

Group Identity

1-Less than 12 years 2-12 years 3-Some college no degree 4-Associate degree (academic) 5-Associoate degree (Votech) 6-Bachelor's degree 7-Masters degree or higher.

THE EFFECT, BY SECTION OF QUESTIONNAIRE, OF EDUCATION
ON KNOWLEDGE OF RECREATIONAL IMPACT
SECTION II FISHERMEN

	Group 1 % Match	Group 2 % Match	Group 3 % Match	Group 4 % Match	Group 5 % Match	Group 6 % Match	Group 7 % Match
1	100.0	50.0	100.0	100.0	50.0	66.6	0.0
2	50.0	66.6	50.0	100.0	50.0	66.6	50.0
4	50.0	50.0	75.0	0.0	100.0	33.3	50.0
5	50.0	50.0	37.5	0.0	50.0	100.0	0.0
6	100.0	50.0	87.5	100.0	100.0	66.6	100.0
7	100.0	58.3	87.5	100.0	100.0	100.0	50.0
				Group Means			
	75.0	54.1	72.9	66.6	75.0	72.2	41.7

Source	SS	DF	MS	F
Between	5869.58	6	978.26	.9995
Within	34253.49	35	978.68	
Total	40123.06	41		

Value of F: 2.40. Not significant, p > .05. Left column of numbers correspondes to statement number on section of questionnaire.

Group Identity

1-Less than 12 years 2-12 years 3-Some college no degree
4-Associate degree (academic) 5-Associate degree (Votech)
6-Bachelors degree 7-Masters degree or higher.

THE EFFECT, BY SECTION OF QUESTIONNAIRE, OF EDUCATION ON KNOWLEDGE OF RECREATIONAL IMPACT
SECTION IV CAMPERS

	Group 1 % Match	Group 2 % Match	Group 3 % Match	Group 4 % Match	Group 5 % Match	Group 6 % Match	Group 7 % Match
1	100.0	55.6	60.0	50.0	50.0	66.6	50.0
2	100.0	44.4	50.0	50.0	0.0	66.6	50.0
3	100.0	66.6	80.0	100.0	100.0	66.6	100.0
5	50.0	55.6	70.0	100.0	100.0	66.6	100.0
7	0.0	55.6	70.0	0.0	100.0	100.0	100.0
				Group Means			
	70.0	55.6	66.0	60.0	70.0	73.3	80.0

Source	SS	DF	MS	F
Between	2012.17	6	335.36	.3394
Within	27658.89	28	987.81	
Total	29671.06	34		

Value of F: 2.45. Not significant, p > .05. Left column of numbers correspondes to statement number on section of questionnaire.

Group Identity
1-Less than 12 years 2-12 years 3-Some college no degree
4-Associate degree (academic) 5-Associate degree (Votech)
6-Bachelors degree 7-Masters degree or higher.

EFFECT OF KNOWLEDGE BASE ON ACCEPTANCE OF ADVERSE RECREATIONAL IMPACT

Knowledge Base	Stmt #	Section #	Percent Impact Acceptable
Day Visitors	5	I	43.8
Swimmers	5	I	36.6
Picnickers	5	I	37.5
Day Visitors	7	I	37.5
Swimmers	7	I	40.0
Picknickers	7	I	31.3
Fishermen	3	II	30.0
Boaters	2	III	20.0
Skiers	2	III	26.7
Boaters	4	III	23.3
Skiers	4	III	23.3
Boaters	6	III	16.7
Skiers	6	III	30.0
Campers	4	IV	16.7
Campers	6	IV	26.6

Group means

Day Visitors-40.6 Swimmers-38.3 Picnickers-34.4 Fishermen-30.0 Boaters-20.0 Skiers-26.6 Campers-22.15

Source	SS	DF	MS	F
Between	854.52	6	142.42	8.8546
Within	128.67	8	16.08	
Total	983.20	14		

Value of F: 3.58. Significant, $p < .05$.

EFFECT OF AGE LEVEL ON KNOWLEDGE OF RECREATIONAL IMPACT

Group Type	Age Level	Frequency	Percent Match
Day visitors	15-19	2	50.0
Swimmers		6	53.3
Picnickers		2	90.0
Fishermen		0	0.0
Boaters		0	0.0
Jet/water skiers		4	37.5
Campers		0	0.0
Day visitors	20-24	11	56.4
Swimmers		5	72.0
Picnickers		4	45.0
Fishermen		4	54.2
Boaters		8	71.9
Jet/water skiers		8	50.0
Campers		2	90.0
Day visitors	25-29	6	80.0
Swimmers		7	48.6
Picnickers		2	80.0
Fishermen		5	60.0
Boaters		4	62.5
Jet/water skiers		6	54.2
Campers		6	60.0
Day visitors	30-34	2	60.0
Swimmers		4	50.0
Picnickers		7	60.0
Fishermen		8	66.7
Boaters		7	57.1
Jet/water skiers		5	55.0
Campers		6	83.3
Day visitors	35-39	4	50.0
Swimmers		5	68.0
Picnickers		3	53.3
Fishermen		4	58.3
Boaters		3	58.3
Jet/water skiers		1	40.0
Campers		5	72.0
Day Visitors	40-44	5	40.0
Swimmers		2	80.0
Picnickers		4	65.0
Fishermen		7	66.7
Boaters		5	40.0
Jet/water skiers		1	20.0
Campers		2	20.0

