RESERVOIR RECREATION ANALYSIS: THE EFFECT OF RESERVOIR MANAGEMENT AGENCY ON RECREATION PARTICIPATION

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MASTER OF SCIENCE

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ABSTRACT

Dams and reservoirs are created to provide flood control, water storage for irrigation and water supply, recreation, and hydroelectric generation. Most US reservoirs provide recreation in some form. However, there are concerns that certain reservoir/dam managers do a better job in providing recreation than others. Some agencies that manage land riparian to US reservoirs, such as the National Park Service (NPS), are dedicated to recreation development. Other agencies such as the Army Corps of Engineers (USACE) might not be interested in catering to the additional demands of recreators as a stakeholder group. Management actions such as boat access, waterfront land and campsite management, safety, aesthetics, and water levels have direct and indirect effects on anglers, swimmers, boaters, and other recreators. The objective of this study is to analyze recreation participation for different reservoirs based different management agencies due to the fact these agencies have different institutional objectives.

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DEDICATION

I dedicate this thesis to my family especially my father, Gabriel Boateng who has been watching on me from heaven and my mother, Elizabeth for her words of encouragement and prayers. Also, to my four big brothers, Anthony, Joseph, Emmanuel and Gabriel for their counseling, guidance, and inspiration towards my academic journey.

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LIST OF ABBREVIATIONS

BLM .... Bureau of Land Management

BLUE .... Best Linear Unbiased Estimator

BT .... Benefit Transfer

CVM .... Contingent Valuation Studies

CWA .... Clean Water Act

EPA .... Environmental Protection Agency

GDP .... Gross Domestic Product

IWR .... Institute for Water Resources

IWRM .... Integrated Water Resource Management

MLE .... Maximum Likelihood Estimation

NPS .... National Park Service

OLS .... Ordinary Least Squares

PRISM .... Parameter-elevation Regression on Independent Slopes Model

RV .... Recreational Vehicle

TC .... Travel Cost

TCM .... Travel Cost Method

TVA .... Tennessee Valley Authority

TWRA .... Tennessee Wildlife Resources Agency

US .... United States

USA .... United States of America

USACE .... United States Army Corps of Engineers

USBEA .... United State Bureau of Economic Analysis

USBR .... United State Bureau of Reclamation

USGS ....United State Geological Service

VER...Visitor Estimation Report

VIF ....Vector Inflation Factor

WTP ....Willingness-To-Pay

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CHAPTER 1. INTRODUCTION

1.1. Background and Overview

A reservoir is a man-made lake behind a dam. Flood control, water storage for irrigation and water supply, recreation, and hydroelectric generation are the major reasons why dams and reservoirs are built. Reservoirs come about as a result from a construction of dam. The United State has about two million dams on various water bodies especially rivers and streams and 84,000 registered in the mandated National Congress Inventory of Dams (*Histroy of Dams.Pdf*, n.d.). Dams are expensive projects to undertake and are usually constructed for specific objectives such as flood control or navigation (Beaumont, 1983; Shi et al., 2019) . A dam and reservoir can be used for navigation, recreation, flood control, irrigation, and water supply. This multipurpose use of dams implies they have major local, regional, national, and socio-economic implications. When a multipurpose dam reservoir is constructed, it becomes part of a larger system of competing uses (Hadjerioua et al., 2015). The emphasis on the use of water in the twentieth century shifted from navigation and building projects to production and protection of natural resources (Reimer, 2013).

Most reservoirs in the United States offer recreational opportunities such as fishing, swimming, boating, and other activities. Generally, recreation is defined as the activity of leisure. Water-based recreation is gaining in popularity. This tendency is predicted to continue if people have access to water that can be used for enjoyment (Bergstrom et al., 1996; Donald et al., 1991; Cordell et al., 1990). The demand for reservoir recreation is growing to the point where, according to the US Bureau of Labor Statistics, outdoor recreation accounted for $459.8 billion in current-dollar GDP in 2019, up from $378.2 billion in 2016 (Outdoor Foundation, 2019). Some contributing factors leading to the growth in outdoor recreation are increased incomes, and improvement in road infrastructure. The completed interstate highways have allowed weekend access to areas as well as reducing travel costs. Moreover, population growth is a primary driver of household water demand, which strains water supplies for municipalities, as well as for agriculture and other industries. The non-consumptive use of surface water has been often viewed as a pure public good by economists (Rogers, 2002).

Reservoir management in the United States has seen significant changes because of shifting attitudes, political movements, and fiscal constraints. Reservoir management encompasses laws and regulations that govern water levels as well as storage for flood control, hydropower production, irrigation, fishing, and other operational objectives or combinations of objectives (Mower et al., 2013). Since the 1960s, a more urbanized and educated culture has placed a greater emphasis on recreation, environmental preservation, and water quality above irrigation, navigation, and flood management. The aims of the Wilderness Act of 1964, the Wild and Scenic Rivers Act of 1968, and the National Environmental Policy Act of 1969 attest to the strength of these new interests (USACE, 2005). Historically, the federal government had sole authority over water use for economic and domestic purposes. Due to the lengthy history of water resource use, a slew of agencies with single-purpose missions have sprung up. Many of these agencies are now multi-resource management agencies that must manage the recreational use of waterways as well as hydroelectric generation, irrigation, flood control, and navigation. These management agencies include the US Army Corps of Engineers (USACE), which was established with the missions of port and shoreline protection, navigation, and flood control (Reimer, 2013; Mower et al., 2013) the United States Bureau of Reclamation (USBR), which was established to assist in the development of western United States of America regions by providing water for large irrigation projects; the Tennessee Valley Authority (TVA) , which was established to help the Tennessee Valley region expand economically by flood control and supplying abundant and relatively inexpensive hydroelectric power to residents. Through the establishment of National Recreation Areas, the National Park Service (NPS), became involves with reservoir recreation, but not dam management. (Loomis, 2002; Dodd, 2006; Reimer, 2013).

1.1.1. Water Scarcity, Competing Water Uses, and Climate Change

According to Bonnet et al (2015), the Federal government initiated the Flood Control Act of 1944 to consolidate the multipurpose use of dams and reservoirs. Section 4 of the Act authorized the construction, operation, and maintenance of recreation facilities at USACE water resources development projects; Section 5 granted the Secretary of the Interior the authority to sell power generated at federal projects; and Section 6 authorized the USACE to provide surplus water at its facilities (Kaval, 2011). All federal navigation facilities are operated and maintained by the USACE. In the West, the USBR initiatives are critical for irrigation and hydropower generation. The TVA, founded by Congress In 1933, provides hydropower, flood control, and recreation to the Southeast, among other things. The bulk of hydropower reservoirs (119 out of 157, or 76%) are designated for recreational usage, while only 42 are designated for navigation (Hadjerioua et al, 2015).

According to Dolesh (2017), climate change has a significant impact on recreation, and outdoor recreation in urban cities. Climate change impacts on water-based recreation varies by region (Brice et al., n.d.). Hurricanes, heavy rainstorms, sea-level rise, heat waves, and severe drought are all projected to worsen because of a changing climate. Such circumstances have a direct impact on how people use their leisure time, limiting possibilities or making outdoor activities unhealthy. It's likely that sometime in future water and snow-based recreation will be phased out totally in some parts of the country. Some sorts of outdoor recreation, such as whitewater rafting, kayaking, and other water-based sports, are already at risk. Water levels may be too low for kayaking, rafting, or canoeing for much of the year, or the areas to do so may have been ruined by storms and flooding (Chan & Wichman, 2018). Moreover, droughts decrease the number of recreational visitors since the water surface levels reduces and thus causes more muds, reduce water for fish habitat and reduce overall aesthetic value of the water site (Ward et al., 1996) . In conclusion to this study, during droughts, reservoirs with lowest marginal recreation values can easily draw down and might not encounter severe economic loss. In contrast, sites with higher recreation value will suffer severe recreation economic loss if there is drawdown in that region due to the incident of drought.

1.1.1.1. Recreation and Economic Benefit

The economic value of reservoir recreation is defined as the total willingness to pay for the resources by the recreating public. These figures are influenced by management actions at project reservoirs and are dependent on several factors. Some of these factors include the project's design size, the amount of water available, the time of year, complementary project facilities, and substitute recreational opportunities. Demographic factors in the market area, such as the number and characteristics of individuals also affects the economic value of reservoir recreation (Ward et al, 1996)

1.1.2. Reservoir Management Agencies

Historically, the USACE and the USBR have overseen management of water resources at the federal level. As time passed and demand grew, other agencies popped up. There are also congress committees dedicated to various aspects of water policy. Since the 19th century, the USACE has served as a "de facto river master" for some US river basins, including the Missouri River basin, and its primary duty has been navigation (Hearne & Prato, 2016; Reimer, 2013). There is also the TVA, NPS and the Bureau of Land Management (BLM). The Environmental Protection

Agency (EPA) enforces federal clean water and safe drinking water regulations, supports municipal wastewater treatment plants, and participates in pollution control activities aimed at safeguarding watersheds and drinking water sources. Each state and territory must adopt water quality standards for all intrastate waters, which must be submitted to the EPA for assessment and approval or disapproval. This section provides a brief overview of these management agencies.

1.1.2.1. Objectives of Management Agencies

The USACE was founded in 1802 and oversaw coastal fortifications, surveyed roads, and canals, and removing navigation hazards during that time. The corps also built lighthouses, assisted in the development of harbor jetties and piers, and identified navigation channels. The USACE is primarily responsible for the creation and maintenance of navigable waterways in the United States. The navigation mandate of the USACE comprises the upkeep and upgrading of over 40,000 kilometers (25,000 miles) of navigable channels serving about 400 ports, including 130 of the country's 150 major cities. (Welp et al, 2004). The Corps became the principal government flood control organization in the twentieth century, and it considerably extended its civil works efforts, becoming a major producer of hydroelectric electricity and the country's leading provider of recreation, among other things. In the years that followed, the Corps constructed numerous massive dams on the Missouri River's main stem. All of these dams served multiple purposes. Flood control, irrigation, navigation, water supply, hydropower, and recreation were all provided by them.

The NPS founded in 1916 and its primary objective is to safeguard park resources and values while also ensuring that parks are enjoyed by current and future generations. The NPS ensures that parks are designed to pique the public's attention, resulting in a steady stream of visitors partaking in a range of park activities (Loomis, 2002). The NPS believes that good park management relies on consistent, trustworthy, and high-quality information about visitor use, and that park managers must monitor that use. To that purpose, park managers invest a large amount of staff time and resources to managing and monitoring visitor use of parks. Currently, the NPS manages about 376 units.

The USBR is mainly concerned with the management of water resources, particularly in the western US. Its primary objective is to maintain existing water facilities, infrastructure, domestic water supply and hydroelectric power projects. This agency has several recreation projects sites which has been designated for public use and managed by the NPS and the US Forest Service (Reimer, 2013).

