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Estimating Recreational User Day Value and Impacts of Congestion and Water Quality: Application to Salt Ponds, Rhode Island

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ESTIMATING RECREATIONAL USER DAY VALUE AND IMPACTS OF CONGESTION AND WATER QUALITY: APPLICATION TO SALT PONDS, RHODE ISLAND

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Abstract

The objective of this study is to estimate values associated with recreation in three Rhode Island salt ponds: Ninigret, Quanochontaug and Point Judith pond. The study estimates values per recreation day, as well as changes in values associated with changes in water quality and congestion.

First the study applies the Travel Cost Method to estimate the user-day value for recreation in Rhode Island salt ponds, based on an on-site survey. The study then applies the Conjoint stated preference approach to estimate changes in recreational values associated with changes in water quality and congestion at the recreation sites. Next the study provides a more robust estimation of the opportunity cost of time spent to traveling to visit the salt ponds by calibrating the opportunity cost of time used in Travel Cost Method using stated preference regarding travel distance obtained from responses to the Conjoint Analysis

The data were collected by administering a survey of visitors at coastal salt ponds, in Rhode Island during July and August of 2015. The survey included questions about the travel related information, followed by a series of choice questions that asked the respondents to select the most preferred site from 3 hypothetical sites described in terms of different levels of water quality, congestion, parking lot size, travel distance and entrance fee. A total of 309 visitors responded to the survey, of which 287 completed the entire survey.

The study estimates the value per recreational user day to be approximately $17. It also estimates a total of approximately 161,576 visits at the three salt ponds during July and

August. Applying these results, the annual recreational value of the three salt ponds is estimated to be approximately $2.8 million for the month of July and August.

Water quality is currently rated as fair in the three Salt Ponds. Conjoint Analysis Stated Preference Method estimates a Willingness To Pay (WTP) of $17 to avoid poor water quality, WTP of $29 to improve water quality to good from fair, and an additional WTP of $12 from good to excellent. Stated Preference Conjoint results estimate that recreational users are willing to pay $23 per user-day to avoid sites becoming over-congested. The incremental willingness to pay to reduce congestion below the status quo level is not statistically significant.

The opportunity cost of time is generally specified to be a fraction of the wage rate. However, there is no consensus in the literature on the proper fraction to use, with studies generally using between 25% to 100% of the wage. We follow this literature in the travel cost model of chapter 3 by using an opportunity cost of time one third of the wage rate. We use the Conjoint Analysis results to calibrate the proper opportunity cost of time, and find it is approximately 15% of the hourly wage, which is closer to the lower bound of existing guiding lines. Using an opportunity cost of time that ranges from 15% to 33% of the hourly wage results in a user-day value that ranges from $13.77 to $17.42, and a total annual recreational use value that ranges from $2.2 million to $2.8 million for the three salt ponds during July and August.

The study uses the results discussed above to provide a perspective on the recreational benefits of water quality improvements, relative to the costs of upgrading septic systems to include nitrate reduction, which is a key action to improve water quality in the salt ponds. The study uses a range of estimate of $2,000 to $15,000 for the incremental cost of adding nitrogen removal at the time new septic system is installed.

We estimate a total of approximately 5,700 visits per day for peak months of July and August to the three Rhode Island salt ponds and a total of 161,576 visits for the two months. We assume that the total visitors of the rest ten months are equal to the visitor number of the two peak months. Applying the value per user-day to avoid to poor quality implies a total recreational value of approximately $5.4 million to avoid deterioration of water quality from fair to poor, and $9.4 million for improving water quality from fair to good. Thus, recreational benefits of water quality improvements are substantial relative to costs of actions to improve water quality.

It is important to note that this is not intended to be a full cost benefit analysis for several reasons. First, we include only estimated benefits to recreational users, and not other benefits, such as ecological effects or aesthetic benefits to nearby residents. Second, we do not provide an estimate of the actual water quality improvement that would result from requiring upgrades in septic systems. Doing so requires an analysis of how reduced nitrogen loads from residential septic in the area would impact water quality in the salt ponds.

In summary, this study finds that recreational activities in Rhode Island salt ponds are highly valued, and that recreational values are quite sensitive to levels of water quality and congestion. These results suggest that efforts to protect and manage the Rhode Island salt ponds can provide significant benefits to the public. We find that recreational values alone might provide a strong rationale for actions to protect and improve quality of Rhode Island salt ponds. This rationale is reinforced by other values that are outside the scope of this study, such as ecological and aesthetic values for water quality improvement.

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First of all, I would like to thank my advisor, James.J.Opaluch. This work could not have been realized without his guidance on both the professional and human level along these years. His advice on academics and life as a doctoral student has been an essential nourishment for me to grow up and reach a higher level. His kindness and patience helped me adapt to and flourish in the new environment.

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Chapter Four

Chapter One. Introduction

The objective of this study is to estimate the user-day value and changes in recreational values associated with water quality and congestion to recreational users of Rhode Island Salt Ponds. To do so, the study applies both a revealed preference travel cost analysis and a stated preference conjoint Analysis. We aim to determine a more robust estimation on the opportunity cost of time spent to visit the Salt Ponds. In order to do, we calibrate the controversial opportunity cost of time used in travel cost method using Marginal Willingness To Pay for travel distance in Conjoint Analysis Method. Lastly, we provide a perspective on the estimated benefits of recreational values associated water quality relative to the cost of actions to improve it.

Rhode Island has nine coastal lagoons along the southern coast bordering Block Island Sound and the southwest of Narragansett Bay (Scott & Moran, 2001; Salt Ponds Watershed). Salt Ponds are a nursery ground and reproductive area for fish and migrating birds. Salt pond are also highly valued recreational sites to local residents and out-of-state recreationists (Fugate, 1999; Torello & Callender, 2013).

The Salt Ponds are experiencing major water quality problems from extensive development in the vicinity primarily due to bacteria and nutrients from septic systems and pets, as well as nutrients from lawn fertilizer (Torello & Smith, 2013; Ely & Argentieri, 2002).

In response, The Salt Pond Coalition was formed in 1985 to protect Salt Ponds with the goals of providing policy makers with scientific information, reducing and reversing water quality degradation, and restoring lost subaquatic vegetation that serves as critical habitat for fish and shellfish (Torello & Callender, 2013; Ely & Argentieri, 2002).

Resultant improvements in quality of salt ponds will be beneficial to various uses, including recreation. However, there is little known about the value that visitors put on a visit to the Salt Ponds, or on improvements of water quality, since the value of these natural resources are not readily priced as in established markets (Hotelling, 1949; Clawson & Knetsch, 1969; Freeman, Herriges, & Kling, 2014).

Chapter 2 presents a descriptive overview of the coastal salt ponds including physical attributes, and identification of the primary environmental issues which results from water quality degradation due to excessive nitrogen input primarily from individual septic systems that do not have nitrogen abatement systems.

Chapter 3 applies the zonal travel cost method to estimates the demand for recreation activity, where the cost of travel to the site plays a role of price, and the quantity demanded is the number of trips taken by the users (Lupi, 2005; Bateman, 1993; Parsons, 2003) The user-day value (consumer surplus) is estimated from demand function and consumer surplus is obtained from the estimated demand function by standard methods (Lupi, 2005; Freeman et al., 2014; Parsons, 2003).). Consumer surplus is the estimate of the net benefit of recreationists, above and beyond the cost of participating (Freeman et al., 2014). Then we employed this consumer surplus per visit to estimate the total consumer surplus for all trips to the Salt Ponds using the observed number of visitors during the peak season of July and August. Total participation during the peak season was estimated using the results of the Salt Pond recreation activity study (Patrolia et al., 2016).

Chapter 4 applies conjoint stated preference method to estimate values associated with improvements in water quality and changes in congestion at salt pond recreation sites. Conjoint Analysis is a survey-based approach that presents a set of hypothetical commodities to respondents in terms of their attributes, and asks respondents to select the most preferred alternative among the set. Statistical methods are then applied to estimate the relative importance of each attribute to respondents. If cost is included as an attribute, the conjoint method can be used to quantify the value of attributes in monetary terms. Within the context of this study conjoint analysis was used to estimate the impacts of water quality and congestion to the user day value for recreation. Conjoint Analysis was applied by constructing hypothetical scenarios on the attributes of Salt Ponds with associated to quality change (Adamowicz, Louviere, & Williams, 1994; Dumas, Schuhmann, & Whitehead, 2005) and respondents were asked to select their most preferred scenario.

Chapter 5 uses the Marginal Willingness to Pay obtained from conjoint analysis to calibrate the opportunity cost of time in travel cost method. The travel cost approach estimates demand for a nonmarket recreational experience using the opportunity cost of time, an important element in the travel cost models, and the proper specification for opportunity cost of time has been controversial in travel cost method. In travel cost method, the cost of travel to the Salt Ponds played a role of the "price" of participating in recreational activity. This cost includes both out-of-pocket cost of gasoline & maintenance and the opportunity cost of time spent to travel to the site. Conjoint Analysis also provides the value of the opportunity cost of time in the model including the travel distance and entrance fee. Respondents' choice among alternatives was used to infer tradeoffs among the attributes, and hence estimate the Willingness to Pay for reduced travel distance.

With the estimated Willingness To Pay and Total Willingness To pay on a stated change in water quality in conjoint analysis method, we provide perspective on the size of the recreational benefits on water quality improvements, relative to the costs of actions to improve water quality. For example, we compare the recreational value associated with water quality improvements to the estimates of the incremental cost of Onsite Wastewater Treatment System (OWTS) in critical resource areas of the Rhode Island salt ponds.

The data for our analysis were collected by administering a survey of visitors on the Coastal Salt Ponds, Rhode Island during July and August 2015. The survey asked questions about the travel-related information, such as the distance and time spent travelling to the salt pond, their frequency of visit, zip code form which their trip originated. Each survey respondent was also presented with four choice questions that asked the respondent to select the most preferred site from among 3 hypothetical scenarios that described site with different levels of water quality, congestion, parking lot size, travel distance and entrance fees . Finally, the survey also asked socio-demographic questions, such as age, income, education level, and gender.

A total of 309 visitors responded to the survey, of which 287 completed the entire survey. Of the 309 respondents, 279(90%) respondents were Rhode Island residents, and 21(7%) from Connecticut, 8 (3%) from Massachusetts and 1 respondent was from New York (< 1%).

The estimated consumer surplus for visiting salt ponds in Rhode Island using zonal travel cost method suggests that recreation in Rhode Island Salt Ponds holds a high value for participants. More importantly, we find that recreational values appear to be highly sensitive to changes in water quality. The calibrated opportunity cost of time using TCM and conjoint analysis method holds a lower hourly wage rate than that widely used in recreation demand literature.

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Chapter Two. Salt Ponds Background

The south shore of Rhode Island has nine coastal lagoons- Pint Judith, Potter Pond, Card's Pond, Trustom Pond, Green Hill Pond, Ninigret Pond, Quonochontaug Pond, Winnapaug Pond, Maschug Pond, and Watch Hill and cross four towns - Narragansett, Charles Town, Westerly and South Kingstown with the area varying from 40 acres to over 1,700 acres (Scott & Moran, 2001; Salt Ponds Watershed). The salt ponds extending along the southern coast of Rhode Island, bordering Block Island Sound and the southwest part of Narragansett Bay provide scenic vistas, habitat and many recreational opportunities (Scott & Moran, 2001; Salt Ponds Watershed). Figure 2.1 presents the study area in the Salt Ponds, Rhode Island.

[Figure 2.1 about here]

Coastal Salt Pond Lagoons in Rhode Island were formed after the retreat of the Laurentide Ice Sheet at the end of the last glaciation Fugate, 1999; Imperial, 1999; Torello & Smith, 2013; Torello & Callender, 2013). With wind, waves, and time, glacial deposits were eroded and fell apart from the headland parallel to the shoreline. Eventually the spits completely connected the headlands, isolating the coastal lagoons behind them from the ocean except for narrow inlets which ocean tides flowed Fugate, 1999; Torello & Smith, 2013; Torello & Callender, 2013). The Rhode Island salt ponds are relatively small (1~8 $*10^6$ m^2), shallow (average depth 1-2m), and characterized by brackish water with salinity 23-30psu (Scott and Moran, 2001). Table 2.1 presents the attributes of Salt Ponds.

[Table 2.1. about here]

Although plants and animals in the Salt Ponds can vary depending on the salinity of the water, Salt ponds have been productive habitat for diverse wildlife such as shorebirds, fish, shellfish and aquatic vegetation as well as a reproductive and nursery grounds for fish, and migrating birds including waterfowl, Canada goose, and great blue heron (Fugate, 1999; Torello & Callender, 2013). In addition to providing a productive habitat, Salt Ponds have provided highly valued amenity and recreational service to local residents and out-of-state recreationists enjoying wind surfing, sailing, kayaking, paddling, boating, canoeing, fishing/shell fishing, swimming thanks to its water quality coming from the exchange of stationary pond waters with clean sea water and tide coming from the ocean through the breach way where wave provides better condition for water sports activity as well as relative shallowness giving people the sense of security (Fugate, 1999; Torello & Smith, 2013). Salt Ponds attracted more than 165,000 recreationists a day in the summer months in the past serving as a lifeline of local economy (Torello & Callender, 2013; Ely & Argentieri, 2002; Salt Ponds Watershed).

However, due to the population growth from the rapid residential & commercial development around the Salt Ponds, nitrate from lawn fertilizer and bacteria from septic systems and animal waste overloaded the salt ponds through surface runoff and ground water causing nutrient enrichment. (Ely & Argentieri, 2002; Torello & Smith, 2013). For example, Ninigret pond, Green Hill pond, Quonochontaug pond had showed consistent downward trend of water quality from excellent/good to good/fair water quality (Ely &

Argentieri, 2002; Torello & Smith, 2013; Lee, V, 1980; Lee,v, Ernst, L, & Marino, 1997). Winnapaug, Point Judith, and Potter ponds have also shown decreasing trend of aquatic vegetation biomass in the range of 5% at least to 34% at maximum (Salt Ponds Watershed; Nixson & Buckley, 2007; Fugate, 1999; Imperial, 1999). Also, threats like excessive algal bloom and viruses and bacteria carried in human feces have resulted in permanent shellfish closures in upper Point Judith Pond, eastern part of Ninigret pond and all Green Hill Pond (Ely & Argentieri, 2002).

The Salt Pond Coalition (previously Salt Pond Watchers) was formed in 1985 to protect Salt Ponds from further degradation and reverse the downward trend of water quality and decreasing amount of aquatic vegetation. The Salt Pond Coalition has monitored water quality, bacteria levels and contaminants and provided policy makers with scientific data to improve the ecosystem and environment of Salt Ponds in Rhode Island (Torello & Callender, 2013; Ely & Argentieri, 2002). A Special Area Management Plan (SAMP) was carried out by Coastal Resources Management Council (CRMC) as watershed management guide such as land-use regulations, nitrogen removal technologies, and nonpoint source pollution controls (Ely & Argentieri, 2002; Torello & Smith, 2013; Imperial, 1999; Hennessey & Imperial, 2000).

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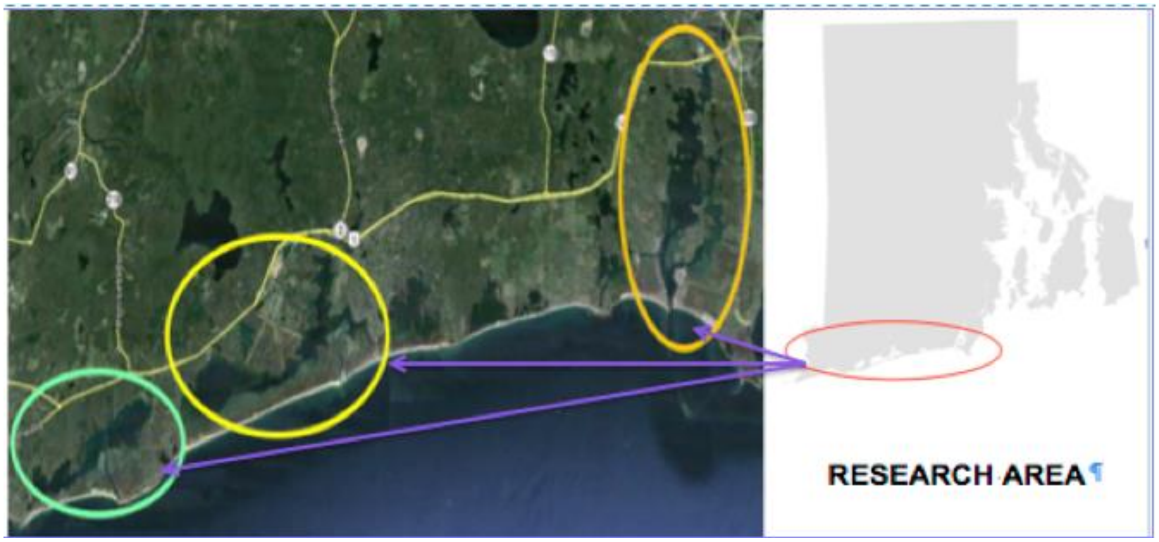
Tables and Figures

Figure 2. 1. Rhode Island Coastal Salt Ponds



Notes: Figure shows the Coastal Salt Ponds. Circled areas are study area from left to right: Quonochontaug, Ninigret, Point Judith Pond.

Table 2. 1. Physical Attribute of Coastal Salt Ponds in Rhode Island

Salt Pond	Area (acres)	Ave. Depth (ft.)	Ave. Salinity (ppt)	Watershed (acres)	Groundwater Volume (m^3/yr)
Pt. Judith	1,530	6	29	3,536	2.5×10^7
Potter	329	2	27	3,311	5.0×10^6
Cards	43	1.5	4	1,820	2.2×10^6
Trustom	169	1.5	5	794	1.1×10^6
Green Hill	431	2.5	19	3,039	6.8×10^6
Ninigret	1,711	4	24	6,025	1.5×10^7
Quonochontaug	732	6	29	2,307	*
Winnapaug	446	5	28	2,294	*
Maschaug	49	7	7	347	0

Sources: CRMC, 1999; Lee, 1980

Chapter Three. Travel Cost Method

3.1. Introduction

The objective of this chapter is to estimate a user-day value of Salt Ponds, Rhode Island using Zonal Travel Cost Approach. Coastal Salt Ponds are important resources, but little is known about the value that visitors and recreationists place on the Salt Ponds since user-day recreational value at the Coastal Salt Ponds in part because the value of natural resources is not readily priced as in established (Hotelling, 1949; Clawson & Knetsch, 1969; Freeman, Herriges, & Kling, 2014). However, Revealed Preference Method using Travel Cost Method enables us to estimate the user day value for recreation since the cost of travel to the recreation site plays a role of price and the quantity demanded is the number of trips per capita (Das, 2013; Morey, 1999; Parsons, 2003).

Individual Travel Cost and Zonal Travel Cost Approach are widely used methods in Travel Cost Method. Individual Travel Cost Approach is used to model the optimal number of trips to the site with socio-demographic information such as education, age, income and gender as a standard utility maximization problem subject to an income constraint. Hence, Individual Travel Cost Approach involves a more detailed survey of individuals (Das, 2013; Timah, 2011; Blackwell, 2007; Manzote, Mandishekwa, & Gombarago, 2013). Zonal Travel Cost Approach divides the area surrounding the recreation site into zones and trips per capita from each zone is calculated by dividing visiting frequency by the population of each zone. (Loomis et al., 2009; Das, 2013; Brown & Nawas, 1973; Herath & Kennedy, 2004). Individual travel cost Approach is preferred, since individual preference influencing recreational behavior is presented, but zonal cost approach has more modest data requirements and useful for sites when an individual visitor takes only one trip or when data are not available on the number of participants (Loomis et al., 2009; Das, 2013). Applying zonal travel cost method, this study constructs the demand curve for a representative individual based on the relationship between the average number of trips per capita and travel cost of participation; closer zones are likely to have visitors with higher visiting numbers and higher participation rates from their population (Loomis et al., 2009). This study estimates consumer surplus using the constructed demand function that explains visiting rate supplied to the change in travel cost. The change in consumer surplus associated with a policy change can be estimated to see if benefits justifies the costs. An on-site survey was conducted to collect a respondent's travel information such as travel distance, time, number of visits to the site and zip code. Since there are limited guidelines for the proper functional form specification, the research applied the linear, log-linear, linear-log, and double-log, inverse of frequency models to analyze the data collected.

With a limited amount of budget, decision makers often face to prioritize among restoration and preservation projects. By estimating the user day value of coastal salt ponds as a recreational resource, this research helps decision makers to identify more reliable and accurate information to manage Salt Ponds that suits best for society. (Das, 2013; Penn, 2013; Sohngen, Lichtkoppler, & Bielen, 2000).

This chapter is organized as follows. The first section provides an introduction on Travel Cost Method, and the second section lay out literature review of Travel Cost Method including strengths and weaknesses of each type of Travel Cost Method, and the third section outlines the conceptual frame of Zonal Travel Cost Method which was used in this study. The fourth section lays out the methodology of the survey and data collection procedure on travel and total visitor counting for a season. The fifth section reports the description of the data and model specification, and estimation results followed by conclusion and further discussion.

3.2. Literature Review

Economists have categorized non-market valuation methods as Revealed Preference Method and Stated Preference Method; Revealed Preference Methods use actual choices made by consumers to develop models of choice while Stated Preference Methods use the statement of consumers that they would behave in certain way. In general, as seen in table 3.1 below, Revealed Preference Method comprises Travel Cost Method and Hedonic Method, and Stated Preference Method consists of Contingent Valuation and Conjoint Analysis (Freeman et al., 2014, p. 23-26; Adamowicz, Louviere, & Williams, 1994; Penn, 2013; Pearce, 2002; King & Mazzotta, 2010; Parsons, 2003).

[Table 3.1 about here]

The two most widely used Revealed Preference Approaches are Travel Cost Approach and Hedonic Approach including Hedonic Price Method and Hedonic Wage Method (Penn, 2013; Freeman, 1993; Parsons, 2003; Adamowicz et al., 1994). This chapter focuses on Travel Cost Approach. The Travel Cost Method (TCM) goes back to 1949 when Harold Hotelling wrote a letter to the director of the National Park Service of the United States.

Hotelling suggested that travel cost can be used as a measure of the “price” of participating in recreational activity (Timah, 2011; Bateman, 1993; Arrow and Lehman, 2005). And then, Clawson first proposed the model in 1959 to get consumer surplus of recreational resources (Clawson & Knetsch, 1969; Loomis et al., 2009, Timah, 2011). Clawson & Knetsch used trips per capita, which is the number of visits coming from a zone, divided by the population of that zone, as a dependent variable. The zones are five-digit zip code or towns around the site to make use of demographic data (Ward & Loomis, 1986; Loomis et al., 2009).

Travel Cost Method (TCM) has been widely used to value the recreational resources and the most well-known approaches are Zonal Travel Cost Approach, Individual Travel Cost Approach and Random Utility Approach. Zonal Travel Cost Method is useful, where the visitor data is from secondary sources, or each visitor takes just one trip to the recreation site (Loomis et a.l, 2009). Zonal Travel Cost Approach is also argued that it is less intensive in data gathering processes. And a downward sloping demand curve is implied by lower number of visitors per capita that are further from the site (Timah, 2011; Ward and Loomis, 1986; Bergstrom and Cordell, 1991).

Following Bateman (1993), the demand function estimated by the TCM is the function of the travel cost and some other socioeconomic variables.

$$V = f(C, X)$$

where, V = the number of visits to a site, C = visit costs, X= other socio-demo graphic variables which significantly explain the number of visits, V (Das, 2013; Bateman, 1993).

In zonal travel cost approach, the dependent variable is the rate of visitation per capita from each zone to the site.

$$V_{hj} / N_h = f(C_h, X_h)$$

where, V_{hj} = visits from zone h to site j, N_h = population of zone h, C_h = visit costs from zone h to site j, X_h = socioeconomic explanatory variables in zone h. The visitor rate V_{hj} / N_h is calculated as visits per 10,000 population in zone h in the paper (Das, 2013; Bateman, 1993). The demand curve for Zonal Travel Cost Approach is illustrated in Figure3.1.

[Figure 3.1 about here]

Zonal Travel Cost Approach is useful for sites where each individual visitor takes just one trip or when data is not available on the number of trips by participants (Loomis et al., 2009).

However, there are several limitations of this Zonal Travel Cost Model; aggregating the individual observations by zone averages out some of the information available in the individual data (Brown & Nawas, 1973; Georgiou, Whittington, Pearce, & Moran, 1997; Das, 2013; Loomis et al., 2009). Because all individuals from within a same zone are considered to have same travel costs in the Zonal Travel Cost Method (Das, 2013).

Individual Travel Cost Method uses individual data so that the dependent variable is the number of visits per individual that allows the substantial variation in visits per person. Individual Travel Cost Approach is preferred when adequate data are available because it allows individual specific values rather than zonal averages for explanatory variables (e.g., income). Limitations of the Zonal Travel Cost Method and the availability of individual visitor survey data allowed the Individual Travel Cost Method to be used (Brown & Nawas, 1973; Gum & Martin, 1975; Loomis et al., 2009).

The demand function estimated by Individual TCM is the function of the individual travel cost and some other individual socioeconomic variables such as income, education, age and gender.

$$V_{ij} = f(C_{ij}, S_i)$$

where, V_{ij} = number of visits made per year by individual i to site j, C_{ij} = individual's total travel cost of visiting site j, S_i = a vector of individual specific variables such as income, age, gender, and education (Das, 2013; Brown & Nawas, 1973; Loomis et al., 2009). Individual travel cost model can be used to model the optimal number of trips to the site as a standard utility maximization problem subject to an income constraint.

When the travel cost, income, and time constraints are given, trips to the site and a composite commodity that is subject to a full income constraint yields the optimum number of trips to take (Haab & McConnell, 2002; Loomis et al., 2009).

The demand curve for the Individual Travel Cost Method(ITCM) is illustrated in Figure3.2. Integrating under this demand curve gives us the estimate of consumer surplus per individual. Total consumer surplus is then obtained by aggregating consumer surplus over participants visiting the site annually (Das, 2013).

[Figure 3.2. about here]

Many factors, other than just travel costs, influence recreational behavior, and to omit them from the visitation equation is to run the risk that OLS estimates will be biased. The facts that should be included in the visitation equation would be individual preferences influencing recreational behavior, for example, age, education, sex, and income (Stoeckl & Mules, 2006; McKean & Revier, 1990, p. 431). The strength of the Individual Travel Cost Method (ITCM) is its closer link to the microeconomic theory of utility maximization, which is a theory of individual behavior (Timah, 2011; Blackwell 2007). In the ITCM, individual specific values of explanatory variables such as age, income, education, and gender are included to explain individual visits rather than averaging over all individuals within the zone (Timah, 2011; Sohngen et al, 2000, Blackwell, 2007).

However, ITCM is not free from problems. As indicated above, if a high percentage of visitors are only one time visitor per year or first time visitors, statistical results will have insufficient variability in the number of visits across observations (Das, 2013; Bowes & Loomis, 1980).