Day visitors	45-49	0	0.0
Swimmers		0	0.0
Picnickers		1	100.0
Fishermen		1	83.3
Boaters		2	50.0
Jet/water skiers		3	41.6
Campers		4	70.0
Day visitors	50-54	1	60.0
Swimmers		0	0.0
Picnickers		4	50.0
Fishermen		0	0.0
Boaters		1	75.0
Jet/water skiers		1	20.0
Campers		2	70.0
Day Visitors	55-59	0	0.0
Swimmers		0	0.0
Picnickers		3	66.7
Fishermen		0	0.0
Boaters		0	0.0
Jet/water skiers		0	0.0
Campers		0	0.0
Day visitors	60-64	0	0.0
Swimmers		1	80.0
Picnickers		1	60.0
Fishermen		2	75.0
Boaters		0	0.0
Jet/water skiers		0	0.0
Campers		1	60.0
Day Visitors	65-69	0	0.0
Swimmers		0	0.0
Picnickers		1	40.0
Fishermen		0	0.0
Boaters		0	0.0
Jet/waters skiers		1	100.0
Campers		0	0.0
Day Visitors	70-74	1	60.0
Swimmers		0	0.0
Picnickers		0	0.0
Fishermen		0	0.0
Boaters		0	0.0
Jet/water skiers		0	0.0
Campers		1	40.0

Group Means

Day visitors-57.05 Swimmers-64.56 Picnickers-64.55
Fishermen-66.31 Boaters-59.26 Jet/water skiers-46.48
Campers-62.8

Source	SS	DF	MS	F
Between	2441.97	6	406.99	1.3511
Within	15362.30	51	301.22	
Total	17804.27			

Value of F: 2.39. Not significant, p > .05.

ANOVA SUMMARY SECCHI DISK OBSERVATIONS BETWEEN STATIONS

Source	SS	DF	MS	F
Between	362.50	3	120.83	.2390
Within	28310.94	56	505.55	
Total	28673.44	59		

Value of F: 2.77. Not significant, p >.05.

Group Means

Station A - 72.97 Station B - 71.79 Station C - 66.62
Station D - 70.79

ANOVA SUMMARY DISSOLVED OXYGEN OBSERVATIONS BETWEEN STATIONS

Source	SS	DF	MS	F
Between	2.55	3	.8489	.5148
Within	98.94	60	1.6489	
Total	101.48	63		

Value of F: 2.76. Not significant, p >.05.

Group Means

Station A - 6.93 Station B - 7.25 Station C - 7.50
Station D - 7.25

ANOVA SUMMARY ALKALINITY OBSERVATIONS BETWEEN STATIONS

Source	SS	DF	MS	F
Between	168.75	3	56.25	.1862
Within	18125.00	60	302.08	
Total	18293.75	63		

Value of F: 2.76. Not significant, p > .05.

Group Means

Station A - 160 Station B - 163.75 Station C - 163.75
Station D - 163.75

ANOVA SUMMARY TEMPERATURE OBSERVATIONS BETWEEN STATIONS

Source	SS	DF	MS	F
Between	.42	3	.14	1.62
Within	520.43	60	8.67	
Total	520.85	63		

Value of F: 2.76. Not significant, p > .05.

Group Means

Station A - 25 Station B - 25.13 Station C - 25.13
Station D - 24.94

ANOVA SUMMARY pH OBSERVATIONS BETWEEN STATIONS

Source	SS	DF	MS	F
Between	.14	3	4.56	.6183
Within	4.42	60	7.37	
Total	4.56	63		

Value of F: 2.76. Not significant, p >.05.

Group Means

Station A - 7.47 Station B - 7.44 Station C - 7.50
Station D - 7.38

VITA

Walter Lee Cross

Candidate for the Degree of

Master of Science

Thesis: RECREATIONAL VISITOR ATTITUDE AND SELECTED LIMNOLOGICAL MEASUREMENTS OF RECREATIONAL IMPACT AT LAKE CARL BLACKWELL

Major Field: Health, Physical Education and Leisure

Biographical:

Personal Data: Born at Fort Hood, Texas, April 20, 1949, the son of Earl and Alice Cross. Married Carol Sellers December 1967 at Perry, Oklahoma. Son, Justin Eric Cross, born May 3, 1980 Stillwater, Oklahoma.

Education: Received Bachelor of Science degree in History from the University of the State of New York in March, 1980; completed requirements for the Master of Science degree at Oklahoma State University in December, 1992.

Professional Experience: Training Instructor, United States Army, October 1967, to June 1988. Ranger, Lake Carl Blackwell, Stillwater, Oklahoma, April 1989 to present.