The TVA was founded in 1933 with the primary goal of preventing flooding along the Tennessee River. The TVA's responsibilities have now been expanded to include not only navigation, but also recreation, reforestation, electricity, and ensuring a good use of marginal lands in the Tennessee valley. TVA manages 49 reservoirs in seven states (Rathbun et al 2005). Many TVA reservoirs are now used mostly for outdoor leisure (Cordell et al, 1990)

1.2. Problem Statement and Motivation for Research

For a substantial portion of the American population, outdoor recreation has become one of the most popular forms of entertainment. One of the most prevalent and popular outdoor recreation activities is water recreation. The five most popular outdoor activities in 2019 according to the outdoor participation report were 1) road, mountain, and BMX bicycling; 2) freshwater-saltwater, and fly fishing; 3) running-jogging, and trail running; 4) Hiking and 5) car-backyard and RV camping (Outdoor Foundation Report, 2019). Water-based recreation mostly occurs on rivers, streams, lakes, and the sea. Some of these activities are boating, fishing, swimming, camping, tubing, and many others. Most of these riparian properties are administered or maintained by public or private bodies. The NPS, BLM, USBR, are some of the federal agencies in the United States that manage wetlands. USACE, for example, can be classified as a private agency. Varied objectives in dam construction led to different management objectives for these entities that administer these wetlands in terms of reservoir management. The authorized function of each reservoir determines the water management goals of each reservoir management agency (Mower & Miranda, 2013).

The USACE, for example, oversees water storage, use, and supply at several US reservoirs. Protection, revitalizing the country, and decreasing disaster risk are all part of their mission (flood control). The NPS's only aim is to promote recreation and conservation of natural resources, as stated in their mission statement: "it preserves undamaged natural and cultural resources and values for future generations' enjoyment and education." It also spreads the advantages of outdoor leisure across the country and around the world." (NPS Management Policies 2006). In terms of recreation, there are issues and disagreements about how some types of agencies are improving water recreation given their differing management regimes. For instance, according to Churchill et al. (2002), anglers targeting species other than striped bass, speculated that striped bass predation led to native species losses, there was competition for food and space, which was also a factor. Fishers claimed that the Tennessee Wildlife Resources Agency (TWRA) was not sufficiently responding to their concerns. Five proposals were filed in the Tennessee state legislature in 1995 and 1996 that would have prohibited striped bass stocking in Norris Reservoir and limited TWRA's power to propagate or control all non-native species. There was a need to effectively diffuse fishery management disputes between stakeholder groups and management agencies before they escalate to unmanageable levels.

The quality of water resource, and how it is managed and controlled has an impact on participation level of recreational users. For example, to optimize their happiness and enjoyment, anglers expect a certain volume of water at certain seasonal levels. Swimmers also prefer to check the clarity of the water before deciding whether to swim or not. Also, due to oscillations in reservoir elevation or water level, changing reservoir operations, or changing the volume and/or timing of reservoir releases and storage, has ramifications for flatwater recreation. Water level fluctuation has several effects on recreational use and commercial value, including changes in water depth and surface acreage and boat access (Platt, 2000). This may affect certain attributes such as safety, water access, water quality aesthetics etc., that recreational users consider before participating in swimming, fishing, boating, and camping.

As a result, recreational users find it difficult to request a change in management decisions because they do not understand what is required to implement changes and are also ignorant of resource constraints that limit the allocation of resources required to make the best management decisions. However, the analysis aims to compare the recreation participation rates of these two agencies, namely the NPS and the USACE, at the national level. A clear and positive conclusion from this study would aid in the promotion of effective collaboration among management agencies, natural resource managers, and recreational users in general. The findings would aid reservoir management in adapting operations to accommodate recreational use for the benefit of the public and the country's economy.

1.3. Research Objectives

The general objective of this research is to quantify the differences in visitation and water-based recreation participation rates attributable to, presumably, different reservoir management agencies' management activities.

Specific objectives include:

i. to analyze reservoir-based recreation participation and visitation by estimating the effects of demographic factors such as population, weather conditions, and income; and

ii. to determine whether changes in existing administrative institutions may be needed, specifically alterations to regulatory processes underlying the permitting and operations of reservoir recreation.

1.4. Organization of the Paper

Following this introduction, the second chapter of this thesis presents a literature review of previous scholars' approaches to the study of water management issues, the existing relationship between reservoir management and recreation, and recreation demand models. In chapter three the theoretical and empirical methodology is presented. The fourth chapter discusses the research results and is followed by the conclusions of this study in chapter five.

CHAPTER 2. LITERATURE REVIEW

2.1. Water Policy

Water policy can be divided up into two complementary major areas of concern: I, water supply and allocation; and ii. Water quality. According to Chenoweth (2012), water policy can be defined as the steps involved in making strategic decisions and choosing of processes that enhance the water sector as well as its individual components. In the United States (USA), water policy is generated from diverse levels based on federal, state, and local jurisdiction. Water policy could also be differentiated depending on the type of water, use of water and even on the geographical destination of water. There is no one kind of national water policy or act stated in the constitution of the USA, but rather, there are fragmented pieces of water policies, and these keep evolving with time and demand of water. The US Environmental Protection Agency (EPA) has water policies that are categorized under topics such as drinking water, ground water, surface water (lakes, rivers, and streams), oceans and coaster waters, impaired waters, watersheds, and wetlands. Some examples of water policy are the Clean Water Act, Safe Drinking Water Act, the Endangered Species Act, and numerous state water laws (Elbakidze & Beeson, 2021). Water policy in the United States is fragmented as aforementioned, and these policies are distributed through many levels of government, from federal to local. For example, the Clean Water Act was enacted to ensure that water quality was safe for recreational use (Reimer, 2013). The Clean Water Act (CWA) was formulated in 1972 to focus on the quality of water and its conservation for drinking purposes and the recreation. Reimer (2013), stated that "the purpose of the CWA is specifically to restore all of the nation's waterways to fishable and swimmable."

Historically, state governments controlled the allocation of water for economic and domestic purpose. However, to facilitate navigation and interstate commerce the USACE was established as the primary federal agency to support water navigation. In the late 20th century, there was shift of focus on the use of water from solely navigation and construction projects to development and conservation of natural resources. The USBR was established in 1902, to expand the uses of water for irrigation in the western States. (Grundvig, 1995; Benson, 2008; Edwards & Hill, 2012). The USACE and the USBR have a major role in water control or water policy formulation, but there some other local or state agencies such as the congressional committees which also have roles in water policy (Reimer, 2013).

However, while these different agencies have the power to affect policy changes in water governance, the fact that these separate governmental agencies do not trust one another undermines the effectiveness of the policies (Edelenbos & Van Meerkerk, 2015). In fact, while the division of water responsibility is into three parts: 1) water quality, 2) water supply, and 3) water safety. These functions have different domains, levels and organization and that's what brings about fragmentation in water governance. These fragmentations occur when there is improper coordination among the water management authorities according to the hierarchical levels of government from federal to local. The purpose of delegation is to improve the implementation of efficiency by utilizing regional authorities' experience with local circumstances. Delegation to states, on the other hand, can allow local interests to exert influence and, to a degree, change environmental standards and enhance water efficiency for all purposes of water, which is why Integrated Water Resource Management was created. (Lubell & Lippert, 2011; Hearne & Prato, 2016; Elbakidze & Beeson, 2021). The problem is to sustain water efficiency with all these fragmented policies, ensuring sustainable water supplies given that year in year out, there is increasing population related to increasing economic activities. Edelenbos & Van Meerkerk (2015) argued that one common way to ensure joint responsibility and solve the problems related to the fragmentation of water policy is ‘trust’. Trust is a new management theory being practiced in different fields even in empirical studies. Trust would help in the interconnection of agencies or domains in water governance in other to make increase water efficiency in policy decision.

2.1.1. Water Rights

Several water resources studies have argued that adopting systems of transferable water rights could improve the efficiency and flexibility of current water allocation systems. (Eheart and Lyon 1983; Delorit & Block 2018; Hartwig 2020). It is assumed that the body with authority has the power and obligation to restrict water withdrawals and consumption from water courses under its jurisdiction in the water right system. As a result, a design decision must be made, along with a set of rules to control the system. Such an example is water permits and its duration and limits (Eheart and Lyon 1983). Riparian rights, prior appropriation, and hybrid systems are the three types of water allocation policies (O’Donnell et al, 2018). Riparian rights are derived from English common law, which states that owners of land adjacent to a waterway have a right to use that water. From the 19th century, during the development of settlement in the United States, priority allotment has been on a first-come, first-served basis (Hearne & Prato, 2016; Reimer, 2013). The hybrid system combines the two, with allocations made on a first-come, first-served basis, but riparian owners receiving similar water rights (Reimer, 2013). Most western states have adopted the first-come, first-served principle for water entitlements (Hearne & Prato, 2016). Water rights legislation and markets exist to encourage economic water resource use efficiency by allowing water rights holders to trade allocations. Hydrologic uncertainty determines the annual assignment of per-water right allocation values in some areas (Delorit & Block 2018).

2.2. Value of Water Quality

Generally, water quality refers to the physical, chemical, biological and organic characteristics of water. Contaminants such as suspended silts, clays, oil, and bacteria all have an impact on water quality. Any of these factors could be the primary cause of water quality impairment in a certain source (Barkman & Davidson, 1972). Water quality problems arises when there is over-supply of nutrients with dissolved oxygen levels that causes increase in algae, spirogyra, reduced water clarity and loss of aquatic vegetation beneath the water (Massey et al, 2017). Therefore, if management decides to improve water quality, it could lead to abundance of aquatic species that sustain commercial and recreational fisheries, as well as the aesthetic character of the water and related habitats that support non-consumptive recreational activities like boating, swimming, and hiking (Ferrini et al, 2014; Massey et al, 2017). Ribaudo (1984) compared the travel cost benefit estimate with the stated preference estimate in research on recreational benefits because of improved water quality at St Albans Bay. According to the travel cost results, the benefit estimate per current user was $123 compared to $97 for former users prior to the improvement in water quality. The combined results demonstrated a $536,700 increase in annual recreational benefit because of improved water quality. Benefit estimates for the contingent rating were $54 per current user, compared to $40 per previous user prior to the water quality upgrade. As a result, the total annual benefit from improved water quality was $230,000In addition, Kaoru (1995) calculated the recreational benefits of improving water quality at the Albemarle-Pamlico Estuary in North Carolina, finding a 25% increase in catch rate on average. Some of the pollution variables, which reflect water quality variables from various scenarios, showed surprising results, such as biochemical oxygen and phosphorus, which had positive effect as improvement in welfare loss, that is $2.45 and $2.63 per trip respectively. As a result of these findings, it appears that to get more recreational benefits from improved water quality, the same decisions cannot be made for all quality variables. Nonetheless, to quantify the sensitivity of benefit estimations, this study used the nested random utility model which showed that the quality variables had negative coefficients at different scenarios which varied from $0.9 to $5.16 per visit.