A variation of the travel cost method is the random utility model (RUM). In Random Utility Model (RUM), an individual is asked to choose a specific site from a given hypothetical finite choice set to maximize the utility (Hotelling 1949; Das 2013; Freeman et al., 2014; Ali, 2008; Parsons, 2003; Bockstael, McConnell, & Strand, 1989). An individual's utility from the chosen recreation site is assumed to be greater than the utility received from the other available options.

$$U_m(R_{mj}, M_m - C_j) > U_m(R_{mk}, M_m - C_k) \ \ (\forall_j \in C : j \neq k)$$

where U (∘) is the utility function for individual m, the subscript j is the chosen recreation site by individual m, the subscript k represents the other recreation site options (j ≠ k). R is a vector of recreation sites attribute levels for each site, M_m is the individual's household income, and C_j is the cost per trip to recreation site j (Mazzotta, 1996). Random Utility Model specifies utility as having deterministic and random components. Strictly speaking, in the standard Random Utility Model as defined by McFadden, the individual knows their own utility, and the random component arises only for the researcher, who cannot observe all elements of utility (Ali 2008; Morey 1997; Opaluch, Grigalunas, Diamantides, Mazzotta, & Johnston, 1999; Mazzotta, 1996; Lupi, 20005; Parson, 2003; Freeman, 1993).

$$U_m(R_{mj}, M_m - C_j) = V(R_{mj}, M_m - C_j) + \varepsilon_{mj}$$

where V (∘) is the deterministic component of utility and ε_{mj} is a random component. However, in McFadden's original model, the random component arises only due to the fact that the researcher is unable to observe all elements of utility and thus researchers estimate the probability that is the best in the choice set. Choice probabilities are expressed as discussed below (Lupi 2005; Morey 1999; Ali 2008; Freeman 1995). An individual (m) is assumed to select alternative (j) in the choice set if the utility of alternative j is greater than the utility of choosing all other alternatives in the choice set.

$$P(J|C) = P[v(R_{mj}, Mm - Cj) + \varepsilon_j] > P[v(R_{mk}, Mm - Ck) + \varepsilon_k](\forall_{j,k} \in C : J \neq k)$$

$$P\ [v(R_{mk}, M_m - C_k) - v(R_{mj}, M_m - C_j)] < \varepsilon_j - \varepsilon_k$$

where C is a choice set, subscripts both j and k are alternatives. The V's are treated as fixed numbers and the ε `are the random component from the perspective of the researcher. Therefore, the probability is with regard to the difference in the $\varepsilon`s$. To estimate the model, a distribution for the disturbance term should be chosen. If we assume that random component of utility is Gumbel distributed, multinomial logit model is used (Train, 2009).

$$P_{mj} = \frac{exp(V_{mj})}{\sum_k\ exp\ (\ V_{mk}\ )}$$

If the deterministic component of the utility function, V_{mj}, is assumed to be linear in parameters, then

$$P_{mj} = \frac{exp\ (\ \beta' z_j\ +\ \alpha' s_m\ )}{\sum_k\ \ exp\ \ (\ \beta' z_k\ +\ \alpha' s_m\ )}$$

where z is a vector of attributes of the choice and the subscript j is the recreation site chosen, P_{mj} is the probability that m^{th} individual will select the j^{th} recreation site; z_j is the vector of attributes of the sites, s_m is the vector of characteristics of individual m; and

β *and* α are vectors of parameters to be estimated (Opaluch et al, 1999; Tay and MaCarthy, 1996). To derive the welfare measure, under the assumption that indirect utility function is linear in parameters, environmental quality and socioeconomic factors that affect an individual's choice, compensating variation (CV) is defined as follows.

$$\mathrm{Max}_{j\,\epsilon\,J^{o}}\,[\,\mu\,(y - p_j^0) + \beta z_j^0 + \epsilon_j\,] = \mathrm{Max}_{j\,\epsilon\,J^{1}}\,[\,\mu\,(y - p_j^1 - CV) + \beta z_j^1 + \epsilon_j\,]$$

Compensation variation is the amount of money that leaves a person as well off as they were before change. Thus, compensation variation measures the amount of money required to maintain a person's satisfaction, economic welfare at the level it was before the change (King & Mazzotta, 2010).

$$CV = \frac{1}{\mu}[\{max_{j\,\epsilon\,J^1}\,(\mu\,p_j^1 + \beta z_j^1 + \epsilon_j)\} - \{(Max_{j\,\epsilon\,J^o}\,(-\mu p_j^0 + \beta z_j^0 + \epsilon_j\,))\}$$

Economic values of attributes are calculated by dividing each resource coefficients by the cost coefficient (Hanemann 1982).

Random Utility Model uses information from multiple recreation sites while the traditional Travel Cost Model focuses on one recreation site (Dumas, Schuhmann, & Whitehead, 2005; Bockstael, Hanemann, & Kling, 1987; McFadden, 1974; Lupi, 2005; Whitehead, Groothuis, & Southwick, 2007; Morey, 1999). Random Utility Model considers a person's choice of a site from among a set of alternative sites for a recreation trip instead of a quantity demanded as in the single site model. Also, while the time frame for a single site model is a season, the time frame for the RUM model is a choice occasion (Parsons, 2003). Random Utility Model is particularly suitable for cases where the major component of recreation behavior is substitution between recreation sites and also is used to estimate values of changes in site attributes like water quality (Das, 2013). The Random Utility Model is also used to the value of the loss of a site, or addition of a new site. However, the Random Utility Model cannot be used to estimate the value of the recreational experience. Thus, to capture the non-market value of quality change in Salt Ponds in terms of water quality and congestion, following chapter employs Random Utility Model.

3.3 Conceptual Frame

The theory and application of Travel Cost Method (TCM) follows the microeconomic theory of consumer behavior. An individual consumer chooses the optimum number of trips to the site given his/her budget constraint to maximize their utility (Timah, 2011, 2004; Douglas & Taylor, 1998). A general solution to this constrained maximization problem is the uncompensated Marshallian demand function (Timah, 2011).

This microeconomic theory of consumer behavior has been extended to publicly provided goods such as public parks, beach recreation, forests, and other recreational services (Timah, 2011). For example, recreation experiences are often not sold in traditional markets, but participating in recreational activities often require payment of a cost in order to participate, such as the cost of travel to the site. Thus, the travel cost model estimates demand for recreation at a site like a normal market good, where the travel cost plays the role of the price of purchasing the recreational experience. The quantity demanded is the number of trips per capita taken to the recreation site per year from the people living at different distances from the (Lupi, 2005; Jones & Sung, 1993; King & Mazzotta, 2010; Smith, Desvousges, & Fisher, 1986; Parsons, 2003; Das, 2013; Bateman, 1993). Price is lower for visitors living near the salt ponds and is higher for people living further away. Thus, the slope of demand function relating to price and quantity is downward ($dV/dC < 0$), where V is a demand function and C is a travel cost to the site. Thus, all else equal, people who have to travel a longer distance will tend to visit the site less often because it incurs a higher price (Parsons, 2003, Das, 2013; Bateman, 1993; Tobias & Mendelsohn, 1991).

The variation in distance travelled and the visiting frequency taken by individuals are used to map out a demand function for the recreation site (Dumas et al., 2005). The choice of functional form between the travel cost incurred and the visitation rate can have significant influence on estimates of recreation value (Stoeckl, 2003, Stoeckl and Mules, 2006). However, the theory does not provide guidance to choose one functional form over the others. This study selects the functional form on statistical grounds (Kerr and Sharp, 1985; Stoeckl and Mules, 2006). This study estimates demand using five alternative functional forms including linear, inverse of visiting frequency, double-log, linear-log, log-linear. We use coefficients from these equations to generate estimates of consumer surplus for each of those forms.

If demand function is assumed to be linear, demand function for visits is:

$$V = \beta_0 + \beta_1 C + \beta_2 X + e$$

where V is the visit rate that the number of visit is divided by the number of population, C is a travel costs, X is a vector of socio economic variables and e is an error term. Given the demand function that the number of visits is negatively related to travel expenses, we can get the quantity a visitor would take at any given travel expense and zero visits at maximum travel expense, that is "choke-off" price (Lupi, 2005; Opaluch et al., 1999; King & Mazzotta, 2010; Smith et al., 1986; Tobias & Mendelsohn, 1991).

To estimate the recreational demand, travel cost, which reflects the price of the participating at the site, is used as an independent variable. For instance, travel longer distance also requires more time spent travelling. Thus, travel cost includes both out of pocket expenditure, plus the opportunity cost of time spent travelling.

The per capita visitation rate which is the division of visiting number by population in each zone, is used as dependent variable. Then, per capita visitation rate is regressed on travel cost and other social demographic variables such as average income and education for the population within the zone. Since there is no clear guidance about the choice of best functional form, a number of functional forms are tested such as linear, log-linear, linear-log, double-log, and inverse of the number of visit.

According to economic theory and statistical specification, the relationship between per capita visiting rate and travel cost should show the negative relationship so that the per capita visitation rate decreases as travel cost increases. Final criterion is the Content Validity such that a model that predicts the closest visiting rate compared to the observed visiting rate is chosen (Prayaga et al., 2006).

Then, the demand curve is used to derive the consumer surplus associated with using the recreation site (Dumas et al., 2005). Consumer surplus is the basis for measuring net economic benefits and is the difference between what the consumer is willing to pay and the actual market price. For example, let's say that a consumer is willing to pay the price of $40 to visit the salt pond. However, if the consumer paid the cost of a day trip of $10 to enjoy recreational activity on the recreation site, then consumer surplus is $30 - the difference between the consumer's maximum willingness to pay to visit the recreation site and the actual price they paid (Dumas et al., 2005). The maximum willingness to pay is called the choke price where a person will no longer takes a trip and where the demand curve crosses the price axis (Figure 3.3).

[Figure 3.3 about here]

In the downward sloping linear demand curve presented in figure 3.3, consumer surplus is the area of triangle under the demand curve between the choke price (t^1) and the actual price (t^0) consumers paid.

In case of non-linear logarithmic demand function, consumer surplus is obtained by taking integral of the area under the nonlinear demand curve between the actual travel cost of t^0 and the choke price of t^1:

$$CS = \int_{t0}^{t1} f\ (C, X)\ dc$$

where, $f\ (C, X)$ is a demand function, where C denotes a travel cost and X represents social demographic factors that significantly affect travel demand. The area of consumer surplus decreases with distance travelled since the paid cost of a day trip increases (Figure 3.4).

[Figure 3.4. about here]

Variants of the Travel Cost Model

Single site versus multiple sites

Travel cost approach has two types of model: multiple site model and single site model. If there are many of recreation sites in the visiting recreation destination such as neighboring ocean, or river, multi-site models are more appropriate because multi-site model better captures an individual's choice behavior by showing availability and substitute alternative sites (Lupi, 2005; Parsons, 2003; Freeman et al., 2014; Train, 2009) Single-site model is appropriate when recreation site is quite unique (Lupi F, 2005). This study employs single-site model because major component of recreation behavior in the salt ponds is not substitution with neighboring recreation sites; salt ponds don't charge admission fee while neighboring state beaches charge admission fee in the form of parking fee per car. In addition, neighboring lakes and rivers don't have unique attributes that the salt ponds have such as soft waves from the connected ocean that allows recreationists to enjoy water sports and relative sense of security derived from the shallower depth of salt ponds. Further, respondents orally reported that they go to other salt ponds if they cannot do recreational activity in one salt pond where they visited. Therefore, this paper uses single site model without substitute sites, but uses individually stated travel time. If all substitution sites are included, attributes may become too complicated and vary in a wide range resulting in too much heterogeneity that gives no importance in anything. Researcher-defined substitutes may not statistically relate to recreation user-defined substitutes. If researchers do not know whether a site is a complement or a substitute, then there is not a priori about either the magnitude or the direction of any resultant omitted variable bias (McKean & Revier, 1990, p. 435; Stoeckl & Mules, 2006). Single recreation site model can predict current demand for a particular site, but cannot estimate the value of change in quality of the site since all participants face the same site quality (Lupi, 2005). To value the effect of water quality change in variation of visits in single site model, estimates can be used on time series data (Parsons, 2013; Brown & Nawas, 1973). Collecting time series data on actual visits with water quality change requires longer and broader spectrum of data collection.

On-Site Sampling

How to generalize the result of on-site sampling to the general population is worth of investigation. Shaw (1991) addressed the issues of truncation and endogenous stratification for on-site sampling using a Poisson model. Englin and Shonkwiler (1995) proposed the negative binomial model with count data to improve estimation. Shonkwiler and Shaw (1996) defined three groups of people in recreation as "nonusers", who never participated, "potential users", who would participate but didn't participate in the survey season, and "users", who always participated, and put single and double hurdles into the count data model. But these solutions are not appropriate for salt pond study because non-visitors are very different than visitors. This is the problem of "excess zeros". There is a high possibility that non-visitors to the Salt Ponds have no interest whatsoever in participating, and we cannot observe these people. Although sampled individuals are likely to be a visitor with higher frequency compared to non-sampled individuals, onsite survey method was essential in the project (Timah, 2011). For the same reason, the onsite survey was the most appropriate method with regard to time and cost efficiency. However, by doing this way, we omit information about the taste of non-visitors. This may reduce the explanatory power of the model (Stoeckl and Mules, 2006; Knapman and Stanley, 1991; Leuschner, Cook, Roggenbuck, & Oderwald, 1987).

Zone Identification

Zonal Travel Cost Approach divides recreational visitors into several zones according to their originating residence. Zone identification and number of zones are often arbitrary and often influenced by the availability of population data (Bateman, 1993, p230; Prabha et al., 2006). For example, in case of using concentric circles to define zones, cities and counties within the circles are treated as the same zone (Herath & Kennedy, 2004). When we applied this method of zone identification to Salt Pond, Rhode Island, we could get only four separate zones and we couldn't get best fitted model that explains the recreation demand function.

In another literature, zones are identified on the basis of zip code clusters, which have approximately equal populations (Lockwood and Tracy, 1995). This method was not a good method for our model as travel distance which is a major factor of Travel Cost Approach was aggregated by zip code, it sacrificed the quality of best fitted model in explaining recreation demand model. This method is more suitable for the large area with well developed roads and highways rather than small state like Rhode Island.

Beal (1995) divided zones on statistical divisions, which were aggregated according to an approximate distance from the site (Beal, 1995). This paper follows the way that Beal divided zones; we divide the zones according to the distance travelled. The rationale is that even if visitors are from the same radius or zip code, the travel distance varies depending on the types and status of existing roads from a visitor's residence to the recreation site; for example, even though the residence of a visitor is located within the five-mile radius on the map, respondents' distance travelled to the recreation site may take equal to or greater than ten miles due to the lack of highway. One large area with a single zip code could be divided into two or three zones; a residence on the closest border and another residence on the farthest border from the recreation site is segregated into different zones and populations of divided zones are concurrently included in these segregated areas so that the disparity of population size across the zones can be minimized.

3.4 Application

To establish the demand function and estimate the user day value of visitors to the Salt Ponds, a survey on a visitor's travel information and experience was conducted. The following sections discuss survey implementation and a summary of the data collected.

A pilot of the survey was conducted in December 2014 and January 2015 to 124 respondents of boat club users and employees working at boat/yacht clubs, avid Salt Pond users, neighborhood association members near the Salt Ponds, graduate and undergraduate students who used salt ponds. The final survey contains two separate parts. The first part asks questions on travel information and the second part elicits preferences from three hypothetical ponds described in terms of attributes. Second part of survey is discussed in the following Conjoint Analysis chapter.

The survey process started with an introduction to the purpose of survey, and background information on salt ponds was provided using a color photo illustrating four different quality levels - poor, fair, good, or excellent -following EPA standard. A map of the studying area of Salt Ponds was shown to the respondents, and respondents were informed about the historic decline in water quality in the Salt Ponds over the 12-year period from 2000 to 2011 (Torello & Callender, 2013). The survey was carried out as self-administered booklet (Appendix A: Salt Pond Survey).

Respondents were, first, asked about the experience with Rhode Island Salt Ponds; respondent were asked to indicate the satisfaction level on parking lot size, the amount of trash, water quality, the amount of trash, the amount of noise, the amount of wild life, scenery around, and accessibility to the pond in the order of 1 (very undesirable), 2 (slightly undesirable), 3 (neither desirable nor undesirable), 4 (slightly desirable), 5 (very desirable), up to not available. Respondents were then asked to indicate the number of visits they took to the Salt Pond in the last twelve months, distance traveled and time spent traveling, five-digit-zip code both of their permanent home and staying hotel or lodging. Those who don't know the five-digit-zip code of their staying hotels or cabins, they wrote down the name of hotel and the town. Later, the correct five-digit zip code for the hotel or lodging was put in the course of data input.

Lastly, the survey collected information on the respondent's social demographic information such as gender, age, party size for the salt pond trip, education, and annual income before tax. Respondents were asked to choose categories for gender, age, education, and income, and the categories were selected to match census categories. To deal with multiple purpose trip, in addition to a question asking the respondent's hometown, was a question asking where did the respondent start today (Travel Cost Approach Questions: See Box 1).

The data were collected using an intercept survey of recreational users at three Salt Ponds - Ninigret, Point Judith, and Quonochontaug from late June to early September of 2015. 309 respondents filled out the survey questionnaire and 287 completed survey while 22 opted out of reporting annual income or education. The data from responses were coded, and a summary of respondents' characteristics are presented in Table 3.2 and Table 3.3.

[Table 3.2. About here]

[Table 3.3. About here]

Travel Cost is the sum of vehicle related out-of-pocket expenses and the time cost associated with travel to the site. To calculate the travel cost, traveled distance was taken from the shortest distance using the google map: shortest distance would provide a base measure of distance with conservative results (Flemming and Cook, 2008). Value of travel distance per mile was estimated to be fifty-seven cents per mile, according to the American Automobile Association's estimate of the average cost of operating a different type of vehicle per mile: average cost per mile of a small sedan, a medium sedan, a large sedan, minivan and 4WD sport utility vehicle (AAA, 2013). To attain the cost of trip, the cost per mile of $0.578 was multiplied by round trip distance. (AAA, 2013; Parsons, 2003; Mazzotta, 1996). This study uses data for respondents whose traveled distance is less than or equal to 150 miles from the Salt Pond, since individuals living further than 150 miles most likely engaged in multiple activities other than the Salt Pond visit.

This study uses the Zonal Travel Cost Method (Das, 2013; Parsons, 2003) by allocating respondents to one of 13 groups depending upon the travel distance with the interval of 10 miles round trip based on the respondents stated zip code. In the case of a group that traveled in a single vehicle, travel cost per person was acquired by dividing the fuel cost per car by the average number of adults in the group from the full sample. Per-person travel cost is calculated as follow

$$\text{Travel Cost}_{\text{per person}} = \frac{Vehicle\ Costs}{Number\ of\ Adults\ in\ the\ Party}$$

Time cost represents the opportunity cost of time spent traveling to the site. In the literatures, travel time is calculated from the traveled distance assuming an average speed of 40 miles per hour (Parsons, 2003). In this study, we used a respondent's stated travel time rather than estimated time under the assumption of average speed of 40 miles per hour to reflect the reality in which some could use high way or dirt road. The most commonly used approach to value time is wage-based approach in which annual income is divided by the number of hours worked in a year (Parsons, 2003). It is also common to use the fraction of the wage from one third of the wage to the full wage, as the value of time (Parsons, 2003; Feather & Shaw, 1999). Feather & Shaw (1999) accepted one third of the full wage as the lower bound and the full wage as the upper bound (Parsons, 2003; Feather & Shaw, 1999; Bockstael, Strand, & Hanemann, 1987). To calculate an average hourly wage, a respondent's annual income before tax was divided by 2000 hours (40hours/week * 50 week/year = 2000 hours/year) and a respondent's self-reported travel time was multiplied by the hourly wage. This study used one third of the wage for the value of opportunity cost of time. One third of the wage would indicate the lower bound of the value of the opportunity cost of time. Total Travel cost is obtained as the sum of the value of traveled distance and the opportunity cost of travel time for round trip. Data summary using this calculation method is shown in Table 3.4.

[Table 3.4 about here]

In order to estimate the total number of recreational users in salt ponds, a team of researchers drove a boat following the transect line of each salt pond with a laser-located binocular and a hand-held computer on a randomly selected day from 7 a.m. to 5p.m. Observed number of recreational users through a pair of binocular was recorded into a handheld computer. Boat observation was conducted for July and August and included 18 times of weekdays and 5 times of weekends on 2014 (Patrolia, 2016). Holiday, for example, on Independence Day, recreational users were not counted due to a heavy rain in 2014. The average number of daily users was estimated by dividing the total users by the number of observation days for weekdays and weekends respectively. The number of average daily users and the number of weekdays and weekends for observation period are presented in Table3.5 and Table 3.6.

[Table 3.5. about here]

[Table 3.6. about here]

3.5 Results

Model Specification

We apply Zonal Travel Cost approach (Parsons, 2003; Das, 2013; Loomis et al., 2009) to estimate demand for recreation at Rhode Island Salt Ponds. To do so, the zonal visitation rate was regressed on travel cost which is the sum of out-of-pocket cost and the value of the opportunity cost of time. Thirteen zones were identified for this study based on the travelled distance from the residence or the staying hotels to the Salt Ponds. Individual specific variables such as age, income, and education level are averaged out into each zonal group.

As there is no theoretical basis for choosing among functional forms for demand, the linear, linear-log, log-log, log-linear, and the inverse of visiting frequency models were all estimated. Equations were assessed using F-tests, t-tests, Box-Cox test, adjusted R^2 values, with consideration of heteroscedasticity, and misspecification problems. The double log performed best in terms of R^2, heteroscedasticity, and misspecification tests. As a consequence, we use double log for the recreational demand function.

When double log model was tested for heteroscedasticity, no heteroscedasticity was present. To test the existence of misspecification of the functional form, RESET (regression specification error test) was conducted, and no misspecification of the functional form was detected in double log form (Kleiber & Seiles, 2008, p.103). Double log model has the highest R^2 of 0.91 of the tested five models and the estimated coefficient of travel cost is statistically significant at the 0.01 level. The estimated equations are given in Table 3.7.

[Table 3.7 about here]

Shown in demand function, the signs are expected. The coefficient of travel cost is negative and statistically highly significant. In all estimated equations, none of the socio-demographic variables were found to be significant.

Results

The results contained in this chapter are based on responses to surveys conducted at the Salt Ponds during July and August in 2015 and boat observation of total users in 2014. Over two months of sampling periods, a total of 309 surveys were collected, of which 287 were useable. Of the 309 respondents 279 (90%) respondents were Rhode Island residents and 21(7%) from Connecticut, 8(3%) from Massachusetts and 1 respondent was from New York. Of total respondents, 134(45%) respondents are male, 175(55%) are female. The mean age of respondents is approximately 54 years old, which is higher than the median age of 38 years old in Rhode Island (United Census Bureau, 2010). The sample is highly educated, with almost half of respondents reporting that they have some college education or more while Rhode Island reported that 31% of adult populations have some college education (United Census Bureau, 2010). Respondents were also comparatively wealthy, reporting a mean annual household income of $ 78,125 compared to a Rhode Island median household income of $54,891 (population estimates, http://www.census.gov/quickfacts/table/PST045215/44). In general, the average party size was three people and respondents, on average, stayed on the salt ponds for three and half hours a day. Respondents were asked how they think about the parking lot size on the scale of one to three; 1= too small, 2=too large, 3=about right. 167(54%) respondents reported that parking lot size is just right, 139(45%) respondents answered that the parking lot is too small, and the 3(1%) respondents answered that parking lot is too large (Table 3.8).

[Table 3.8. about here]

Visitors coming from different locations to salt ponds paid a different cost to access the site because traveled distance and also the opportunity cost of time differ. The demand function was estimated by regressing visitation rate per capita and differing travel prices, which are the sum of fuel cost and the opportunity cost of traveled time. Then consumer surplus was estimated to determine the net economic value of a visit per person to the salt ponds. There are two components of Economic Value; one is "economic impact", which represents the value of dollars spent in the local economy such as restaurants and other service industries by visitors to the salt ponds while the other is the individual's "value of the satisfaction" by visiting the salt ponds, above and beyond the cost of visiting the site. To measure the "value of the satisfaction", consumer surplus was measured and consumer surplus is the area under the demand function between the price actually paid and the choke price that an individual is willing to pay for visiting salt ponds. (Sohngen et al., 2000; Maharaj, 1995). In theory, the choke price occurs at the point where cost of visiting the site is just high enough that an individual would not visit to the site. Table 3.9 shows consumer surplus by zone using the double log model, and consumer surplus estimates for different functional forms are presented in Table 3.10.

[Table 3.9. about here]

[Table 3.10. about here]

In double log demand function, it is not possible to obtain a zero level of visitation, which is essential element in determining the choke price, since exponential curve is asymptotic to the price axis; as visit rate approaches zero, price approaches infinite. To test the sensitivity of double log function, two arbitrary choke prices of $50, which is an average choke price of all the five functional forms and $100, for comparison purpose, were used to calculate the consumer surplus (Table 3.11).

[Table 3.11. about here]

Total consumer surplus estimates by pond and by function is recorded in Table 3.12 and total consumer surplus for three ponds that was calculated by multiplying the total number of salt pond users by the consumer surplus estimates per visit is presented in Table 3.13.

[Table 3.12. about here]

[Table 3.13. about here]

3.6. Conclusion and Discussion

This chapter estimated recreational user-day value using Travel Cost Method and applied to three salt ponds – Point Judith, Ninigret, Quonochontaug - in Rhode Island. Consumer surplus was estimated to determine the value of visits to the Salt Ponds for July and August. These values are, in turn, used to obtain the average value of one trip, and the total value of recreational visits for two observation period - July and August.

The results suggest that total value of recreational visits to Salt Ponds is $2.8 million for July and August: $1.15million for Point Judith Pond, $744 thousand for Ninigret pond, and $954 thousand for Quonochontaug Pond respectively. Although the estimated values are likely to under-estimate the true value of recreation, because they include only two months in a peak season of a year and the counting of the number of total users are conducted once a day that ended early afternoon for the safety purpose when driving a boat, the results suggest that Coastal Salt Ponds are highly valuable recreational resources for individual visitors. Although there is no tangible market price on the recreation resources such as Salt Ponds, more attention may be required when policy is made to manage, preserve and restore valuable recreational source of salt ponds.

These estimates are consistent with the findings of consumer surplus of visiting similar recreational resources in Travel Cost Method literature. The estimate of consumer surplus for visiting bay area in Ohio ranged from $15.50 to $25.60 (Sohngen et al., 2000). Next chapter will introduce Contingent Analysis to estimate the impacts of water quality improvement and congestions on the recreational user-day value.

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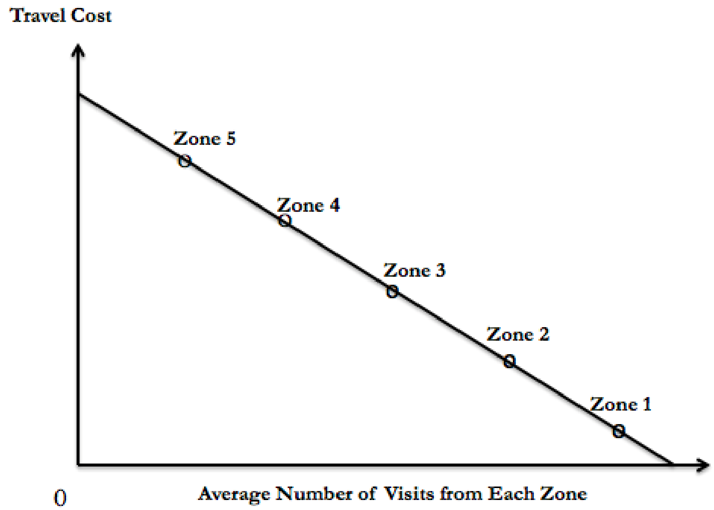
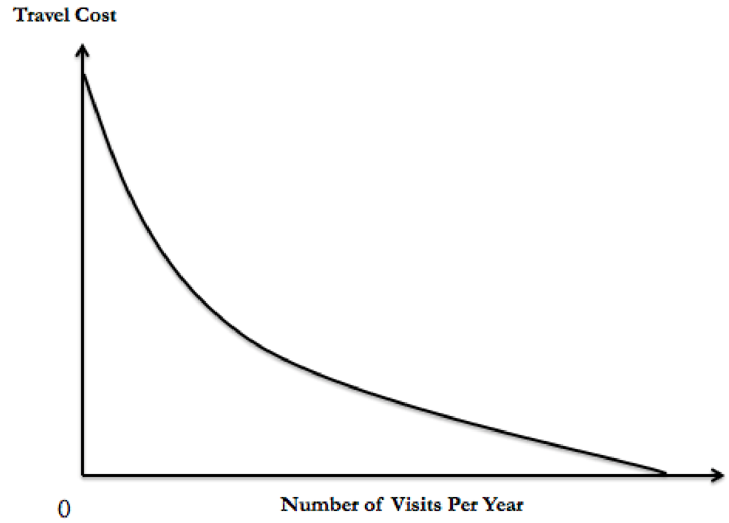
Tables and Figures

Figure 3. 1. Demand Curve of Zonal Travel Cost Model



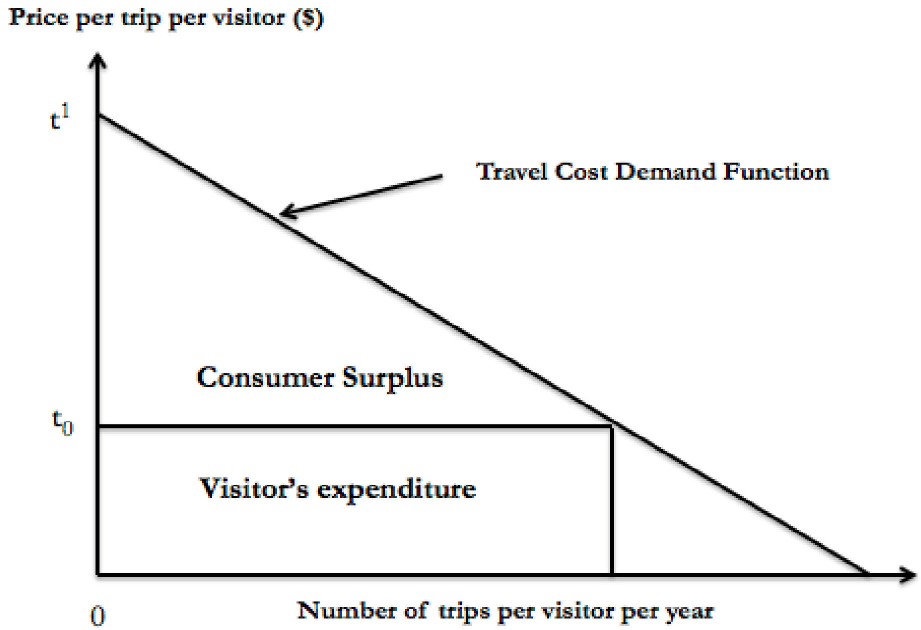
Notes: Zonal Travel Cost Model (adapted from Das, 2013). Figure illustrates demand curve of Zonal Travel Cost Approach. Y-axis is travel costs, and x-axis is the average number of visits from each zone on the scale of 1 to 5; zone 1 is the closest area and zone 5 is the farthest area from the recreation site. Five points on the downward demand curves presents that the greater number of visits, the less is travel cost.

