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INVESTIGATING COASTAL RECREATION AND CLIMATE
IN THE COASTAL LAGOONS OF RHODE ISLAND, USA:

A MULTI-METHODS APPROACH

BY

EMILY PATROLIA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

IN

MARINE AFFAIRS

UNIVERSITY OF RHODE ISLAND

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MASTER OF MARINE AFFAIRS THESIS
OF
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2016

ABSTRACT

Recreational use of the coastal lagoons in Rhode Island is one of the major factors that makes the southern part of the state a tourism-dependent economy. The coastal lagoons (also known as salt ponds) are highly valued for a wide range of recreational activities such as fishing, clamming, boating, and water tubing. Weather considerably affects an individual's decisions to recreate outside, especially on the water. Climate change will affect the weather in Rhode Island, thereby affecting when, how, and how much people recreate in the coastal areas of the state. Understanding both short- and long-term variance in coastal recreation could help state managers and business owners better utilize resources and plan for the future.

This mixed methods study focuses on how sensitive different types of coastal recreational users (relaxing, kayaking, motor boating, and fishing) are to different weather conditions and how much weather is perceived by the recreationist to play a role in the decision making process. Observational data of human activities in RI coastal lagoons was used to determine revealed importance for weather factors using linear regression models. Intercept surveys were used to determine how much weather played a role in the decision to recreate at the lagoon that day. Based on these results, short- and long-term forecasts can be made about how recreational activities might change with day-to-day weather changes and, in the longer term, with climate change trends.

Recreational fishing and clamming was found to be the least affected by weather factors, which is complemented by interview results which suggest the main motivators for fishers are not weather factors but mostly tidal conditions. Humidity,

precipitation, and wind were found to have significant negative effects across activities and average high temperatures were found to have significant positive effects across activities, with higher coefficients indicating a high percent increase in recreational use with a one degree increase in temperature. Results also indicate a high temperature threshold for all uses tested (relaxing, kayaking, fishing) except motor boating, which may have implications for recreational activity as summer temperature trends increase with climate change. Observational and interview results were qualitatively compared, and it was found that stated importance of weather factors matches relatively well with observed action for relaxing and rowing, and less well for fishing and motoring.

If climate change brings warmer temperatures and more intense wind and rain events, the results indicate that we can expect a decrease in relaxing, rowing, and fishing on the hotter days and a decrease in especially rowing and fishing on windier days. Warmer temperatures may increase the length of the summer season and may lead to an overall increase in recreational use, though in the peak of the heat there may be a shift towards motor boating as it was found to be the most resistant to high temperatures. This information can help businesses and managers better understand fluctuations in recreational use type and amount on the coastal lagoons.

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I especially want to thank my parents, Sue and Tom, and my sister, Meghan, for their love and encouragement and for enduring my endless chatter about social science! You have been there for me through it all and I will always be thankful for you. I owe a great deal of gratitude to all of my friends as well who supported me and believed in me.

PREFACE

This thesis is written in Manuscript Format because it will be submitted for the Coastal Management Journal. Because this thesis is comprised of three proposed journal articles, it will be separated into three parts with joint introduction and conclusion sections. The three proposed articles are:

Part A: "Modeling coastal recreation user groups and climate"

Part B: "Investigating stated importance of climate to coastal recreation user groups"

Part C: "Comparing two methods used to predict the effects of weather on recreation: Revealed versus stated importance"

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1. Introduction

1.1 Statement of Problem

The coastal lagoons (also called salt ponds) of the south shore of Rhode Island contain a dense and diverse number of coastal recreational uses, including beach-going, swimming, fishing, clamming, boating, and a multitude of other uses. As climate change affects weather in Rhode Island, it will become increasingly important for managers, property owners, and tourism-dependent business owners to better understand how recreational uses of the ponds might be affected by changing weather.

Coastal recreation and tourism industries are influenced by weather and climate as these factors may affect an individual's decision to engage in outdoor recreation. Some weather factors may affect this decision more than others and some uses may be more affected by weather factors than others. Climate change will affect weather and, therefore, perhaps affect the types, amount, and timing of recreational activity. It is currently unknown to what extent and how weather may affect these activities. This research examines how much different climate factors affect people's decisions to engage in a particular recreational activity on and along the coastal lagoons in Southern Rhode Island.

1.2. Tourism and the Coast

Tourism is a large part of the local economy of coastal towns in the United States. Coastal states receive roughly 85% of tourist-related revenues in the United States and it is estimated that roughly twice as many Americans visit beaches as visit National Parks (Haisman and Houston 2008). Humans are drawn to the shore when the weather is warm to cool off, relax, and enjoy the many activities these ecosystems

offer. In the summer months, tourists come from great distances to visit coastal communities and are the economic lifeline for local businesses, providing the income that sustains them during the offseason. Weather and tourism, especially coastal tourism, are inextricably linked. For example, it is widely understood that "a good beach day" means higher temperatures, mid to low wind, and sunny skies. A summer of "bad" weather will lead to lower profit for local businesses due to reduced volume of visitors.

As Kidlow et al. (2009) write, "At the mercy of the economy and climate, tourism waxes and wanes dependent on the state of these." Travel and tourism in the United States generates an estimated \$746 billion dollars per year (Jones and Phillips 2009) and it is estimated that U.S. beaches contribute more than \$320 billion annually to the national economy (Haisman and Houston 2008). It is an important industry that will be affected by climate change. Among other factors, climate change has the potential to impact recreational use of the coastal environment due to changing patterns in weather and therefore changing volume of recreationists and tourists and activities they engage in.

1.2.2 Coastal Tourism in Rhode Island

Along Rhode Island's southern shore, the state's slogan "The Ocean State" rings especially true. As soon as the weather warms, recreationists and tourists come to experience the many miles of coastline this small state has to offer. They come to lounge and swim at the beach, fish, kayak, boat, eat local seafood, and partake in a multitude of other uses. Importantly, these tourists and users of Rhode Island's natural resources are an important part of the local economy and ecology. Not only does

Rhode Island have beautiful barrier beaches, but it also has unique coastal lagoons along the southern coast between the barrier beaches and the mainland.