Differently Massey et al (2006) made a study which employed a bioeconomic model to assess the effects of changing water quality on recreational fishing in Maryland's coastal bays. The first model looked at the impact of water quality on fish survival and abundance, the second looked at the impact of fish abundance and water quality on angler catch rates, and the third looked at the impact of angler catch rates on trip demand. The findings suggest that improving water quality in all bays and estuaries across the species' range could result in significant increases in summer flounder populations and corresponding advantages to recreational anglers. Nonetheless, if water quality improvements are limited to a small area, only small gains will be achievable. Extendedly, using monthly harvest data from 1991 to 2011, Massey et al. (2017) calculated the economic benefits of recreational fishing and other non-consumptive water recreation in the Chesapeake Bay TMDL as a results of improved water quality. The benefits of recreational fishing were estimated to be worth between $5 and $59 million per year, as well as all the water quality variables were found to be positive and significant at 5%. Outdoor recreation benefits such as swimming and boating, excluding fishing, are estimated to be worth between $105 and $280 million per year based on aggregate statistics from the total number of visits to national parks and states.

Also, Zhang and Sohngen (2018) employed a stated preference technique with 767 recreational anglers from Ohio Lake Erie to investigate how harmful algal blooms affect these anglers and their catch rates. Anglers' willingness to pay for any mechanism or practice that reduces dangerous algal blooms on the lake increased significantly, according to the findings.

Anglers were ready to pay an extra $8 to $10 each trip in exchange for less miles of boating due to toxic algal blooms, improved water quality, and higher catch rates.

2.3. Recreation Value Studies

Cordell and Bergstrom (1992) looked analyzed the economic benefits of water-based recreation in four reservoirs in western North Carolina under various water level management scenarios. The three management options were to delay the river's drawdown by one month, two months, and three months at the start of summer. One management alternative resulted in an increase in aggregate recreational benefit of about $3.7 million per year, according to the findings. The alternative management increased yearly recreational benefits by $7.6 million and $13.6 million.

Cline and Crowly (2018) summarized the contributions of outdoor recreation for 2016 and concluded that there were more than 889 million visits, spending about $49 billion and creating about 826,000 jobs in USA. According to Outdoor Foundation (2019), the report showed that the outdoor recreation accounted for 2.1% ($459.8billion), of current-dollar GDP for the nation in 2019. At the state level, the value added of outdoor recreation, as a share of state GDP, ranged from 5.8% in Hawaii to 1.3% in Connecticut. Activities such as fishing, boating, hiking, swimming, bird watching and many others are known as conventional outdoor recreation. In 2019, conventional outdoor recreation accounted for 30% of US outdoor recreation (Outdoor Foundation, 2019). Moreover, according to Sausser et al. (2019) boating and fishing was the largest recreation activity for the United States, at $23.6 billion in current-dollar value added in 2019. It was also the largest for about 30 states. Florida, California, and Texas were the largest contributing states ranging from $3.3 billion to $1.7 billion. Snow activities were the sixth largest conventional recreation at $6.3billion.

Moreover, Creel and Loomis (1992), using the multinomial logit model, looked at the economic benefits of improving water availability to wildlife and fishery areas in the San Joaquin Valley. Despite the lack of data, the estimated increases in recreational benefits resulting from improved habitat condition implied a recreational value per acre foot of water that is competitive with the economic value gained from other alternative uses of water such as irrigation, according to the findings. Also, Bonnet et al. (2015) in analyzing the economic benefits of a multipurpose reservoirs in the United States federal hydropower fleet, revealed that TVA and USACE reservoirs have a similar benefit structure, with recreation accounting for approximately 40 percent of total economic benefit, but USBR reservoirs have a higher percentage (about 60%) of benefits devoted to irrigation.

2.4. Recreation Demand

The TVA, as a reservoir management agency, mostly decides to maintain higher water levels in the reservoirs in North Carolina during the summer, based on evidence from a study that higher water levels increase recreation participation, thus increasing regional economic impact (Donald et al, 1991 Cordell et al, 1990). Hence, keeping the water levels higher as a reservoir management policy, resulted in about $62 million in total gross output for the North Carolina Mountain reservoir region. Also, about 1500 jobs were created during 1982 when this policy was made. Thus, showing an increase in economic value in that specific region. Moreover, the forecasted management policy was that, should the agency keep the water level near full for two more months, it is expected to increase revenue to $37.4 million more and jobs to about 900 more in addition to the existing ones (Donald et al, 1990).

Researchers often use the unit-day-value technique in a pure economic benefit analysis, which posits that the entire benefit of the reservoir can be evaluated by multiplying the number of visitors to the reservoir by the average amount spent per visitor every trip. The travel cost method (TCM) and the contingent valuation method (CVM) are two alternative procedures. The former depends on surveys that ask individuals about their desire to pay for recreational activities at a specific location, whereas the latter relies on surveys that ask individuals about their willingness to pay for recreational activities at a certain location (USACE, 2005). However, the revealed choice data can be combined with the stated preference contingent behavior data, resulting in a single TCM demand equation (Loomis, 2002). Therefore Loomis (2002) used the contingent behavior TCM to evaluate recreational benefits in the Lower Snake River by focusing on intended trips after dams are removed and rivers are restored. The removal of the dam, according to this study, might result in a rapid recovery of Chinook salmon runs in the Snake River, as well as increased usage of the river for other recreational activities including rafting, tubing, jet boating, and fishing. The 70 tiny inlands that existed before the dams would reemerge if the dams were dismantled, and the river Canyon would be over 1000 feet deep in parts. Using the TCM, the results suggest that the annual recreation usage value estimates increased to $311 million, which is 6 times greater than the recreation value estimates at $31.6 million before the removal of the dam.

In addition, Bi et al. (2019) estimate the economic advantages of recreation at the reservoir and upstream using the travel cost approach to examine the trade-offs between the dam removal and restoring the free-flowing river. Visitors' spending on the natural lengths of the Ocklawaha River result in greater contributions to the regional economy than recreation on the Rodman Reservoir sites, according to the study. It was discovered that both fishing and non-fishing alternatives are key attractions for visitors to the area and bring economic benefits, albeit fishing visitors had higher visit frequency. Although other research on dam removal in other parts of the United States found significant increases in recreation because of river restoration, this study shows how river restoration might increase some types of activities such as canoeing and kayaking while potentially diminishing others such as fishing (Loomis 2002; Hollander 2020; Ancaies 2020). Recreational activities such as non-motorized boating may increase because of the restored river. Visitors can also transfer from reservoir fishing to river fishing or fishing in other local freshwater lakes.

Anciaes (2020) used the TCM approach to study on the implementation of management policy to improve water quality in beaches and rivers in Wales. This research suggests that this approach has advantages such as the ability to estimate more preference trade-offs between costs and water quality improvements, trade-offs between the use value of water quality for recreation and non-use value, and trade-offs between water quality and other beach and river characteristics. Individuals' real-life choices are solved using the revealed preference approach. The findings revealed that improving a beach's water quality from good to exceptional results in a 52 percent increase in participation, resulting in a monthly income of 199,164 euros (US$214,230.76). Similarly, increasing the water quality of a river length from poor to good results in a 64% increase in participation rate, resulting in a monthly savings of 15,671 euros (US$16,856.51).

Furthermore, using the travel cost technique, Hwang et al. (2021) assessed the economic value of the Florida Black Crappie recreational fishery for both residents and non-residents. This research also satisfies the argument that revealed preference is the most suitable technique for estimating recreational activity values. The method is designed to assess the cost of visiting a specific recreational facility when visitors go further away. The travel cost parameter was highly significant and negative, indicating a downward slope demand curve. Also, the findings showed that anglers who fish from motorized boats and who are older are observed to take more trips.

In contrast to Loomis (2002), Ferrini et al (2014) analyzed the water quality improvement based using stated preference data and revealed preference data for a Benefit Transfer (BT) method. This study suggested that nonuse values are assessed with stated preferences methods utilizing hypothetical markets, whereas travel cost values are based on revealed preference facts of actual behavior and do not reflect nonuse values. The data set included CVM and TCM of sampling data from 1759 respondents from the North of England. The results indicated that the respondents had a favorable Willingness-To-Pay (WTP) for improving water quality in the River Aire in the United Kingdom. Also, it showed that the CVM data produced superior BT results than the TCM data, indicating that the differences in WTP between valuation methods are greater than the variations in WTP between study areas.

Surveys are used in stated preference methods to capture preferences for different characteristics of water recreation activities, and to estimate willingness to pay for improvements in those aspects. This strategy, on the other hand, is prone to eliciting negative responses, with many participants declaring that they are unwilling to pay any sum (Anciaes, 2020; Womble & Hanemann, 2020). In addition, according to Ribaudo (1984), the optimum method for estimating recreational benefit is contingent rating, or the preference approach. The reason for this is that the travel cost technique overestimates values due to clustered data, failure to specify a valid demand function, and overestimating the number of visits, all of which can cause the mean to rise, affecting the aggregate benefit estimate.

CHAPTER 3. METHODOLOGY

This chapter discusses the theoretical framework and the empirical model specification used for this study. The chapter also includes the data, sources of data, variable description, and the data construction method.

3.1. Conceptual Framework

In this study, a national level model of recreation participation is developed to determine the role of the management agency in water recreation provision. The methodological approach that would be used in this research is national recreation model that will yield an empirical estimate of recreational participation based on determinants such as water quality, weather, recreation facilities, distance to nearest metropolitan area, and local population and income. Due to a lack of travel cost data and the varying prices across recreational sites, a recreation demand model will not be utilized. Therefore, prices cannot be used because they are non-linear, hence the study will not estimate recreation demand. The framework can be represented as:

V= f [management agency, recreation facilities, water quality, reservoir levels, weather, local demographic characteristics]

Where: V represents visitation; management agencies include the NPS, USACE, TVA, and others; recreation facilities include boat launches and marinas, campsites, picnic areas, and beaches; weather shows the climate condition recreational users consider before participation; and local demographic characteristics include population and income.

3.1.1. Empirical Model Specification

The study employs panel data with many cross-section units, n, that spans a short time, t, of seven years. Using panel data summaries of individual reservoir sites and management agency as a dummy variable to estimate the effect of the type of reservoir management agency of recreation participation, the econometric model that may supports this theory is Ordinary Least Squares (OLS) and is generally represented as:

$$Y = a + \beta X + u \tag{3.1}$$

The dependent variable ***Y*** is the number of visits, which is regressed on ***X*** as the vector for all explanatory variables, $\boldsymbol{\alpha}$ is the constant, $\boldsymbol{\beta}$ is the estimated parameter vector of the independent variables which must be Best Linear Unbiased Estimator (BLUE) according to the Gauss-Markov Theorem. $\boldsymbol{u}$ is the error term. The usefulness of integrating fixed effects in discrete choice models built from market data has been demonstrated in consumer choice modeling and environmental valuation studies (Von Heafen & Phaneuf, 2008; Petrin & Train, 2010; Maelstrom & Vasarhelyi, 2018). Fixed effects are used to resolve the endogeneity the introduced dummy variable allow the intercept term to vary over across time and over cross-section units. Therefore, the OLS fixed effects model is as follows:

$$\boldsymbol{Y_{it} = \beta_0 + \delta_1 mgt_i + \beta_1 \sum X_{it} + \alpha_i + u_{it}} \tag{3.2}$$

The subscript ***I*** denotes reservoir site and ***t*** denotes time. Therefore, it is assumed that the panel is balanced so that each individual has observations for N as the total number of sites for the same number of periods, T. $\boldsymbol{Y_{it}}$ is the number of visits at site ***I*** in year ***t***, ***mgt*** is a dummy variable representing reservoir management institutions, $\boldsymbol{X_{it}}$ is a vector of explanatory variables with respect to each site and time. $\boldsymbol{\alpha_i}$ is the individual location effects which accounts for unobserved heterogeneity that is constant over time but varies by location and u is the error term.