Figure 3. 2. Demand Curve of Individual Travel Cost Approach



Notes: Individual Travel Cost Model (adapted from Das, 2013). Figure Illustrates the demand curve of Individual Travel Cost Approach. Y-axis is travel costs, and x-axis is the individual's visiting number.

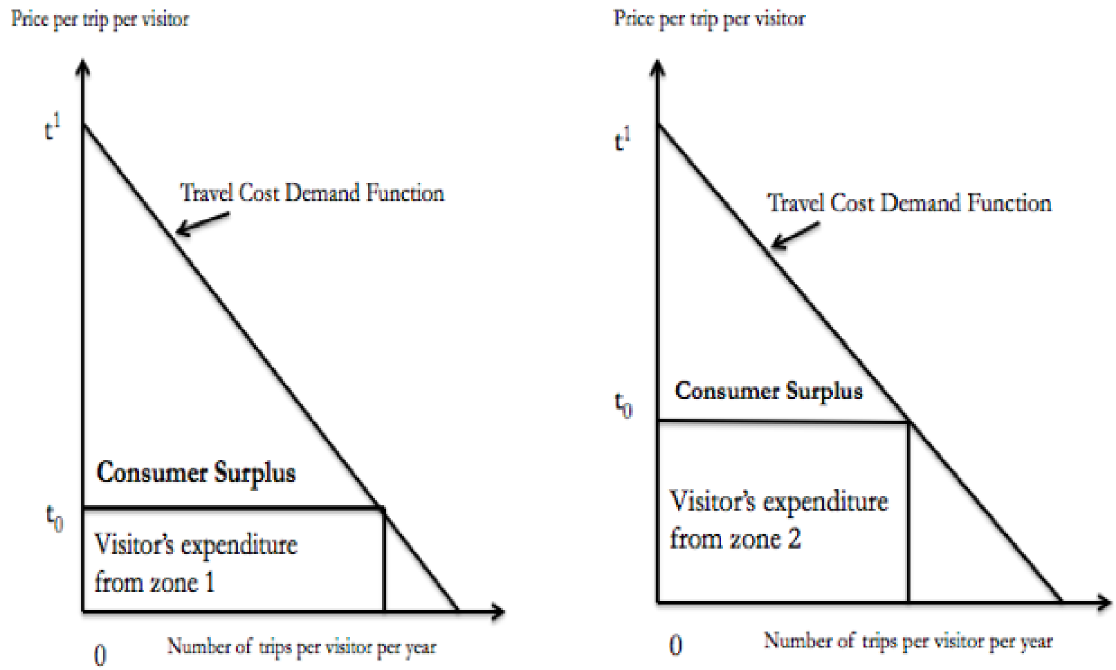
Figure 3. 3. Travel Cost Demand Function and Consumer Surplus



Source: Adapted from Sohgen et al(1999) and Dumas et al (2004)

Notes: Y-axis denotes price per trip per visitor and X-axis denotes visiting frequency per person. t^1 is the maximum price consumers are willing to pay and t^0 is the actual price consumers paid to come to the destination.

Figure 3. 4. Consumer Surplus Change along the Travel Distance



Notes: Zone 1 represents a closer distance with lower travel cost paid and zone 2 represents a longer distance travelled with higher travel cost paid where t^1 denotes the choke price and t^0 the actual price the recreationists pays.

Table 3. 1. Non-Market Valuation Methods

Valuation Method	Basis	Why to Use	Advantages	Limits
Revealed Preference				
Hedonic Price	Amenity values are capitalized in housing price	Housing price in the area appears to be related to proximity	Estimates based on actual choice Property market: efficient in response	The scope is limited to housing price
Hedonic Wage	Estimate the value of risk reduction	Difference in wages is associated with riskier jobs.	Estimates based on actual choice.	Individual is required to have perfect information about the risk and be capable of how to evaluate
Travel Cost	Price of accessing good is equal to opportunity cost of time and travel cost	Mainly used for recreation. E.g. waterbody, national park	Travel cost is based on actual behavior rather than stated Willingness To Pay	Individual's purpose for the trip (single or multiple purpose) The value of time
Stated Preference				
Contingent Valuation	Non-consumptive Values	Nonuse values are important and their potentially significant levels	Flexible (Contingent ranking, paired rating, Discrete choice)	Placing a dollar value can be unfamiliar Validity and reliability
Conjoint Analysis	Ranking Rating Choice Based	Determines which attributes of a product people value most	Effective in finding what attributes people most value in choices	Validity and reliability

Source: adapted from Pearce, D (2002); http://www.ecosystemvaluation.org

Table 3. 2. Characteristics of respondents

Question	Category	Number	Percentage (%)
Gender	Female	175	55
	Male	134	45
Party Size	1~2	161	52
	3~5	111	36
	6~10	33	11
	11~15	4	1
	Did not answer	0	0
Age	20 or under	10	3
	21~24	15	5
	25~34	41	13
	35~44	51	17
	45~54	74	24
	55~64	74	24
	65~74	38	12
	75~84	5	2
	85~0ver	1	0
	Did not answer	0	0
Education	Less than high school	0	0
	Some high school	6	2
	Completed high school or GED	60	19
	Associate's Degree	44	14
	Some College	60	19
	Bachelor's Degree	62	20
	Graduate or Advanced Degree	76	25
	Did not answer	1	0
Annual Income	< $15,000	25	8
	$15,000~$24,999	26	8
	$25,000~$34,999	15	5
	$35,000~$49,999	31	10
	$50,000~$74,999	59	19
	$75,000~$99,999	61	20
	$100,000~$149,999	44	14
	$150,000 or more	43	14
	Did not answer	18	6

Table 3. 3. Characteristics of visit

Question	Category	Number	Percentage (%)
Salt Pond Visited	Point Judith	166	54
	Ninigret	37	12
	Quanochuntaug	106	34
Visiting Frequency	1 times	38	12
	2~5 times	111	36
	6~10 times	58	19
	11~15 times	26	8
	16~20 times	20	6
	21~30 times	17	6
	31~50 times	23	7
	51 times or more	16	5
Starting State	RI	279	90
	CT	21	7
	MA	8	3
	NY	1	0
	Other States	0	0
Travel Distance (Round Trip)	Less than 5 miles	48	16
	6-10 miles	37	12
	11-20 miles	77	25
	21-30 miles	20	6
	31-40 miles	16	5
	41-60 miles	33	11
	61-90 miles	39	13
	91-120 miles	20	6
	More than 120 miles	19	6
Travel Time (Round Trip)	Less than 5 minutes	22	7
	5~10 minutes	56	18
	11~20 minutes	43	14
	21~30 minutes	40	13
	31~60 minutes	62	20
	61~90 minutes	37	12
	91~120 minutes	29	9
	More than 120 minutes	20	6
Staying Hour	1h ~ 2h	99	32
	2h~4h	99	32
	4h~6h	78	25
	6h~8h	11	4
	Did not answer	22	7

Table 3. 4. Data Summary

Number of Respondents	309
Average out of pocket cost	$10.13
Average one-way travel time (minutes)	17.43
Average number of visit	18.69
Average income	$78,125
Average age	54
Average education	Some college
Average number of visit rate (unit: 1000 people)	12.58
Average number of company	2.93
Average staying hour	4.17

Table 3. 5. The number of weekdays and weekends for July & August (Observation Period) in 2014

Number of days	Total	July	August
Weekdays	44	23	21
Weekends	18	8	10

Note: The number for weekdays and weekends for July and August in 2014 was counted

Table 3. 6. The number of average daily users

Daily Users	Total	Point Judith	Ninigret	Quonochontaug
Weekdays	2,269	856	593	820
Weekends	3,430	1,537	892	1,001
Total	5,699	2,393	1,485	1,821

Table 3. 7. Demand Function

	Dependent variable:				
	v.rate	inv.visit	log.v.rate		v.rate
	(1)	(2)	(3)	(4)	(5)
tot.cost	−2.332***	−0.257**		−0.078***	
	(0.682)	(0.088)		(0.010)	
log.tot.cost			−1.840***		−66.472***
			(0.174)		(9.319)
Constant	107.329***	13.944***	8.350***	4.884***	247.873***
	(24.165)	(3.124)	(0.573)	(0.366)	(30.649)
Observations	13	13	13	13	13
R^2	0.515	0.435	0.910	0.839	0.822
Adjusted R^2	0.471	0.384	0.902	0.824	0.806
Residual Std. Error (df = 11)	42.808	5.534	0.485	0.649	25.924
F Statistic (df = 1; 11)	11.694***	8.483**	111.541***	57.304***	50.879***
Note:					*p<0.1; **p<0.05; ***p<0.01

Model (1) is a linear model. Dependent variable is visiting rate per capita and explanatory variable is total cost. Model (2) is an inverse of visiting frequency model; Dependent variable is the inverse of visiting frequency rate per capita, and explanatory variable is total cost. Model (3) is double log model. Model (4) is log-linear model and model (5) is linear-log model.

Table 3. 8. Responses on the size of parking lot

N=309	**Parking Lot Size**		
	1=too small	2=too big	3=just right
Number of respondents	139	3	167
Percentage	45	1	54

Table 3. 9. Consumer Surplus by Zone: Double-log model

Zone	**Aggregate Estimates of CS (using only the sample of visitors**	**Per-visit Estimates of CS (using only the sample of visitors)**
1	60,143	26.55
2	16,004	13.30
3	4,017	9.99
4	2,882	8.26
5	2,339	7.57
6	849	4.85
7	646	4.78
8	427	3.99
9	355	3.95
10	96	3.70
11	80	3.18
12	88	3.05
13	52	2.62
	Weighted Mean: $87,979	Weighted Mean: $17.42

Table 3. 10. Consumer Surplus estimates by functional form

Zone	**Aggregate Estimates of CS (using only the sample of visitors)**	**Per-visit Estimates of CS (using only the sample of visitors)**
Double-Log	$87,979	$17.42
Log-Linear	$76,894	$15.18
Linear-Log	$77,081	$15.24
Linear	$89,527	$17.65
Inverse of Visit	$110,469	$18.23
	mean: $88,390	mean: $16.74

Table 3. 11. Double log form sensitivity analysis

Zone	**Aggregate Estimates of CS (using only the sample of visitors)**	**Per-visit Estimates of CS (using only the sample of visitors)**
Asymptotic	$89,451	$17.42
$50	$99,644	$19.67
$100	$227,773	$44.89

Table 3. 12. Total Consumer Surplus Estimates by pond and by functional form

Salt Ponds	Linear	Inverse of Visit	Log-Log	Log-Lin	Lin-Log
Point Judith	$1,153,075	$1,190,966	$1,138,049	$991,709	$995,629
Ninigret	$743,912	$768,358	$734,218	$639,807	$642,336
Quonochontaug	$954,830	$986,207	$942,387	$821,208	$824,454
Total	$2,851,817	$2,945,530	$2,814,654	$2,452,723	$2,462,418

Table 3. 13. Total Consumer Surplus Estimates (Double-log function)

Salt Ponds		Average Daily Users	Number of Days in July and August			CS Estimates	Total User Value Estimates
			subtotal	July	August		
Point Judith	weekdays	856	44	23	21	$17.42	$656,107
	weekends	1537	18	8	10	$17.42	$481,942
	subtotal	2393	62	31	31	$17.42	$1,138,049
Ninigret	weekdays	593	44	23	21	$17.42	$454,523
	weekends	892	18	8	10	$17.42	$279,696
	subtotal	1485	62	31	31	$17.42	$734,218
Quonochontaug	weekdays	820	44	23	21	$17.42	$628,514
	weekends	1001	18	8	10	$17.42	$313,874
	subtotal	1821	62	31	31	$17.42	$942,387
Total	weekdays	2269	44	23	21	$17.42	$1,739,143
	weekends	3430	18	8	10	$17.42	$1,075,511
	subtotal	5699	62	31	31	$17.42	$2,814,654

Box 1. The Travel Cost Approach Questions

VISIT CHARACTERISTICS

1. Which salt pond were you at today (or last time at the salt pond)?
____

2. When was the last time you visited a RI salt pond?______________

3. Approximately how many times did you visit RI coastal salt ponds in the last year? ____________times

4. Where is your hometown?

Village/town/state___________________________

zipcode____________________________________

5. Where did you start from today (your home, place of lodging, etc).
Village/town/state___________________________

zipcode____________________________________

6. Approximately how far did you travel today to get here?___________miles ____________hours:minutes

7. How long did you stay (or are you planning to stay) in total at the salt pond today (or last time at salt pond)

______________________________ hours:minute

8. What do you think about the size of the parking lot here?

□ too small □ too large □ about right

Why do you think so? Please write down what you think?

Note: Box shows the questions asked to respondents about the information on their travel to each Salt Pond. For the Conjoint Analysis Approach, the hypothetical questions were asked to elicit respondents' preference in a separate section, and will be described in following chapter. Survey questionnaire is shown in Appendix.

Appendices

Appendix A. Survey Questionnaire

Thank you for taking the time
to answer this survey.

Your responses are very important

Salt Pond

Recreation Activity and Water Quality Improvement Survey

UNIVERSITY OF
Rhode Island

The goal of this study is to determine the economic value of improving water quality for coastal salt ponds in Rhode Island and to include public opinions in decisions to manage the coastal salt ponds.

Your opinions are very important

All answers are confidential

BACKGROUND INFORMATION

This information presents the comparison of water quality in 1990 (25 years ago) and that in 2015 in Salt Ponds. This information may help you answer the questions on the next few pages. **(Source: http://www.saltpondscoalition.org)**

POND	Approximate Water Quality in 1990 (25 years ago)	Trend	Approximate Water Quality in 2015 (Now)
Point Judith	EXCELLENT	↘	FAIR
Potter	EXCELLENT	↓	POOR
Green Hill	FAIR	↘	POOR
Ninigret	EXCELLENT	↘	FAIR
Quonochontaug	EXCELLENT GOOD	↘	GOOD FAIR
Winnapaug	GOOD	↘	FAIR

Water Quality	Characteristics
EXCELLENT	Pristine Appearance, Swimmable, Boatable, Bodily Contact O.K
GOOD	Swimmable, Boatable, Bodily contact O.K
FAIR	Swimmable, Boatable, Bodily Contact NOT O.K
POOR	Boatable, Bodily Contact NOT Safe, Odor

Your thoughts about the experiences in Salt Ponds
(Please Check Appropriate Response in the table below)

What do you think about the place you spent the most time today (or last time on the salt ponds)?						
Pond Features	Very Undesirable	Slightly Undesirable	Neither Desirable Nor Undesirable	Slightly Desirable	Very Desirable	N/A
Water Quality						
Parking Lot Size						
Amount of Trash						
Amount of Noise						
Amount of Wild Life						
Scenery Around						
Accessibility to the Pond						

Your Choice of Recreation Site

On the following two pages, you are asked to choose one recreation site on each hypothetical scenario

We are trying to understand how people choose among different sites to recreate.

Below we describe different hypothetical scenarios.

- For each question, choose which of the three sites you would prefer to go to if you could only select one of the three sites that are described
- **Consider each question separately. Do not add them up.**
- With your choice, we try to learn
  - How important water quality is to you
  - How water quality affects your recreation site choice
  - How much you would pay to improve the water quality

1. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality 	**FAIR** 	**GOOD** 	**EXCELLENT** 
Travel Distance 	20miles(30min) 	80miles(2 hr) 	80miles(2 hr) 
Crowded Level 	**Not Crowded** (30 people/0.1 acre) (144 sf/person) 	**Not Crowded** (30 people/0.1 acre) (144 sf/person) 	**Not Crowded** (30 people/0.1 acre) (144 sf/person) 
Admission Fee per visit 	**$0**	**$0**	**$20**

2. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality 	**FAIR** 	**GOOD** 	**EXCELLENT** 
Travel Distance 	20miles(30min) 	20miles(30min) 	20miles(30min) 
Crowded Level 	**Not Crowded** (30 people/0.1 acre) (144 sf/person) 	**Not Crowded** (30 people/0.1 acre) (144 sf/person) 	**Overcrowded** (121people/ 0.1 acre)(36 sf/person) 
Admission Fee per visit 	**$0**	**$20**	**$20**

3. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality	POOR	FAIR	EXCELLENT
Travel Distance	80miles(2 hr)	80miles(2 hr)	80miles(2 hr)
Crowded Level	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)
Admission Fee per visit	**$ 0**	**$20**	**$20**

4. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality	POOR	FAIR	EXCELLENT
Travel Distance	20miles(30min)	80miles(2 hr)	20miles(30min)
Crowded Level	Medium (68 people/ 0.1 acre (64sf/person	Overcrowded (121people/ 0.1 acre)(36 sf/person)	Overcrowded (121people/ 0.1 acre)(36 sf/person)
Admission Fee per visit	**$ 0**	**$20**	**$20**

Appendix B

Linear function

In linear function, demand function is that visit rate = 107.33 - 2.33* travel cost. By rearranging the equation and setting visit rate equal to zero, choke price is obtained: zero visit rate = 107.33 - 2.33* choke price (choke price = 46.02). To get consumer surplus, linear demand function is integrated between the actual travel cost of $10.13 and the obtained choke price of $46.02.

$$CS = 107.33 - 2.33 \int_{10.13}^{46.02(p.choke)} (tc)\ dtc$$

Inverse of Visit Frequency Function

In inverse of visit ~~frequency~~ function, demand function is that inverse of visit frequency = 13.94 – 0.26* travel cost. By rearranging the equation and setting visit frequency equal to zero, choke price is obtained: zero visit frequency = 13.94 – 0.26* choke price (choke price = 54.26). To get consumer surplus, inverse of visit frequency demand function is integrated between the actual travel cost of $10.13 and the obtained choke price of $54.26

$$CS = 13.94 - 0.26 \int_{10.13}^{54.26(p.choke)} (tc)\ dtc$$

Linear-log function

In linear-log function, demand function is that visit. rate = 247- 66.47 * ln (travel. cost). Likewise, I rearrange the equation and set up visit rate equal to zero to get choke price, zero visit rate = 247- 66.47 *ln (travel. cost) and the choke price is 41.1 dollars.

$$CS = 247- 66.47 \int_{10.132}^{41.1(p.choke)} ln(tc)\ dtc$$

Log-linear function,

Ln (visit. rate) = 4.884 - 0.078(travel. cost)

visit. rate = exp $\{\beta_0 + \beta_1(\text{travel. cost})\}$ = $e^{4.884} * e^{-0.078(\text{travel. cost}))}$

As visit. rate approaches zero, choke price approaches infinite. Integrating and taking limit gives

$$CS = \frac{-e^{4.884}}{-0.078} * e^{-0.078(travel.cost)}$$

Log-log Function

It is not possible to obtain a zero level of visitation when demand function is a logarithmic function since exponential curve is asymptotic to the price axis. As price approaches infinite, visit rate approaches zero.

Ln (visit. rate) = 8.35 – 1.84* ln (travel. cost)

visit. rate = exp {8.35 – 1.84*ln (travel.cost)} = $\exp^{8.35} * (\text{travel.cost})^{-1.84}$

To get consumer surplus, we take an integral between the actual price and an infinite price.

$$CS = e^{8.35} * \lim_{p \to \infty} \int_{p.actual.price}^{p.choke} tc^{-1.84}\, dtc$$

$$CS = \left[\frac{e^{8.35}}{-0.84}\right] * \lim_{p \to \infty} \left[(p.choke)^{-0.84} - (p.actual.price)^{-0.84}\right]$$

Since β_1 is less than -1, $\lim_{p \to \infty} \left(p^{choke}\right)^{\beta_1+1}$ is zero and the CS becomes

$$CS = \frac{e^{8.35}}{-0.84} * \left(-p.actual.price^{-0.85}\right)$$

Chapter Four. Conjoint Analysis

This chapter discusses application of a Stated Preference Survey for valuing changes in recreation site attributes including water quality and congestion by estimating the impact of different levels of the attributes on the probability of selecting an alternative. This chapter is organized as follows. The first section provides an introduction on Conjoint Analysis of Stated Preference Method, and the second section lay out literature review of Conjoint Analysis including strengths and limitation of Conjoint Analysis. The third section outlines the conceptual frame of how discrete choice models are applied to Conjoint Analysis. Multinomial Logit Model, Multinomial Probit Model, and Mixed Logit Model are used to estimate the probability that a respondent will choose a specific alternative through the maximum likelihood estimator. Then application section describes survey development and implementation and data collection. Model specification and the empirical analysis section is followed by results and conclusion.

4.1. Introduction

The purpose of this chapter is to estimate the impacts of water quality and congestion to the user day value for recreation on the Rhode Island Coastal Salt Ponds. The previous section described an application of the Travel Cost Method to estimate user day values for Salt pond recreation. However, the Travel Cost Method could not estimate welfare effects associated with water quality or congestion. Hence, we apply Conjoint Analysis Approach in Stated Preference Method to measure welfare effects of qualities of the recreational experience, in particular, water quality and congestion. Conjoint Analysis is widely used State Preference Method in non-market valuation, and allows us to construct hypothetical scenarios on the attributes of Salt Ponds with associated to quality change (Adamowicz, Boxall, Williams, & Louviere, 1998; Dumas, Schuhmann, & Whitehead, 2005; Hanley, Shogren, & White, 2013). For example, Conjoint Analysis provides a choice set with the attributes of the recreation sites that mimic the actual travel site and ask respondents to choose the one that gives the maximum utility (Hanemann & Kanninen, 1999; Adamowicz, Lourviere, & Williams, 1994; Ryan & Farrar, 1994). Hence, Conjoint Analysis may be argued to provide a more natural approach for valuing the non-market goods since the choice set mimics the actual recreation site (Melichar & Scasny, 2004; Stevens, Belkner, Dennis, Kittredge, & Willis, 2000; Adamowicz et al., 1994).

Conjoint Analysis Method is consistent with the Random Utility Theory which assumes that a respondent chooses the most preferable choice out of the choice set to maximize their utility (MacFadden 1986). From observed factions of choices by respondents, probability that a respondent chooses the specific alternative (recreation site) is calculated. Depending on the assumption on the error term, different models are applied to estimate the probability of the choice made by the respondent using Multinomial Logit Model (MNL) to Multinomial Probit Model(MNP) and Mixed Logit Model (MXL) (Train, 2009).

In general, Multinomial Logit Model (MNL) assumes that the error terms are independently and identically distributed (IID) and follow a Gumbel Distribution (Train, 2009). In Multinomial Logit Model (MNL), Independence of Irrelevant Alternatives(IIA) is implied that relative values of choice probabilities between two alternatives do not change when a third alternative is added or removed. If IIA assumption does not hold in

Multinomial Logit Model (MNL), we have to allow the alternatives to be correlated. In order to relax IIA condition, Multinomial Probit Model is introduced (Train, 2009). Multinomial Probit Model assumes that error terms are normally distributed and relaxes IID condition in error terms (Train, 2009).By estimating the parameter coefficients using Multinomial Probit Model (MNP), which allows choice alternatives to be correlated, independence of measurement of preferences over alternatives can be relaxed (Haaijer, 1999; McFadden, 1986; Train, 2009). Multinomial Probit Model (MNP) assumes that error term is normally distributed (Train, 2009). However, unobserved factors may not be normally distributed; unobserved factors for a desirable attribute of a recreation site may be positive resulting in non-normal distribution (Train, 2009). To address this issue, we apply Mixed Logit Model that allows the unobserved factors to follow any distribution (Train, 2009). In Mixed Logit Model (MXL), varied functional forms on cumulative distribution of error tem is applied to derive the expected utility function. The parameters of the probability function are estimated using maximum likelihood methods with the Multinomial Logit Model(MNL), Multinomial Probit Model (MNP), and Mixed Logit Model (MXL) (Lee, 2012; Train, 2009). And then marginal willingness to pay for a specific attribute, for instance, water quality, is computed (Gan & Luzar, 1993; Koppelman & Bhat, 2006). This research helps to draw inferences about preference about changes in recreation site attributes including water quality and congestion by estimating the impact of different levels of the attributes on the probability of selecting an alternative.

4.2. Literature Review

This chapter provides theoretical background of the Conjoint Analysis Method, which is an example of a Stated Preference Approach to inferring values. See Carson & Hanemann (2005), Mitchel and Carson (1989), Boxall, Adamowicz, Swait, Williams, and Louviere (1996), Bateman et al., (2002), and Brown (2003) for a broader review of stated preference methods. Contingent Valuation Method and Conjoint Analysis Method are the two widely used Stated Preference Method.

Contingent Valuation Method is a stated Preference Method that asks individuals the most they would be willing to pay for some hypothetical commodity and Conjoint Analysis is a choice-based approach that infers preferences by observing choices among hypothetical commodities that differ in terms of attributes (Carson & Hanemann, 2005). This chapter focuses on Conjoint Analysis Method. Conjoint Analysis Method was first introduced by Luce and Tukey in the mathematical psychology literature (Harpman, 2008; Luce & Tukey, 1964) and originally was applied in marketing field to analyze consumer choice based on the attributes of products (Gan & Luzar, 1993; Green & Rao, 1971). For a more comprehensive review of Conjoint Analysis, see Harpman (2008), Ryan & Farrar (2000), and Green, Krieger, and Wind (2001).

Conjoint analysis is a survey-based approach that describes commodities in terms of a set attribute, and ask respondents to rank, rate or choose among the alternatives; contingent ranking format requires individuals to rank alternatives from most to least preferred and contingent rating format asks individuals to rate the alternatives based on pre-specified scale. Choice Experiment format asks individuals to choose the most preferable alternatives based on the attributes and characteristics given in the choice set (Harpman, 2008; Adamowicz et al., 1998; Holmes & Adamowicz, 2003). Choice Experiment approach in Conjoint Analysis is sometimes termed the contingent behavior approach. We interpret these two terms synonymous and use it as choice experiment approach. Choice Experiment Approach in Conjoint Analysis is similar to Contingent Valuation Method in many ways, except that responses are framed as choices among alternatives, rather than willing to pay for a particular commodity.

As a stated preference method, Conjoint Analysis Method allows the research to present hypothetical alternatives that have attribute levels that are not present in actual sites. For example, Conjoint Analysis Method allows one to assess improvements in site quality on the recreation site like water quality and congestion (Cattin & Wittink, 1989; Gan & Luzar, 1993). This study uses the choice experiment approach in Conjoint Analysis to capture the preference made by a respondent and then quantify the respondent's marginal willingness to pay of each level of each attribute.

The choice experiment approach in Conjoint Analysis Method employed in this chapter may be argued to frame the decision in a more familiar environment, as respondent is asked to choose among alternative sites that mimic the actual choice of travel sites, thereby removing the need to indicate a dollar value for the experience. Choice experiment approach in Conjoint Analysis may reduce strategic bias because the variety of choice sets obscures the policy options being evaluated (Hanemann and Kanninen 1999; Adamowicz et.al., 1994: Ryan & Farrar, 2000).

In principle, Conjoint Analysis can be applied to complex commodities involving a large number of attributes. However, an excessive number of attributes can complicate the tasks for respondents, possibly confusing respondents and reducing the quality of statistical analysis (Mangham, Hanson, & McPake, 2009; Holmes & Adamowicz, 2003). Given with greater number of attributes, the respondents may simply pick the choice based on a single or subset of attributes due to cognitive difficulty of completing a too complicated questionnaire that may cause a violation of neoclassical theory (Mazzotta & Opaluch, 1995; Mangham et al., 2009). Hence, through a pretest of the survey instrument is essential. Some have recommended keeping the number of attributes to fewer than 10 to keep the task manageable (DeShazo and Fermo, 2002; Mangham et al., 2009).