Figure 1 Rhode Island, USA (source: RI GIS)

Figure 2 Southern Shore of Rhode Island: Coastal Lagoons (source: Google Earth)

The lagoons are shallow, productive marine embayments separated from the ocean by barrier spits with engineered breachways, allowing for tidal fluctuation and navigation. They provide important ecosystem and habitat functions for fin and shellfish (Anthony et al. 2009) as well as areas for hunting, fishing and pleasure boating (Jones and Phillips 2009).

The coastal salt ponds in Rhode Island are important areas in the state for recreational use and tourism and it is important to plan for potential impacts from changes in climate. The survival and prosperity of coastal tourism in the United States requires effective coastal management (Cicin-Sain et al. 1998) and local businesses should be prepared for any changes in recreation and tourism activity levels. It is important for managers of tourism destinations and business owners to understand short-term, day-to-day fluctuations and it will become increasingly important to anticipate in the long-term how climate change may affect recreational demand and hence the local economy (Moreno and Becken 2009).

1.3 Weather, Comfort and Decisions

1.3.1 Weather and Comfort

Many outdoor uses are assumed to be weather-dependent or at least weather-influenced. Coastal tourism is strongly dependent not only on the natural resources like beach quality and extent, but also climate (Rutty and Scott 2014a). Weather conditions influence a person's comfort when they are outdoors.

Nikolopoulou et al. (2001) examined how microclimatic characteristics influence people's behavior and usage of outdoor urban space. The maximum number of people outside is found in the summer when most people interviewed responded that they were warm ('warm' = 1 degree above neutral on a 5 point temperature comfort scale), indicating that most people prefer to be warm than to be neutral. It is speculated that in warmer climates the situation is reversed in that more people are found outdoors when the temperature is lower and they would state their preference to be cooler than neutral. They concluded that the thermal environment is an important

factor influencing people's decisions regarding outdoor recreation, but that psychological adaptations such as choice, thermal history, memory, and expectation among other factors also affect use (Nikolopoulou et al. 2001). Based on these findings, this research investigates thermal comfort and other psychological factors that influence recreational use in the coastal environment.

It is also found that expected discomfort levels tend to be overestimated in many cases as they are based on indoor, steady state thermal comfort. Researchers find that people are more likely to stay comfortable in colder settings while engaging in outdoor activity rather than in a steady state. People will get too warm more quickly than too cold when engaging in outdoor activity (Höppe 2002). It may be expected that less active outdoor recreational users would have a lower threshold for colder temperatures than more active users. Similarly, less active recreational users may have a higher threshold for warmer temperatures than more active users.

1.3.2 Weather Forecasts and Short-Term Decisions

People check the weather before they engage in an outdoor activity, particularly as weather and climate have been shown to be strong motivators for coastal recreation (Rutty 2014). Based on a survey asking questions regarding weather forecasts and people's value for them, Lazo et al. (2009) found that the United States public obtains, through all available formats (radio, smart phone, NOAA website, etc.), several hundred billion forecasts per year at an estimated \$31.5 billion in benefits. This demonstrates the importance of day-to-day weather overall to the United States public.

For many people, checking the weather is a part of the daily routine and the weather forecast is a tool used to make short-term decisions. In the same survey, Lazo et. al. (2009) studied people's sources, perceptions, uses, and values of weather forecast and found that 72% of people usually or always check the weather for the purpose of simply knowing what the weather will be like. Forty two percent of people usually or always check the weather for planning weekend activities; 40% usually or always check the weather to plan travel; 38% usually or always check the weather to do yard work or outdoor housework; and 32% usually or always check the weather when planning social activities (Lazo et al. 2009).

Changes in weather variables from day to day influence short-term decision making. Which factors have the biggest effect and to what extent they influence outdoor coastal recreation will be examined in this research.

1.4 Climate Change Weather Predictions for the Northeast

Climate change projections used for this research are based on the National Climate Assessment. The assessment summarized the impacts of climate change in the United States with a team of more than 300 experts, guided by a 60-member Federal Advisory Committee and extensively reviewed by the public and experts including a panel of the National Academy of Sciences (Horton et. al. 2014). The assessment concluded that with climate change, the northeast region of the United States is expected to see an increase in average air temperatures and an increase in intensity of precipitation and drought, with a small change in overall precipitation amounts in the summer season by 2080.

Projections indicate warming of 4.5-10°F by 2080. If emissions are immediately reduced substantially, the projected increase by 2080 would be from 3°F to 6°F. The frequency, intensity, and length of heat waves is also expected to increase. Projections of precipitation changes are less certain than temperature changes. The total amount of precipitation and frequency of heavy precipitation events are expected to continue to rise from 5% to 25% in the winter. Summer and fall precipitation are projected to be generally similar to natural variation at the end of the century. However, frequency of heavy downpours and droughts are expected to continue to increase as the century progresses (Horton et. al. 2014).

It should be noted that sea level rise, increased storm intensity, and storm surge are expected to increase flooding and coastal erosion in Rhode Island, reducing beach space, accessibility, and water quality and safety (Rowley et al. 2007). While these climate change factors are not examined in the scope of this weather-related research, they should be kept in mind when considering longer term forecasting of coastal recreation.

1.5 Weather, Climate Change, Recreation and Tourism Studies

Climate and its effects on tourism and recreation is a growing academic field of knowledge since the first publication on the topic in 1986 (Rudihartmann 1986). This influx of research has perhaps been further spurred by the Intergovernmental Panel on Climate Change (IPCC) which began referencing the effects of climate change on tourism in 2007 and onwards (Amelung et al. 2008). Some climate change impact research has examined how tourist activities may change with changes in climate and weather parameters. Studying coastal tourism through quantitative and

qualitative behavior analysis is one of the themes and methods for this body of research, though the main focus of publications in the field has been on winter tourism (Becken 2013).

Becken (2013) found that, as of 2012, only 14 studies explicitly examined coastal tourism and eight of them were social and physical vulnerability assessments for specific coastal destinations. Since then, some studies have been published examining revealed weather and climate preferences for beach-goers in tropical tourist destinations (e.g. Rutty 2014; Rutty and Scott 2014a; Rutty and Scott 2014b). The purpose of these studies is to examine what microclimates are preferred and to understand if changing climates may make these destinations less desirable for a long-haul (flight and stay over) vacation.