Therefore, as this study analysis the effect the type of management agency on visitation participation, the multiple regression equation is represented as:

$$\begin{aligned} visitation_{it} = {} & \beta_0 + \delta_1 NPS_i + \beta_1 impairement_{it} + \beta_2 distance_i + \beta_3 population_i + \beta_4 income_{it} \\ & + \beta_5 tempearture_{it} + \beta_6 swimming_i + \beta_7 waterlevel_{it} + \beta_8 boatlaunch_i \\ & + \beta_9 campsites_i + \beta_{10} precipiatation_{it} + \beta_{11} precipitation^2{}_{it} + \alpha_i + u_{it} \end{aligned} \tag{3.3}$$

The β_o is the intercept, δ_1 is the parameter estimate for the agency dummy. $B_{1,}$ $\beta_{2...}$………., β_{12} are the estimation parameters for the other independent variables respectfully and u_{it} is the error term.

3.1.2. Variable Description and *a priori* Expectations

Table 1: Description of all Variables

Variable Name	Description	Data Source	Expected sign
Visitation	this is the annual count of recreation trips to NPS and USACE sites	NPS Statistics Database & USACE Visitor Estimation Report (VER) Systems.	
Income	Gross Domestic Product (GDP) per capita income adjusted for inflation.	United States Bureau of Economic Analysis (US.BEA)	positive
Impairment	it serves as a water quality indicator	United State Environmental Protection Agency (EPA)	negative
Distance	it is measured in miles from the nearest metropolitan area with population exceeding one million to the reservoir site	Google Maps	negative
Swimming	this indicates the availability of swimming area. Its 1 if there is a swimmable site and 0 otherwise	Recreation.gov & NPS	positive
Water Level	measures the difference between the flood pool level and the actual level of water, measured in feet.	United State Geological Service (USGS), USACE & lakesonline.com	positive
Temperature	it is the minimum, maximum and mean monthly averages for January and July. It measures in degree Fahrenheit	Parameter-elevation Regressions on Independent Slopes Model (PRISM) Climate Group	positive
Boat launch Facilities	the combination of the number of boat ramps and marinas provided as recreational facilities at each site	U.S Army Engineer Institute for Water Resources (IWR) and NPS	positive
Campsites	The camping variable measures the number electrical campsites, rustic sites, and day-use picnic sites	U.S Army Engineer Institute for Water Resources (IWR) and NPS	positive
Precipitation	is the amount of rainfall averaged annually and is recorded in millimeters	Parameter-elevation Regressions on Independent Slopes Model (PRISM) Climate Group	positive
Population	is the total number of people from the surrounding counties 100 miles from the reservoir site from the 2020 census	United State Bureau of Census	positive

3.2. Data Sources

Efforts were made to collect visitation data from a variety of reservoir management agencies, including the TVA and the USBR, and a variety of state parks' departments, but data was only available from the NPS and USACE. Visitation as the dependent variable, is the count of recreation trips to NPS and USCAE-managed reservoir sites over the course of a year. It consists of 11 NPS reservoir recreation sites and 85 USACE reservoir recreation sites. The largest reservoirs were considered by selecting reservoirs with more than 9000 acres of surface area. The variable of interest is a dummy variable as a proxy for the management agency of these reservoir sites. A reservoir site is equal to 0 if it is managed by NPS and equal to 1 if it's managed by USACE.

Income per capita is an economic factor that contributes to the willingness to participate in recreation. Real Gross Domestic Product per capita income data was collected for the surrounding counties 100 miles from the reservoir site as well as the 2020 Population Census data for these counties. The per capita income was then averaged by the number of surrounding counties for each site for each year, from 2014 to 2020. It is expected that as population increases, visits to recreational site should increase as well as an increase in income should cause people to be willing to visit recreational sites.

Water quality is measured using impairment as a proxy. When an applicable water quality criterion is not met, the water is classified as impaired. Sections 305(b) and 303(d) of the Clean Water Act require states to file Water Quality Assessment Reports every two years, summarizing the quality of their waters. (Shipp & Cordy, 2002). This indicator shows of an impairment, other than a fish consumption warning, has been reported in the reservoir. The use of water impairment as an indicator is feasible for this research because the study is interested in the most voluminous water recreation activities such as swimming and boating. If a reservoir is not listed as impaired, visitors should feel safe participating in water-borne recreational activities. When water quality deteriorates, tourists are more likely to reduce their recreational visits, and vice versa (Tienhaara et al., 2021; McKean et al., 2005). Water impairment data was taken from the EPA mandated biannual state water quality inventory, specifically the 303(d) list of impaired waters produced by each state.

Average monthly data from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) Climate Group at Oregon State University was used to collect temperature and precipitation data from 2014 to 2020. Precipitation is recorded in millimeters, while temperature is reported in Fahrenheit. The minimum, maximum, and mean monthly averages for January, as well as July, were used. The effects of temperature are particularly noticeable in the winter months, and as the climate warms, winter recreation is predicted to drop (Melstrom & Vasarhelyi, 2019; Scott & Jones, 2006). In 2016, around 1.8 million Americans went ice fishing and 3.5 million went snowshoeing, according to Climate Central Research Brief (2020).

The distance in miles between the nearest metropolitan area with populations exceeding one million and the reservoir recreational spot was estimated using Google Maps. Distance is predicted to be a major factor in recreational involvement. For day-use visits, most people prefer to drive within 100 miles, and if the distance is greater than 100 miles, most tourists take several trips and camp overnight (Lucas, 1980; Phaneuf & Smith, 2005). The distance between the recreational facility and the nearest urban region was calculated using Google Maps. As a result, it's likely to be negative.

The difference between the flood pool level and the actual level of water for the present period is measured by the water level. Flood pool level, actual water level data was obtained from

USACE, USGS and lakesonline.com. Normal water elevation data was gathered and measured in feet, which is the height of the water at which the reservoir is considered full. This was compered to June 1st water levels of every year for all the sites. Because June 1st is often a period of high water, with levels above normal pool levels, these water levels figures are sometimes negative. In figure.3, a scatter plot of visits verses level reveals that highest visiting occurs near normal water elevation.

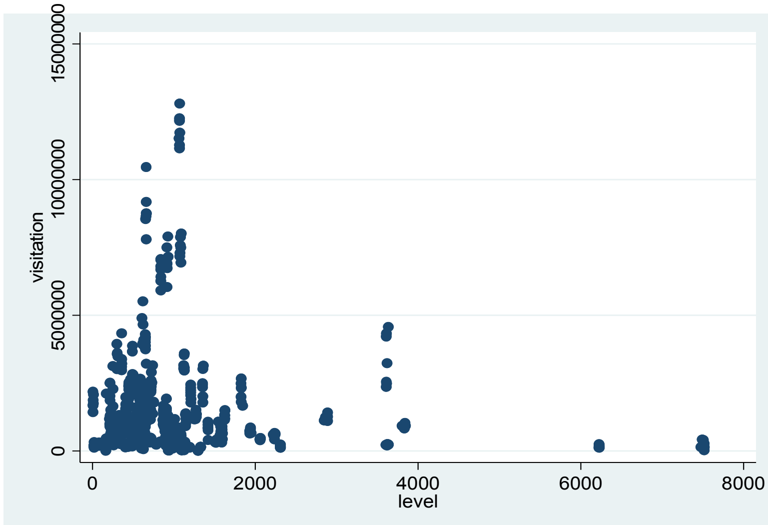

Figure 1: Scatter Plots for Annual Visitation and Water Levels for all Sites

Figure 1 shows the annual visitation and water levels for all 96 reservoirs recreational site in USA, during 2014 to 2020. Levels are measured in feet above sea level. Visitors for most sites are clustered around the time when water levels are at or near normal elevation.

Camping, beaches, boat launches are explanatory variables. The camping variable measures the number electrical campsites, rustic sites, and day-use picnic sites at each project site. Boat launch is the combination of the number of boat ramps and marinas provided as recreational facilities at each site. Camping is normalized by dividing with surface area to obtain "ncampsite" to achieve the number of campsites per 1 acre for each recreational site. Therefore, camping is expected to be positive showing that one additional campsite per acre of surface area would lead to an additional number of visitors per acre for that site. Boat launch facilities are expected to increase visitation significantly.

This study uses secondary data. The NPS annual visitation data was taken from NPS database, and the USACE data was collected from the USACE Visitor Estimation Report (VER) systems. Data for Surface Area was taken from the US National Dams (https://nationaldams.com/index). Counties selected for local population and income were those with county seats within 100 miles of the reservoir. The population data were collected from United States Bureau of Census using the 2020 census count. Proxy for per capita income was Real Gross Domestic product by county which was obtained from United States Bureau of Economic Analysis (USBEA). Temperature and precipitation data were obtained from Parameter-elevation Regressions on Independent Slopes Model (PRISM) dataset from Oregon State University. Data for Boat launch facilities and camping for USACE and NPS sites was taken from the office of the U.S Army Engineer Institute for Water Resources (IWR) and NPS, and Recreation.gov. Water levels, flood pool levels, elevation data was obtained from United States Geological Survey (USGS), and lakeonline.com. There were limitations in collecting data for other management agencies which remained unresolved; therefore, the study would apply to only two agencies, NPS and USACE.

3.3. Estimation Technique and Procedures

After the original Ordinary Least Squares' estimation was conducted, attempts were made to control for multicollinearity and produce a preferred model with higher explanatory power. An estimated model with high standard errors and low **T** statistics is an indicator for multicollinearity, therefore using Variance Inflation factor (VIF), multicollinearity was tested for showing an existence among the multiple regression variables. Income and population were highly correlated as well as the weather variables. The dependent variable, visitation is an integer that is not negative but there were extremely large figures for number of visits as well as small number of visits. Due to the dissimilarities of the visitation data across sites and years, the visitation data was normalized by dividing it by surface area. Therefore, dependent variable is normalized visitation, which is expressed as a ratio of number of visitors and surface area. Our normalized visitation is termed as visit per 1 acre of surface area (n_visitation). Normalizing reduces the impact of multicollinearity, but this may imply that the dependent variable is truncated and therefore, may imply that Tobit model would be the preferred model.