Then, Statistical methods are applied to the resultant data to estimate the relative importance of the attributes; if cost is one of the attributes, then the Conjoint Analysis Method can be used to estimate the monetary value that respondents place on changes in an attribute (Gan & Luzar, 1993; Dumas et al., 2005; Louviere 1988; Adamowicz et al., 1998; Holmes & Adamowicz, 2003; Lee, 2012).

4.3. Conceptual Frame

Conjoint analysis employs Random Utility Model (RUM) in which an individual is asked to choose a specific site from a given hypothetical finite choice set including attributes of the recreation site (Adamowicz et al., 1998; McFadden, 1986; Swallow, Weaver, Opaluch, & Michelman, 1994). Within the Random Utility Model (RUM) framework, this chapter compares Multinomial Logit Model (MNL), Multinomial Probit Model(MNP), Mixed Logit Model(MXP).

4.3.1 Multinomial Logit Model (MNL)

Multinomial Logit Model (MNL) is used when the dependent variable is unordered response variable such as the selection of a mode of transportation or a recreation site choice based on its attributes. The MNL model is consistent with the RUM model in that an individual maximizes their utility by choosing the most preferred alternative out of choice set (Louviere, 1988; Lee, 2012; MacFadden, 1974). Random Utility Model developed by McFadden states that an individual's utility (U_i) can be divided into an observable deterministic component (V_i) and an unobservable random stochastic component (ε_i) (McFadden, 1974; Holmes and Adamowicz, 2003; Lee, 2012). A deterministic element is a linear combination of the attributes (R) of the j different alternatives

$$U_{mj} = V_{mj} + \epsilon_j \quad \ldots\ldots(1)$$

$$V_{mj} = \beta R_{mj} \quad \ldots\ldots(2)$$

where U_{mj} is the true but unobservable indirect utility of mth person associated with choice alternative j, V_{mj} is an observable deterministic component of mth person, and ϵ_j is a random error term of mth person not observable to the researcher. R_{mj} is the attributes that is associated with an alternative j that mth individual chooses, and β is parameters.

The probability of a m^th individual's most preferred alternative j, is derived as the probability that the utility with alternative j is greater than any utilities with any other alternatives (k) in the choice set (McFadden, 1973; Lupi 2005; Morey 1999; Ali 2008; Freeman 1995; Mazzotta and Opaluch, 1995).

$$P(U_{mj}) > P(U_{mk}) \qquad \forall \ j \neq k \text{..(3)}$$

$$P(V_{mj} + \epsilon_{mj}) > P(V_{mk} + \epsilon_{mk}) \text{..(4)}$$

$$P(\epsilon_{mj} - \epsilon_{mk}) > P(V_{mk} - V_{mj}) \text{..(5)}$$

To estimate the model, a probability distribution for the disturbance term must be chosen. Multinomial Logit Model assumes that error term is extreme value distributed (Gumbel distributed) and independently and identically distributed (IID). (MacFadden, 1986; Koppelman and Bhat, 2006; Train, 2009).

$$F(\epsilon) = exp\{-exp[-\epsilon)] \text{..(6)}$$

[Figure 4.1.a about here]

[Figure 4.1.b about here]

Given assumption of error term with Gumbel distribution, multinomial logit model denotes the probability of a specific alternative j chosen as the most preferred alternative as below (Train, 2009).

$$Probability_{mj} = \frac{expV_{mj}}{\sum_{k=1}^{K} expV_{mk}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(7)$$

where $Probability_{mj}$ is the probability of the individual, m, choosing alternative j and V_j is the systematic component of the utility of alternative J (Koppelman and Bhat, 2006; Train, 2009).

The deterministic component of the utility function, V_{mj}, is linear in parameters. Thus, probability of individual, *m,* to choose the site, *j,* is expressed as:

$$Probability_{mj} = \frac{exp\ (\beta' z_j + \alpha' s_m)}{\sum_k exp\ (\beta' z_k + \alpha' s_m)} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(8)$$

where z is a vector of attributes of the choice and the subscript j is the recreation site chosen, P_{mj} is the probability that m^{th} individual will select the j^{th} recreation site; s_m is the vector of characteristics of individual m; and $\beta\ and\ \alpha$ are vectors of parameters to be estimated (MacFadden, 1973; Tay and MaCarthy, 1994; Train, 2009).

This probability equation can be expressed in a different form. For instance, a respondent chooses an alternative 1, the numerator and denominator of the standard probability expression, $exp(-V_{alternative1})$ can be multiplied.

$$Pr(j) = \frac{1}{1+\sum_{j\neq k}\exp(V_j - V_k)} \quad \forall \quad j \neq k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Then we can interpret the remaining parameters to represent difference relative to the base alternative, for example $alternative$ (1) (Koppelman and Bhat, 2006; Train, 2009).

The parameter coefficients of the probability function are estimated through a maximum likelihood procedure by taking a first derivative of the log-likelihood function to fit a model that best explains the choices made by respondents (Lee, 2012; Train, 2009). We can write down likelihood function of Multinomial Logit Model as below:

$$L\ (\beta) = \Pi_{m=1}^{M} \prod_{j\in C} P_m(j)_{jm}^{y} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(10)$$

where β is a vector of the parameters of the model, m is each respondent who makes the choice, and j is the choice made by the respondent out of choice set (C). P_m is the probability that the individual m chooses alternative, j. y is the indicator variable, y =1 if a respondent, m, chooses alternative, j, and y = 0, otherwise.

Then we take a Log-likelihood function

$$LL\ (\beta) = \Sigma_{m=1}^{M} \sum_j y_{mj}\ lnP_{mj} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

$$\text{LL}(\beta) = \Sigma_m \Sigma_j y_{mj} \ln \frac{e^{\beta\prime x_{mj}}}{\Sigma_k e^{\beta\prime x_{mk}}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

In order to maximize the likelihood function with respect to the coefficients ($\beta's$) in this function, we take a derivative of log-likelihood function with respect to each of the parameter and set it equal to zero.

$$\frac{dLL(\beta)}{d(\beta)} = \frac{\Sigma_m \Sigma_j y_{mj}(\beta\prime x_{mj})}{d(\beta\prime)} - \frac{\Sigma_m \Sigma_j y_{mj} ln(\Sigma_k e^{\beta' x_{mk}})}{d(\beta\prime)}$$

$$= \Sigma_m \Sigma_j y_{mj}(x_{mj}) - \Sigma_m \Sigma_j y_{mj} \Sigma_k p_{mk} x_{mk}$$

$$= \Sigma_m \Sigma_j y_{mj}(x_{mj}) - \Sigma_m (\Sigma_k p_{mk} x_{mk}) \Sigma_j y_{mj}$$

$$= \Sigma_m \Sigma_j y_{mj}(x_{mj}) - \Sigma_m (\Sigma_k p_{mk} x_{mk})$$

$$= \Sigma_m \Sigma_j (y_{mj} p_{mj})\, x_{mj} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

where p_{mj} is the probability of an individual m chooses an alternative m and x_{mj} is the attributes of the site j an individual m chooses. Then, this maximum likelihood estimates are the values of $\beta's$ that satisfy this first-order condition (Train, 2009; Koppelman & Bhat, 2006).

With the estimated parameter coefficients ($\beta's$) through maximum likelihood procedure, marginal Willingness To Pay for an attribute in each level is derived from the marginal rate of substitution between each attribute and cost attribute (Lee, 2012).

$$\text{Marginal WTP} = [-\frac{\frac{dU}{\beta_k}}{\frac{dU}{\beta_c}}] = -(\frac{\beta_k}{\beta_c}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

Where β_k is the parameter coefficient for the non-market attribute, β_c is the parameter coefficient for the monetary payment vehicle that includes cost.

Economic theory suggests that individual's WTP might interact with income. Individual's WTP will increase as their income go up. According to Foster & Mourato (2000), the income effect can be estimated by using an interaction between income and one or more site attributes, which express cost attribute as a function of individual's income (Y), as given below. The so-called income interaction model (Bae, 2017: Foster & Mourato, 2000) has utility of the form:

$$U_{ij} = \beta_{cost} * Cost_{mj} + \beta_{income} * \frac{cost_{mj}}{income_m} + \beta_{attribute} * X_{mj} + \epsilon ..(15)$$

This implies a marginal willingness to pay for attribute j of the form:

$$MarginalWTP = \frac{\frac{dU_{mj}}{dz_{mj}}}{\frac{dU_{mj}}{dC_{mj}}} = \frac{\beta_{attribute}}{\beta_{cost}+(\beta_{income/INCOME_m})} \quad \text{................(16)}$$

Independence of Irrelevant Alternative (IIA)

However, the choice probabilities of Multinomial Logit Model may suffer from the well-known problem of independence of irrelevant alternatives (IIA). What IIA says is that the ratio of choice probabilities for j and k ($\frac{exp(V_j)}{exp(V_k)}$) are unaffected by the attributes of other alternatives. For example, when a particular site improves, the decrease of probabilities in other sites will be spread out so as to preserve the pre-existing ratios between unchanged sites (Lupi, 2005). The ratio of choice probabilities for j and k can be generalized to any pair of alternatives.

$$\frac{Pr(j)}{Pr(k)} = \frac{exp(V_j)}{exp(V_k)} = exp(V_j - V_k) \quad \text{..(17)}$$

In the standard Multinomial Logit model, the ratio of probability for a pair of alternatives depend only on the attributes of those alternatives and not on the attributes of any other alternative (Koppelman and Bhat, 2006: Train, 2009).

However, the IIA property may not properly reflect the behavioral relationship among groups of alternatives. The third alternative may be relevant to the ratio of probabilities between a pair of alternatives. As illustrated with the classic read bus-blue bus problem (McFadden, 1973), assume that there are two choice options between auto and blue bus such that the probability of choosing the auto is two thirds and the blue bus is one third. Thus, the ratio of these two choice probabilities is 2:1. Now, suppose red bus with the exact same quality is introduced with a red color. The most reasonable expectation, in this case, is that the same share of people will choose auto and bus, but bus riders will split equally between the red and blue bus. Because the addition of the red bus to the commuter's choice set should have no effect on the share of commuters choosing auto since this change does not affect the relative quality of drive a car and bus. Therefore, we expect choice probabilities following the initiation of red bus service to be auto, two-thirds, blue bus, one sixth, and red bus, one-sixth (Koppelman and Bhat, 2006).

However, due to the IIA property, the multinomial logit model will maintain the relative probability of auto and blue bus as 2:1. If we assume that people are indifferent to color of their transit vehicle, the two bus services will have the same representative utility. Consequently, their relative probabilities will be 1:1 and the probabilities for the three alternatives will be $Pr(Auto) = \frac{1}{2}$, $\Pr(blueBus) = \frac{1}{4}$ and $Pr(RedBus) = \frac{1}{4}$. Consequently, probability of choosing auto will decline from $\frac{2}{3}$ to $\frac{1}{2}$ as a result of introducing an alternative which is identical to an existing alternative (Koppelman and Bhat, 2006). This arises the problem because of correlation among error terms across alternatives. In the example above, the error terms likely include unobservable characteristics that the red bus and blue bus have in common, but that differ from those for the car. A person who prefers to travel by car rather than by the blue bus is likely to also prefer travel by the car over travel by the red bus. Conversely, a person who prefers traveling by the blue bus rather than the car is also likely to prefer traveling by the read bus rather than the car. To deal with the case of violation of IIA, different models that allow for correlated errors such as Multinomial Probit Model (MNP) and Mixed Logit Model (MXL) Models are introduced.

4.3.2 Multinomial Probit Model (MNP)

In Multinomial Logit Model, we assumed that errors are independent of each other, which means that the unobserved portion of utility for one alternative is uncorrelated with the unobserved portion of utility for another alternative (Train, 2009, p 35). Multinomial Probit Model(MNP) relaxes the IID assumption in error terms (Train, 2009, p. 35). Again, in Multinomial Probit Model(MNP), utility is expressed as deterministic term and the error term and the error terms are assumed to be normally distributed. Probability density function of error term (ϵ) is

$$U_{mj} = V_{mj} + \epsilon_{mj} \quad \text{………………………………………………………….(18)}$$

$$\phi\ (\epsilon) = \frac{1}{(2\pi)^{\frac{j}{2}}(\Omega)^{\frac{1}{2}}} * e^{\frac{-1}{2}\epsilon\prime\Omega^{-1}\epsilon} \qquad \text{…………………………………………..(19)}$$

where $\phi(\epsilon)$ is the probability density of the error term, and Ω is covariance of error terms across observations, and j is the number of alternatives. As can be seen, correlation among error terms can be accounted for in the multinomial Probit model, although doing so requires imposing structure on the covariance matrix.

Then the probability that the J^{th} alternative to be chosen by m^{th} individual is

$$P_{mj} = \int I\big(V_{mj} + \epsilon_{mj} > V_{mk} + \epsilon_{mk}\ ,\forall\ j \neq k\big)\phi(\epsilon_m)\mathrm{d}\epsilon_m \qquad \text{……………….(20)}$$

$$P_{mj} = \int_{-\infty}^{\beta x_j}(2\pi)^{-1/2}\ \exp\ (\frac{z^2}{2})\ \mathrm{dz} \qquad \text{……………………..…………(21)}$$

$$\mathrm{Z} = (x_{j,}\ \beta)$$

where the integral is over all values of individual error term, ϵ_m, and $I(\cdot)$ is an indicator of whether the statement in parentheses holds (Train, 2009, p. 98). The integral term does not have a closed form so that it is evaluated using simulation methods.

The marginal effect that changes in attribute x on the probabilities of the j^{th} outcome depends on the functional form linking p_m and $x_m\beta$.

$$\frac{\partial p_{mj}}{\partial x_{mj}} = \frac{\partial F(x_{j,}\ \beta)}{\partial x_{mj}}$$

$$= f\ (x_j\ ,\beta)\ \beta_j \quad = (2\pi)^{-1/2} \exp\left[-\frac{1}{2} (x_{m.}\beta)^2)\right] \beta_j \ \ldots\ldots\ldots\ldots(22)$$

where F $(x_m\ ,\beta)$ is the cumulatiative distribution function and f $(x_m\ ,\beta)$ is the probability density function. Then maximum likelihood estimates of these derivatives are obtained by replacing the unknown β by Maximum Likelihood estimate.

The primary advantage of Multinomial Probit Model (MNP) is that the unobserved factors may be correlated over time and over alternatives; MNP can accommodate the correlation (Train, 2009). This seems to be the overlying advantage, and panel data is one example where error terms can be correlated (Train, 2009).

One limitation of Multinomial Probit Model(MNP) is that MNP model imposes normality on error terms, which may or may not be a good approximation to reality in any particular case. For example, normality implies symmetry about the mean, and as a two parameter distribution, it has limited flexibility. The tails of the normal distribution are necessarily infinite in length, which could result in a violation of a known non-negativity constraint (Train 2009, p. 97).

In order to deal with the limitation on the error term distribution in Multinomial Probit Model (MNP), Mixed Logit Model (MXL) is applied.

4.3.3 Mixed Logit Model (MXL)

Mixed logit is a highly flexible model that can follow any distribution, so it can approximate any Random Utility Model (McFadden & Train, 2000). Let's assume that a sampled individual *m* faces a choice among *j* alternatives in each of T choice occasion and the individual is assumed to consider the full set of offered alternatives in choice occasion t. The utility associated with each alternative *j* is represented like below (Hensher & Greene, 2003):

$$U_{mjt} = \beta'_{m} x_{mjt} + \varepsilon_{mjt} \quad \ldots\ldots (23)$$

Where x_{mjt} is a vector of explanatory variables that are observed by the researcher such as attributes of alternatives, socio-economic characteristics of the respondent in choice situation *t*. The components that are not observed by the researcher are treated as stochastic influences (Hensher & Greene, 2003). In Mixed Logit Model, error term is divided into two parts. One part is correlated over alternatives and heteroskedastic, and another part is IID over alternatives and individuals (Hensher & Greene, 2003).

$$\varepsilon_{mjt} = \eta_{mjt} + \delta_{mjt} \quad \ldots\ldots (24)$$

Where η_{mj} is a random term with zero mean whose distribution over individuals and alternatives depends on underlying parameters and observed data. Although η_{mj} is an unobservable attribute that is potentially individual specific and alternative specific. This attribute also has its own unobservable parameters which are potentially individual specific, but not alternative specific. This allows the error component to be correlated across alternatives. δ_{mjt} is a random term with zero mean that is IID over alternatives and individuals (Hensher & Green, 2003; Train, 2009).

Like Multinomial Probit (MNP) model, it allows random taste variation, unrestricted substitution patterns, and correlation in unobserved factors over time. Mixed Logit Model is not restricted to normal distribution unlike MNP model (Train, 2009). Thus, Mixed Logit Model can be derived under a variety of different behavioral specifications, and the Mixed Logit Model is defined on the basis of the functional form for its choice probabilities. Mixed Logit probabilities are the integrals of standard logit probabilities over a density parameters (Train, 2009).

$$P_{mj} = \int L_{mj} (\beta)\, f\, (\beta)\; d\beta \quad \text{....(25)}$$

$$L_{mj}(\beta|\eta) = \frac{exp\,\{V_{mj}\,(\beta\,)\}}{\sum_k\; exp\,\{\,V_{mk(\beta}\,)\}} \quad \text{....(26)}$$

$$V_{mj}(\beta) = \beta`_m\, x_{mj} + \eta_{mj} \quad \text{.... (27)}$$

Where $L_{mj}\,(\beta)$ is the logit probability evaluated at parameters β and $f\,(\beta)$ is a density function that is called a mixed function and plays as a weighted average of the logit formula evaluated at different values of β. The density of $f\,(\beta)$ is called mixing distribution. Thus, Mixed Logit Model is a mixture of the logit function evaluated at different $\beta's$ with $f\,(\beta)$

as the mixing distribution (Train, 2009; Hensher & Green, 2003). Mixing distribution can take forms such as normal, lognormal, triangular, uniform or gamma. When mixing distribution ($f\ (\beta)$) is equal to 1 for $\beta = b$, then the model becomes the standard logit model. Mixing distribution is equal to 0 for $\beta \neq b$. $V_{mj}(\beta)$ is a portion of utility, which depends on parameters β (Train, 2009, Hensher & Green, 2003).

When mixing distribution $f\ (\beta)$ is discrete, the mixed logit model becomes the latent class model and the choice probability is given below. If β takes n possible values labeled $b_1, b_2, ... b_n$ with probability s_n that $\beta = b_n$

$$P_{mj} = \sum_{n=0}^{N} s_n \left(\frac{e^{b'_n x_{mj}}}{\sum_k e^{b'_n x_{mk}}}\right) \quad (28)$$

When mixing distribution $f\ (\beta)$ is continuous, the density of β can be specified. If the density of β is specified to be normal with mean b and covariance W, the choice probability under this density is given below (Train, 2009).

$$P_{mj} = \int \left(\frac{exp\,\{V_{mj}\,(\beta\,)\}}{\sum_k\ exp\,\{\,V_{mk(\beta}\,)\}}\right) \phi\ (\beta \mid \text{b, W})\ d\,\beta \quad (29)$$

Where $\phi\ (\beta \mid \text{b, W})$ can be lognormal, uniform, triangular or any other distribution with mean b and covariance. The lognormal distribution is useful when the coefficient is known to have the same sign for every decision maker such as a price coefficient. The uniform distribution tells the coefficient is distributed uniformly between b - s and b + s where b is mean and s is spread. Triangular distribution has the form of b – s and b + s as with the uniform, but density is the shape of triangle instead of flat in uniform distribution. The triangular distribution bounds both sides so that it can avoid having unreasonably large coefficients as in lognormal and normal distribution (Train, 2009).

Hence, the Mixed Logit Model has the advantage of allowing correlations among alternatives and choice occasions, similar to the Multinomial Probit Model. However, the Mixed Logit Model also has the advantage of not imposing any single statistical distribution for the error terms. Rather Mixed Logit Model allows the researcher to select the distributions that conforms best to the underlying data and/or that incorporate theoretical considerations, such as any non-negativity constraints.

This chapter reviewed three of the most commonly used discrete choice models that are applied in recreation economics literature. Below we apply each of these models to a choice experiment survey, that presents respondents with different hypothetical salt pond recreation sites, expressed in terms of their attributes: water quality, congestion, distance to the site and admission fee. The goal of the analysis is the two-fold. First we use the stated preference survey to calculate welfare effects of changes in salt pond water quality. Next we use the results for the out-of-pocket cost of the admission fee to calibrate the opportunity cost of time, as determined by distance to the site.

4.4. Application and Model Specification

Application

A survey of recreational Salt Pond users was carried out in order to assess the values of Salt Pond attributes, including water quality and congestion, on the recreational user day value. The survey contained conjoint analysis questions, where hypothetical scenarios of salt pond attributes were described to the recreationists, who were then asked to choose the one they prefer the most. The following sections discuss the survey development, survey design and implementation, and a summary of the data collected.

We followed a rigorous survey development process in order to construct a survey that was understandable to respondents, and that could elicit values for important Salt Pond attributes that respondents cared about. The process started with in-person interviews of the regular users of the Salt Ponds as a sailing group, the employees in marinas who manages regular boating groups in the Salt Ponds and regular quahog and fishermen. These person-to-person interviews allowed us to learn about the important characteristics of the Salt Ponds, which Salt Pond users cared. We used interviews to identify the following.

1) The important attributes to be used in the hypothetical recreational user scenarios in Salt Ponds and the levels of these variables

2) The reasons recreationists come to Salt Ponds and the alternative recreational sites

3) The payment vehicle to be used in the hypothetical recreational use scenarios: annual/monthly fee or the daily parking fee

After in person interviews, pretest of preliminary survey was conducted in December 2014 and January of 2015 to 124 respondents that included avid Salt Pond users, graduate and undergraduate students who used Salt Ponds and boat club members and employees of yacht clubs. The goal of this preliminary survey was to obtain the insight on how respondents make decisions under the given multiple attributes recreation site scenarios.

For this preliminary survey, five attributes were grouped to present hypothetical recreational visit scenarios. At these preliminary surveys, respondents claimed that 5 attributes and 4 levels in each attribute are complicated to understand in making the choice decision. The response of the preliminary survey suggested that recreational users were not familiar with multi-attributes hypothetical scenarios so that survey questionnaire was refined by reducing both the number of variables and levels from five to four attributes and the levels of each variables from four levels to three levels except for the water quality that was already set on the regulation of EPA.

From our in-person interviews, we identified 5 Salt Pond attributes: water quality, congestion, distance, parking lot size and entrance fee. However, from our interviews, we learned that respondents inferred a relationship between parking lot size and the level of congestion such that anticipated congestions would increase with parking lot size, despite the fact that there was a separate attribute for the level of congestion. In order to avoid this complication, we dropped parking lot size as an attribute, and instead simply used congestion level.

Water Quality

Four different levels of water quality were identified following EPA regulation: "excellent", "good", "fair", and "poor." "Excellent" water quality means that people can do water-contact activities and drink. "Good" water quality means people can do water-contact activities, but cannot drink. For example, people can contact to water while boating and fishing. "Fair" water quality means people can boat but internal bodily contact with water is not safe. Lastly, "poor" water quality means people can boat, but cannot swim and poor water quality generates visible turbidity through eutrophication and generates odor. We focused on water clarity as an indicator of water quality, and used a color printed depiction showing a Secchi disk to indicate clarity: With a standardized Secchi disk (Figure 4. 2), an onboard observer measures a depth of water to which a Secchi disk is visible and the visible depth from the surface of the water is reported in units of meters (The SecchiDip-in, 2017)

[Figure 4.2. about here]

Although water clarity is not a perfect measure of water quality, as it only measures water clarity, it is often argued to be the only indicator that the general public is able to directly perceive. (Ge, Kling, & Herriges, 2013; Brashres, 1985; Feenberg, 2000; Steinnes: 1992). Secchi disk depth is also highly correlated with eutrophication, which is a major water quality problem in the Salt Ponds, thereby Secchi disk depth can be argued to be a good proxy for perceivable water quality (Lee and Olsen, 1985). Brashares considered 8 different measures of water quality for 78 lakes in southeast Michigan and found that only turbidity and fecal coliforms were significantly correlated with property prices. Fecal coliforms were not visually perceptible, but were monitored and were reported to potential property buyers by the state board so that people were only aware of the water quality through water transparency or the degree of turbidity (Brashares, 1985). Feenberg and Mills tested thirteen physical measures of water quality variables, and only oil and turbidity showed the strongest correlation with property prices (Feenberg, 2000). Steinnes studied lakes in Northern Minnesota using dummy variables for clean and polluted lakes and found out that water clarity, as measured by Secchi disk reading, was positive and significantly related to the sale price (Steinnes, 1992).

Travel Distance

In deciding to visit the Salt Ponds, travel distance is an important criterion for many recreationists. In these scenarios, three different levels of travel distance were identified in the form of one-way trip both by distance and in time so that people can link travel distance in practice using one or the other indicator to Willingness To Pay (WTP). The maximum travel distance was set up to 80 miles for one-way trip since recreationists travels more than 80 miles for one-way trip that takes about 2 hours may be engaged in multiple activities other than Salt Pond visit.

Congestion

For most recreationists in the Salt Ponds, congestion of the recreation site was mentioned as an important criterion in deciding the visit to the recreation site. Three different levels of congestion were presented to respondents in the form of the illustration to ensure the respondents to get clear picture of congestion when making a choice decision. There is no clear guidance or standard on congestion of the beaches so that we followed the case of how to control over-crowded beach article published in the local newspaper (Solutions for Hampton Beach overcrowding, 2014). "Over-crowded" level presents the minimum available beach space of 36 square feet per person that is the space for one person to spread a towel, cooler, and other beach accessories with room to evacuate the beach in case of an emergency (Solutions for Hampton Beach overcrowding, 2014). Under over-crowded condition, on average, 121 people can be held in a 0.1-acre (4,356 square feet) beach space. “Medium-crowded” level presents the available beach space of 81 square feet (9’ x 9’) per person and 54 people can be held per 0.1-acre beach space. “Non-crowded” space presents the available beach space of 144 square feet (12’ x 12’) and 30 people can be held per 0.1-acre beach space.

Admission Fee

A payment vehicle was chosen as Admission fee was because it is a familiar payment vehicle acceptable to recreational visitors. There is no admission fee or parking lot fee yet in Salt Ponds, but recreationists are aware that other recreation sites charge a daily parking fee or admission fee. We want to use the fee to calibrate the opportunity cost of time spent traveling, and refer to more detailed discussion later.

Survey Design

The attributes for the hypothetical recreational visit scenarios were refined through the in-person interviews and preliminary tests of the survey. In-person interviews were conducted to learn about the important attributes, alternative recreational sites, and the reason to visit Salt Ponds. After personal interview, preliminary tests were carried out to 124 respondents including avid Salt Pond users such as fishermen, boat club members, yacht club and marina employees, and graduate and undergraduate students who used Salt Ponds to ascertain how respondents make decisions under the given multiple attributes recreation site scenarios.

To ensure the respondents to consider all attributes listed on the choice set when making their choice without being confused, the number of attributes were reduced from five to four and the number of levels were simplified as well. Too many number of attributes not only can cause confusion to respondents but also may cause respondents to adopt a simplified decision rule, rather than considering all attributes (Mangham et al., 2009; Mazzotta & Opaluch, 1995).

A fractional factorial design (Addelman, 1962; Groemping, nd) was used to create alternatives with different levels of the various attributes. A fractional design only includes subsets of all possible combinations of attribute levels. The design ensured orthogonal main effects to ensure statistical independence of attribute main effects. Each question presented respondents with three alternatives: a status quo option and two hypothetical alternatives. The resulting choice sets were organized to eliminate implausible or dominated alternatives (Bennett & Adamowicz, 2001; Lee, 2012).

For example, questions were dropped when they included an alternative that was preferred to the others in terms of all of the attributes.

Administering the survey

The survey was administered on-site at 14 different locations. We recognize the challenges of site-based sampling. Sampled individuals may be a visitor with higher visiting frequency compared to non-sampled individual. However, a more general population survey was not practical, as only a small proportion of the general population visit the Salt Ponds and there is high possibility that non-visitors to the Salt Ponds have no interest whatsoever in participating. For the same reason, the onsite survey was the most appropriate method in regard to time and cost efficiency. However, by doing this way, we omit information about the taste of non-visitors. This may reduce the explanatory power of the (Stoeckl & Mules, 2006; Knapman & Stanley, 1993; Leuschner, Cook, Roggenbuck, & Oderwald, 1987). An example survey is presented in Appendix A.

[Appendix A about here]

Prior to the introduction of the choice scenarios, respondents were presented with a perceptional/experiential rating task. Respondents were asked to indicate the extent to which these factors affected their experience on the Salt Ponds. A five-point Likert scale was utilized and the results are presented in Table 4.1.