One of the critiques Becken (2013) raises is the over-utilization of behavioral analyses using quantitative approaches without the support of other research methods, such as interviews, in order to advance the field. This research begins addressing these concerns by using observational data and modeling as well as quantitative and qualitative in-person interview results from a similar population in the same location. Behavioral analysis in the form of regression modeling was used in most observational studies (Ibarra 2010; Ploner and Brandenburg 2003; Moreno et al. 2008, etc.). These studies of behavioral observations of tourists and recreational users show that microclimatic conditions have a significant effect on the usage of coastal areas (Freitas 2003) and have been used to craft the models used in this research.

Many researchers have studied how climate change might affect recreation by conducting revealed importance surveys of outdoor recreationists and beach-goers

(e.g. Rutty and Scott 2014; Gössling et al. 2006, Ibarra 2010; Moreno and Amelung 2009; Moreno et al. 2008). These studies ask people about their comfort in the current conditions and their preferred conditions for the activities in which they are engaging. While the focus and conclusions are related to thermal comfort, questions are raised about the influence of psychological factors such as expectation, context, and people's ability to estimate or understand fine changes in weather parameters.

The research focused in the coastal areas seeks to discover which temperatures or conditions people find acceptable for lounging at the beach (Moreno and Amelung 2009; Ibarra 2010; Moreno et al. 2008; Rutty and Scott 2014a etc.). However, they do not explore which temperatures or conditions people find acceptable for the various other uses of the coastal areas. The studies that have examined differences between different recreational uses (Perry 2004; Ploner and Brandenburg 2003; Brandenburg and Arnberger 2001; Bellomo et al. 1999, etc.) have been in non-coastal areas such as parks. This research seeks to relate both observed activity of various coastal recreational uses and weather factors as well as stated importance of weather factors for those coastal recreational groups.

1.6 Research Questions

This study examines how future climate change might affect recreational use of the coastal lagoons in Rhode Island in order to inform local planners, state regulators, and businesses what to expect so that they can plan and adapt.

Accordingly, my overall research question is: How does weather affect different recreational activities on and along the coastal lagoons in Rhode Island? In order to adequately answer this question, I also have four sub-questions. They are: (1) How do

different weather conditions affect levels of observed recreational use and are they different among user groups?; (2) What is the stated importance of weather factors to coastal recreational user groups and are they different among user groups?; (3) What other factors, besides weather, might explain an individual's decision to recreate at the lagoons?; and (4) How do observed effects of weather factors relate to perceived importance of weather factors among recreational groups?

Part A: "Modeling Coastal Recreational User Groups and Climate" will help answer research question (1) through revealed importance. Observational data from boat-based surveys during the summers 2014 and 2015 provide the dependent variable for regression models to examine the relationships between different activities and weather factors.

Part B: "Investigating Importance of Climate to Coastal Recreational User Groups" will help answer research questions (2) and (3). In-person interviews of recreational users on and around the salt ponds during the summer of 2015 will be used to understand the stated importance of weather factors among recreational user groups. Also, open-ended questions will address main motivators for use.

Part C: "Comparing two methods used to predict the effects of weather on recreation: Revealed versus stated importance" will help answer research question (4). I will qualitatively compare the results from these two methods to understand how observed effects of weather factors relate to perceived importance of weather factors among recreational groups.

Five total groups are analyzed: all recreational users (including all other recreational user groups not separately tested), people relaxing/lounging, people in

rowed vessels, people in motorized vessels, and fishers (including both clamming and hook-and-line). Rowed vessels are here defined as all people using manual force to power their boat or board (e.g. kayaks, stand-up paddleboards etc.) and motor boaters are limited to recreational use only (commercial activity not counted).

MANUSCRIPT A

Prepared for submission to Coastal Management Journal, April 2016

Modeling Coastal Recreation User Groups and Climate

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2.1. Observational Data Methods

2.1.1. Studying Human Uses in Coastal Areas

Thompson and Dalton (2010) discuss how different methods for observing and mapping coastal activities have advantages and disadvantages, depending on the physical and regulatory characteristics of the study area. Due to the size and complex shoreline in Rhode Island's coastal salt ponds, the B-BOTS method is highly suitable for these areas.

B-BOTS uses advances in GIS, GPS, and light ranging technologies to create a methodology that is derived from line transect sampling methods that were developed in the field of ecology over eighty years ago (e.g., Burnham, Anderson, and Laake 1980) to take censuses of organisms (fish, birds, people) along a specified route. Researchers have used modified line transect sampling to record positions of recreational fishermen in a marine park in Australia (Lynch 2006) and to investigate relationships between distributions of marine mammals and human activities in a marine sanctuary off the northeastern U.S. (Wiley et al. 2003). Using similar methods, Sidman et al. (2005) recorded positions and associated attributes of recreational boats from stationary shoreline locations. Dalton et al. (2010) used B-BOTS to characterize the distribution and composition of vessels on upper Narragansett Bay and to demonstrate how composition changed in response to such factors as nearby land uses, cloud cover, and water quality. Thompson and Dalton (2010) used B-BOTS to study the distribution, intensity, and composition of shoreline access along Narragansett Bay.

2.1.2. Observational Data Collection Methods

Through the B-BOTS method, data were recorded of recreational use on and along the lagoons over the course of the day. In this study, researchers used a 17-foot Boston Whaler along with a Trimble GPS unit that is capable of sub-foot accuracy and Trupulse range finders. Transect lines were established for all of the lagoons that were surveyed, allowing for complete coverage of each lagoon and its shoreline. The dates surveyed and the order in which each transect line was run for each lagoon were determined by stratified random selection (see, Thompson and Dalton, 2010).

As the boat navigated the transect line using onboard GPS, a team member pointed range finders, which have a Class 1 (eye-safe) laser and a built-in compass at the boat or shoreline user. With the press of a button, the rangefinders transmitted the distance and compass bearing via bluetooth to the Trimble handheld computer with built in GPS. The Trimble was loaded with ESRI's ArcPad, which is software for mobile GIS and field mapping. Starting with the coordinates of the Trimble GPS unit, ArcPad used the distance and bearing measurements from the range finders to immediately calculate an "offset point" for the observed boat or person on the shoreline.