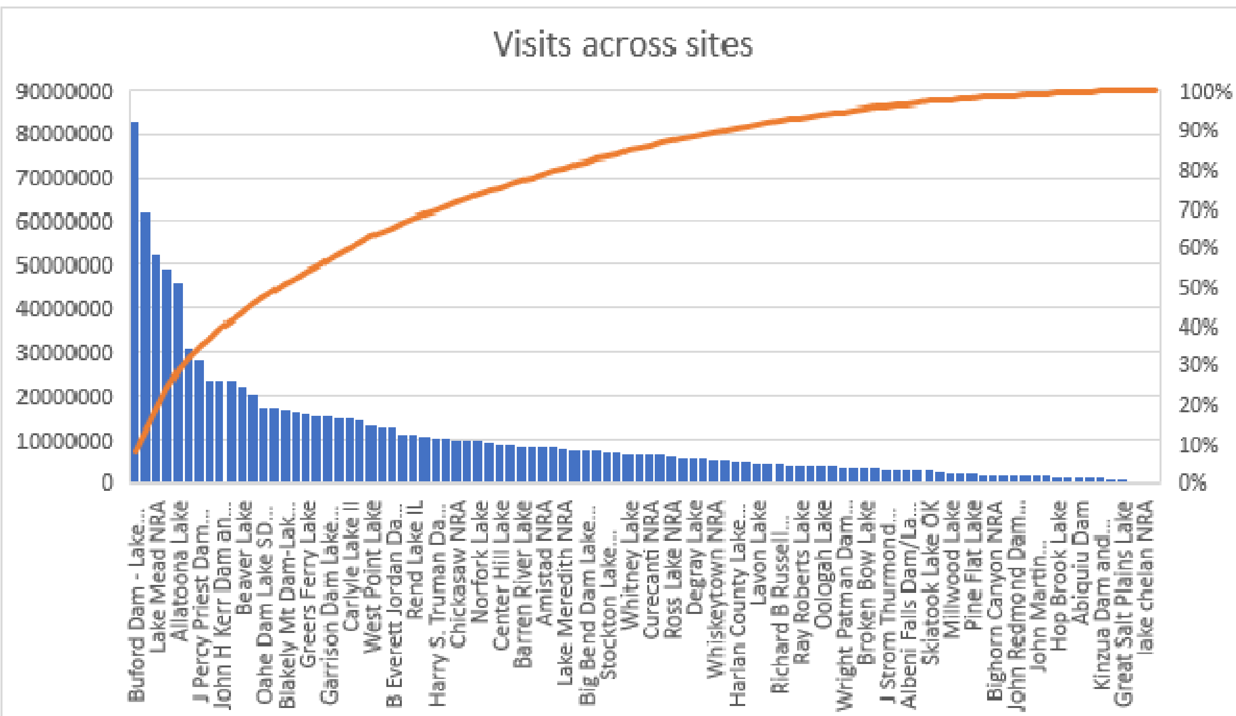

Figure 2: Cumulative Visitation Across all 95 Reservoirs

Figure 2 shows the disparities of number of visits across recreation sites. It shows that the highest number of visits occur at larger and popular reservoirs. It shows the cumulative frequency of visits from the highest to the lowest across all the sampled reservoirs. This could show the institutions that have higher participation in the recreation industry.

3.3.1. Tobit Fixed Effect Model

The asymptotic model to utilize is one with fixed n. This study's preferred model is Tobit regression. Tobit assumes that an unobserved latent variable—a function of the independent variable(s), *x*—links the value of the non-negative dependent variable, *y*, to the values of the independent variables, as below:

$$\mathbf{Y}^* = \mathbf{X}\boldsymbol{\beta} + \mathbf{u} \tag{3.4}$$

Where $\mathbf{Y}^*$ is a *NT* by 1 matrix of values of the latent variable, $\mathbf{X}$ is a *NT* by *K* matrix of independent variable values, $\boldsymbol{\beta}$ is a *K* by 1 vector of parameters to be estimated relating *K* independent variables to $\mathbf{Y}^*$, and $\mathbf{u}$ is a *NT* by 1 vector of normally distributed error terms with mean zero and variance σ_u^2. The analysis adopts the fixed-effect Tobit model. When the independent variable is left or right censored, the Tobit model is used to estimate linear correlations between variables. A regression model is said to be censored when the recorded data on the dependent variable cuts off outside a certain range with multiple observations. Variation in the observed dependent variable will understate the effect of the regressors on the true dependent variable. Ordinary Least Squares (OLS) yields a biased estimator with this type of dependent variable in that it will result in coefficient estimates that are biased toward zero. Predictions after using OLS is negative, showing that in future, there would be negative visitation participation and that is not consistent with recreation demand theory. Example of such situation could corner solutions such as labor force participation, smoking and others (Gajardo, 2009). As a result, the Fixed Effect Tobit model is estimated by Maximum Likelihood Estimates (MLE). The fixed effects are treated as parameters to be estimated and where it is assumed that the error term is independent and identically normally distributed random variables. Predictions after Tobit model shows positive visitation in the future.

The results indicate that, therefore, a mathematical representation of fixed effect Tobit model would be in the form:

$$Y_{it} = \begin{cases} Y_{it}^* & \text{if } Y_{it}^* > 0 \\ 0 & \text{if } Y_{it}^* \leq 0 \end{cases}, \text{ where} \tag{3.5}$$

$$Y_{it}^* = \beta_0 + \delta_1 mgt_i + \sum_{j=1}^{k} \beta_j X_{jit} + \alpha_i + u_{it}, \tag{3.6}$$

where Y_{it} is the observed value of the censored dependent variable at location *i* in year *t*, Y_{it}^* is the value of the unobserved latent variable, β_0 is the intercept, δ_1 is a parameter linking visitation to the reservoir management organization, mgt_i is a dummy variable equal to one if the reservoir manager is USACE and 0 otherwise, $\beta_j = \beta_1, \cdots, \beta_k$ are the effects of *k* explanatory variables on visitation, X_{jit} is the observed value of explanatory variable *j* (*j* = 1 to *k*) specific to each time and location, α_i is a fixed-effect for location *i* to account for unobserved heterogeneity that is constant over time but varies by location, and u_{it} is the error term at reservoir *i* in time *t*. Therefore, the log-likelihood function is:

$$\text{Log L} = \sum_{i,t}(1 - d_{it}) log\emptyset(\frac{-\alpha_i - \beta x_{it}}{\sigma}) + \sum_{i,t} d_{it}\{-\frac{1}{2} log\sigma^2 - \frac{1}{2\sigma^2}(Y_{it} - \alpha_i - \beta x_{it})^2\} \tag{3.7}$$

Unlike the OLS, it is impossible to create estimators in this model that are not functions of the fixed effects of the location identities. This is based on the concept proposed by Heckman and Macurdy (1980). Therefore, this study analyzes the effect the type of management agency on visitation participation using the following multiple regression equation

$$\begin{aligned} nvisitation_{it}^* = \; & \beta_0 + \delta_1 NPS_i + \beta_1 impairement_i + \beta_2 distance_i + \beta_3 population_i \\ & + \beta_4 income_{it} + \beta_5 tempearture_{it} + \beta_6 swimming_i + \beta_7 waterlevel_{it} \\ & + \beta_8 boatlaunch_i + \beta_9 ncampsites_i + \beta_{10} precipiatation_{it} \\ & + \beta_{11} precipitation_{it}^2 + \beta_{12} total\ wealth_{it} + \alpha_i + u_{it} \end{aligned} \tag{3.8}$$

The β_o is the intercept, δ_1 is the parameter estimate for the agency dummy. β_1, β_2..........., β_{12} are the estimation parameters for the other independent variables respectfully.

Campsites was also normalized by dividing by 100 to obtain at least 1 campsite for all reservoirs. The Breusch Pagan test was used to check for heteroskedasticity as it is assumed that the error terms are normally distributed and therefore a robust check is necessary. Location identities was created for all reservoir sites and used the Jarque-Bera test to check for normal distribution among the location identity coefficients. The sampled data had skewness and kurtosis that matched the normal distribution. From equation 8, variables, such as average January maximum temperature, average annual precipitation, county level income and population, recreation site facility information such as boat ramps, marinas and camping were used as control variables for this model.

CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents and discusses the empirical for this study. The section begins with descriptive statistics of the dependent variables and some key explanatory variables considered for the study. In addition, the regression results for Ordinary Least Square (OLS) estimations are presented as well as that of the OLS fixed Effect. Finally, the chapter concludes with the results and discussions of the preferred model, which is the Tobit Fixed Effect model which estimates the effect of reservoir management agency on recreation visitation participation.

4.1. Descriptive Statistics

Table 2 shows that there is a high variability across reservoirs visitation and for all explanatory variables. The total number of observations is 665 with 95 recreational reservoirs, 11 sites for NPS and 84 visit sites for USACE. The data ranges from 2014 to 2020.

Table 2: Descriptive Statistics of Annual Visitation, Environmental and Economic Data for all 95 Reservoirs.

Variable	Obs	Mean	Std. Dev.	Min	Max
visitation	665	1528448	1933701	14130	12803892
income	665	94245	141386	1113	840117
distance	665	161	122	11	670
Surface area	665	69135	151136	9300	1254117
population	665	1794544	2465820	25979	17021660
Water level	665	20	30	-33	155
Jan-maxi-temp	665	45	10	9	68
July-maxi-temp	665	89	56	59	101
Boat launches	665	20	17	0	84
Sunny days	665	217	22	152	290
precipitation	665	1162	480	102	3717
camping	665	343	580	0	5531

4.2. Regression Results for OLS and Fixed Effects Estimates

Table 2 shows the regression results of OLS estimation of three models. This is the initial analysis that shows the relationship between reservoir management and recreation participation. Model 1 uses the annual number of visitors as its dependent variable, "visitation". Visitation is regressed on all explanatory variables. The r-squared for model 1 is 0.55. In model 1, the management agency indicator variable, NPS, shows a positive, highly significant ($p < 0.001$) relation to visitation. This means that NPS sites had higher visitation than the USACE sites, even after controlling for several other explanatory factors. Per capita income was negatively significant which could mean that overall visits are affected by some unknown factor that's negatively correlated with income variable and (probably) that (1) visits by locals are a small proportion of overall visits and (2) locals' decision to visit is income inelastic. Impairment is positively significant at 10% level which shows that 303(d) listed reservoirs are somewhat more likely to be visited. This is not consistent with expectations. It may perhaps be that people aren't fishing to eat, but to fish for commercial, and thus the impairment does not affect the safety of fishing. Also, perhaps most impairments are unrelated to fish consumption warnings. Eutrophication from nutrient pollution, for example, would have no impact. Also, impairments like these don't typically affect the entire reservoir at once, which limits their impact on fish populations.