[Table 4.1. about here]

The results in Table 4.1. indicate that a vast majority of respondents believed that visiting Salt Pond has a better water quality than as it is. Then, respondents were asked about travel information questions as described in Chapter three. Second, respondents were given verbal instructions to choose the most preferable option in the Conjoint Analysis questions among a status-quo option and two hypothetical alternatives described with pictograph in terms of travel distance, water quality, congestion and admission fee in different levels. Finally, respondents were asked to fill up the socio-demographic information. After the preliminary survey, even though Conjoint Analysis questions were simplified, in the field, the Conjoint Analysis questions posed some level of difficulty to respondents or respondents' level of concentration because the environment was not as demanding as in work place. Hence, respondents were given verbal instructions for answering the Conjoint Analysis (Maharaj, 1995).

Survey Results

This section contains a summary of data collected by the Conjoint Analysis survey. A total of 309 respondents filled out the survey questionnaire and 288 completed survey questionnaires while 21 were incomplete, either respondents opted out annual income or education questions. Out of 21 incomplete responses, four people indicated that they did not want to choose any option given the hypothetical scenarios because neither they wanted to pay for the recreation site visit, nor wanted to compromise the quality in the site. After dropping observations with missing values for annual income and education, the completed 288 responses contain 1,149 choice observations. Respondents' demographic characteristics are presented in table 4. 2.

[Table 4.2. about here]

Model Specification

This section provides the statistical methods used to analyze data on the choice respondents made for recreational visiting. This analysis includes a description of model specification, model results and an evaluation of the model output.

In this study, respondents were asked to choose the most preferable site they would visit out of three hypothetical choice alternatives. Thus, recreational visitors evaluated each choice set based on the combination of site attributes, and were asked to choose the most preferred site. Indirect utility function to estimate the model is presented below. Table 4.3. provides a description of the variables, and table 4.4. describes the list of socio-demographic information used in model specification.

[Table 4.3. about here]

[Table 4.4. about here]

$$Y_{mj} = \alpha_2 + \alpha_3 + \beta_1(W.QualityPoor) + \beta_2(W.QualityFair) + \beta_3(W.QualityGood) + \beta_4(W.QualityExcellent) + \beta_5(CongestionNotCrowded) + \beta_6(CongestionMediumCrowded) + \beta_7(CongestionOverCrowded) + \beta_8(TravelDistacne) + \beta_9(EntranceFee) + \epsilon$$

where

y_{mj}	= the index of a respondent m choosing alternative j
α_1	= the intercept of alternative 2; base
α_2	= the intercept of alternative 2; alternative specific constant
α_3	= the intercept of alternative 3; alternative specific constant
$\beta_1(W.QualityPoor)$	= 1 if a respondent chooses water quality poor; Base
$\beta_2(W.QualityFair)$	= 1 if a respondent chooses water quality fair
$\beta_3(W.QualityGood)$	= 1 if a respondent chooses water quality good

$\beta_4(W.QualityExcellent)$ = 1 if a respondent chooses water quality excellent

$\beta_5(CongestionNotCrowded)$ = 1 if a respondent chooses not crowded condition

$\beta_6(CongestionMediumCrowded)$ = 1 if a respondent chooses middle crowded condition

$\beta_7(CongestionOverCrowded)$ = 1 if a respondent chooses over crowded condtion; Base

$\beta_8(TravelDistacne)$ = travel distance (20, 50, 80 miles) (30, 60, 90 minutes)

$\beta_9(EntranceFee)$ = entrance fee (0, 10, 20 dollars)

ϵ = error term

Interpretation of alternative specific constant gets different when alternatives are generic as opposed to distinct commodities. For example, if alternatives are car, bus, and train, the alternative specific constants may represent unexplained characteristics of the alternatives and represent the total possibility of choosing that distinct commodity, such as car or bus or train. Alternative specific constants of generic alternatives do not represent distinctive possibility of choosing one alternative over the other alternatives since alternatives are not distinctive, but still alternative specific constants capture unexplained characteristics.

Criteria for Model Selection

To obtain the probability through the indirect utility function that reflects the respondents' choice depending on the different attributes and levels of the Salt Pond, Multinomial Logit Model(MNL), Multinomial Probit Model(MNP), and Mixed Logit Model(MXL) were used. To determine the goodness of the fit to the data, the models were evaluated whether the relationships among the estimated variables conform and consistent with theoretical expectations (Bennett and Adamowicz, 2001; Lee, 2012). And then, the models were evaluated through statistical measures such as log-likelihood test and McFadden's pseudo-R^2 (Lancsar & Louviere, 2008; Lee, 2012).

McFadden's pseudoR^2

To check the goodness of fit of overall model, we estimate the model with McFadden's pseudoR^2. pseudoR^2 statistic is different from traditional R^2 measures from Ordinary Least Squares regression since McFadden's pseudoR^2 is estimated through maximum likelihood estimator (MLE).

$$\text{McFadden's pseudo} \quad R^2 = 1 - \frac{LL_{estimatedmodel}}{LL_{basemodel}}$$

To compare the pseudo_R^2 value, from log-likelihood estimate from base model that includes only Alternative Specific Constants (ASC) and to log-likelihood estimates from full model that include all the attributes were compared. However, the attributes of the individual respondents do not differ across alternatives, so these explanatory variables drop out of standard discrete choice model, unless respondent attributes are interacted with attributes of the alternatives. To include the characteristics of the respondents with attributes, individual specific variables are incorporated with Alternative Specific Constants (ASC). Respectively, to see the effect of income, income variable was interacted with the attribute variable “fee” to test whether respondents with different income levels place different weight on the admission fee.

Table 4. 5. provides the description of five models applied in Multinomial Logit Model (MNL), Multinomial Probit Model (MNP), Mixed Logit Model (MXL), and Mixed Logit Model with random parameter distribution.

[Table4.5. about here]

The results of the pseudo_R^2 values for five models of table 4.5. using MNL, MNP, MXL, and MXL with random parameter distribution models are presented in table 4.6.

[Table4.6. about here]

PseudoR^2 bears similar information as does R^2; the lager $R^{2\ is}$, the larger is proportion of respondents' choice explained by the model (Transport Research Board, 2015). McFadden suggested pseudo_R^2 values between 0.2 and 0.4 should be taken to represent a good fit of the model (Beennet & Adamowciz, 2001; Lee, 2012). The range of McFadden's pseudo_R^2 of 0.2 to 0.4 is equivalent to the range of 0.7 to 0.9 for a linear function according to the simulations. (Louviere, Hensher, & Swait, 2000). From here on, model 1 through model 5 follows the description of table 4.5.

In table 4.6, Intercept only model (model 1), and intercept and attributes model (model 2) in Multinomial Logit Model (MNL), the pseudo_R^2 value for model 1 was 0.00 and model 2 was 0.10. In the survey, one person answered four choice sets. Thus, social demographic characteristics such as income, education, age, and gender don't change along choices. In order to capture the heterogeneity of respondents, income was treated as alternative specific variable, not individual specific variable. The pseudo_R^2 value for intercept and attribute and income alternative specific model (model 3) was 0.13 and full model with all the socio-demographic variables (model 5) was 0.15 indicating that full model with all the social demographic variables better capture the heterogeneity of respondents. Lastly, the pseudo_R^2 value for full model with income interaction with the entrance fee (model 4) was 0.12. To measure the income interaction, mid-point income from each category was chosen to be converted to a numeric number and multiplied by fee. The pseudo_R^2 value for model 4 was smaller than that for model 5. In the survey, respondents expressed their income by selecting the range in which their income lies, not the exact amount of income. Thus, when income was treated as a categorical value, the model demonstrated a better fit than when income was treated numerically. These pseudo R^2 value results provide the comprehensive model specification, but likelihood ratio test should be accounted for the model specification.

In Multinomial Probit Model, Mixed Logit Model, and MXL with random parameter distribution model all presented consistent form of pseudo_R^2 value results with similar magnitude indicating that model 5 is the good fit for analysis.

Mixed Logit Model (MXL) with normally distributed parameters assumed that all the coefficients are normally distributed and the coefficient of fee is fixed. MXL with random parameter distribution assumed that categorical variable such as water quality (poor, fair, good, and excellent) and congestion (not crowded, medium crowded, over crowded) are uniformly distributed; the coefficient of travel distance follows triangular distribution (Train, 2009; Henshir & Green, 2003).

Likelihood Ratio Test

To determine whether the models are statistically significant overall, a log-likelihood ratio-test was performed. The test involves the comparison of the log-likelihood (LL) function of the estimated model at convergence with the log-likelihood function of a reference model with constant terms only (Lee, 2012).

Equation of log-likelihood

The resulting value, referred to as the (-2LL) statistic is then compared to a critical chi-square value with degrees of freedom (dof) which is equal to the number of new parameters estimated. The likelihood ratio test compares log likelihood functions of the more constrained (constant only) to the less constrained model. Null hypothesis is rejected if there is a sufficiently large difference (Hensher, Rose, & Greene, 2005). The test formula is provided as below.

$$-2LL(LL_{base} - LL_{estimated})\ \chi^2_{number\ of\ new\ parameters\ in\ the\ estimated\ model}$$

The log-likelihood ratio-test was carried out for five models from table 4.5 in MNL, MNP, MXL models, and MXL model with random parameter distribution model to determine whether the inclusion of the key design attributes and the inclusion of the socio-demographic variables enhance the explanatory power of the model. The relevant test statistics are shown in table 4.7.

[Table 4.7. about here]

As described in table 4.5 on the five models to be tested in MNL, MNP, MXL, and MXL random parameter model, results of log-likelihood ratio test of five models on MNL model show that comprehensive models better capture the heterogeneity of the respondents' choice. Out of five MNL models, full socio-demographic variables interaction with Alternative Specific Constants (Model 5) shows the highest log-likelihood (less negative). With income interaction that means entrance fee multiplied by income (Model 4), we can see that high income households are less concerned with admission fee for the pond than the lower income households. Applied models from model 1 through 5 all showed statistical significance in MXL models indicating that every model has explanatory power but the value of likelihood suggested that model 5 with the highest log-likelihood value (less negative) was good fit to be applied. Five models applied to MNL model showed statistical significance at the 99% level but for model 1 (intercept only model). Consistently model 5 was the good fit for MNL model as well. For the empirical result, we use model 5 to MNL, MNP, MXL with normal distribution and MXL with random parameter distribution. Model 1 through model 4 applied to MNL, MXP, MXL models are presented in the appendix.

Hausman & MacFadden Test

We also test to see whether the Independence of Irrelevant Alternatives assumption holds in the Multinomial Logit Model (MNL) using the Hausman & McFadden Test. See section 4.3.1. above for a discussion of the IIA assumption.

Whether IIA holds in Multinomial Logit Model(MNL) can be tested by Hausman and McFadden Test (Hausman and McFadden, 1984; Train 2009). Hausman and McFadden test re-estimates and compares the parameter estimates between an unrestricted model that includes all three alternatives and a restricted model that excludes one alternative (Lee, 2012). IIA implies that relative values of choice probabilities between tow alternative do not change when a third alternative is added and removed. When IIA holds, the estimates of the parameters of the choice function should be not differ statistically when using the full data set for all alternatives, vs. using a restricted data set for a subset of alternatives, using only the observations where the subset of alternatives were selected. IIA is rejected if different coefficient estimates are statistically significant when using the full data vs. the restricted data set (Bhat & Koppelman, 2006) The results of the Hausman & MacFadden test are presented in table 4.8.

[Table 4.8. about here]

In both cases, the calculated chi-square statistic is negative value and the result is not statistically significant (p=1) indicating that any difference in the parameter estimates was not statistically significant indicating IIA is not violated. Hausman and McFadden conclude that a negative chi-square outcome is the evidence that IIA is not violated (Hausman and McFadden; 1984).

To determine whether five models are significant overall, log-likelihood ratio-test was performed for Multinomial Probit Model(MNP) and the results are shown in table 4.9. A reference model with constant terms only was compared with four different models at convergence as in Multinomial Logit Model.

[Table 4.9. about here]

As in Multinomial Logit Model (MNL), every model showed statistical significance at 0.01 percent level except for Alternative Specific Constants only model. As described on the type of model in table 4.5.

Overall, Multinomial Logit Model (MNL) and Multinomial Probit Model (MNP) showed consistent sign and magnitude with statistical significance at 99% level but for the model 1 in both MNL and MNP models. MNP Model has its own limitation that says error terms are normally distributed. Since unobserved factors may not be normally distributed, to relax the normal distribution assumption in MNP model, we apply Mixed Logit Model (MXL) that allows the unobserved factors to follow any distribution since MXL model can handle non-normal distributions for random coefficients (Train, 2009; Koppelman & Bhat, 2006).

The MXL model is the model where MNL model is mixed with the multivariate distribution (generally multivariate normal) of the random parameters. The MXL model represents a relaxation of IID error structure as well as the response homogeneity assumption (Train, 2009; Revelt and Train, 2000, Hensher and Greene, 2003; Koppleman and Bhat, 2006). MXL model is very flexible in the sense of being able to capture random taste variations. In Mixed Logit Model, while a normal distribution remains the most common assumption for the probability density function for a random coefficient structure, other probability density functions may be more appropriate. For example, lognormal distribution may be used, if, from a theoretical perspective, an element of β has to take the same sign for every individual such as a negative coefficient on the travel distance parameter (Koppelman & Bhat, 2006). Other distributions that have been used in the literature include triangular and uniform distribution (Train, 2009; Revelt and Train, 2000, Hensher and Greene, 2003; Koppelman and Bhat, 2006). The triangular and uniform distributions have the nice property that they are bounded on both sides, thus preventing the possibility of very high positive and negative coefficients for some decision makers as would be the case if normal or log-normal distributions are used. With both the uniform and triangular distribution, the researcher can impose sign restrictions on parameters of the model by selecting appropriate values for the mean and the spread of the distribution. First, we use the MXL model that all the attribute variables were treated as normally distributed. Table 4.10 presents the likelihood ratio test of MXL model with normal distribution assumption.

[Table 4.10 about here]

Five models applied to MXL model with normal distribution assumption provided overall higher log-likelihood values (less negative) with statistical significance at 1% level.

In the MXL random parameter normal distribution model, the coefficient on entrance fee (price) was assumed to be normally distributed that means some people are assumed to have a positive price effects since normal distribution has support on both sides of zero (Train & Croissant, 2012). Thus, following model treats the coefficient of fee as a fixed effect. A fixed price coefficient makes it easier to calculate the distribution of WTP for each non-price attribute since the distribution of WTP because the price attribute has the same distribution as the attribute's coefficient scaled by the price coefficient (Train & Croissant, 2012). With regard to other random variables, we select specific distributions. Regarding travel distance, we can argue that the normal distribution of the travel distance has no bound on both sides and hence include extreme values on both sides. Individuals are typically don't have an unbound willingness to pay (Hensher & Green, 2003).

Thus, the distribution of travel distance variable was revised as triangular distribution which as bounds on both sides preventing the coefficient from having unbounded value. Regarding congestion and water quality, uniform distribution is assumed since uniform distribution is sensible when we have dummy variables since distribution is uniform from 0 to 1 (Hensher & Green, 2003; Train, 2009).

[Table 4.11. about here]

Five models applied in MXL random parameter distribution model provided similar patterns as the MNL, MNP, and MXL with normal distribution models. With log-likelihood ratio test with five models applied to MNL, MNP, MXL, MXL random parameter models consistently showed the highest log-likelihood value as well as highest McFadden pseudo R^2 value in model 5. Based on the statistical significance presented in table 4.12, we can't reject the hypothesis that each individual specific information like age, gender, education, income interaction with ASC is zero.

[Table 4.12 about here]

Thus, for comparison purpose among models with different assumptions, we use full model with all the socio-demographic variables (Model 5).

4.6 Empirical Results

This section presents the empirical results of this study, and it compares and interprets the results from different models. Next, the section presents the marginal willingness to pay for each attribute of these models. The parameter estimates for the MNL model, MNP Model, MXL with random parameter normal distribution and MXL Model with random parameter distribution are shown in Table 4. 13. through table 4.17. The models include dependent variable as a categorical variable with three categories: alternative 1, alternative 2, alternative 3. The explanatory variables in the models are travel distance, water quality, the level of congestion, and travel cost. All estimation was performed with R software program.

MNL, MNP, MXLs Model Comparison

Table 4.13. presents model 5 applied to MNL, MNP, MXL, and MXL random parameter distribution. In our model, Alternative Specific Constants (ASC) are kept since Alternative Specific Constants can capture unobserved characteristics of alternatives.

[Table 4.13 about here]

Our model has generic ASCs, not distinctive ASCs so that ASCs do not represent distinct possibility of choosing one alternative over another. One would not expect Alternative Specific Constants to be important if alternatives are purely generic. In model 2, model3, and model 4 applied to MNL, MNP, MXLs from Appendix C, Appendix D, and Appendix E, ASCs show the statistical significance at the 5% level. ASCs provide a couple of hypothesis about why they might be important. This relates primarily to the fact that we did not order alternatives randomly, for example, alternative 1 is always status quo; water quality improves; and cost increases from status quo toward Alternative 2 and 3. Some respondents might have a status quo bias or a do something bias. Some night use simplified decision rules, like selecting the middle ground, or they might select the most environmentally preferred water quality option. Some respondents might always pick an option with zero cost, as a signal to authorities not to starting charging an entrance fee. These are speculations, and more research is need to better understand how people answer questions.

Models 1 through 4 (refer to table 4.5. for description) applied to MNL, MNP, MXL, and MXL random parameter distribution are presented in Appendix B, C, D, E.

[Appendix B about here]

[Appendix C about here]

[Appendix D about here]

[Appendix E about here]

Model 5 applied to MNL, MNP, MXL, and MXL random parameter distribution model, the signs of the coefficient of travel distance and fee are negative, indicating that respondents prefer shorter travel distances and lower entrance fees with statistical significance at 1% level. The signs on water quality variables are positive with greater magnitude coefficients for higher levels of water quality implying respondents prefer sites with higher water quality, all else equal with statistical significance at 1% level. The categorical variable of congestion with over-congestion as a reference level, shows a positive sign for both low-congestion and medium-congestion attribute levels with statistical significance at 1% level. However, the magnitude on the coefficients for low and medium congestion are very similar. This means respondents prefer sites without high congestion, but do not show a strong preference for low- versus medium-congestion.

As described in table 4.4, education variable is a dummy variable with level 1 as a base level indicating high school or less; education level 2 means some college, associate degree, and some universities and level 3 indicates advanced degree and graduate school or more. With regard to the coefficient of education with category one as a reference level, the sign of education level two, respondents who indicated they had some university education, is negative in alternative 2 and significant at 5% level indicating respondents who indicated they had some university education are more likely to visit alternative 1 over alternative 2. Alternative 1 represents the status quo and alternative 2 and alternative 3 are randomly mixed while only water quality is moving toward the higher quality. The sign of education level three, graduate or advanced degree holders, is positive and significant at 1% level indicating that advanced degree holders prefer alternative 3 over alternative 1.

In terms of gender with male as a reference level, the sign of coefficient of female on alternative 3 is significant at 1% and the sign is positive indicating that female is more likely to choose Alternative 3. There was no statistical significance on Alternative 2.

In regard to income, with income level one as a reference level, the coefficients of income level 2, 3 and 4 are positive with greater magnitude on Alternative 2 ad 3 implying that the higher income is the more likely to prefer a better water quality place with greater coefficients on Alternative 3. Income level 3 and 4 are significant at 1% level, indicating that those who earn more than $75,000 and $100,000~$150,000 annual income are more likely to choose higher water quality recreation site despite higher cost. Model 5 applied in MNL, MNP, MXL, and MXL random parameter distributions presents the signs of the four attribute variables are consistent with the rest of models conducted and the magnitude of coefficients are similar across the models.

Regarding age when compared with age group one, the sign of age group three, those who are between 55~ 74 years old, is positive and significant at 10% level implying that people from this age group prefer to visit Alternative 2. The sign of the coefficients of the age group two, 35~54 years old, and age group four, 75~90 years old, are negative and significant at 5% and 1% level implying that they are less likely select Alternative 3.

[Table 4.13 about here]

In summary, models 5 applied to MNP, MXL, and MXL random parameter model, the signs of the coefficients of travel distance and fee are negative showing consistency across the models and showing consistency with prior expectations. The coefficients of water quality and congestion also showed the same sign and the same magnitude in the size of coefficients showing consistency across the models.

Drawing numbers

MXL model is a simulation based approach. Simulation approach produce the number of draws to produce a stable set of parameter in Mixed Logit Model (MXL) depends on how complex the model is in terms of the number of random parameters, the treatment of heterogeneity around the mean, and the correlation of attributes and alternatives (Henshier & Green, 2003). A choice model with three alternatives with one or two random parameters may require at least 25 draws, but 100 appears to be a better number (Henshier & Green, 2003). To test a model, a range of draws were performed from the draws of 25, 100, 250, 500, and to 1,000 and checked the robustness of the model 5 that had the best fit. The results are summarized in Table 4.14, and we applied 1,000 number of draws.

[Table 4.14 about here]

Willingness To Pay for change in quality

A full model with all socio-demographic variables (Model 5) was estimated with each method (MNL, MPL, MXL, MXL random parameter) to determine the impact of the attributes of the Salt Ponds in the survey (Water quality, congestion, travel distance). Economic values per attribute change were calculated by dividing each attribute coefficient by the cost coefficients (Hanemann, 1984, Train, 2009). For the variables that are statistically significant at the 5% or better, the following conclusions may be drawn about the sample population. Table 4. 15 presents the Willingness To Pay to avoid poor water quality and to improve Water Quality in each level.

[Table 4. 15 about here]

Using WTP per trip, total WTP is calculated using the same total number of visitors estimated in Travel Cost Method. Total Willingness To Pay to avoid poor water quality from a current fair water quality is $2.7 million, $4.7 million to improve water quality to good quality from fair and $6.6 million to improve to excellent from fair water quality. Total Willingness To Pay for water quality at each level is presented in table 4. 16.

[Table 4. 16 about here]

Willingness to Pay to avoid over-congestion is presented in table 4.17. MWTP is consistent across the models.

[Table 4. 17 about here]

Willingness to Pay to avoid one mile further travel distance is presented in table 4.18.

[Table 4. 18 about here]

To see the Willingness to Pay for travel distance to avoid one mile further distance under different distribution assumption, we carried out normal-, triangular-, uniform-, and lognormal distribution assumption on the coefficient of travel distance in MXL random parameter model. The coefficient on travel distance treated as log-normal distribution allowed the model to have infinite positive value with a fat tail resulting in relatively high marginal WTP. MWTP of travel distance under different distribution assumption is presented in table 4.19. Given normal and uniform distribution assumption, the MWTP of travel distance is consistent across the distribution assumption. Triangular distribution assumption with both sides bounded presents a smaller MWTP and consistent with prior expectation. With log-normal assumption on travel distance, the estimate is not credible due to the thick tail of the log-normal.

[Table 4. 19 about here]

The signs and the relative sizes of the coefficients are consistent with prior expectations, with excellent water quality having the largest positive coefficient, followed by good water quality, and fair water quality when poor water quality is a base. Regarding congestion, the coefficient estimates indicate over congested sites are least preferred by respondents, but there is no clear preference between low and middle levels of congestion. Alternative Specific Constants indicate revealed preference that are not explained by the attributes. Since we have generic alternatives - not distinctive alternatives like bus, train, car- economic theory suggests the ASCs should be zero. Non-zero estimates might suggest respondents are reacting to factors other than the attributes. For example, there might be an order effect, whereby Alternative 2 is more likely to be chosen because it is in the center of the page; or respondents may keep the Alternative 1, or 2 or 3 throughout the four options. Or respondents might have chosen the highest water quality since it is the most environmentally desirable alternative throughout the survey. Further research is needed to better understand decision strategies that are adopted by respondents.

Results from different models indicate that the model is robust with respect to priorities and relative values, although the estimated dollar values vary with model specification. The estimated dollar values for the four models are within the same general magnitude except in log-normal distribution assumption on travel distance in MXL model; $76 per mile is not credible and likely results from the thick tails of the log-normal distribution in the positive range. In normal, uniform and triangular distribution, the range is from $0.17 to $0.22 presenting consistency, and hence we did not choose log-normal distribution for the coefficient of travel distance.

4.7 Conclusion and Discussion

This section discussed the use of Conjoint choice experiment to assess preference of recreational users for key salt pond attributes. We focus on water quality, congestion, travel distance, and a hypothetical entrance fee. We developed and administered a survey instrument and implemented in July and August of 2015. Total 309 people responded and 288 completed the questionnaire out of 309 full samples. Each respondent completed four choice set questions and hence total 1152 observations were analyzed for Conjoint Analysis.

We compared coefficient estimates using several different approaches: Multinomial Logit, Multinomial Probit, Mixed Logit Model, and Mixed Logit with different assumptions for the distribution of parameters. Multinomial Logit Model (MNL) analysis was used to assess the impacts of the attributes influencing the recreation site visit. Socio-demographic variables were used in the model as an alternative specific variable in a R statistical software to be evaluated. With MNL models, alternatives within a choice set were assumed to be uncorrelated.

Our Conjoint Analysis choice experiment has generic alternatives: status-quo, alternative 1 and alternative 2. IIA might be violated if respondents have a positive or negative status quo bias. But if respondents do the comparisons correctly, considering the attributes only, IIA violations should not be an issue. As in the classical red bus and blue bus problem (McFadden, 1974), as red bus with the exact same quality is introduced to existing car and blue bus options, the same share of people have to choose auto since the red bus introduction does not affect the quality of drive. If IIA property holds, the relative probability of auto and blue bus should maintain as 2:1 since the relative value of choice probabilities between two alternatives do not change. To test the IIA assumption in MNL model, Hausman and McFadden test was conducted and the outcome presented that our MNL model did not violate IIA assumption as described in Hausman & McFadden Test.

To further pursue the robustness of the model, Multinomial Probit, Mixed Logit Model (MXL) with normal distribution and random parameter distribution were tested. After performing likelihood ratio test on social demographic variable, the best fit model was chosen that includes ASCs, attributes, and socio-demographic variables across the different approaches: MNL, MNP, MXL, and MXL random parameter models. In MXL and random parameter MXL models, HALTON number that decides the number of simulation was chosen as 100, which shows the stability after trying out different number of simulations.

Then using different models, WTP of each attribute was calculated. Regarding WTP for Water quality, Willingness To Pay to avoid poor water quality is $16.69, to improve water quality to good from poor and to excellent water quality from poor water quality is respectively $45.81 and $57.73 in MXL random parameter model. Regarding WTP for congestion, Willingness To Pay to avid over-congestion for no-congestion is $24.76 and for medium-congestions is $23.82 in MXL random parameter model. With regard to WTP for travel distance, Willingness To Pay to avoid one mile is $0.15 when the distribution of the coefficient of travel distance was assumed to be triangular and $0.22 under the normal distribution assumption in MXL random parameter model. Using WTP per trip, total WTP is calculated using the same total number of visitors estimated in Travel Cost Method. Total Willingness To Pay to avoid poor water quality is $2,7 million, $4,7 million to improve to good quality from current fair water quality and $6,6 million to improve to excellent from current fair water quality. It is also important to note that these estimates are restricted only to values associated with on-site recreational use of the salt ponds during July and August in a year of 2015.

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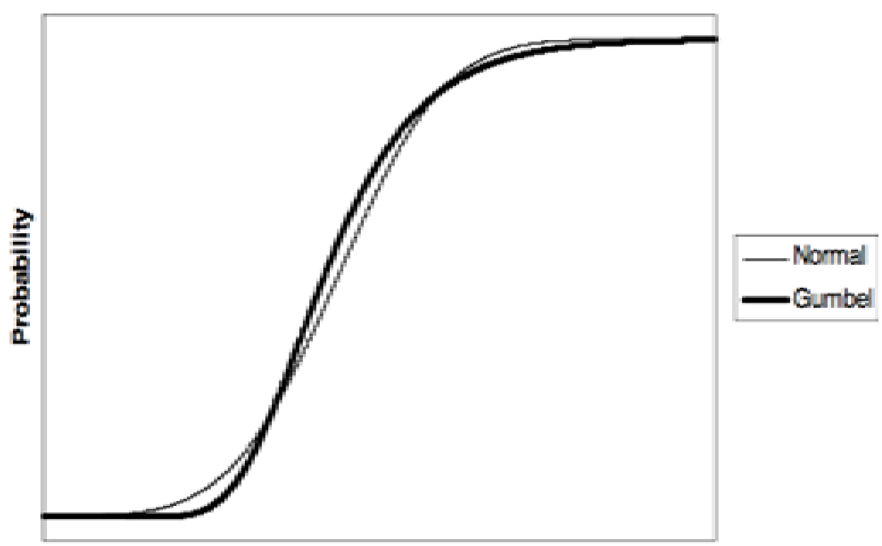
Tables and Figures

Figure 4. 1.. Probability Density Function for Gumbel and Normal Distribution

Note; Adjusted from Bhat & Koppelman, 2006

Figure 4. 2 . Cumulative Density Function for Gumbel and Normal Distribution



Note; Adjusted from Bhat & Koppelman, 2006

Figure 4. 3. Secchi Disk Method to measure Water Clarity

Note: In general, 8-inch diameter metal disk is divided into black and white quadrants and dropped into the water until the observer can't see the Secchi disk anymore and then the disk is raised again until the observer can see it again and the maximum death of visibility indicates the turbidity/clarity of the water body (The SecchiDip-in, 2017).