The research team utilized ESRI's ArcPad Application Builder to develop custom touch screen forms so that team members could quickly add attribute data to each recorded observation. As the button is pushed on the rangefinders and a record is created in the database, a data collection form simultaneously appears on the screen of the Trimble computer. The second team member, who is holding the Trimble, can then use a stylus and a series of dropdown menus to rapidly add attributes to each

observation, such as type of use, type of boat, time of day, etc. The starting point for this preloaded attribute system was developed for Thompson and Dalton (2010) and Dalton et al. (2010). The system used widely available classification systems when possible. For example, the United States Coast Guard boat classification system was used and then modified to better describe the types of use occurring in the shallow coastal lagoons.

One salt pond was surveyed per day between 8am and 5pm and split between the three coastal ponds with 22 total days on Quonochontaug, 23 on Ninigret, and 18 on Point Judith for a total of 63 total survey days. The survey days were randomly selected with a mix of weekend, weekday, and holidays. 20 weekend days and 43 week days were surveyed.

Table 1. Total Number of Survey Days per Month

2014	Number of Survey Days
July (2014)	12
August (2014)	14
September (2014)	3
2015	
June (2015)	11
July (2015)	13
August (2015)	10

For the purposes of the larger research project (social carrying capacity of the coastal lagoons), holidays were intentionally added to the survey schedule. However,

due to weather and technical difficulties, only one 4th of July and one Labor Day were surveyed over the two summers. The surveys were conducted from June to September in the 2014 and 2015 summer seasons. A total of 43,892 individual point observations of human uses were recorded over the two seasons. About 25% of all recreational users were relaxers, 16% were rowed boat users, 25% were motor boaters, and 13% were fish and clammers.

2.1.3. Weather Data Collection Methods

Weather factors were collected for the dates surveyed with data from the most local stations as well as from the Providence Airport in Warwick, RI through Weather Underground (“Weather Underground” 2016). On days when local stations were down, daily weather data was taken from the station next closest to the lagoon studied on that particular day. Weather data were also collected from the weather station at Rhode Island's airport, T.F. Green for a number of reasons. As direct proximity (within 1 mile) to the ocean often alters the local compared to locations removed from the open ocean, and as many people travel from 'inland' to recreate on the ocean beaches and nearby lagoons, it is prudent to examine relationships between inland weather factors as well as local. 'Inland' here is defined as away from the open ocean and describes northern Rhode Island even though it is near the Narragansett Bay. Also, the airport was used because it is the official station for state weather records and many news meteorologists report weather factors based on the airport station.

Weather factors collected included low, average, and high air temperatures, average and high wind speed, humidity, dew points, daily precipitation totals (in.), and high and low air pressure. These data were collected for local stations as well as the

T.F Green airport station in Warwick, RI. Weather factors from the airport will be denoted with an AP.

Table 2. Descriptive Statistics of Weather Factors

Weather factor	Mean	Std. Dev.	Min	Max	Range
Low Air Temp °F (local)	61.6	6.2	44.8	71.6	26.8
Avg. Air Temp °F (local)	67.4	5	50.1	78.4	28.3
High Air Temp °F (local)	75.7	6.1	53.5	90.1	36.6
Avg. Wind mph (local)	3.7	2.9	0	12	12
High Wind mph (local)	12.6	7.3	0	41	41
Avg. Humidity % (local)	86.8	7.8	63	100	37
Avg. Dew Pt °F (local)	63.7	5.4	50.2	74.2	24
Precip. in. (local)	0.1	0.3	0	1.7	1.7
High Air Press. ° (local)	30	0.2	29.7	30.3	0.6
Low Air Press. ° (local)	29.9	0.2	28.9	30.2	1.3
Low Air Temp °F (AP)	62.4	6.2	46	73	27
Avg Air Temp °F (AP)	72.4	5.9	51	82	31
High Air Temp °F (AP)	81.9	6.5	53	93	40
Avg. Wind mph (AP)	7.7	2.2	3	14	11
Avg. Humidity % (AP)	72.4	10.8	22	98	76
Avg. Dew Pt °F (AP)	60.4	6.6	46	72	26
Precip. in. (AP)	0	0.1	0	0.4	0.4
Avg. Air Press. ° (AP)	30	0.2	29.1	30.3	1.2

2.2. Observational Data Analysis

In order to analyze if and how much weather factors affect different recreational uses, a daily tally was created with the total numbers of each category of use for each day. Linear regression was then used to analyze the data. The R^2 statistic was used to determine how well the models fit the data. The natural log of the daily tallies of each use was used as the dependent variable in order to make the dependent variable more normally distributed. This strategy was used in similar studies (Dwyer 1988; Ploner and Brandenburg 2003). Independent variables included lagoon, number of transects conducted that day, day of the week (weekend/holiday or not), and a dummy variable for July and August. July and August are considered peak summer

season and tend to have more tourists in the coastal areas of Rhode Island, while June and September tend not to have as many. Coding a 1 for days surveyed in July and August was found to be significant and to increase the goodness-of-fit of the model, suggesting that they help explain changes in amount of activity not tied to the weather or the other variables.

In order to identify the model with the best fit to the data, the first regressions were run with as many weather variables as possible on each of the five groups (overall recreation numbers and numbers for specific categories). Variables that were never significant at 5% level, or that were seen to be covariant variables, were deleted to improve the fit of the model. For example, local high and average temperatures were not found to be significant while the average temperature at the airport was significant, so local high and average temperatures were removed from the model. Local low temperature was found to be significant and increase the goodness-of-fit of the model, so it was kept. A variety of models were tested until the highest R^2 values were found, indicating that the models describe a large portion of the dependent variable.

2.3. Observational Data Results

A semi-log regression model was used in this analysis by taking the natural log of the dependent variables. Air temperature variables were squared due to the non-linear nature of the temperature and its relationship to the dependent variables. Coefficients of a semi-log regression can be interpreted as for every one unit change in the predictor (independent variable), there will be an x% change in the dependent variable. In order to convert the coefficients, the exponent of each coefficient was

subtracted by one and then multiplied by 100 (%change = (exp(coefficient)-1)*100).

The method was the same for the two temperature coefficients but the square root was first taken of the coefficient (as those variables were originally squared).

Below are the results from the regression showing the percent effect of each of the statistically significant factors. These estimates can be read as: "on the weekend, there are estimated to be 63.4% more recreational users at the lagoons than on the week days." And, "For every 1 % increase in humidity, there are estimated to be 2.8% fewer recreational users at the lagoons."