Swimming is positive and significant. This is consistent with expectations. Temperature which is the maximum temperature for January is highly negatively significant. This may be because much of the nation's reservoirs are in southern states where high summer temperatures might reduce visitation.   Boat launch facilities include both marinas and boat ramps. Additional boat launch facilities increase visitation. Precipitation is negatively related at 10% level.

Population shows a positive significance at 1% meaning that if the surrounding counties increase in population, visitation will increase. Water level had a significant a positive impact on visitation at 10%. Distance to the nearest large metropolitan area is negatively not significant which is consistent with the expectations

Model 2 shows OLS regression estimators with normalized visitation as its dependent variable. Visitation was normalized with respect to reservoir size to reduce multicollinearity. The overall explanatory power of the model is reduced so that the r-squared is 0.26. Significant variables were NPS, per capita income, impairment distance, temperature, boat launch and population. The signs of these variables did not change as compared to model 1.

Model 3 shows results for fixed effect model across locations with an r-squared of about 0.97. In model 3, NPS remains positive and highly significant. Income was not significant. Temperature is positively significant at 5% showing that at higher temperatures imply increased reservoir recreation. Boat launch facilities remain positive and significant for all three models at 1% level. Distance to the nearest large metropolitan area is positively significant at 1% which is consistent with the expectations. Income, impairment, water level precipitation and population remain insignificant in model 3.

Table 3: Regression Results for OLS Estimates (Fixed Effect Model)

	(1) visitation	(2) nvisitation	(3) nvisitation
NPS	1174033.1***	27.96**	65.70***
	(6.43)	(3.20)	(4.06)
Income	-73.65***	-0.00448***	-0.0000197
	(-5.73)	(-7.38)	(-0.07)
Surface Area	-1.175		
	(-1.92)		
impairment	224453.6*	11.64*	1.904
	(2.08)	(2.27)	(1.01)
Distance	-974.6	-0.0795**	0.452**
	(-1.72)	(-2.96)	(3.19)
swimming	184647.8	2.211	-39.73***
	(1.68)	(0.42)	(-4.52)
Water level	4935.8*	-0.100	0.0643
	(2.52)	(-1.07)	(1.01)
Temperature	-21503***	-1.212***	0.484**
	(-3.60)	(-4.24)	(3.11)
Boat launch	68588***	0.877***	2.329***
	(20.81)	(5.57)	(4.80)
ncampsites	41669.9**	-0.584	11.79**
	(2.63)	(-1.26)	(2.89)
precipitation	-276.5*	-0.00203	-0.00159
	(-2.08)	(0.32)	(-0.72)
population	0.161***	0.0000092***	-0.00000199
	(5.99)	(7.16)	(-1.44)
_cons	3704047***	250.4***	-141.7***
Mean value for location effect.			69.49 (26.47)
N	665	665	665
R-squared	0.5488	0.2695	0.9721

Standard Errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The prediction of the dependent variable after running OLS fixed effects and it shows that visitation would be negative for some reservoirs in the future and the past, which is not consistent with recreation participation theory, because the dependent variable must be a non-negative integer. The accuracy of in-sample predictions is important. Some sites between 2014 and 2020 have negative predicted visitation based on the OLS model. The negative predictions occur in

Montana for Ft Perk Dam and Lake. Therefore, the OLS fixed effects is not an adequate model for this analysis.

4.3. Regression Results for Tobit Fixed Effect Model

As established in the estimation technique in chapter 3, the preferred model for this analysis is the Tobit fixed effect model. As seen in the above OLS estimation, visitation becomes negative after prediction, which is not consistent with the theory, but Tobit fixed effect model ensures otherwise. Table 3 shows the regression results for Tobit fixed-effects model. NPS is consistently positively significant at 1% which explains that there are more visits per an acre of surface area to NPS reservoir recreation sites as compared to USACE sites. Distance is positive and at 1% significant level as well as camping. This means that as recreation site is further than 100 miles, visit will increase, and users would choose to camp since there are more visitors with an additional campsite.

Swimming remains negatively significant at 1% and that could probably be that places with lots of boats are less desirable for swimming. Temperature is positive at 1% significance level. Per capita income, impairment, water level, precipitation and population are insignificant variables.

Table 4: Tobit Fixed Effect Regression Results

nvisitation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
NPS	65.701	14.909	4.41	0.000	36.417	94.985	***
Income	-0.001	0.002	-0.07	0.941	-0.001	0.001	
impairment	1.904	1.733	1.10	0.272	-1.499	5.307	
distance	0.452	0.131	3.46	0.000	0.195	0.708	***
swimming	-39.727	8.098	-4.91	0.000	-55.633	-23.821	***
water level	0.064	0.059	1.10	0.273	-0.051	0.180	
Temperature	0.484	0.144	3.37	0.001	0.202	0.766	***
Boat launch	2.329	0.447	5.21	0.000	1.451	3.207	***
ncampsites	11.791	3.76	3.14	0.002	4.406	19.175	***
precipitation	-0.002	0.002	-0.78	0.434	-0.006	0.002	
population	0.001	0.001	-1.56	0.120	0.001	0.001	
Constant	-141.705	40.764	-3.48	0.001	-221.773	-61.637	***
Log likelihood	-2578.029						

Mean dependent var	50.446	SD dependent var	72.812
Pseudo r-squared	0.328	Number of obs	665
Chi-square	2486.567	Prob > chi2	0.000
Akaike crit. (AIC)	5304.504	Bayesian crit. (BIC)	5758.982

**** p<.01, ** p<.05, * p<.1*

CHAPTER 5. SUMMARY AND CONCLUSION

This chapter presents a summary of the findings of this study. The section includes conclusions and policy implications of the impact of reservoir management operations on recreation participation.

Reservoirs were developed for flood control, hydropower, water storage, navigation, recreation, irrigation, and water supply. This multipurpose use of dams implies they have major local, regional, national, and socio-economic implications. When a multipurpose dam reservoir is constructed, it becomes part of a larger system of competing uses (Hadjerioua et al., 2015)

However, as the country's population and affluence have grown, recreation has become more significant, especially as the demand for reservoir recreation has grown (Outdoor Foundation, 2019). Various entities in the United States built reservoirs, including the USACE, the United States USBR, Tennessee Valley Resort (TVA), and others. Most of these agencies provide recreation in some form, and the NPS has taken up recreational projects and reservoir sites from some of these agencies as it transitions to become a recreation developer. Recreation.gov is a nationwide recreation reservation system that is used by all federal entities. These agencies also offer yearly, and lifetime passes for all federal recreation facilities, allowing customers to easily access all reservoir recreation locations.

The purpose of this research was to analyze the effect of reservoir management agency on recreation participation using aggregate data from publicly available national databases. For this study a unique database was developed using annual visitation data for both NPS and USACE obtained from the NPS stats database and USACE Visitor Estimation Report (VER) systems respectfully. The sample covered a period between 2014 to 2020 and included 665 observations.

In estimating the recreation participation function, fixed effect OLS and Tobit Fixed effect-Maximum Likelihood Estimation (MLE) were used. The two methods allowed the inclusion of location fixed effect into the models. The preferred model good for the analysis was the Tobit Fixed Effect model.

In the econometric results, the coefficient of the variable of interest, NPS had the expected positive sign and significant in all the models used as consistent with the theory. The positive sign indicates that all other factors held constant, there is higher recreation participation for NPS reservoir sites as compared to that of USACE reservoir sites. Other significant variables from the outcome of the estimation of the preferred model includes distance, site available for swimming, temperature, availability of boat launches and camp sites. The square of precipitation was added to check for the robustness of the model.

One reason for the significance of the NPS parameter in relation to recreation participation is NPS has been entrusted to manage the most attractive reservoirs for conservation and recreation. Many of these reservoirs have national prominence. Recreation is one of the primary foci of the NPS. Whereas the USACE, which has additional, competing objectives such that recreation is not a top priority objective. Since its founding in 1916, the NPS has managed and encouraged recreation in its parks and monuments. It develops, designs, and builds the necessary buildings and projects, as well as providing educational and interpretive services. Its policies and processes are intended to control and regulate visitor use (Dell & Service, 2016; Press et al., 2007). For example, in the 1970s, South Dakota took up Lake Oahe and handed the recreational facilities and project to its state parks department, believing that its state parks department would do a better job at recreation (Speakman, 2006; Lueck & Winham, 1993). In 1929, the NPS took over the reservoir created by the Boulder Dam, which was the start of the national recreation area for Lake Mead (Press et al., 2007).

In terms of policy implication, national and local policy makers should be open to considering the transfer of management of reservoir sites to alternative agencies which would lead to an improvement in water-based recreation participation. If the society value water-based recreation, the priorities, objectives, and efforts of water-management agencies should be re-weighted toward increasing recreational use. USACE could also adopt recreation development strategies being used by NPS to improve recreation participation should it decide to make recreation a primary objective. One important development is the unified reservation system, recreation.gov. However, this system has been problematic (Repanshek, 2021).

The lack of annual data for all other reservoir management agencies, such as the USBR, Fish and Wildlife Services, TVA, and others, is the study's principal shortcoming. Due to this issue, the research was confined to two agencies: The NPS and the USACE. Also, for both organizations, visitation data might be collected monthly rather than annually to check for seasonal trends throughout all years, and the number of years could be extended to about the last 20 years rather than the current 7. Therefore, future research should be conducted, while most management agencies and reservoir sites should account for the daily number of visitors that may accrue over time and years. It may be possible to review data directly from receation.gov, instead of the management agencies. However, this may be problematic because USACE visitation data available on recreation.gov also includes visitation to nearby non-USACE sites such as state and local parks. From 1940 to the present, NPS had the best data collection to account for visitor involvement on all its sites. On the other hand, the USACE has a visiting record from 2014 to 2020.