Table 4. 1. Experiences on the Salt Ponds

Experience/ Perception	Perception about Salt Pond Attribute/Experience (1=least favorite, 3=neither like nor dislike, 5=most favorite)				
	1	2	3	4	5
Water Quality	6 (1.9%)	21 (6.8%)	3 (1%)	137 (44.3%)	115 (37.2%)
Amount of trash	16 (5.2%)	37 (12%)	42 (13.6%)	87 (28.2%)	127 (41.1%)
Amount of noise	5 (1.6%)	21 (6.8%)	43 (13.9%)	73 (23.6%)	167 (54%)
Amount of wildlife	5 (1.6%)	33 (10.7%)	59 (19.1%)	95 (30.7%)	116 (37.5%)
Scenery	2 (0.6%)	5 (1.6%)	12 (3.9%)	80 (25.9%)	210 (68.0%)
Access	5 (1.6%)	19 (6.1%)	23 (7.4%)	79 (25.6%)	183 (59.2%)

Table 4. 2. Characteristics of respondents

Question	Category	Number	Percentage (%)
Gender	Female	175	55
	Male	134	45
Party Size	1~2	161	52
	3~5	111	36
	6~10	33	11
	11~15	4	1
	Did not answer	0	0
Age	20 or under	10	3
	21~24	15	5
	25~34	41	13
	35~44	51	17
	45~54	74	24
	55~64	74	24
	65~74	38	12
	75~84	5	2
	85~0ver	1	0
	Did not answer	0	0
Education	Less than high school	0	0
	Some high school	6	2
	Completed high school or GED	60	19
	Associate's Degree	44	14
	Some College	60	19
	Bachelor's Degree	62	20
	Graduate or Advanced Degree	76	25
	Did not answer	1	0
Annual Income	< $15,000	25	8
	$15,000~$24,999	26	8
	$25,000~$34,999	15	5
	$35,000~$49,999	31	10
	$50,000~$74,999	59	19
	$75,000~$99,999	61	20
	$100,000~$149,999	44	14
	$150,000 or more	43	14
	Did not answer	18	6

Table 4. 3. List of Attributes of Salt Ponds Used in the Conjoint Analysis

Attribute	Level
Water Quality	Excellent – Pristine appearance, swimmable, boatable, and bodily contact is O.K. Good – swimmable, boatable, and bodily contact is O.K. Fair – swimmable, boatable, and bodily contact is not safe Poor - boatable, and bodily contact is not safe
One-way Travel Distance (Travel time)	80 miles (2 hours) 50 miles (1hour and 15 minutes) 20 miles (30 minutes)
Congestion	Over Crowded – The ponds are overcrowded and extremely noise Medium Crowded – The congestion and noise at the pond are present but do not hinder the experience Non-Crowded – The ponds have sufficient open space, and little noise
Admission Fee (Daily)	$20 $10 $0

Table 4. 4. List of Socio-Demographic Information Used in the Conjoint Analysis

Variables	Category
Income	One - household income $12,000/year. Reference level. Base model Two - household income $35,000/year Three - household income $75,000/year Four - household income $125,000/year
Education	One – High school or less. Reference level. Base model Two – Some college, associate degree, some universities Three - Advanced degree, graduate school or more
Gender	Male. Reference level. Omitted from model Female
Age	One - Age 20 ~ 34 years old. Reference level. Base model Two - Age 35 ~ 54 years old Three - Age 55~74 years old Four - Age 75 ~ 90 years old

Table 4. 5. Model description to be applied in MNL, MNP, MXL, MXL random parameter

Model	Category
Model 1	Alternative Specific Constants (ASC)
Model 2	Alternative Specific Constants (ASC) + attributes
Model 3	Alternative Specific Constants + attributes + income interaction with ASC
Model 4	Alternative Specific Constants + attributes + income interaction with entrance fee
Model 5	Alternative Specific Constants + attributes + income interaction with ASC + education interaction with ASC + age interaction with ASC + gender interaction with ASC

Table 4. 6. Pseudo_R^2 values in MNL, MNP, MXL, MXL random parameter model

Model		Pseudo R^2 values			
		MNL	MNP	MXL: Normal distribution	MXL:[1] Random Parameter Distribution
Model 1	Intercept Only	0.00	0.00	0.06	0.06
Model 2	Full Model	0.10	0.10	0.17	0.17
Model 3	Full Model Alternative Specific Income	0.13	0.13	0.18	0.18
Model 4	Full Model Income Interaction with fee	0.11	0.11	0.17	0.17
Model 5	Full Model Social Demographic Factors	0.15	0.156	0.201	0.202

[1] Mixed Logit Model treated all the variables but "fee" variables are treated as random parameters. Each attribute variable has different distribution. Water quality fair, good, and excellent variables have uniform distribution. Congestion variable also have uniform distribution. Travel distance has triangular distribution.

Table 4. 7. Likelihood ratio test in MNL Model

Model		-2 Log Likelihood	LR test	df	Sig.
Model 1	Intercept Only	-1,205.90	0	2	P =1.00
Model 2	Full Model	-1.080.32	251.09	9	P < 0.01
Model 3	Full Model Alternative Specific Income	-1,053.71	304.31	15	P < 0.01
Model 4	Full Model Income Interaction with fee	-1077.43	270.00	10	P < 0.01
Model 5	Full Model Social Demographic Factors	-1020.10	371.50	27	P < 0.01

Table 4. 8. Hausman Test for IIA

	Alternative Excluded	DOF	Calculated chi Square statistic	Probability
MNL Model	Alternative 2	9	-3.1629	1
	Alternative 3	9	-3.1629	1

Table 4. 9. Likelihood ration in MNP Model

Model		-2 Log Likelihood	LR test	df	Sig.
Model 1	Intercept Only	-1,205.50	0.76	5	P =1.00
Model 2	Full Model	-1.079.70	252.28	12	P < 0.01
Model 3	Full Model Alternative Specific Income	-1,052.10	307.52	18	P < 0.01
Model 4	Full Model Income Interaction with fee	-1076.40	258.95	13	P < 0.01
Model 5	Full Model Social Demographic Factors	-1017.43	376.88	30	P < 0.01

Table 4. 10. Likelihood ratio test in MXL model with normal distribution

Model		-2 Log Likelihood	LR test	df	Sig.
Model 1	Intercept Only	-1,132.94	145.86	4	P < 0.01
Model 2	Full Model	-1,002.95	405.85	15	P < 0.01
Model 3	Full Model Alternative Specific Income	-986.71	438.32	21	P < 0.01
Model 4	Full Model Income Interaction with fee	-1,004.86	402.01	16	P < 0.01
Model 5	Full Model Social Demographic Factors	-963.40	484.94	33	P < 0.01

Table 4. 11. Likelihood ratio test in MXL model with random parameter distribution

Model		-2 Log Likelihood	Chi-Square	df	Sig.
Model 1	Intercept Only	-1,132.94	145.86	4	P < 0.01
Model 2	Full Model	-1,005.11	401.53	15	P < 0.01
Model 3	Full Model Alternative Specific Income	-986.77	483.21	21	P < 0.01
Model 4	Full Model Income Interaction with entrance fee	-1004.14	403.46	16	P < 0.01
Model 5	Full Model Social Demographic Factors	-961.81	488.11	33	P < 0.01

*note: Fee Fixed, Travel Distance (triangular distribution), Water quality and Congestion (uniform distribution).

Table 4. 12. Likelihood ratio test for Socio Demographic Variables

Variables Tested	Log-Likelihood	Degrees of Freedom	Test Statistics	R^2	Chi Square P-value
Basic Model	-1205	2	0	0.000	P < 0.01
Gender	-1199	4	13.356	0.006	P < 0.01
Education	-1188	6	34.837	0.014	P < 0.01
Age	-1191	8	28.933	0.012	P < 0.01
Income	-1178	8	55.237	0.023	P < 0.01

Table 4. 13. MNL, MNP, MXL, MXL random parameter Model Comparison

	Dependent variable:Alternative 1,2,3			
	choice			
	(MNL)	(MNP)	(MXL)	(MXL r.parameter)
Alt2:(intercept)	−0.034 (0.402)	0.078 (0.218)	0.033 (0.538)	0.073 (0.529)
Alt3:(intercept)	−0.698 (0.540)	−0.141 (0.292)	−0.878 (0.754)	−0.898 (0.737)
wqf	1.255*** (0.215)	0.530*** (0.136)	1.306*** (0.336)	1.106*** (0.338)
wqg	2.413*** (0.345)	1.033*** (0.238)	3.137*** (0.539)	3.035*** (0.524)
wqe	2.991*** (0.511)	1.284*** (0.330)	3.918*** (0.778)	3.824*** (0.760)
trd	−0.011*** (0.002)	−0.004*** (0.001)	−0.015*** (0.003)	−0.010*** (0.003)
cdmc	1.222*** (0.143)	0.563*** (0.105)	1.663*** (0.233)	1.579*** (0.219)
cdnc	1.234*** (0.135)	0.553*** (0.105)	1.713*** (0.250)	1.641*** (0.238)
fee	−0.050*** (0.008)	−0.024*** (0.005)	−0.067*** (0.011)	−0.066*** (0.011)
Alt2:incometwo	0.200 (0.289)	0.076 (0.150)	0.720* (0.371)	0.588 (0.363)
Alt3:incometwo	0.753** (0.316)	0.305** (0.153)	1.426*** (0.469)	1.277*** (0.454)
Alt2:incomethree	0.458* (0.262)	0.237* (0.141)	1.086*** (0.336)	1.016*** (0.328)
Alt3:incomethree	1.239*** (0.288)	0.553*** (0.164)	2.188*** (0.442)	2.010*** (0.421)
Alt2:incomefour	0.693** (0.299)	0.331** (0.160)	1.302*** (0.394)	1.186*** (0.386)
Alt3:incomefour	1.759*** (0.316)	0.779*** (0.194)	2.721*** (0.478)	2.547*** (0.462)
Alt2:edutwo	−0.515** (0.222)	−0.281** (0.120)	−0.696** (0.312)	−0.707** (0.308)
Alt3:edutwo	−0.196 (0.236)	−0.112 (0.113)	−0.366 (0.365)	−0.298 (0.356)
Alt2:eduthree	0.240 (0.290)	0.103 (0.148)	0.424 (0.372)	0.451 (0.369)
Alt3:eduthree	0.785*** (0.300)	0.329** (0.149)	1.101** (0.429)	1.118*** (0.423)
Alt2:genderfemale	−0.002 (0.178)	−0.009 (0.094)	0.099 (0.235)	0.065 (0.233)
Alt3:genderfemale	0.489*** (0.183)	0.211** (0.094)	0.712*** (0.259)	0.693*** (0.254)
Alt2:agetwo	0.213 (0.361)	0.115 (0.190)	−0.274 (0.470)	−0.191 (0.463)
Alt3:agetwo	−0.875** (0.349)	−0.353** (0.177)	−1.623*** (0.513)	−1.465*** (0.495)
Alt2:agethree	0.610* (0.359)	0.297 (0.184)	0.290 (0.450)	0.347 (0.447)
Alt3:agethree	−0.374 (0.347)	−0.140 (0.165)	−1.047** (0.500)	−0.933* (0.485)
Alt2:agefour	0.114 (0.373)	0.061 (0.199)	−0.422 (0.483)	−0.321 (0.478)
Alt3:agefour	−1.439*** (0.380)	−0.600*** (0.208)	−2.525*** (0.582)	−2.253*** (0.560)
Alt2.Alt3		0.540*** (0.122)		
Alt3.Alt3		0.628*** (0.145)		
sd.wqf			1.541*** (0.259)	2.778*** (0.413)
sd.wqg			0.436 (0.533)	0.263 (1.871)
sd.wqe			1.326*** (0.254)	1.965*** (0.375)
sd.trd			−0.019*** (0.005)	−0.028*** (0.007)
sd.cdmc			0.044 (1.839)	−0.001 (4.339)
sd.cdnc			−0.644 (0.547)	0.875 (1.106)
Observations	1,149	1,149	1,149	1,149
R^2	0.154	0.156	0.201	0.202
Log Likelihood	−1,020.122	−1,017.429	−963.397	−961.811
LR Test	371.499*** (df = 27)	376.884*** (df = 30)	484.947*** (df = 33)	488.120*** (df = 33)
Note:				*p<0.1; **p<0.05; ***p<0.01

note: MXL model has two types; MXL normal distribution and MXL random parameter distribution assumption models. In normal distribution, all the coefficients are normally distributed. Random parameter distribution assumes that the coefficient of travel distance has triangular distribution while the coefficient of each level of water quality and congestion is uniformly distributed. In both MXL models, entrance fee (price) is fixed.

Table 4. 14. Different Draws in MXL random parameter Model

	Dependent variable: Alternative1, 2, 3				
	choice				
	(25)	(100)	(250)	(500)	(1,000)
Alt2:(intercept)	0.052 (0.522)	0.073 (0.529)	0.046 (0.530)	0.041 (0.537)	0.031 (0.539)
Alt3:(intercept)	−0.911 (0.724)	−0.898 (0.737)	−0.982 (0.740)	−0.973 (0.750)	−0.966 (0.752)
wqf	1.198*** (0.327)	1.106*** (0.338)	1.167*** (0.335)	1.214*** (0.338)	1.207*** (0.339)
wqg	3.007*** (0.515)	3.035*** (0.524)	3.087*** (0.528)	3.142*** (0.535)	3.122*** (0.532)
wqe	3.792*** (0.745)	3.824*** (0.760)	3.904*** (0.764)	3.960*** (0.774)	3.917*** (0.770)
trd	−0.010*** (0.003)	−0.010*** (0.003)	−0.019*** (0.003)	−0.019*** (0.003)	−0.010*** (0.003)
cdmc	1.580*** (0.212)	1.579*** (0.219)	1.582*** (0.224)	1.631*** (0.232)	1.633*** (0.227)
cdnc	1.643*** (0.226)	1.641*** (0.238)	1.640*** (0.246)	1.708*** (0.257)	1.695*** (0.255)
fee	−0.065*** (0.011)	−0.066*** (0.011)	−0.066*** (0.011)	−0.067*** (0.011)	−0.067*** (0.011)
Alt2:incometwo	0.639* (0.359)	0.588 (0.363)	0.645* (0.362)	0.673* (0.366)	0.657* (0.367)
Alt3:incometwo	1.293*** (0.449)	1.277*** (0.454)	1.341*** (0.456)	1.357*** (0.461)	1.344*** (0.461)
Alt2:incomethree	1.074*** (0.327)	1.016*** (0.328)	1.050*** (0.328)	1.085*** (0.332)	1.082*** (0.332)
Alt3:incomethree	2.065*** (0.421)	2.010*** (0.421)	2.081*** (0.427)	2.113*** (0.433)	2.117*** (0.430)
Alt2:incomefour	1.287*** (0.382)	1.186*** (0.386)	1.220*** (0.382)	1.275*** (0.387)	1.276*** (0.391)
Alt3:incomefour	2.687*** (0.458)	2.547*** (0.462)	2.603*** (0.462)	2.655*** (0.470)	2.673*** (0.470)
Alt2:edutwo	−0.643** (0.302)	−0.707** (0.308)	−0.728** (0.306)	−0.723** (0.309)	−0.719** (0.311)
Alt3:edutwo	−0.221 (0.352)	−0.298 (0.356)	−0.328 (0.354)	−0.331 (0.358)	−0.326 (0.361)
Alt2:eduthree	0.386 (0.360)	0.451 (0.369)	0.417 (0.363)	0.432 (0.366)	0.467 (0.371)
Alt3:eduthree	1.076*** (0.416)	1.118*** (0.423)	1.105*** (0.418)	1.138*** (0.423)	1.156*** (0.428)
Alt2:genderfemale	0.046 (0.231)	0.065 (0.233)	0.076 (0.230)	0.085 (0.233)	0.097 (0.235)
Alt3:genderfemale	0.664*** (0.252)	0.693*** (0.254)	0.711*** (0.253)	0.719*** (0.256)	0.730*** (0.258)
Alt2:agetwo	−0.232 (0.461)	−0.191 (0.463)	−0.238 (0.461)	−0.278 (0.465)	−0.245 (0.468)
Alt3:agetwo	−1.589*** (0.494)	−1.465*** (0.495)	−1.537*** (0.498)	−1.566*** (0.504)	−1.528*** (0.503)
Alt2:agethree	0.325 (0.443)	0.347 (0.447)	0.304 (0.445)	0.277 (0.448)	0.313 (0.450)
Alt3:agethree	−0.958** (0.481)	−0.933* (0.485)	−0.975** (0.489)	−1.003** (0.494)	−0.966** (0.492)
Alt2:agefour	−0.349 (0.472)	−0.321 (0.478)	−0.363 (0.475)	−0.404 (0.480)	−0.390 (0.482)
Alt3:agefour	−2.381*** (0.554)	−2.253*** (0.560)	−2.353*** (0.567)	−2.409*** (0.575)	−2.388*** (0.568)
sd.wqf	−2.604*** (0.386)	2.778*** (0.413)	−2.692*** (0.406)	2.691*** (0.414)	2.716*** (0.416)
sd.wqg	−0.056 (0.788)	0.263 (1.871)	−0.264 (2.342)	0.578 (1.183)	−0.434 (1.570)
sd.wqe	1.975*** (0.363)	1.965*** (0.375)	1.989*** (0.383)	2.061*** (0.391)	2.056*** (0.384)
sd.trd	−0.026*** (0.007)	−0.028*** (0.007)	0.026*** (0.008)	0.027*** (0.008)	−0.030*** (0.007)
sd.cdmc	−0.072 (1.180)	−0.001 (4.339)	−0.069 (7.309)	−0.098 (9.131)	−0.003 (27.652)
sd.cdnc	1.003 (0.823)	0.875 (1.106)	1.044 (1.040)	1.234 (0.925)	−1.129 (1.008)
Observations	1,149	1,149	1,149	1,149	1,149
R^2	0.200	0.202	0.201	0.202	0.202
Log Likelihood	−964.696	−961.811	−963.071	−962.580	−961.778
LR Test (df = 33)	482.350***	488.120***	485.600***	486.582***	488.186***

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4. 15. Willingness to Pay for change in Water Quality to avoid poor water quality

Water Quality	MNL Value	MNP Value	MXL Normal distribution	MXL Random parameter distribution
Poor	Reference	Level		
Fair	$25.25	$22.08	$19.60	$16.69
Good	$48.55	$43.04	$47.11	$45.82
Excellent	$60.18	$53.50	$58.82	$57.73

Table 4. 16. Total Willingness to Pay in change of Water Quality

Salt Ponds	week/ weekend	Average Daily Users	Number of Days in July & August			WTP to avoid poor water quality	WTP for good from fair water quality	WTP for excellent from fair water quality
			Subtotal	July	August			
Total	weekdays	2,269	44	23	21	$1,666,262.84	$2,908,222.68	$4,097,269.44
	weekends	3,430	18	8	10	$1,030,440.60	$1,798,486.20	$2,533,809.60
	Total	5,699	62	31	31	$2,696,703.44	$4,706,708.88	$6,631,079.04

Table 4. 17. Willingness to Pay to avoid over congestion

Congestion	MNL Value	MNP Value	MXL Normal distribution	MXL Random Par. distribution
Not-Crowded	$24.59	$21.21	$25.72	$24.76
Medium-Crowded	$24.83	$23.46	$24.97	$23.82
Over-Crowded	Reference	Level		

Table 4. 18. Willingness To Pay to avoid one mile further travel distance

Congestion	MNL Value	MNP Value	MXL Normal distribution	MXL Random Parameter distribution
Travel Distance	$0.22	$0.17	$0.22	$0.15

Table 4. 19. Willingness to Pay of travel distance under different distribution assumption

Distribution	Normal	Uniform	Triangular
Travel Distance	$0.22	$0.23	$0.15

Table 4. 20. MXL Different Travel Distance Distributions Model

	Dependent variable: Alternative			
	choice			
	(normal)	(triangular)	(uniform)	(log-normal)
Alt2:(intercept)	0.033 (0.538)	0.073 (0.529)	0.036 (0.531)	−0.058 (0.537)
Alt3:(intercept)	−0.878 (0.754)	−0.898 (0.737)	−0.962 (0.744)	−0.999 (0.756)
wqf	1.306*** (0.336)	1.106*** (0.338)	1.177*** (0.333)	1.182*** (0.343)
wqg	3.137*** (0.539)	3.035*** (0.524)	3.074*** (0.526)	3.071*** (0.526)
wqe	3.918*** (0.778)	3.824*** (0.760)	3.851*** (0.761)	3.816*** (0.768)
trd	−0.015*** (0.003)	−0.010*** (0.003)	−0.015*** (0.003)	−5.038*** (0.495)
cdmc	1.663*** (0.233)	1.579*** (0.219)	1.599*** (0.223)	1.629*** (0.213)
cdnc	1.713*** (0.250)	1.641*** (0.238)	1.645*** (0.242)	1.696*** (0.245)
fee	−0.067*** (0.011)	−0.066*** (0.011)	−0.066*** (0.011)	−0.066*** (0.011)
Alt2:incometwo	0.720* (0.371)	0.588 (0.363)	0.674* (0.366)	0.650* (0.370)
Alt3:incometwo	1.426*** (0.469)	1.277*** (0.454)	1.351*** (0.457)	1.351*** (0.466)
Alt2:incomethree	1.086*** (0.336)	1.016*** (0.328)	1.082*** (0.331)	0.971*** (0.330)
Alt3:incomethree	2.188*** (0.442)	2.010*** (0.421)	2.094*** (0.427)	2.000*** (0.427)
Alt2:incomefour	1.302*** (0.394)	1.186*** (0.386)	1.273*** (0.387)	1.336*** (0.398)
Alt3:incomefour	2.721*** (0.478)	2.547*** (0.462)	2.631*** (0.465)	2.752*** (0.472)
Alt2:edutwo	−0.696** (0.312)	−0.707** (0.308)	−0.727** (0.308)	−0.684** (0.313)
Alt3:edutwo	−0.366 (0.365)	−0.298 (0.356)	−0.318 (0.357)	−0.285 (0.364)
Alt2:eduthree	0.424 (0.372)	0.451 (0.369)	0.437 (0.366)	0.644* (0.385)
Alt3:eduthree	1.101** (0.429)	1.118*** (0.423)	1.153*** (0.424)	1.310*** (0.442)
Alt2:genderfemale	0.099 (0.235)	0.065 (0.233)	0.084 (0.233)	0.096 (0.242)
Alt3:genderfemale	0.712*** (0.259)	0.693*** (0.254)	0.690*** (0.254)	0.747*** (0.264)
Alt2:agetwo	−0.274 (0.470)	−0.191 (0.463)	−0.264 (0.463)	−0.101 (0.471)
Alt3:agetwo	−1.623*** (0.513)	−1.465*** (0.495)	−1.511*** (0.496)	−1.401*** (0.508)
Alt2:agethree	0.290 (0.450)	0.347 (0.447)	0.301 (0.445)	0.430 (0.448)
Alt3:agethree	−1.047** (0.500)	−0.933* (0.485)	−0.932* (0.487)	−0.861* (0.493)
Alt2:agefour	−0.422 (0.483)	−0.321 (0.478)	−0.369 (0.475)	−0.349 (0.481)
Alt3:agefour	−2.525*** (0.582)	−2.253*** (0.560)	−2.315*** (0.561)	−2.374*** (0.567)
sd.wqf	1.541*** (0.259)	2.778*** (0.413)	2.668*** (0.407)	2.813*** (0.417)
sd.wqg	0.436 (0.533)	0.263 (1.871)	0.489 (1.214)	0.436 (1.371)
sd.wqe	1.326*** (0.254)	1.965*** (0.375)	2.014*** (0.382)	2.027*** (0.384)
sd.trd	−0.019*** (0.005)	−0.028*** (0.007)	0.029*** (0.008)	1.415*** (0.384)
sd.cdmc	0.044 (1.839)	−0.001 (4.339)	0.255 (2.938)	0.066 (3.492)
sd.cdnc	−0.644 (0.547)	0.875 (1.106)	0.803 (1.213)	−1.046 (1.017)
Observations	1,149	1,149	1,149	1,149
R^2	0.201	0.202	0.201	0.205
Log Likelihood	−963.397	−961.811	−962.972	−958.500
LR Test (df = 33)	484.947***	488.120***	485.799***	494.741***

Note: *p<0.1; **p<0.05; ***p<0.01

note: the coefficient of travel distance is estimated under the different distribution assumption including normal, triangular, uniform, and log-normal distribution.

Appendices

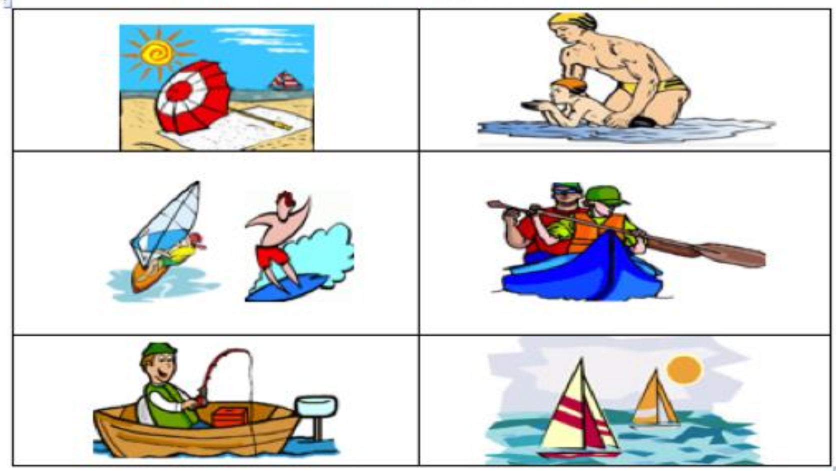
APPENDIX A: SURVEY QUESTIONNAIRE

Thank you for taking the time
to answer this survey.

Your responses are very important

Salt Pond

Recreation Activity and Water Quality Improvement Survey



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Rhode Island

The goal of this study is to determine the economic value of improving water quality for coastal salt ponds in Rhode Island and to include public opinions in decisions to manage the coastal salt ponds.

Your opinions are very important

All answers are confidential

BACKGROUND INFORMATION

This information presents the comparison of water quality in 1990 (25 years ago) and that in 2015 in Salt Ponds. This information may help you answer the questions on the next few pages. **(Source: http://www.saltpondscoalition.org)**

POND	Approximate Water Quality in 1990 **(25 years ago)**	Trend	Approximate Water Quality in 2015 **(Now)**
Point Judith	EXCELLENT	↘	FAIR
Potter	EXCELLENT	↓	POOR
Green Hill	FAIR	↘	POOR
Ninigret	EXCELLENT	↘	FAIR
Quonochontaug	EXCELLENT GOOD	↘	GOOD FAIR
Winnapaug	GOOD	↘	FAIR

Water Quality	Characteristics
EXCELLENT	Pristine Appearance, Swimmable, Boatable, Bodily Contact O.K
GOOD	Swimmable, Boatable, Bodily contact O.K
FAIR	Swimmable, Boatable, Bodily Contact NOT O.K
POOR	Boatable, Bodily Contact NOT Safe, Odor

Your thoughts about the experiences in Salt Ponds
(Please Check Appropriate Response in the table below)

What do you think about the place you spent the most time today (or last time on the salt ponds)?						
Pond Features	Very Undesirable	Slightly Undesirable	Neither Desirable Nor Undesirable	Slightly Desirable	Very Desirable	N/A
Water Quality						
Parking Lot Size						
Amount of Trash						
Amount of Noise						
Amount of Wild Life						
Scenery Around						
Accessibility to the Pond						

Your Choice of Recreation Site

On the following two pages, you are asked to choose one recreation site on each hypothetical scenario

We are trying to understand how people choose among different sites to recreate.

Below we describe different hypothetical scenarios.