Table 3. Coefficient Results from Regression Analysis.

	Weekend	Avg. Hum. (%)	Precip. (in.)	Avg. Wind (mph)	Avg. Temp. (°F)	Local Low Temp. (°F)
All (R².759)	+ 63.4% **	-2.8% **	-36.3% **	- 6.6% *	+ 2.5% **	-2% *
Relaxing (R².649)	+ 297.4% *	-11.2% **	-86.7% **		+5% **	-2.2% *
Rowed (R².622)		-6.3% *	-77.8% **	-20.8% *	+4.5% **	-3.6% *
Motor (R².785)	+128.7% **	-2.8% **	-38.6% **	-8.2% *	+2.2% *	
Fishing (R².689)	+77.3% *	-2.7% *	-35.6% *	-14% **	+2.5% *	

*=p<.05, **=p<.001 (red)=negative relationship, (green)=positive relationship

While the weekend is has a strong positive relationship with all the recreational user groups, relaxing is estimated to be the most affected by the day of the week; indeed, on the weekend the model predicts almost a threefold increase in people relaxing at the lagoons. Relaxing is also the most sensitive to the average humidity with an estimated 11% decrease in all relaxers for every 1% increase in the average humidity. It should be noted how sensitive relaxing user groups are to weather factors compared to the other user groups. Rowers are also quite affected by the humidity (6.3% decrease) and the other three groups. Precipitation negatively affected all

groups but again relaxers were the most affected (-87%) with rowers second most affected (-78%). Average wind affected rowed boat users the most with an estimated 20% decrease in rowed boat users for every one mile per hour increase in average wind speeds. Fishers were next most affected (-14%) with motor boaters behind with -8%. Average wind was not found to have a significant effect on people relaxing. Average temperature at the airport was positively significant for all groups and most for people relaxing with a 5% estimated increase in relaxers for every 1°F increase in average temperature. Rowed boat users had a similar estimated effect (4.5%), fishers were estimated to have a 2.5% increase for every temperature degree increase and motor boaters had the smallest percent change with 2.2%. Local low temperature, surprisingly, had negative correlations for all recreational users, relaxers, and rowed boat users. For every 1°F increase in the local low temperature, rowed boat users decreased an estimated 3.6% and relaxers by an estimated 2.2%. All recreational use is estimated to decrease by about 2% for every 1°F increase in the local low temperature.

2.4. Observational Data Discussion

The fact that the weekend was strongly significant with a high coefficient for all user groups except rowing may indicate that the type of user who engages in rowing may not be as tied to weekend/week day distinctions. It could also indicate that people prefer to partake in rowed boat activities when there is less traffic on the lagoons. It is important to remember that many individuals partake in multiple types of recreational use throughout the summer. The same people may, for example, choose to relax on the weekend rather than kayak because of high traffic on the water. Wind having a strong effect on rowed boat users may be because rowed boat activities are

more difficult with high amounts of wind pushing the relatively light boats across the surface of the water. Rowed boat users may check the wind forecast for the day and decide not to go or, again, may make the decision once at the lagoon and choose an alternate activity due to the conditions.

Of all the temperature variables originally tested in regression analysis, it is interesting that the average daily temperature at the airport was the best for increasing the goodness-of-fit of the model. The fact that the 'inland' airport temperature was the best may indicate that warmer temperatures inland drive people to recreate on the coast, no matter the immediate coastal temperature. This seems intuitive as people tend to go to the coast to "cool off" and the temperatures on the ocean coastline tend to be lower and have less variation through the summer season.

It is also interesting that of the three local temperatures tested, the local low temperature was the only one found to be significant. Even more intriguing was the unexpected result of local low temperature having a negative correlation. As the average temperature was positively correlated with the dependent variables, it would be expected that the local low temperature would be positively correlated in a similar fashion. However, for all recreational users, relaxing, and rowing it is negatively correlated. The low temperature of the day is usually recorded during the evening and early morning. It may be that if the day starts out warmer in those early morning hours, the day heats up quickly and becomes too hot for some users to partake in particular activities. One can imagine waking up after a hot summer night, already feeling the heat in the air and perhaps deciding that staying cool should be one of the goals of the day.

This may indicate that while, in general, warmer temperatures lead to more coastal recreation (as is suggested by the positive relationship with the average temperature at the airport), there is a threshold above which it is considered too hot to be on the lagoon, particularly for rowed boat activities and also, but less so, for relaxing. This is especially intuitive for rowing as it requires effort and exercise that may be less appealing on hotter days.

A limitation of this study is the interconnectedness of weather factors. A windy day may be correlated with a day that a storm was moving in. A humid day may be correlated with a rainy day. High temperature may be correlated with humidity. While we attempted to address these limitations in the regression analyses by removing variables with too much covariance, this is still something to consider.

In order to further investigate weather and other factors that lead to coastal recreation decisions, in-person intercept interviews were conducted on the same population studied in the observational study as explained in Part B.

MANUSCRIPT B

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Investigating Stated Importance of Climate to Coastal Recreation User Groups

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3.1 Interview Data Collection Methods

3.1.1 Studying Stated Importance of Weather Factors

Researchers have interviewed tourists to understand the optimal beach-going conditions (e.g. Rutty and Scott 2014a; Moreno 2010; Morgan et al. 2000). In these studies, tourists were asked how comfortable they were and if they would like it to be warmer or cooler, windier or less windy, etc. For the purposes of this study, this was not seen to be a preferable method. This research is not necessarily looking for the preferred "sweet spot" of weather factors as stated by individuals. Rather, it is being used to determine how much each weather factor affects different uses. Rutty (2014) asked tourists how IMPORTANT each weather factor was to the tourist in their decision to come to the beach that day. This stated importance of weather factors is used in this research because it gives the value of how much it matters to the different recreational user groups. Stated importance questions used in this study were modeled after those in Rutty (2014).

3.1.2 Interview Data Collection Methods

For the in-person interviews, a team of four researchers interviewed people found at different access points to the lagoons and asked them about their time there. Dates were randomly selected for each of the three lagoons with varying weekend and week days in 4 hour morning or afternoon blocks during the summer of 2015. At each lagoon researchers surveyed three or four different access points and asked every person present to participate in the interview. The various access points were selected in an attempt to represent a range of recreational users and included boat ramps, marinas, wildlife areas, and beaches.