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APPENDIX A. SUPPLEMENTAL TABLES

Table A1. Linear Regression

nvisitation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
surfacearea	0	0	-5.03	0	0	0	***
camping	.029	.008	3.50	0	.013	.045	***
distance	-.064	.028	-2.31	.021	-.118	-.01	**
elevation	.002	.003	0.73	.468	-.004	.009	
impairment	8.434	5.111	1.65	.099	-1.603	18.47	*
aveargerealpercapita	-.004	.001	-5.98	0	-.005	-.002	***
population	0	0	6.46	0	0	0	***
swimming	-.524	5.249	-0.10	.921	-10.832	9.784	
waterlevel	-.037	.098	-0.38	.705	-.229	.155	
janmaxitemp	-.87	.399	-2.18	.03	-1.653	-.086	**
julymaxitemp	-.566	.654	-0.87	.387	-1.85	.718	
precipitation	.001	.007	0.08	.938	-.014	.015	
Boatlaunches	.886	.154	5.76	0	.584	1.189	***
Constant	251.322	59.142	4.25	0	135.189	367.455	***
Mean dependent var		50.446	SD dependent var			72.812	
R-squared		0.297	Number of obs			665.000	
F-test		21.151	Prob > F			0.000	
Akaike crit. (AIC)		7382.778	Bayesian crit. (BIC)			7445.775	

**** p<.01, ** p<.05, * p<.1*

Table A2. Matrix of Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) visitation	1.000															
(2) surfacearea	0.091	1.000														
(3) camping	0.223	0.796	1.000													
(4) distance	-0.185	0.199	-0.001	1.000												
(5) elevation	-0.012	0.258	0.333	0.444	1.000											
(6) floodcontrol	-0.084	0.204	0.207	0.457	0.823	1.000										
(7) impairment	0.107	-0.028	0.055	-0.120	-0.037	-0.078	1.000									
(8) aveargerealper~a	-0.276	0.083	-0.089	0.255	0.217	0.211	0.040	1.000								
(9) level	-0.086	0.201	0.205	0.457	0.820	1.000	-0.079	0.212	1.000							
(10) population	0.221	-0.132	-0.066	-0.455	-0.251	-0.281	0.099	0.196	-0.281	1.000						
(11) swimming	0.168	-0.153	-0.068	-0.107	-0.182	-0.094	0.005	-0.191	-0.096	-0.071	1.000					
(12) waterlevel	0.056	0.218	0.172	0.198	0.469	0.431	0.015	0.054	0.409	-0.114	0.051	1.000				
(13) janmaxitemp	0.140	-0.159	-0.022	-0.489	-0.318	-0.262	0.083	-0.340	-0.263	0.281	0.137	-0.064	1.000			
(14) julymaxitemp	0.106	-0.016	0.010	-0.303	-0.250	-0.208	0.139	-0.193	-0.208	0.204	0.003	-0.092	0.707	1.000		
(15) precipitation	0.041	-0.278	-0.170	-0.415	-0.579	-0.470	-0.031	-0.336	-0.466	0.144	0.194	-0.377	0.322	-0.003	1.000	
(16) Boatlaunches	0.663	0.072	0.138	-0.120	-0.176	-0.206	0.055	-0.284	-0.206	0.171	0.180	-0.114	0.180	0.180	0.128	1.000

Table A3. Pairwise Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) visitation	1.000															
(2) surfacearea	0.091	1.000														
(3) camping	0.223	0.796	1.000													
(4) distance	-0.185	0.199	-0.001	1.000												
(5) elevation	-0.012	0.258	0.333	0.444	1.000											
(6) floodcontrol	-0.084	0.204	0.207	0.457	0.823	1.000										
(7) impairment	0.107	-0.028	0.055	-0.120	-0.037	-0.078	1.000									
(8) aveargerealper~a	-0.276	0.083	-0.089	0.255	0.217	0.211	0.040	1.000								
(9) level	-0.086	0.201	0.205	0.457	0.820	1.000	-0.079	0.212	1.000							
(10) population	0.221	-0.132	-0.066	-0.455	-0.251	-0.281	0.099	0.196	-0.281	1.000						
(11) swimming	0.168	-0.153	-0.068	-0.107	-0.182	-0.094	0.005	-0.191	-0.096	-0.071	1.000					
(12) waterlevel	0.056	0.218	0.172	0.198	0.469	0.431	0.015	0.054	0.409	-0.114	0.051	1.000				
(13) janmaxitemp	0.140	-0.159	-0.022	-0.489	-0.318	-0.262	0.083	-0.340	-0.263	0.281	0.137	-0.064	1.000			
(14) julymaxitemp	0.106	-0.016	0.010	-0.303	-0.250	-0.208	0.139	-0.193	-0.208	0.204	0.003	-0.092	0.707	1.000		
(15) precipitation	0.041	-0.278	-0.170	-0.415	-0.579	-0.470	-0.031	-0.336	-0.466	0.144	0.194	-0.377	0.322	-0.003	1.000	
(16) Boatlaunches	0.663	0.072	0.138	-0.120	-0.176	-0.206	0.055	-0.284	-0.206	0.171	0.180	-0.114	0.180	0.180	0.128	1.000

Table A4. Ordinary Least Square Regression

visitation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
surfacearea	-.59	.68	-0.87	.386	-1.924	.745	
camping	383.509	181.493	2.11	.035	27.126	739.892	**
distance	-1387.158	607.04	-2.29	.023	-2579.154	-195.162	**
elevation	220.293	99.472	2.21	.027	24.968	415.618	**
floodcontrol	5432.958	2133.665	2.55	.011	1243.249	9622.666	**
impairment	213743.98	111667.73	1.91	.056	-5529.05	433017.01	*
aveargerealpercapita	-59.52	12.987	-4.58	0	-85.022	-34.018	***
level	-5476.694	2137.417	-2.56	.011	-9673.769	-1279.619	**
population	.137	.027	5.00	0	.083	.19	***
swimming	259288.38	115191.89	2.25	.025	33095.244	485481.52	**
o.waterlevel	0	.	.	.	.	.	
janmaxitemp	-11223.665	8721.88	-1.29	.199	-28350.125	5902.795	
julymaxitemp	-8536.746	14275.182	-0.60	.55	-36567.782	19494.291	
precipitation	-163.869	160.168	-1.02	.307	-478.379	150.64	
Boatlaunches	65989.558	3370.184	19.58	0	59371.796	72607.321	***
Constant	3345492.9	1293594.4	2.59	.01	805364.64	5885621.1	***

Mean dependent var	1528448.699	SD dependent var	1933701.340
R-squared	0.526	Number of obs	665.000
F-test	51.566	Prob > F	0.000
Akaike crit. (AIC)	20671.117	Bayesian crit. (BIC)	20738.613

**** p<.01, ** p<.05, * p<.1*

Table A5. Variance Inflation Factor – Multicollinearity Test 1

	VIF	1/VIF
floodcontrol	2177.315	0
level	2137.353	0
elevation	4.793	.209
camping	4.073	.245
surfacearea	3.871	.258
janmaxitemp	3.062	.327
julymaxitemp	2.605	.384
precipitation	2.173	.46
distance	2.045	.489
aveargerealpercapita	1.678	.596
population	1.67	.599
Boatlaunches	1.279	.782
swimming	1.203	.832
impairment	1.068	.936
Mean VIF	310.299	.

Table A6. Variance Inflation Factor - Multicollinearity Test 2

	VIF	1/VIF
camping	4.028	.248
surfacearea	3.847	.26
janmaxitemp	3.053	.328
julymaxitemp	2.603	.384
elevation	2.519	.397
precipitation	2.162	.463
distance	2.015	.496
aveargerealpercapita	1.673	.598
population	1.663	.601
waterlevel	1.482	.675
Boatlaunches	1.271	.787
swimming	1.189	.841
impairment	1.065	.939
Mean VIF	2.198	.

Table A7. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
id	665	48	27.443	1	95
year	665	2017	2.002	2014	2020
visitation	665	1528448.7	1933701.3	14130	12803892
surfacearea	665	69135.547	151136.67	9300	1254117
acemarina	665	.095	.358	0	2
aceboat	665	8.526	7.589	0	45
camping	665	342.726	580.555	0	5531
comfortindex	665	7.176	.312	6.2	7.8
distance	665	161.526	122.974	11	670
elevation	665	1086.484	1149.069	203	7703
floodcontrol	665	1044.586	1141.72	16.28	7519.4
impairment	665	.37	.483	0	1
aveargerealpercapita	665	38676.03	5207.649	30650.939	61405.02
income	665	94245.129	141386.3	1113.6	840117
janlow	665	24.365	9.271	-3.9	39
julyhigh	665	90.023	4.222	77	102.5
level	665	1024.436	1129.209	6.74	7517.76
otherlaunchboat	665	7.895	10.033	0	48
othermarina	665	3.232	4.017	0	24
population	665	1794544	2465819.7	25979	17021660
sunnydays	665	216.832	22.474	152	290
swimming	665	.558	.497	0	1
waterlevel	665	20.15	29.8	-32.65	155.3
marinas	665	3.326	4.111	0	24
boatlaunches	665	16.421	14.59	0	79
janmintemp	665	24.387	9.78	-14.08	47.66
janmeantemp	665	34.868	9.902	-2.74	57.2
janmaxitemp	665	45.352	10.474	8.6	67.82
julymintemp	665	66.731	7.151	46.04	76.46
julymeantemp	665	77.791	6.252	52.7	88.34
julymaxitemp	665	88.849	5.903	59.36	100.76
nvisitation	665	50.446	72.812	.03	588.7
ncampsites	665	3.432	5.803	0	55.31
precipitation	665	1162.246	480.455	102.23	3716.6
Boatlaunches	665	19.747	17.519	0	84
totalwealth	665	7.192e+10	1.217e+11	1.006e+09	1.045e+12
state1	665	17.853	9.59	1	33
project1	665	48	27.443	1	95
NPS	665	.116	.32	0	1
USACE	665	.884	.32	0	1

Table A8. Tobit Regression

nvisitation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
NPS	65.701	14.909	4.41	0	36.417	94.985	***
aveargerealpercapita	0	0	0.07	.941	-.001	.001	
impairment	1.904	1.733	1.10	.272	-1.499	5.307	
distance	.452	.131	3.46	.001	.195	.708	***
swimming	-39.727	8.098	-4.91	0	-55.633	-23.821	***
waterlevel	.064	.059	1.10	.273	-.051	.18	
janmaxitemp	.484	.144	3.37	.001	.202	.766	***
Boatlaunches	2.329	.447	5.21	0	1.451	3.207	***
ncampsites	11.791	3.76	3.14	.002	4.406	19.175	***
precipitation	-.002	.002	-0.78	.434	-.006	.002	
population	0	0	-1.56	.12	0	0	
1b.id	0	.	.	.	.	.	
2.id	-68.011	19.332	-3.52	0	-105.983	-30.04	***
3.id	539.535	8.981	60.07	0	521.894	557.176	***
4.id	-11.175	7.484	-1.49	.136	-25.874	3.525	
5.id	118.888	28.101	4.23	0	63.693	174.084	***
6.id	210.041	26.52	7.92	0	157.952	262.13	***
7.id	1.296	12.994	0.10	.921	-24.227	26.819	
8.id	118.655	8.806	13.47	0	101.359	135.951	***
9.id	3.574	8.854	0.40	.687	-13.817	20.965	
10.id	23.7	21.821	1.09	.278	-19.16	66.56	
11.id	102.498	20.055	5.11	0	63.107	141.889	***
12.id	-39.032	17.189	-2.27	.024	-72.795	-5.27	**
13.id	-153.721	46.291	-3.32	.001	-244.645	-62.797	***
14.id	-4.997	12.434	-0.40	.688	-29.419	19.425	
15.id	62.236	11.005	5.66	0	40.621	83.851	***
16.id	165.73	18.122	9.15	0	130.136	201.325	***
17.id	-73.098	19.42	-3.76	0	-111.242	-34.954	***
18.id	52.183	11.078	4.71	0	30.424	73.941	***
19.id	152.169	19.728	7.71	0	113.419	190.919	***
20.id	68.385	8.213	8.33	0	52.253	84.517	***
21.id	97.336	13.155	7.40	0	71.498	123.174	***
22.id	119.826	24.806	4.83	0	71.103	168.549	***
23.id	25.574	10.517	2.43	.015	4.918	46.23	**
24.id	-187.593	54.621	-3.43	.001	-294.877	-80.309	***
25.id	12.625	8.149	1.55	.122	-3.381	28.63	
26.id	18.284	10.778	1.70	.09	-2.886	39.453	*
27.id	-90.362	28.074	-3.22	.001	-145.504	-35.22	***
28.id	10.775	12.561	0.86	.391	-13.897	35.446	
29.id	90.697	18.953	4.79	0	53.47	127.924	***
30.id	-64.945	15.753	-4.12	0	-95.886	-34.004	***
31.id	101.883	22.334	4.56	0	58.015	145.751	***
32.id	217.114	23.281	9.33	0	171.387	262.842	***
33.id	-.311	7.577	-0.04	.967	-15.193	14.571	
34.id	97.391	15.179	6.42	0	67.577	127.205	***
35.id	-244.267	64.477	-3.79	0	-370.912	-117.623	***
36.id	-134.801	33.075	-4.08	0	-199.766	-69.836	***
37.id	-191.37	51.746	-3.70	0	-293.007	-89.733	***
38.id	35.879	13.224	2.71	.007	9.905	61.852	***
39.id	-768.44	222.425	-3.45	.001	-1205.319	-331.561	***