- For each question, choose which of the three sites you would prefer to go to if you could only select one of the three sites that are described
- **Consider each question separately. Do not add them up.**
- With your choice, we try to learn
  - How important water quality is to you
  - How water quality affects your recreation site choice
  - How much you would pay to improve the water quality

1. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality	FAIR	GOOD	EXCELLENT
Travel Distance	20miles(30min)	80miles(2 hr)	80miles(2 hr)
Crowded Level	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)
Admission Fee per visit	$0	$0	$20

2. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality	FAIR	GOOD	EXCELLENT
Travel Distance	20miles(30min)	20miles(30min)	20miles(30min)
Crowded Level	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)	Overcrowded (121people/ 0.1 acre)(36 sf/person)
Admission Fee per visit	$0	$20	$20

3. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality	POOR	FAIR	EXCELLENT
Travel Distance	80miles(2 hr)	80miles(2 hr)	80miles(2 hr)
Crowded Level	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)	Not Crowded (30 people/0.1 acre) (144 sf/person)
Admission Fee per visit	$ 0	$20	$20

4. If you had to choose one of the 3 options below, which one would you choose?

(Do not compare these to program on any other pages)

Your Choice (check one)	☐	☐	☐
Pond Attribute	**CHOICE A**	**CHOICE B**	**CHOICE C**
Water quality	POOR	FAIR	EXCELLENT
Travel Distance	20miles(30min)	80miles(2 hr)	20miles(30min)
Crowded Level	Medium (68 people/ 0.1 acre (64sf/person	Overcrowded (121people/ 0.1 acre)(36 sf/person)	Overcrowded (121people/ 0.1 acre)(36 sf/person)
Admission Fee per visit	$ 0	$20	$20

Appendix B: Model 1(table 4.5) comparison in MNL, MNP, MXL

	Dependent variable:Alternative 1,2,3			
	choice			
	(MNL)	(MNP)	(MXL)	(MXL r.parameter)
Alt2:(intercept)	0.622*** (0.082)	0.744*** (0.251)	0.677*** (0.106)	0.677*** (0.106)
Alt3:(intercept)	0.798*** (0.080)	0.762*** (0.215)	0.823*** (0.120)	0.823*** (0.120)
Alt2.Alt3		0.998*** (0.119)		
Alt3.Alt3		0.280 (0.630)		
sd.Alt2:(intercept)			−1.086*** (0.178)	−1.086*** (0.178)
sd.Alt3:(intercept)			1.730*** (0.199)	1.730*** (0.199)
Observations	1,149	1,149	1,149	1,149
R^2	0.000	0.0003	0.060	0.060
Log Likelihood	−1,205.871	−1,205.491	−1,132.940	−1,132.940
LR Test	0.000 (df = 2)	0.761 (df = 5)	145.863*** (df = 4)	145.863*** (df = 4)
Note:				*p<0.1; **p<0.05; ***p<0.01

Appendix C: Model 2 comparison in MNL, MNP, MXL

	Dependent variable:Alternative1, 2, 3			
	choice			
	(MNL)	(MNP)	(MXL)	(MXL r.parameter)
Alt2:(intercept)	0.447** (0.214)	0.270** (0.136)	0.556* (0.317)	0.492 (0.315)
Alt3:(intercept)	0.201 (0.412)	0.226 (0.227)	0.203 (0.622)	0.053 (0.615)
wqf	1.144*** (0.205)	0.493*** (0.132)	1.310*** (0.332)	1.297*** (0.331)
wqg	2.221*** (0.328)	0.976*** (0.230)	3.156*** (0.545)	3.201*** (0.541)
wqe	2.692*** (0.486)	1.179*** (0.315)	3.724*** (0.786)	3.819*** (0.775)
trd	0.010*** (0.002)	0.004*** (0.001)	0.014*** (0.003)	0.018*** (0.003)
cdmc	1.194*** (0.139)	0.559*** (0.102)	1.727*** (0.238)	1.708*** (0.235)
cdnc	1.187*** (0.130)	0.531*** (0.101)	1.765*** (0.250)	1.746*** (0.257)
fee	−0.047*** (0.008)	−0.022*** (0.004)	−0.065*** (0.011)	−0.066*** (0.011)
Alt2.Alt3		0.523*** (0.118)		
Alt3.Alt3		0.641*** (0.150)		
sd.wqf			1.532*** (0.274)	−2.497*** (0.423)
sd.wqg			0.991*** (0.304)	−1.409** (0.551)
sd.wqe			1.674*** (0.265)	2.609*** (0.390)
sd.trd			0.017*** (0.005)	−0.025*** (0.008)
sd.cdmc			−0.123 (1.108)	−0.001 (2.419)
sd.cdnc			0.612 (0.551)	−1.224 (0.894)
Observations	1,149	1,149	1,149	1,149
R^2	0.104	0.105	0.168	0.166
Log Likelihood	−1,080.325	−1,079.731	−1,002.949	−1,005.109
LR Test	251.091*** (df = 9)	252.281*** (df = 12)	405.845*** (df = 15)	401.525*** (df = 15)
Note:				*p<0.1; **p<0.05; ***p<0.01

Appendix D: Model 3 comparison in MNL, MNP, MXL

	Dependent variable:Alternative 1,2,3			
	choice			
	(MNL)	(MNP)	(MXL)	(MXL r.par)
Alt2:(intercept)	0.007 (0.269)	0.060 (0.146)	−0.318 (0.370)	−0.275 (0.366)
Alt3:(intercept)	−0.738 (0.460)	−0.145 (0.253)	−1.371** (0.683)	−1.337** (0.670)
wqf	1.176*** (0.210)	0.480*** (0.130)	1.386*** (0.325)	1.216*** (0.332)
wqg	2.269*** (0.335)	0.948*** (0.224)	3.164*** (0.541)	3.108*** (0.531)
wqe	2.751*** (0.497)	1.141*** (0.305)	3.763*** (0.778)	3.708*** (0.771)
trd	0.010*** (0.002)	0.004*** (0.001)	0.015*** (0.003)	0.010*** (0.003)
cdmc	1.175*** (0.141)	0.528*** (0.100)	1.715*** (0.240)	1.661*** (0.232)
cdnc	1.198*** (0.132)	0.520*** (0.099)	1.769*** (0.250)	1.732*** (0.257)
fee	−0.048*** (0.008)	−0.023*** (0.004)	−0.065*** (0.011)	−0.066*** (0.011)
Alt2:incometwo	0.234 (0.268)	0.137 (0.141)	0.708* (0.364)	0.687* (0.362)
Alt3:incometwo	0.452 (0.284)	0.198 (0.129)	0.990** (0.440)	0.940** (0.435)
Alt2:incomethree	0.586** (0.229)	0.314*** (0.121)	1.110*** (0.298)	1.090*** (0.295)
Alt3:incomethree	1.060*** (0.241)	0.475*** (0.127)	1.855*** (0.368)	1.788*** (0.361)
Alt2:incomefour	0.911*** (0.263)	0.442*** (0.143)	1.485*** (0.360)	1.461*** (0.358)
Alt3:incomefour	1.763*** (0.271)	0.768*** (0.169)	2.601*** (0.423)	2.615*** (0.421)
Alt2.Alt3		0.536*** (0.117)		
Alt3.Alt3		0.609*** (0.144)		
sd.wqf			−1.412*** (0.266)	−2.639*** (0.423)
sd.wqg			1.010*** (0.308)	−1.232** (0.598)
sd.wqe			1.557*** (0.263)	2.373*** (0.386)
sd.trd			−0.018*** (0.005)	0.029*** (0.008)
sd.cdmc			0.002 (1.197)	0.156 (3.164)
sd.cdnc			−0.662 (0.509)	1.231 (0.936)
Observations	1,149	1,149	1,149	1,149
R^2	0.126	0.128	0.182	0.182
Log Likelihood	−1,053.715	−1,052.110	−986.712	−986.765
LR Test	304.313*** (df = 15)	307.523*** (df = 18)	438.319*** (df = 21)	438.213*** (df = 21)
Note:				*p<0.1; **p<0.05; ***p<0.01

Appendix E: Model 4 comparison in MNL, MNP, MXL

	Dependent variable:Alternative 1, 2, 3			
	choice			
	(MNL)	(MNP)	(MXL)	(MXL.r.parameter)
Alt2:(intercept)	0.465** (0.214)	0.272** (0.131)	0.553* (0.312)	0.538* (0.312)
Alt3:(intercept)	0.237 (0.413)	0.263 (0.213)	0.209 (0.616)	0.173 (0.614)
wqf	1.143*** (0.205)	0.457*** (0.123)	1.287*** (0.323)	1.249*** (0.330)
wqg	2.213*** (0.328)	0.918*** (0.214)	3.091*** (0.537)	3.127*** (0.531)
wqe	2.664*** (0.487)	1.096*** (0.292)	3.653*** (0.775)	3.690*** (0.770)
trd	−0.010*** (0.002)	−0.004*** (0.001)	−0.014*** (0.003)	−0.010*** (0.003)
cdmc	1.189*** (0.139)	0.537*** (0.096)	1.706*** (0.235)	1.699*** (0.229)
cdnc	1.188*** (0.130)	0.509*** (0.095)	1.705*** (0.241)	1.721*** (0.255)
fee	−0.033*** (0.010)	−0.015*** (0.005)	−0.058*** (0.014)	−0.057*** (0.014)
I(fee *income)	−0.0002** (0.0001)	−0.0001** (0.00005)	−0.0001 (0.0002)	−0.0001 (0.0001)
Alt2.Alt3		0.504*** (0.108)		
Alt3.Alt3		0.595*** (0.140)		
sd.wqf			−1.429*** (0.266)	−2.548*** (0.430)
sd.wqg			0.953*** (0.307)	−1.418** (0.559)
sd.wqe			1.644*** (0.267)	−2.538*** (0.382)
sd.trd			−0.016*** (0.005)	−0.027*** (0.008)
sd.cdmc			0.161 (1.325)	−0.038 (2.874)
sd.cdnc			0.507 (0.639)	1.107 (0.964)
Observations	1,149	1,149	1,149	1,149
R^2	0.107	0.107	0.167	0.167
Log Likelihood	−1,077.434	−1,076.395	−1,004.861	−1,004.142
LR Test	256.875*** (df = 10)	258.951*** (df = 13)	402.021*** (df = 16)	403.459*** (df = 16)
Note:				*p<0.1; **p<0.05; ***p<0.01

No: the unit of income is $1,000

Chapter Five. Calibration of the Opportunity Cost of Time

In the previous two chapters, we used Travel Cost Method (Revealed Preference Method) and Conjoint Analysis Method (Stated Preference Method). This chapter calibrates the opportunity cost of time of Travel Cost Method using the Marginal Willingness To Pay for travel distance in Conjoint Analysis Method. Since time is scarce, using it up in traveling to a recreation site has an opportunity cost, but the value of leisure time has long been a controversial issue because the opportunity cost of time differs from an individual to individual and from recreation activity to activity (Hanley, Bell, & Alvarez-Farizo, 2003). Thus, using Conjoint Analysis which also provides the value of the opportunity cost of time in the model, we investigate the empirical opportunity cost of time used in visiting Salt Ponds.

This chapter starts with introduction that outlines the issues of the opportunity cost of time in Travel Cost Method and Conjoint Analysis Method that enables us to infer Marginal Willingness to Pay for reduced travel distance. The second section lay out literature review on how the opportunity cost of time has been estimated and what were the controversial issues followed by the conceptual frame of how to get empirical estimates of the opportunity cost of travel time by calibrating. Then results of the calibration and conclusions are followed.

5.1 Introduction

The purpose of this chapter is to calibrate the controversial opportunity cost of time in recreation demand model using the empirical data from the Conjoint Analysis Method (Stated Preference Method). Respondents were asked sequentially about their travel cost related information and hypothetical attribute trade-off questions. The Travel Cost Method is based on the notion that, while there may be no standard price for many recreational activities, recreation requires travel to the site. The cost of travel to the site plays the role of the "price" of participating in the recreational activity. However, in addition to the out-of-pocket cost of gasoline and maintenance, recreational participants also have to spend time to the access to the site. Thus, the opportunity cost of time spent traveling represents an additional cost of participating in recreation. Each Method has the information that are associated with travel distance and out-of-pocket cost. Thus, this study examines the appropriate values for the opportunity cost of time in recreation demand model.

Travel Cost Method was based on Zonal Travel Cost Method to estimate the demand function and consumer surplus. Conjoint Analysis presents individuals with hypothetical alternatives, described in terms of their attributes, including the travel distance and an entrance fee. Respondents' choice among alternatives can be used to infer tradeoffs among the attributes, and hence estimate the marginal willingness to pay for reduced travel distance.

In Travel Cost Method, the most commonly employed approach to value the opportunity cost of time is based on a fraction of the wage rate from one fourth to the full wage rate (Parsons, 2003; Fleming & Cook, 2007). Like recreation consumption where there is not market price, time consumption has no market price. Thus, the opportunity cost of time for an individual depends on what activities are traded off. If the individual is trading off travel time for work time and then the opportunity cost of time can be estimated at the wage rate (Cesario, 1976). Then equation for consumers to maximize utility can be described as below.

$$\frac{\partial U}{\partial t_l} = P * \frac{\partial U}{\partial Y} + \frac{\partial U}{\partial t_w}$$

$$\frac{\frac{\partial U}{\partial t_l}}{\frac{\partial U}{\partial Y}} = \mathrm{P} + \frac{\frac{\partial U}{\partial t_w}}{\frac{\partial U}{\partial Y}}$$

where U is utility, t_l is leisure time, t_w is work time, P is the money wage, and Y is income. We rearrange this equation by dividing marginal utility of income ($\frac{\partial U}{\partial Y}$) on both sides. Consequently, the marginal rate of substitution between income and leisure is defined as the sum of the money wage rate and the marginal rate of substitution between income and the time spent at work. Since marginal utility of time spent work is negative, the value of leisure time should be somewhat less than the wage rate (Cesario, 1976; Freeman, Herriges, & Kling, 2014).

However, issue arises when we assume that people can continuously trade-off time spent work with time spent at leisure. Self-employed and freelancer can freely trade-off time between work and leisure, but those who have fixed working hours or who are unemployed cannot trade-off time between work and leisure (Bockstael, Strand, & Hanemann 1987; Flemming & Cook, 2008).

In a more realistic model with income and payroll taxes, time would be valued at the after-tax wage rate. However, surveys provide household income before tax amount rather than after tax amount. To infer wage rate from household income, that household income is generally divided by some estimated hours (50weeks * 40 hours = 2000 hours); this inferring can induce measurement error (Freeman et al, 2014, Flemming & Cook, 2008; Smith,Desvousges, & McGivney1983). Some might make tradeoffs for overtime, where it is common to receive pay at time-and a half or double (Shaw, 1992). As described above, the value of the opportunity cost of time is still debated in the travel cost literature and thus empirical work became necessary to clarify the assumptions on the role of the opportunity cost of time in travel cost demand models.

5.2. Literature Review

In using Revealed Preference Method, this study applied TCM (Zonal Travel Cost Method) to estimate the single day recreation user value. However, TCM doesn't come without limitation. For example, travel cost is analogous to price. But travel cost includes not only the cost of gasoline, but also includes factors such as maintenance and vehicle wear and tear. As a consequence, the general practice in the literature is to use the daily driving cost per mile from the American Automobile Association (Freeman et al., 2014). Hence, out of pocket cost is the average daily price of operation and management cost per mile times the traveled distance for round-trip (AAA, 2013). Recreationists also have to spend time to travel to the recreation site. Thus, the opportunity cost of time spent traveling represent additional cost of participating in recreation. Since time consumption has no market price, the value of the opportunity cost was estimated on what activities are traded-off. If the individual trades off travel time for work time, the opportunity cost of time can be estimated at the wage rate (Cesario, 1976). As described in introduction section, the marginal rate of substitution between income and leisure is the sum of the money wage rate and the marginal rate of substitution between income and the time spent at work. Since marginal utility of time spent work is negative, the value of leisure time is less than the wage rate (Cesario, 1976; Freeman et al., 2014). Thus, the value of opportunity cost of time spent for traveling is generally expressed as a fraction of wage rate which is annual household income divided by 2,000 hours (Belenky, 2011; Freeman et al., 2014). However, there is no consensus on the value of opportunity cost yet. Different literature used different fraction of wage rate. For example, Belenky (2011) used 50% of wage rate as the value of the opportunity cost of time. Beesley (1965) studied time-money tradeoff in urban commuter choices between public transports and found that travel time is valued at about one third wage rate. However, for higher income workers, the opportunity cost of time was slightly less than one-half of wage rate. Other literature inferred the opportunity cost of time using two variables, and measure of out-of-pocket cost and measure of time cost (McConnel and Strand, 1981). To express the opportunity cost of time in dollar terms, separate coefficients on the out-of-pocket expense and the "time cost" of travel were measured. Then, the opportunity cost of time was estimated as the ratio of these two coefficients. However, out of pocket expense and time cost are both related to distance travelled, and so are likely to be highly correlated. So it may not be possible to estimate separate coefficients. This study concluded that in their sample of individuals fishing in Chesapeake Bay region in 1978, the opportunity cost of time is 61.2% of hourly income (McConnell and Strand, 1981). And then they added that opportunity costs may be overstated for the wealthy and for some visitors whose travels are limited to vacation or weekend time. It is important to note that there is likely no single opportunity cost of time that is applicable to all individuals. Rather the value of travel time is likely to vary greatly across sites and across individuals. Thus, it is not possible to generalize the opportunity cost of time as a fraction of the hourly wage (Smith et al., 1983).

Other literatures use a fraction following the majority of the literature suggestions. Empirical studies like Blackwell (2007), Xue, Cook, and Tisdell (2000), Ward & Beal (2000) used 40% of wage rate as the value of the opportunity cost explaining that this fraction is preferred allocation for similar studies and that is why they followed. Other studies such as Beesley (1965), and Sohngen, Lichtkoppler, and Bielen (2000) used 30% of wage rate as the opportunity cost following the Cesario's suggestions (Cesario, 1976). Empirical studies such as Quarmby (1967) used 25% of wage rate as the opportunity cost of time. Quarmby (1967) studied a sample of car owners who chose between private car and public transport and concluded that the opportunity cost of time is between 20% to 25%. Other empirical studies that excluded the opportunity cost of time includes Siderelis and Moore (1995), Beal (1995a), Whitten and Bennett (2002), and Prayaga, Rolfe, and Sinden (2006) used 0% of wage rate for the value of the opportunity cost since individuals travel to recreation sites mostly during holidays (Amoako-Tuffour & Martinez-Espineria, 2008).

As we have seen from the previous literature, consensus on the value of the opportunity cost of time was not yet reached and issues associated to the value of opportunity cost of time are remained. For example, when a self-employed man or freelancer go to a recreation site, the value of opportunity cost of time imposes that the cost of his leisure time is equal to his hourly income because he gave up the working opportunities to pursue leisure at the margin (Hanley et al., 2003). Thus, there are challenges because all the respondents are not self-employed or freelancer who can freely trade off time between work and leisure and self-employed people could represent small portion of population (Bocksteal et al., 1987; Hanley et al., 2003; McKean, Johnson, & Walsh, 1995).

Some might make tradeoffs for overtime, where it is common to receive pay at time-and a half or double (Shaw, 1992). Or for those who are engaged in lawn mowing, gardening, or child care as a home keeper when they are not engaged in the recreation activity, the opportunity cost of time can be the cost of hiring someone else to do the work as a proxy not the zero amount (Shaw, 1992). Surveys used for Travel Cost Method provide before tax annual income which is divided by 2000 hours to infer hourly wage rate (Freeman et al., 2014). This application assumes zero tax rate, but after tax-wage rate would be more appropriate in reflecting real opportunity cost of time (Smith et al., 1983).

In summary, the opportunity cost of time will tend to be context specific; the opportunity cost of time can be different depending on the type of recreational activities. Some activities such as mountain climbing and hunting can be more dangerous than lake fishing. Utility of mount climbers can come from the intensity of the activity not from the number of visit. A respondents' employment status and other activities which the respondent would be doing if not engaged in the activity under examination can differ the opportunity cost of time (Shaw, 1992). Depending on the location of the recreation site, the opportunity cost of time can differ. Local recreation sites may have demands from the neighbor region on weekdays and weekends while national recreation sites may have demands with a great distance and the allocation of different types of time such as annual long vacation or leave (Smith et al, 1983).

An approach for addressing this issue is to design questions in the survey to refine estimates of the opportunity cost of time, and to specify differences across individuals. For example, another TCM study used survey instrument that includes travel information questions and the contingent valuation type questions to elicit the value of the opportunity cost of time; hikers to the Grandfather Mountain, North Carolina were asked how much they would be compensated if they were working overtime instead of hiking through a mail survey (Shaw, 1992, Casey, Vukina & Danielson,1995). Many jobs are based on a fixed 40 hour per week basis so that trade-off between work and recreation were estimated as the value of overtime. Out of 185 returned survey, 42 completed in both income questions of TCM section and Willingness-To-Accept for the value of time that was the contingent valuation type question. Consumer surplus of both traditional wage rate approximation and the self-reported time value were compared (Shaw, 1992, Casey et al., 1995). They found that consumer surplus was nearly twice as large when using self-reported opportunity cost of time, as compared to using the full wage rate model (Shaw, 1992; Casey et al., 1995). The fraction of the wage approach can be sensitive and consumer surplus will depend on the specific fraction of wage rate (Shaw, 1992). Thus, sensitivity analysis of the consumer surplus can be conducted. Lower fraction of the wage rate can be taken as a lower bound and higher fraction of wage rate or two or three times the wage rate can be used as an upper bound since some individuals might have given up the opportunity to earn double times the wage rate (Shaw, 1992).

In summary, in Travel Cost Method, the most commonly employed approach to value time is based on a fraction of the wage rate from one fourth of the wage to the full wage (Parsons, 2003; Flemming & Cook, 2008; Freeman et al., 2014). The literature shows that different approaches for measuring the opportunity cost of time can result in different measures of consumer surplus, and there is no consensus on a single correct approach. Yet, there has not been enough empirical research on the opportunity cost of time in Travel Cost to come to consensus on the preferred approach. For this reason, the value of time cost has long been a controversial issue and there has been the necessity of empirical study on how to value on the value of opportunity cost. This study calibrates the opportunity cost of time in Travel Cost Method using the results of Conjoint Analysis Method. With empirical data collected from two different methods from the same respondents, this study examines the appropriate values for controversial opportunity cost of time in travel cost demand models.

5.3 Conceptual Framework

The Conjoint Analysis questionnaire was designed to include travel distance and an entrance fee so that the approach could be used to estimate the relationship between travel distance and an out-of-pocket expenses. As discussed above, the value of time has been much discussed in the literature, and the most common approach is use one fourth of the wage rate as a lower bound on opportunity cost of time, and the full wage as an upper bound (Xue et al., 2000; Parsons, 2003; Freeman et al., 2014). However, theory provides limited guidance on the appropriate fraction to use, and the opportunity cost of time has been very controversial (Smith et al, 1983; Randall, 1994; Freeman et al., 2014). By combining both non-market valuation methods, this paper tries to gain the insights into the relationship, if any, between annual income and the opportunity cost of time since two methods have travel distance. Travel Cost Method uses the distance to estimate the monetary cost and time cost, and Conjoint Analysis Method has travel distance and an entrance fee, which is an explicit out-of-pocket cost. In Travel Cost Method, total travel cost equals the sum of trip cost (out-of-pocket cost) for the distance travelled and the opportunity cost of time travelled.

Then trip cost is estimated by multiplying the distance for a round trip and the operation cost per mile, where the out-of-pocket cost per mile, was assumed to be \$0.578 based on estimates of the American Automobile Association (AAA, 2013).

$$TripCost = \$0.578/mile * Distance(RoundTrip) \quad \text{..................................(1)}$$

$$TimeCost = \frac{Annual\_Income}{2000hours} * \frac{1}{3} * time_{travelled(Round\ Trip)} \quad \text{..............................(2)}$$

For the opportunity cost of time, this study used the lower bound of $\frac{1}{3}$. In order to get the hourly income, annula income is divided by 2000 hours = 40 hours per week times 50 weeks/year. The Conjoint Analysis model expresses the total cost of travel distance in monetary terms by dividing the estimated coefficient on travel distance by the estimated coefficient on the entrance fee.

$$\frac{MWP_{travelled\_distance}}{MWP_{entrance\ fee}} = \frac{\frac{\partial U}{\partial travel\ ditance}}{\frac{\partial U}{\partial entrance\ fee}}$$

$$= \frac{\partial U}{\partial td} * \frac{\partial fee}{\partial U}$$

$$=$$

$$\left.\frac{\partial \$}{\partial td}\right|_{U=U^0} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Then we use the Conjoint Analysis results to estimate the total marginal cost of travel distance, which includes both the time cost and the out-of-pocket expense. This result is used to specify

$$Tripcost + F * (timecost) = \frac{\partial \$}{\partial td}$$

……………………………………………(4)

where F is a fraction of wage rate which will represent for the empirical time value from the acquired data. Then we solve this equation for the appropriate fraction of the time, F, using.

$$F * (timecost) = \frac{\partial \$}{\partial td} - (tripcost)$$

……………………………………………(5)

$$F = \frac{\frac{\partial \$}{\partial td} - (tripcost)}{timecost} \quad \text{.........(6)}$$

Thereby the value of the opportunity cost of time can be estimated from the two different non-market valuation methods and the estimated opportunity cost from the empirical data is compared with the general value of the opportunity cost used in the literature.

5.4 Results

We construct the Marginal Willingness to Pay for a reduced travel distance from Travel Cost Method by estimating total cost of mile that is the sum of time cost plus out-of-pocket cost. Based on TCM, out-of-pocket cost per mile of distance travelled was \$0.578 and the opportunity cost of time was estimated as \$39.06 per hour. Table 5.1 presents out-of-pocket cost per mile and the value of time acquired by rearranging given information in Chapter 3. To convert annual household income to hourly wage rate, average income of respondents as described in Chapter 3 – Travel Cost Method – was used; average income of \$78,120 is divided by 2,000 hours to get wage rate of \$39.06 per hour.

[Table 5.1 about here]

According to Conjoint Analysis results of Mixed Logit Model with random parameter distribution (table 4.17), Marginal Willingness To Pay for one mile increased travel distance is -0.01 and for increased entrance fee is -0.066. In order to get monetary value per mile, we divide Marginal Willingness to Pay for increased travel distance by Marginal Willingness to Pay for increased entrance fee (-0.066 /- 0.01) to get the estimated cost of $6.6 per mile which is the sum of the out-of-pocket expense ($0.58) plus the opportunity cost of time ($6.02). Following the estimate of the opportunity cost of time in Conjoint Analysis, the value of the opportunity cost of time is $6.02.

[Table 5.2 about here]

To get the fraction that will be used to get the part of the wage rate, we utilize the equation (6) and plug in the numbers acquired from each equation.

$$F = \frac{\frac{\partial \$}{\partial td} - (tripcost)}{timecost}$$

Denomination is obtained by subtracting out-of-pocket cost of $0.578 per mile of TCM from $6.6 that is the estimated monetary value per mile from random parameter Mixed Logit Model (table 5.2) in conjoint Analysis and thus we get $6.02. Numerator is the time cost per hour from Travel Cost Method when average income of respondents of $78,120 is divided by 2,000 hours. We get hourly time cost of $39.06.

To get fraction of wage rate, we divide $6.02 by $39.06 to get 0.154 ($F = \frac{6.02}{39.06} = 0.154$). Following the result of Mixed Logit Model with random parameter distribution, fraction of wage rate based on the collected data is roughly 15.4 percent of the wage, which is lower than the commonly recommended lower bound of fraction of wage of $\frac{1}{3}$.

Table 5.3 presents the estimated monetary value per mile using the Conjoint Analysis Method. Under the Multinomial Logit, Multinomial Probit, and Mixed Logit Models, estimated monetary value per mile is $4.55 per mile using MNL model, $6 per mile in MNP model, $4.47 per mile using MXL model and $6.6 per mile using random parameter distribution MXL model. Mixed Logit Model was used with two different assumptions on the coefficients of the attributes: one is normal distribution assumption and another is random parameter distribution. Within the random parameter distribution assumption on the coefficients of the attributes, fee was fixed, congestion and water quality parameters followed uniform distribution, and travel distance followed triangular distribution as described in Chapter four (table 4.13).

[Table 5.3 about here]

Table 5.4 summarizes the outcomes of estimated monetary value per mile in Mixed Logit Model when different assumption on the distribution of travel distance variable was applied. Estimated monetary value per mile ranged from $4.47 to $6.6 dollars per mile traveled. When log-normal distribution was assumed on travel distance, estimated monetary value per mile was one cent indicating that log-normal distribution assumption on the coefficient of travel distance is not credible.