Figure 3. Intercept Interview Locations

Table 4. Number of People Interviewed on Each Lagoon

Lagoon	# of People Interviewed (2015)
Quonochontaug (Quonnie)	93
Ninigret	65
Pt. Judith	121

The interview questions asked what the interviewee was doing on the lagoon and what activity they did at the place they spent the most time. Interviewees were asked to list their main reasons for coming to the lagoon and then to rank them in importance. We then asked them whether or not they checked the weather before they came that day, and then asked them to rank on a 5-point Likert scale (1=not important to 5=extremely important) how important a number of weather factors were in their

decision to come to the pond. Factors included weather forecast overall, air temperature, "feels like" temperature, wind speed, wind direction, relative humidity, chance of precipitation, cloud cover, visibility, UV Index, water temperature, and tide. Interviewees were asked how warm (°F) it has to be for them to come and do their activity at the lagoon and how warm (°F) would be too warm (essentially the lower and upper thermal limits for that individual partaking in that recreational activity).

Finally, they were asked where they came from today (if other than their primary home), their primary home, gender, age, education, and household income. For the larger project of which these questions were a part, the survey also included questions asking respondents where they go on the ponds and what they think about different features of those areas. The survey instrument can be found in Appendix A. 283 surveys were conducted between June, July, and August in 2015. 92 interviews were conducted on Quonochontaug, 65 on Ninigret, and 121 on Point Judith Pond.

3.2. Interview Data Analysis

Interviews were coded and input into an excel spreadsheet in a binary method (1=yes, 0=no) with a separate column for each possible answer to each question for ease of analyzing in SPSS software. Interviews were coded usually within the day or at least in the same week that they were conducted. Coding was spot checked to ensure accuracy and consistency.

Descriptive statistics were conducted. In order to analyze the Likert scale responses about the importance of weather factors, a Mann-Whitney U test was used. A non-parametric analysis is typically used for Likert Scale questions as it cannot be assumed that there is an equal space between two adjacent numerical responses. In

other words, it may be more of a leap for a person to go from a 3 to a 4 than from a 4 to a 5 on the Likert scale.

Because interviewees were often engaging in more than one activity (for example, someone kayaking may also be relaxing or fishing on the day they were interviewed), it was not possible to compare four distinct groups of users in the same analysis. Instead, a separate Mann-Whitney U test was conducted for each group testing the difference between all of the respondents who DID engage in the activity that day and all of the respondents who DID NOT (everyone else). For example, to test if there is a significant difference in weather factor responses of people relaxing, two groups were created: one of all of the people who said that they were relaxing and one of all those who were never relaxing on the day they were interviewed. Relaxing vs. non-relaxing, rowing vs. non-rowing, motoring vs. non-motoring, and fishing vs. non-fishing tests were conducted.

In order to test how other variables influence perceived importance of weather factors, the test was also conducted on responses grouped by travel time (short vs. long distance) and visitors vs. locals. Travel time was split at 30 minutes, so that those who traveled less than 30 minutes were in one group and those who traveled 30 minutes or more were in another. The 30 minute definition was chosen by the researcher based on the size of the state and the amount of time it takes to travel around it. Providence is just over 30 minutes from the ponds and it is about as far north as you can travel and still be in Rhode Island.

Local vs. visitor was determined by ascertaining if the zip codes of where the respondent came from and their primary residence were different. If the zip codes

were different, it was assumed they were a visitor and were coded as such. If the zip codes were the same (they came to the lagoon from their primary residence), they were treated as a local.

3.3. Interview Results

Out of a total of 283 surveys, 135 respondents were male and 140 were female (the rest chose not to answer this question). The average age of respondents was 50. The mean education was an Associate's degree, with a median of a Bachelor's degree. Both the average and the median household income before taxes of the respondents was between \$75,000 and \$99,999. One hundred and ninety seven respondents travelled less than 30 minutes to arrive at the place where they were interviewed and 80 respondents travelled 30 minutes or more. One hundred and six respondents came from home (here determined to be locals) and 173 from somewhere other than primary home (here determined to be visitors).

Table 5 shows the percentage of people in each recreational user group who reported that they checked the weather before coming to recreate at the lagoon. A chi-square test was run on each group (relaxing vs. all other users, rowing vs. all other users etc.). Percent of each user group that did check the weather is reported and an asterisks indicates that group is significantly different from all other users. Tables 6 and 7 show comparisons between short and long distance travelers as well as visitors versus locals.

Table 5. Percent of people in each user group who reported that they checked the weather before coming to recreate at the lagoon.

User Group	% reported checked the weather before coming to recreate at lagoon
All Interviewees	75%
Relaxing	73%
Rowing	70%
Motoring	89%*
Fishing	76%

(* = $p < .05$, ** = $p < .01$ significantly different than all other users)

Table 6. Comparing how many short vs. long distance travelers checked the weather

	Short Distance Traveler	Long Distance Traveler
% checked weather	72.8% **	78.9% **

(* = $p < .05$, ** = $p < .01$)

Table 7. Comparing how many locals vs. visitors checked the weather

	Locals	Visitors
% checked weather	70% **	78% **

(* = $p < .05$, ** = $p < .01$)

Motoring was the only recreational user group to be significantly different than all other recreators. Motor boaters checked the weather significantly more (89%) than all other users. Short distance travelers who traveled for less than 30 minutes to arrive at the lagoons checked the weather significantly less than people who traveled farther. Locals (people who came from their permanent home address) checked the weather significantly less than people who came from somewhere other than their home address.

In order to show how user groups responded to importance of specific weather factors, figures 5 through 9 will show the mean responses of the two groups and which weather factors held significantly different importance across the user groups.

Figure 4. Importance of weather factors to people relaxing vs. people who are not

Relaxers tended to have a significantly (95%-98% confidence) stronger or weaker response to the importance of weather factors questions. Compared to all other users, relaxers cared significantly more about the air temperature, humidity, precipitation, cloudiness, and UV Index. They cared significantly less about the wind speed, wind direction, visibility and the tide. These results seem intuitive: the factors relaxers tended to care more about are the types of weather factors that would affect someone sitting on a beach. While they did care significantly more about the UV Index and humidity, it should be noted that overall the average responses to those factors are below a 3 so they are not considered to be very important in general to all user groups.