Table A8. Tobit Regression (continued)

nvisitation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
40.id	85.569	19.358	4.42	0	47.547	123.592	***
41.id	-36.365	25.746	-1.41	.158	-86.934	14.205	
42.id	86.95	18.051	4.82	0	51.494	122.405	***
43.id	123.197	24.95	4.94	0	74.192	172.203	***
44.id	-19.256	19.035	-1.01	.312	-56.644	18.132	
45.id	-36.726	14.486	-2.54	.012	-65.178	-8.274	**
46.id	23.573	25.03	0.94	.347	-25.59	72.737	
47.id	158.536	33.297	4.76	0	93.136	223.936	***
48.id	50.843	14.758	3.45	.001	21.856	79.83	***
49.id	317.894	17.508	18.16	0	283.505	352.283	***
50.id	-83.55	17.035	-4.90	0	-117.008	-50.091	***
51.id	57.775	10.351	5.58	0	37.444	78.106	***
52.id	9.282	6.361	1.46	.145	-3.212	21.775	
53.id	78.687	18.476	4.26	0	42.396	114.977	***
54.id	51.045	12.439	4.10	0	26.612	75.477	***
55.id	117.812	18.429	6.39	0	81.614	154.011	***
56.id	-3.416	10.87	-0.31	.753	-24.766	17.933	
57.id	-50.066	22.597	-2.22	.027	-94.449	-5.682	**
58.id	-16.687	14.368	-1.16	.246	-44.909	11.535	
59.id	-28.018	15.804	-1.77	.077	-59.06	3.024	*
60.id	-89.418	21.94	-4.08	0	-132.511	-46.326	***
61.id	144.746	8.566	16.90	0	127.921	161.571	***
62.id	80.986	17.786	4.55	0	46.05	115.921	***
63.id	155.064	14.528	10.67	0	126.529	183.599	***
64.id	-58.002	16.67	-3.48	.001	-90.744	-25.26	***
65.id	-76.962	32.591	-2.36	.019	-140.975	-12.949	**
66.id	-25.865	6.557	-3.94	0	-38.743	-12.986	***
67.id	160.748	18.699	8.60	0	124.02	197.476	***
68.id	37.822	7.97	4.75	0	22.168	53.477	***
69.id	-163.634	35.305	-4.63	0	-232.979	-94.289	***
70.id	63.081	12.596	5.01	0	38.341	87.82	***
71.id	87.516	22.935	3.82	0	42.468	132.565	***
72.id	59.344	14.265	4.16	0	31.325	87.363	***
73.id	93.158	17.032	5.47	0	59.704	126.611	***
74.id	121.872	12.352	9.87	0	97.61	146.134	***
75.id	26.785	11.927	2.25	.025	3.359	50.21	**
76.id	108.683	13.412	8.10	0	82.339	135.026	***
77.id	8.41	6.661	1.26	.207	-4.673	21.493	
78.id	51.671	14.285	3.62	0	23.613	79.728	***
79.id	151.036	30.474	4.96	0	91.181	210.892	***
80.id	67.819	12.417	5.46	0	43.429	92.208	***
81.id	25.779	7.679	3.36	.001	10.697	40.862	***
82.id	73.634	16.658	4.42	0	40.914	106.354	***
83.id	45.102	7.986	5.65	0	29.417	60.787	***
84.id	58.301	14.469	4.03	0	29.881	86.721	***
85.id	80.683	20.717	3.89	0	39.99	121.375	***
86.id	4.892	6.653	0.74	.462	-8.176	17.961	
87.id	40.543	12.256	3.31	.001	16.471	64.616	***
88.id	42.756	5.829	7.34	0	31.307	54.204	***
89.id	-19.243	7.342	-2.62	.009	-33.663	-4.822	***
90o.id	0	.	.	.	.	.	
91o.id	0	.	.	.	.	.	

Table A8. Tobit Regression (continued)

nvisitation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
92o.id	0	.	.	.	.	.	
93o.id	0	.	.	.	.	.	
94o.id	0	.	.	.	.	.	
95o.id	0	.	.	.	.	.	
Constant	-141.705	40.764	-3.48	.001	-221.773	-61.637	***
var(e.nvisitation)	125.846	6.902	.b	.b	112.995	140.159	
Mean dependent var		50.446	SD dependent var			72.812	
Pseudo r-squared		0.328	Number of obs			665.000	
Chi-square		2486.567	Prob > chi2			0.000	
Akaike crit. (AIC)		5304.504	Bayesian crit. (BIC)			5758.982	

*** *p<.01, *** *p<.05, * p<.1*

APPENDIX B. STATA OUTPUT: RESULTS OF ALL TESTS

	(1) visitation	(2) nvisitation	(3) nvisitation
NPS	1174033.1***	27.96**	65.70***
	(6.43)	(3.20)	(4.06)
surfacearea	-1.175		
	(-1.92)		
aveargerea~a	-73.65***	-0.00448***	0.0000197
	(-5.73)	(-7.38)	(0.07)
impairment	224453.6*	11.64*	1.904
	(2.08)	(2.27)	(1.01)
distance	-974.6	-0.0795**	0.452**
	(-1.72)	(-2.96)	(3.19)
swimming	184647.8	2.211	-39.73***
	(1.68)	(0.42)	(-4.52)
waterlevel	4935.8*	-0.100	0.0643
	(2.52)	(-1.07)	(1.01)
janmaxitemp	-21503.0***	-1.212***	0.484**
	(-3.60)	(-4.24)	(3.11)
Boatlaunches	68588.0***	0.877***	2.329***
	(20.81)	(5.57)	(4.80)
ncampsites	41669.9**	-0.584	11.79**
	(2.63)	(-1.26)	(2.89)
precipitat~n	-276.5*	0.00203	-0.00159
	(-2.08)	(0.32)	(-0.72)
population	0.161***	0.00000920***	-0.00000199
	(5.99)	(7.16)	(-1.44)
1.id			0
			(.)
2.id			-68.01**
			(-3.24)
3.id			539.5***
			(55.37)
4.id			-11.17
			(-1.38)

5.id	118.9***
	(3.90)
6.id	210.0***
	(7.30)
7.id	1.296
	(0.09)
8.id	118.7***
	(12.42)
9.id	3.574
	(0.37)
10.id	23.70
	(1.00)
11.id	102.5***
	(4.71)
12.id	-39.03*
	(-2.09)
13.id	-153.7**
	(-3.06)
14.id	-4.997
	(-0.37)
15.id	62.24***
	(5.21)
16.id	165.7***
	(8.43)
17.id	-73.10***
	(-3.47)
18.id	52.18***
	(4.34)
19.id	152.2***
	(7.11)
20.id	68.38***
	(7.67)
21.id	97.34***
	(6.82)
22.id	119.8***
	(4.45)

23.id	25.57*
	(2.24)
24.id	-187.6**
	(-3.17)
25.id	12.62
	(1.43)
26.id	18.28
	(1.56)
27.id	-90.36**
	(-2.97)
28.id	10.77
	(0.79)
29.id	90.70***
	(4.41)
30.id	-64.94***
	(-3.80)
31.id	101.9***
	(4.20)
32.id	217.1***
	(8.60)
33.id	-0.311
	(-0.04)
34.id	97.39***
	(5.91)
35.id	-244.3***
	(-3.49)
36.id	-134.8***
	(-3.76)
37.id	-191.4***
	(-3.41)
38.id	35.88*
	(2.50)
39.id	-768.4**
	(-3.18)
40.id	85.57***
	(4.07)

41.id	-36.36 (-1.30)
42.id	86.95*** (4.44)
43.id	123.2*** (4.55)
44.id	-19.26 (-0.93)
45.id	-36.73* (-2.34)
46.id	23.57 (0.87)
47.id	158.5*** (4.39)
48.id	50.84** (3.18)
49.id	317.9*** (16.74)
50.id	-83.55*** (-4.52)
51.id	57.78*** (5.14)
52.id	9.282 (1.35)
53.id	78.69*** (3.93)
54.id	51.04*** (3.78)
55.id	117.8*** (5.89)
56.id	-3.416 (-0.29)
57.id	-50.07* (-2.04)
58.id	-16.69 (-1.07)

59.id	-28.02
	(-1.63)
60.id	-89.42***
	(-3.76)
61.id	144.7***
	(15.58)
62.id	80.99***
	(4.20)
63.id	155.1***
	(9.84)
64.id	-58.00**
	(-3.21)
65.id	-76.96*
	(-2.18)
66.id	-25.86***
	(-3.64)
67.id	160.7***
	(7.92)
68.id	37.82***
	(4.37)
69.id	-163.6***
	(-4.27)
70.id	63.08***
	(4.62)
71.id	87.52***
	(3.52)
72.id	59.34***
	(3.83)
73.id	93.16***
	(5.04)
74.id	121.9***
	(9.09)
75.id	26.78*
	(2.07)
76.id	108.7***
	(7.47)

77.id	8.410
	(1.16)
78.id	51.67***
	(3.33)
79.id	151.0***
	(4.57)
80.id	67.82***
	(5.03)
81.id	25.78**
	(3.09)
82.id	73.63***
	(4.07)
83.id	45.10***
	(5.21)
84.id	58.30***
	(3.71)
85.id	80.68***
	(3.59)
86.id	4.892
	(0.68)
87.id	40.54**
	(3.05)
88.id	42.76***
	(6.76)
89.id	-19.24*
	(-2.42)
90.id	0
	(.)
91.id	0
	(.)
92.id	0
	(.)
93.id	0
	(.)
94.id	0
	(.)

95.id			0
			(.)
_cons	3704047.0***	250.4***	-141.7**
	(5.47)	(7.79)	(-3.20)
N	665	665	665

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001