[Table 5.4 about here]

As discussed in section 4.4, the Mixed Logit Model uses a simulation-based approach using random draws from a given distribution on the random components to approximate choice probabilities (Train, 2000). Table 5.5 shows estimated monetary value per mile when drawing numbers are different even in the same triangular distribution. From the smallest number of 25, 100, 250, 500, up to 1,000 HALTON drawing numbers were respectively conducted in the Mixed Logit Model with random parameter distribution (Bhat 2001; Train 2000). In this Mixed Logit Model with random parameter distribution, we assumed the coefficient of travel distance followed triangular distribution, and the coefficient of fee is fixed. The coefficients of Water quality and Congestions followed uniform distribution.

[Table 5.5 about here]

As shown in table 5.5, estimated monetary value per mile ranges from $3.47 to $6.7 and in table 5.6, the estimated fraction of the wage rate per hour ranged from 10% to 15% depending on the distribution assumption made.

[Table 5.6 about here]

Fraction was calculated following the equation (6). Under the same Mixed Logit Model, the first model assumed every coefficient is normally distributed. The second MXL model used separate random parameter distribution assumption; the coefficient of the entrance fee is fixed, and coefficient on travel distance is normally distributed while the coefficients of water quality and congestion are uniform distribution following Train's suggestion (Train, 2000).

Table 5.7 summarizes the estimated fraction of the wage rate when different distribution assumption was used on the interest coefficient of travel distance in Mixed Logit Model of Conjoint Analysis to compare.

[Table 5.7 about here]

The fraction of the wage rate, the calculation followed the equation (6) described in conceptual frame section and was estimated to be 10 percent when the coefficient of travel distance is assumed to be normally distributed while the fraction of that was 9.8 percent when the coefficient of travel distance is assumed to be uniform distributed. Interest of distribution on the coefficient of travel distance is triangular distribution and log-normal distribution. When the coefficient of travel distribution followed the log-normal distribution assumption, fraction of wage rate was 0.025 percent. This low value may come from a thick tail of log-normal distribution. Triangular distribution assumption on the coefficient of travel distance that cut out the long tail of log-normal distribution that contributed to the extreme value of parameter reported the fraction of wage rate value 15 percent. Table 5.8 presents the total consumer surplus when the wage rate of 15% was applied to the opportunity cost of time.

[Table 5. 8 about here]

Compared to the total consumer surplus of $2,8million, when we applied the wage rate of 33% to the opportunity cost of time, the total consumer surplus when 15% of wage rate is applied to the opportunity cost of time is $2,2 million.

5.5 Conclusion and Discussion

There is a considerable degree of uncertainty in the Travel Cost literature on how to translate travel distance into a cost that includes both out-of-pocket travel expenses and the time cost of travel to the site. The literature most commonly uses AAA estimates of the cost per mile, plus a time cost that is based on a fraction of the wage rate that ranges from one fourth of the wage to the full wage. These assumptions can make a considerable difference in the estimated recreational user day value. We used data collected from three Salt Ponds (Point Judith, Ninigret, Quonochontaug), Rhode Island and then estimated the value of opportunity cost of time by applying the results of Conjoint Analysis Models to the estimated value from Travel Cost Method.

The literature on the opportunity cost of time shows different approaches and there is no consensus on a single correct approach. For the time cost, wage rate was used from the full wage rate to one fourth the wage rate(Cesario, 1976; Freeman et al.,, 2014; Parsons, 2003). However, fraction of wage rate for the time cost in Travel Cost Method assumes that people can continuously trade-off time for work with time for leisure. Self-employed people or freelancer may take a small proportion of population and those who have fixed working hours cannot freely trade-off time between work and leisure (Bockstael et al., 1987; Flemming & Cook, 2008).

This study can argue that recreationists visiting Salt Ponds, Rhode Island, perceive their time value 15% of hourly wage and the estimated value of time in a context of recreation based on the empirical results is closer to the lower bound of the existing guideline that ranges from one fourth to full wage rate. However, this estimate of proportion is consistent with the value that is based on the examination of the empirical results in which the study of urban commuters in the United Kingdom found that the value of time value ranged from 20 to 25 percent of the wage rate (Quarmby, 1967; Cesario, 1976). New proportion of time value on the wage rate affects in estimating consumer surplus. We applied the newly estimated fraction of the hourly wage to the recreation demand model that was studied in Travel Cost Method chapter to check the sensitivity in consumer surplus in Travel Cost Method. Consumer surplus of recreational user-day value decreased from $2,8 million to $2,2 million when the fraction varied from 33% to 15%.

This study assumed that total recreation price can be approximated by the sum of out-of-pocket cost and time spent to reach the recreation site. We did not include the value of on-site time in recreation site demand function. Whether to include the opportunity cost of on-site time is still not clear across the literature. On-site time values in recreation demand is important in that on-site time also has the time value and thus has the potential to improve the recreation demand model (Berman & Kim, 1999). However, spending more time at the site both enhances the value of visit and increases the opportunity cost of time. This dual role of on-site time complicates the role of on-site time and thus, examining the opportunity cost of on-site time based on empirical data would be a direction to be headed.

In conclusion, this study suggests that the fraction of hourly wage rate that accounts for the opportunity cost of time is an empirical question because the fraction for time value may vary among regions and sites and recreation activities an individual is engaged in. Thus, in recreation demand model, it is recommended that the fraction of the wage rate for the time cost should be estimated on a case-by-case basis This is particularly the relevant for those local sites like Salt Ponds, Rhode Island where users' recreational demands come from the near regions like Connecticut, and Massachusetts. National sites that have a great distance and the substantial subset of visitors may have the different value of the opportunity cost of time which require the allocation of different types of time (i.e. annual vacation or leave). The value of the opportunity cost of time can be different for these different characteristic sites (Smith et al., 1983).

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Tables and Figure

Table 5. 1. Estimated Travel Cost from TCM

MWP for travel	Value
Trip Cost	$\frac{\$0.578}{mile}$
Time Cost	$\frac{\$78{,}120\ (average\ annual\ income)}{20000h} = \frac{\$39.06}{hour}$

Table 5. 2. Marginal Willingness To Pay for travel from Conjoint Analysis

MWP For travel	Value	
CAM	$\frac{\partial U}{\partial tcost}$	-0.010
	$\frac{\partial U}{\partial \$value}$	-0.066
	$\frac{\partial \$value}{\partial tcost}$	$\frac{0.066}{0.01}$ = \$6.6

Table 5. 3. Values of MWP for a travel from Conjoint Analysis

Value	MNL	MNP	MXL Normal distribution	MXL Random parameter distribution
$\frac{\partial U}{\partial tcost}$	-0.11	-0.004	-0.015	-0.01
$\frac{\partial U}{\partial \$value}$	-0.05	-0.024	-0.067	-0.066
$\frac{\partial \$value}{\partial tcost}$	4.55	6	4.47	6.6

Table 5. 4. Values of MWP per mile in Conjoint Analysis

Value	MXL with random parameter distribution with Different distribution on travel distance			
	Normal Distribution	Uniform Distribution	Triangular Distribution	Log-normal Distribution
$\frac{\partial U}{\partial tcost}$	-0.015	-0.015	-0.010	-5.038
$\frac{\partial U}{\partial \$value}$	-0.067	-0.066	-0.066	-0.066
$\frac{\partial \$value}{\partial tcost}$	4.47	4.4	6.6	0.01

Table 5. 5. Values of MWP per mile under different HALTON numbers

Value	MXL with random parameter distribution & each drawing numbers				
	25	100	250	500	1,000
$\frac{\partial U}{\partial tcost}$	-0.010	-0.010	-0.019	-0.019	-0.010
$\frac{\partial U}{\partial \$value}$	-0.065	-0.066	-0.066	-0.067	-0.067
$\frac{\partial \$value}{\partial tcost}$	6.5	6.6	3.47	3.52	6.7

Table 5. 6. Fraction of hourly wage from different models

Value		Models			
		MNL	MNP	MXL Normal Distribution	MXL Random parameter Distribution
Numerator	$\frac{\partial \$}{\partial td} - (tripcost)$	3.97	5.42	3.89	6.02
Denominator	$\frac{\$value}{hour}$	39.06	39.06	39.06	39.06
Fraction	$\frac{\frac{\partial \$}{\partial td} - (tripcost)}{timecost}$	0.10	0.14	0.10	0.15

Table 5. 7. Fraction of hourly wage from different distribution on travel distance

Value		MXL with random parameter distribution with Different distribution on travel distance			
		Normal Distribution	Uniform Distribution	Triangular Distribution	Log-normal Distribution
Numerator	$\frac{\partial \$}{\partial td} - (tripcost)$	3.89	3.82	6.02	0.01
Denominator	$\frac{\$value}{hour}$	39.06	39.06	39.06	39.06
Fraction	$\frac{\frac{\partial \$}{\partial td} - (tripcost)}{timecost}$	0.10	0.098	0.15	0.0002

Table 5. 8. Total Consumer Surplus using wage rage of 15% for the opportunity cost of time

Salt Ponds		**Average Daily Users**	**Number of Days in July and August**			**CS Estimates**	**Total User Value Estimates**
			subtotal	**July**	**August**		
Point Judith	weekdays	856	44	23	21	$13.77	$518,633
	weekends	1,537	18	8	10	$13.77	$380,961
	subtotal	2,393	62	31	31	$13.77	$899,594
Ninigret	weekdays	593	44	23	21	$13.77	$359,287
	weekends	892	18	8	10	$13.77	$221,091
	subtotal	1,485	62	31	31	$13.77	$580,378
Quono-chontaug	weekdays	820	44	23	21	$13.77	$496,822
	weekends	1,001	18	8	10	$13.77	$248,108
	subtotal	1,821	62	31	31	$13.77	$744,929
Total	weekdays	2,269	132	69	63	$13.77	$1,374,742
	weekends	3,430	54	24	30	$13.77	$850,160
	subtotal	5,699	186	93	93	$13.77	$2,224,902

Chapter Six. Policy Implication

6.1. Introduction

The object of this chapter is to provide a perspective on the size of the recreational benefits of water quality improvements, relative to the cost of actions to improve water quality. The previous Chapter provided estimates of the benefits of water quality improvements based on the Conjoint stated preference method. This Chapter compares benefit estimates with costs of actions to improve water quality in the salt ponds.

It is important to note that it is beyond the scope of the present study to carry out a systematic benefit-cost analysis of actions to improve water quality. Rather, this Chapter uses the benefit estimates associated with different levels of water quality improvement, and compares these estimates with the cost of upgrading septic systems for residential structures within the State of Rhode Island designated Critical Resource Area (CRA) around the salt ponds.

[Figure 6.1 about here]

On January 1, 2008, the Rhode Island Department of Environmental Management (RI DEM) implemented rule 39 to control the amount of nitrogen entering the salt ponds. Nitrogen has been known the major pollutant in the salt ponds and the primary source of nitrogen input to the salt pond is Individual Sewer Disposal System (ISDS) (Salt Pond Coalition, 2009). Conventional septic systems within the Critical Resource Area (CRA) adequately treat bacteria, which is another type of pollutant in the salt ponds, but does not treat nitrates. Thus, RI DEM required Onsite Wastewater Treatment System (OWTS) to be installed within the CRA to control and reduce nitrates entering the salt ponds to improve water quality (Salt Pond Coalition, 2009). However, it is important to note that it is beyond the scope of the present study to estimate the resultant water quality change.

Unlike conventional septic systems, OWTS, which are also called de-nite systems, treat nitrogen. For example, for Green Hill Pond if all cesspools and conventional septic systems in the CRA are converted to OWTS, there would be a subsequent nitrogen reduction of up to 27% (Salt Pond Coalition 2009). The cost of conventional septic system is estimated as $20,000 and an Individual OWTS I roughly $35,000. Because most septic systems replaced by OWTS would have to be replaced by a new conventional system, incremental cost of installing individual OWTS is $15,000. We estimate the total and the incremental annualized cost. (Salt Pond Coalition, 2009). Approximately, there would be total of 13,777 households in CRA area after subtracting the number of houses served by centralized waste water treatment systems (DEM, Jonathan Zwarg, Personal Communication, October 13, 2017).

6.2. Total Cost and Incremental Cost of the Replacing Existing Systems

We provide two estimates of the cost of actions to improve water quality: the total cost of installing onsite wastewater treatment systems with nitrogen removal, and incremental cost above and beyond the cost of a new conventional septic system. The total cost of installing an onsite wastewater treatment system with nitrogen removal is $35,000 and relevant for policies that require the replacement of all existing systems. The incremental cost of $15,000 includes the cost of adding nitrogen removal element onto the function of conventional individual septic system, which is the difference between the cost of beyond and above the new conventional septic system (Salt Pond Coalition, 2009). Individual Onsite Wastewater Treatment System includes the cost of installing and the operation and maintenance cost for 20 years of lifespan. We applied 2% of discount rate to amortize the cost based on the community septic system loan program (Community Septic System Loan Program, 2017).

The annualized cost is the sum of the operation & management cost and the amortized capital cost. The total cost and the incremental cost vary depending on which institution calculates the cost so that we present the range of costs using available data from Salt Pond Coalition, DEM, and case study of Cape Cod (Salt Pond Coalition, 2009; Barnstable County Wastewater Cost Task Force, 2010; DEM, Jonathan Zwarg, Personal Communication, October 13, 2017). Table 6.1 reports the total and the incremental cost of replacing the conventional septic systems within the critical resource area using Salt Pond Coalition calculation, DEM, and Cape Cod case study.

[Table 6.1 about here]

The estimated total and incremental annual costs in table 6.1 include data for all nine salt ponds located in CRA. However, the existing estimates of residential user-days and recreational benefits associated with water quality improvement is limited to the three studied salt ponds: Point Judith, Ninigret, Quonochontaug. Since the exact number of households on the ponds was not determined, we used a range of house numbers as a proxy for three ponds to compare to the estimates of recreational benefits of the three studied ponds. One half, and one third of total number of houses were used and table 6.2 and table 6.3 present the range of total and incremental costs based on the number of households. Through cost benefit analysis would be beyond the scope of this chapter and require a further independent research.

[Table 6.2 about here]

[Table 6.3 about here]

When we used the number of total households on the nine lagoons, presented in table 6.1, total annual incremental cost of OWTS ranged from $8,6 million to $29.9 million. The cost provided by the Salt Pond Coalition produced the highest figure followed by Cape Cod case with $24 million. The lowest cost was generated by RI DEM source. With 50% of the total households used as a proxy for three studied ponds, total annual incremental cost ranges from $4.3 million to $15 million; one third of total number of households produced the total annual incremental cost ranging from $2.9 million to $10 million.

6.3. Recreational Benefits Associated to water quality improvement

Previous Conjoint Analysis chapter estimated the recreational benefits associated with water quality improvement and a reduction in congestion for user-day values in the salt ponds. Then we estimated aggregated recreational benefits associated with water quality improvements using the number of total users during the peak season – July and August of 2014. Table 6.4 through 6. 6 present the aggregated recreational benefits of future water quality for only two peak months.

[Table 6.4 about here]

[Table 6.5 about here]

[Table 6.6 about here]

Recreational benefits associated with water quality improvement is the value only for two peak months from July to August of 2014. Visits during the remainder of the year(10 months) are not calculated due to the lack of counted data. To extrapolate the estimate to include the entire year, we approximately assume that the total visitors of the rest ten months are equal to the visitor number of the two peak months. The estimate of recreational benefits associated with water quality improvements for a full year is presented in table 6.7. Water quality is currently rated as fair. The analysis below estimates benefits of avoiding a reduction in water quality from fair to poor, as well as benefits from improving water quality from fair to good, and from fair to excellent.

[Table 6.7 about here]

The recreational benefits to avoid further degradation to poor from current fair status is $5.4 million, $9.4 million to improve water quality from fair to good, and $13.3 million from fair to excellent status. If we assume the total visits of the remaining ten months are double the visitor number of the two peak months, recreational benefits to avoid further degradation to poor from current fair status is $8.1 million, $14.1 million to improve water quality from fair to good, and $19.8 million from fair to excellent status.

6.4. Comparison & Conclusion

It is important to acknowledge that we do not know the actual improvement in water quality from nitrogen removal septic systems, but we use these estimates of the coast of action to provide a rough indication of benefits associated with water quality improvements. Recreational benefits associated with water quality improvement from fair to good status is estimated to be $9.4 million while the incremental cost of action to improve water quality through OWTS installation ranges from $2.8 million to $10 million. Recreational benefit associated with water quality improvement from fair to excellent is $13.3 million which is greater than any cost of action.

Thus, these estimates suggest that recreational use values associated with water quality improvements could be similar in magnitude to the costs of implementing programs requiring nitrogen removing septic systems designed to maintain and improve water quality. It is important to note two key points here. First, our benefit estimates include only benefit to recreational users of salt ponds, and not other potential benefits, including ecosystem benefits, general aesthetic effects, etc. Second it is important to note that this research does not quantify the effectiveness of nitrogen removing technology in improving water quality in the salt ponds, which is beyond the scope of this study. Rather we provide a perspective on benefits of maintaining and improving water quality, and compare those benefits to the costs of implementing measures intended to improve water quality. Further research is needed to carry out a full benefit-cost analysis of programs to improve water quality in Rhode Island salt ponds.

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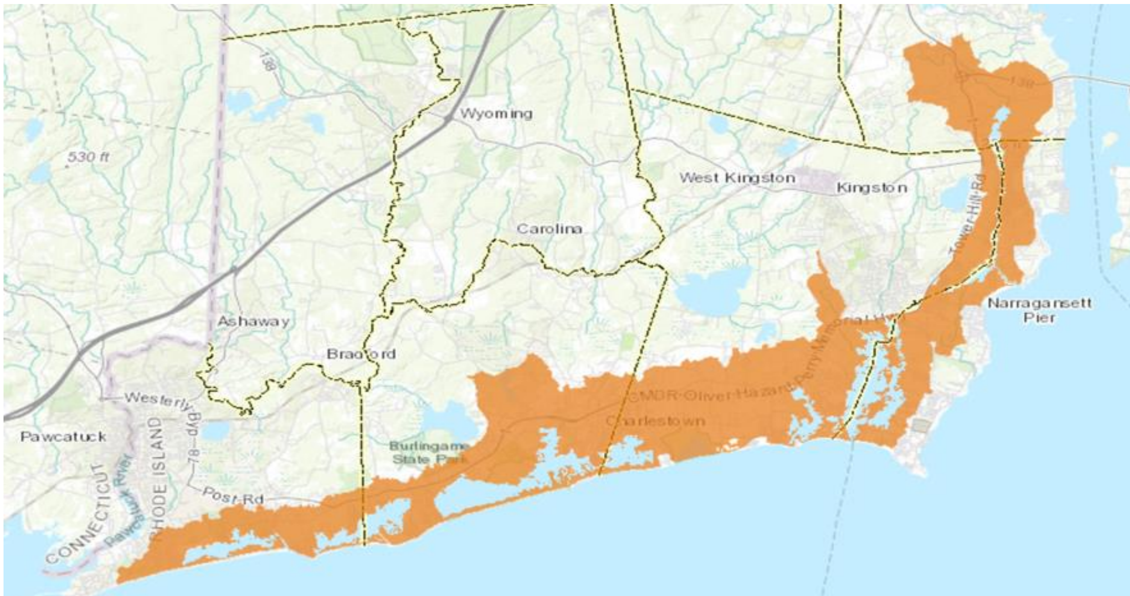
Tables and Figures

Figure 6. 1. Figure 6. 1. Critical Resource Area (CRA) in the Salt Ponds



Source: Adjusted from DEM website (http://www.dem.ri.gov/programs/water/owts/regulations-reports/crabndry.php)

Table 6. 1. Annual Total Cost and Incremental Cost of Onsite Waste Water Treatment Systems

Institution	Total Cost	Annual Payment	Total # of Households	Total Annual Payment (million)
Salt Pond Coalition	$35,000	$ 3,390	13,775	$46.70
DEM	$22,000	$ 2,959	13,775	$40.76
Cape Cod Case Study	$28,000	$ 2,962	13,775	$40.80
Institution	Incremental Cost	Annual Payment	Total # of Households	Total Annual Payment
Salt Pond Coalition	$15,000	$ 2,167	13,775	$29.85
DEM	$ 2,000	$ 622	13,775	$8.57
Cape Cod Case Study	$ 8,000	$1,739	13,775	$23.95

Note: According to the estimate of DEM, total number of household (13,775) in critical resource area is used.

Table 6. 2. Annual Total Cost of Onsite Waste Water Treatment Systems

Institution	Total Cost	Annual Payment	Total # of Households	Total Annual Payment (million)
Salt Pond Coalition	35,000	3,390	6,888	$23.35
DEM	22,000	2,959	6,888	$20.38
Cape Cod Case Study	28,000	2,962	6,888	$20.40
Salt Pond Coalition	35,000	3,390	4,592	$15.56
DEM	22,000	2,959	4,592	$13.59
Cape Cod Case Study	28,000	2,962	4,592	$13.60

Note: Half (6,888) and one third (4,592) of the total number of household as a proxy for three studied salt ponds

Table 6. 3. Annual Incremental Cost of Onsite Waste Water Treatment Systems

Institution	Incremental Cost	Annual Payment	Total # of Households	Total Annual Payment (million)
Salt Pond Coalition	15,000	2,167	6,888	$14.93
DEM	2,000	622	6,888	$4.28
Cape Cod Case Study	8,000	1,739	6,888	$11.98
Institution	Incremental Cost	Annual Payment	Total # of Households	Total Annual Payment
Salt Pond Coalition	15,000	2,167	4,592	$10
DEM	2,000	622	4,592	$2.86
Cape Cod Case Study	8,000	1,739	4,592	$7.98

Note: Half (6,888) and one third (4,592) of the total number of household as a proxy for three studied salt ponds

Table 6. 4. Total Two Months of Willingness To Pay to avoid poor water quality

Salt Ponds	week/weekend	Average Daily Users	Number of Days in July & August			MWTP for Water Quality Fair	Total MWTP for Water Quality Fair
			Subtotal	July	August		
Total	weekdays	2,269	44	23	21	$ 16.69	$ 1,666,262.84
	weekends	3,430	18	8	10	$ 16.69	$ 1,030,440.60
	Total	5,699	62	31	31	$ 16.69	$ 2,696,703.44

Table 6. 5. Total Two Months of Willingness To Pay to improve water quality to good from fair water quality

Salt Ponds	week/weekend	Average	Number of Days in July & August			MWTP for Water Quality Good	Total MWTP for Water Quality Good
		Daily Users	Subtotal	July	August		
Total	weekdays	2,269	44	23	21	$ 29.13	$ 2,908,222.68
	weekends	3,430	18	8	10	$ 29.13	$ 1,798,486.20
	Total	5,699	62	31	31	$ 29.13	$ 4,706,708.88

Table 6. 6. Total Two Months of Willingness To Pay to improve water quality to excellent from good water quality

Salt Ponds	week/weekend	Average	Number of Days in July & August			MWTP for Water Quality Excellent	Total MWTP for Water Quality Excellent
		Daily Users	Subtotal	July	August		
Total	weekdays	2,269	44	23	21	$ 41.04	$ 4,097,269.44
	weekends	3,430	18	8	10	$ 41.04	$ 2,533,809.60
	Total	5,699	62	31	31	$ 41.04	$ 6,631,079.04

Table 6. 7. Recreational Benefits Associated with Future Water Quality for a full year

Current Water Quality	Recreational Benefits (million)		
	Avoid deterioration to Poor	Improve Fair to Good	Improve Fair Excellent
Fair	5.4	9.4	13.3

Chapter Seven. Conclusion

The objective of this dissertation is to use the Travel Cost Method and Conjoint Analysis to estimate values associated with recreation as well as changes in values associated with changes in water quality and congestion in Rhode Island coastal salt ponds. Next we use data from a Conjoint stated preference approach to calibrate the controversial opportunity cost of time in the travel cost recreation demand model. Finally, these results are used to provide a perspective on the estimated benefits of recreational values associated with water quality, relative to the cost of actions to improve water quality.

The main research questions are (1) what is the user-day value of recreational activity in the three studied area of Rhode Island Salt Ponds, (2) What is the estimated willingness to pay to avoid degradation to poor water quality, and to improve to higher levels of water quality, (3) What is the value of the opportunity cost of time for the travel cost model, (4) How do the estimated values of water quality changes compared to the costs of key activities to improve water quality?

The Travel Cost Method is used to estimate the demand function for recreation using data on the number of trips taken by participants who face different travel costs. This estimated demand function is then used to calculate consumer surplus for users from different distances. The total consumer surplus is estimated by this estimated value per day times the estimated total number of visits to the Salt Ponds. We estimate a total user days for two peak months at the three Rhode Island salt ponds to be 161,576 user days. It also estimates the value per recreational user day to be $17.42. Applying these results, the annual recreational value of the three salt ponds is estimated to be approximately $2.8 million for the months of July and August.

Next a Conjoint Analysis Stated Preference Method is used to estimate the impacts of changes in water quality and congestion for value of recreation in the Rhode Island coastal salt ponds. Currently, water quality of three studied area in the Salt Pond is fair. We estimated a Willingness To Pay (WTP) of $17 to avoid poor water quality, WTP of $29 to improve water quality to good from fair, and WTP of $41 to excellent from fair using a random parameter Mixed Logit Model. Stated Preference Conjoint results estimate that recreational users are willing to pay $23 per user-day to avoid sites becoming over-congested. The incremental willingness to pay to reduce congestion below the status quo level is not statistically significant.

We estimate a total of approximately 161,576 visits for peak months of July and August to the three Rhode Island salt ponds. We assume that the total visitors of the rest ten months are equal to the visitor number of the two peak months. Applying the value per user-day to avoid to poor quality implies a total recreational value of approximately $5.4 million to avoid deterioration of water quality from fair to poor. Applying the value per recreational user day of improving water quality to good from fair status results in a total recreational value of approximately $9.4 million. Similarly, applying the estimated value of $41.04 per user day for improving water quality to excellent from fair results in a total value of $13.2 million.

Travel cost includes both out-of-pocket travel expense and the opportunity cost of travel time to the site. However, Travel Cost literature has not come to consensus on how to translate time spent travelling to the site into a monetary cost of visiting the site. We use a stated preference Conjoint Analysis to estimate the opportunity cost of time by applying the results of Conjoint Analysis models to the estimated recreation value from Travel Cost Method. Travel Cost Method used in chapter 3 used 33% of user wage rate as the estimate of the opportunity cost of time. The conjoint results estimate that the opportunity cost of time is approximately 15% of their hourly wage rate, which is closer to the lower bound of the existing guidelines that ranges from one fourth to full wage rate. The estimated user day value reported above is based on a conventional estimate of the opportunity cost of time of 33% of the wage rate. Based on this result, we recalculate the recreational value using a lower range on the opportunity cost of time. Using an opportunity cost of time that ranges from 15% to 33% of the hourly wage results in a user-day value that ranges from $13.77 to $17.42, and a total annual recreational use value that ranges from $2.2 million to $2.8 million for the three salt ponds during July and August.

Finally, we provide a perspective on potential desirability of actions to improve water quality by comparing the estimated benefits of water quality with the costs of actions designed to improve it. In order to do so, we compare the recreational value associated with water quality improvements discussed above, with the estimates of cost of improving water quality by requiring advanced onsite wastewater treatment system that includes nutrient removal in critical resource area of salt ponds, Rhode Island.

We estimate values of $2,000, $8,000, and $15,000 as the incremental cost of adding nitrogen removal at the time new septic system is installed depending on the institution which calculated the cost (DEM, Jonathan Zwarg, Personal Communication, October 13, 2017; Salt Pond Coalition, 2009; Barnstable County Wastewater Cost Task Force, 2010).

We use a range of proxy for the number of houses for three studied salt ponds since total houses of 13,577 in the CRA (Critical Resource Area) includes whole nine salt ponds and the number of households by the pond was not estimated. Applying one third of total houses with septic systems for three salt ponds as a proxy results in a total cost of $2.9 million, $7.9 million, and $10 million.

As indicated above, the estimated annual benefit of recreation to avoid further deterioration to poor is $5.4 million, $9.4 million to improve to good from current fair condition.

It is important to note that this is not intended to be a full cost benefit analysis for several reasons. First, we include only estimated benefits to recreational users, and not other benefits, such as ecological effects or aesthetic benefits to nearby residents. Second, we do not provide an estimate of the actual water quality improvement that would result from requiring upgrades in septic systems. Doing so requires an analysis of how reduced nitrogen loads from residential septic in the area would impact water quality in the salt ponds.

In summary, this study finds that recreational activities in Rhode Island salt ponds are highly valued, and that recreational values are quite sensitive to levels of water quality and congestion. These results suggest that efforts to protect and management the Rhode Island salt ponds can provide significant benefits to the public. We find that recreational values alone might provide a strong rationale for actions to protect and improve quality of Rhode Island salt ponds. This rationale is reinforced by other values that are outside the scope of this study, such as ecological and aesthetic values for water quality improvement.

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