Figure 5. Importance of weather factors to people using rowed boats versus people who are not

In stark contrast to relaxers, rowed boat users did not think significantly differently about the importance of weather factors than other users. This may be because the sample size is so low compared to all other users. Even without significance, it is still interesting to note the trends in differences in the mean responses of the two groups. Rowers appear to care more about the air temperature, "feels like" temperature, wind speed and direction, precipitation, cloudiness, visibility and tide than other users. They appear to care less about humidity, UV index, and water temperature than other users.

Figure 6. Importance of weather factors to people using motor boats versus people who are not

As seen in the above graph, motor boaters had eight significantly different weather factors. They reported to care significantly more than other users about the overall forecast, the wind speed and direction, and visibility. They cared significantly less about the air temperature, humidity, cloudiness, and UV index. These results describe a user that may care less about thermal comfort for the individual and more about the recreational use itself or the safety of the conditions.

Figure 7. Importance of weather factors to people fishing versus people who are not fishers

Recreational fishers cared significantly less than all other users about air temperature and humidity while caring significantly more about the tide. These results are also intuitive and describe a user who appears more concerned with what is happening in the water column than her comfort level. As the fishing category also includes people clamming, it makes sense that this user group cares significantly more about the tide as clamming tends to be best during low tide. Notably, the mean responses for fishers indicate that they care less than all other users about the overall forecast

Figure 8. Importance of weather factors to short versus long distance travelers

People who travelled for longer to arrive at the lagoons (greater than 30 minutes) cared significantly more than those who travelled shorter distances about the overall forecast, though they both still care quite a bit. People who travelled a shorter distance cared significantly more about the UV Index. The overall forecast makes sense as one would want to know the weather would be nice before committing to a long drive. Why people who were closer cared more about UV Index is unclear, however it should be noted that both average responses were around 2 on the Likert scale which was only somewhat important.

There was not found to be any significant difference in responses about importance of specific weather factors between "visitors" and "locals". This was a surprise as there was much speculation concerning tourists, visitors, and renters. It was assumed that a visitor would be more likely to recreate regardless of the weather as

they are on vacation and locals might be able to go to the salt ponds another day. It is possible that the local New Englander "hardy" attitude skews these results (many local interviewees made it a point to tell us they use the lagoons all year round, not just in the summer). There is also a limitation in the definition of "local" versus "visitor" as many people own second homes in Rhode Island and while the different zip codes would put them in the "visitor" category, they may not have the same sense of urgency to recreate on the lagoons. Summer homeowners may need to be in their own category for a more accurate analysis. A limitation of this study is the inability to differentiate between summer homeowners and shorter-term visitors. Future research should address this.

When we asked interviewees to tell us how warm (°F) would be too warm to participate in their recreational activity at the lagoon, many reported that there was no such thing; there was no upper limit on the air temperature that would keep them from engaging in their recreational activity of choice on the salt pond. Chi-square tests were used to examine differences between user groups in the upper limit for air temperature comfort. Table 8 reports on the percentage of each user group that defined a temperature after which they would not participate in that activity due to the heat.

Table 8. Percent of each user group that defined an upper thermal limit.

	Relaxers	Everyone Else
% defined upper limit	61%	46%
	Rowed Boat Users	Everyone Else
% defined upper limit	70% **	57% **
	Motor Boat Users	Everyone Else
% defined upper limit	15% **	61% **
	Fishers	Everyone Else
% defined upper limit	68% **	36% **

* = p<.05, **p<.001

Rowed boat users and fishers are significantly more likely to have an upper limit on thermal comfort. In other words, there is a point where it is too hot, and once reached they will not participate in that activity. Only 15% of motor boaters defined a thermal limit, which means that 85% of motor boaters said there was no such thing as too hot to motor. Relaxers appear to be more likely to have an upper limit on thermal comfort (there is a point where it is too hot) but the difference was not significant.

In the open-ended question about what the main reasons for coming were, people listed and ranked their reasons. Each response was recorded individually and then grouped into categories. In coding, if responses were essentially the same (e.g. "to go fishing" and "in order to fish") they were coded as the same. I then used a point system to assign a value for each response. If it was stated as the first most important reason, it was given three points. If it was the second most important reason, it was given two points and the third most important reason had a value of one. Figure 9 shows the top responses.

Figure 9. Most frequently stated reasons people came to RI coastal lagoons to recreate.

Table 9. Frequencies of Responses of Most Important Reasons for Recreating at the Lagoons

Open Responses	1st Most Important	2nd Most Important	3rd Most Important
1st Most Common	Fishing (17%)	Weather (9%)	Relax (3%)
2nd Most Common	Relax (12%)	Relax (5%)	Scenery (2%)
3rd Most Common	Weather (10%)	Fishing (5%)	Play for Kids (2%)
4th Most Common	Play for Kids (9%)	Family/Friend visiting (4%)	Day off from work (2%)
5th Most Common	Family/Friend visiting (7%)	Boating (4%)	Free (as opposed to state beach) (2%)

It is notable the fishing, relaxing, and enjoy the weather are the top three most important reasons that people stated for coming to the lagoon in an open-ended question. The fact that fishing and relaxing had greater scores than weather might indicate that the use itself has more of a draw than the weather factors. This may be particularly true for fishing, as it has repeatedly been a user group that has been less affected by weather factors and it is the most frequently stated reason for being at the lagoons.

3.4. Interview Discussion

Of the four main user groups, only motor boaters were found to check the weather significantly more than the others, indicating that the other coastal recreationists, overall, have a similar interest in the weather forecast. About 75% of them check the weather before choosing to recreate at the lagoons. This parallels well with the fact that motor boat users cared significantly more than all other users about the overall weather forecast. It is also interesting to note that the motor boat user group cared significantly more than others about the types of weather factors that would affect their ability or safety maneuvering their craft (such as tide, wind etc.) rather than their thermal comfort.

Overall, the relaxing user group had the highest number of significant weather factors. This indicates that this user group is the most conscious of the weather and their comfort level because of it. It should be noted that while they cared significantly more about the UV Index, the mean was 2.2 compared to a non-relaxer mean of 1.8. Both of these average responses are similarly low and the medians are the same,

indicating that this may be one of the factors where a statistically significant result does not necessarily translate to real-world significance.

For rowed boat users, there was no significant difference in the stated importance of weather factors in comparison with non-rowed boat users. Wind speed and precipitation were the closest to being significant at a p value of .082 and .078, respectively. Perhaps with a higher n value (only an n value of 26 for rowed boat users), more significance would have been found.

Varying sample sizes were a limitation of this study, particularly as the significance of factors is determined by the difference between a particular user group and all other respondents. Relaxing accounted for almost half of the study sample while rowing accounted for only 26, motoring for 37 and fishing for 69. If this study were conducted again it would be preferable to try to target users that are under-represented.

It was interesting that relaxing, rowing, and kayaking user groups seemed to have lower limits of "too hot" air temperatures than motoring user groups. Relaxing, however, was not significant. This indicates that these recreational users will be deterred from coming to the coastal lagoons on hotter days. Implications for the warmer summers expected with climate change might include fewer people recreating overall or a shift in recreational use away from relaxing, rowing, and fishing and towards motor boating. This may be especially true for users who travel longer distances as the results suggest these users put more thought into their plans as they related to the weather forecast. If the forecast calls for a hotter day these recreationists

may choose not to make the drive to the coastal areas or they may alter the type of activity they plan on participating in based on the higher temperatures.

Of all the open-ended questions, weather was the third ranked reason for coming to recreate at the lagoon. Relaxing scored slightly higher than weather, and fishing scored quite a bit higher as the most common response. It seems that while weather is an important factor, people's reasons for coming to the lagoon are often to engage in the activity itself, particularly with fishing and relaxing. These responses help support the assertion that while physiological (weather and comfort) factors are important in outdoor human behavior, psychological factors also play a large role (Nikolopoulou, Baker, and Steemers 2001). The conditions people expect as well as their desire to partake in a particular activity may outweigh the actual conditions or thermal comfort experienced once at the lagoons.

MANUSCRIPT C

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Comparing two methods used to predict the effects of weather on recreation:

Revealed versus stated importance

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4.1. Comparing Methods Introduction

There has not been much research on comparing revealed versus stated importance of weather factors and how well results from the two methods correlate. While it may be more reliable to use observational data to study people's actual behavior rather than their perception of importance, methods to collect observational data are frequently more expensive. Observational data also lacks avenues for understanding more about the individuals such as demographics, reasons for coming, etc. This research affords a unique opportunity to examine how well the results from each method can predict the other as both studies have been applied on a very similar population.

4.2. Comparison Methods and Analysis

While it is interesting to compare significantly different responses between user groups in the interview data, it is necessary to look at the average stated importance of weather factors on the 1-5 scale (5 being extremely important, 1 being not at all important) for the purposes of comparing the stated to the revealed importance results. The regression analyses do not compare if a weather factor is more important for one use than another; they only show which factors are significant and the percent change in the dependent variable that can be expected with a one unit change in the independent variable. For the purposes of this comparison, all mean Likert scale responses will be reported with those that were significantly different being noted.

In order to compare the two methods, humidity, precipitation, wind speed, and air temperature will be compared across the two sets of results. It is important to note

that the comparison across Parts A and B must be analyzed qualitatively as the methods for both data collection and statistic tests were completely different.

4.3. Comparison Results

Table 10 below compares the results for each weather factor for each user group. For the revealed importance results, significant weather factors are reported in the form of the coefficient converted into percentage and can be interpreted as for every one unit change in the predictor there will be a ___% change in the numbers of people participating in that activity per day. For the stated importance, average stated importance on the 5-point scale (1=not important to 5=extremely important) will be reported with a (+) or a (-) after it, indicating that the average response for that weather factor in that user group was significantly more or less important than the rest of the interviewees.

Table 10. Comparing results from observational and interview methods.

	Air Temp (°F)	Wind Speed (mph)	Humidity (°)	Precipitation (in.)
RELAX	Revealed Importance	+5% **	-11.2% **	-86.7% **
	Average Stated Importance	3.4 (+)	2.6 (+)	3.8 (+)
ROWED	Revealed Importance	+4.5% **	-20.8% *	-6.3% *
	Average Stated Importance	3.5	3.7	2.2
MOTOR	Revealed Importance	+2.2% *	-8.2% *	-2.8% **
	Average Stated Importance	2.8 (-)	4.3 (+)	1.7 (-)
FISH	Revealed Importance	+2.5% *	-14% **	-2.7% *
	Average Stated Importance	2.9 (-)	3.3	1.8 (-)

(* = $p < .05$, ** = $p < .001$, (-) = significantly less than other users, (+) = significantly more than other users)
(red) = not well correlated, (green) = well correlated

If the weather factor has a significant relationship in the revealed importance results and the average response was above 3 on the Likert scale in the stated importance, then that weather factor is considered well correlated. As can be seen, the results from the revealed and stated importance methods match up relatively well.

All user groups under-estimated humidity as important while it showed up as significant for all groups. However, relaxers did care significantly more about the humidity than all other user groups (2.6) and they were the most affected (11.2%) by humidity out of the four user groups. This may indicate that while the importance of humidity was understated, the ratio of importance among the four groups is still reliable. Motor boaters and fishers also underestimated their importance for the air temperature, though the average stated importance of air temperature was 2.8 and 2.9 respectively which is quite close to a 3 (important).

Relaxers stated that air temperature and precipitation were important to them and indeed they were significant in the revealed importance model. They also stated that wind speed was not important to them and it was not found to be significant in the model. Rowed boat users stated that air temperature, wind speed, and precipitation were all very important to them and they were found to be significant in the models. Motor boaters and fishers both stated wind speed and precipitation were important to them and they were found to be significant in the models. It is interesting to note that motor boaters had a much higher average importance on the Likert scale than fishers but were found with a lower coefficient for wind speed in the revealed importance model than fishers.

The Local Low Temperature results from the regression analyses which seemed to suggest that some days were "too hot" for relaxing or rowing is addressed by analyzing those user groups responses to the open question "how warm would be too warm to come here?". It was found in the interview results that rowed boat users and fishers reported an actual temperature limit (rather than reporting no limit on high temperature) significantly more than the other interviewees meaning these users did have a limit that was considered "too hot" more than other users. Motor boat users reported an actual temperature (rather than reporting no limit on high temperature) significantly less than other interviewees, meaning these users did not have a "too hot" limit compared to other users. On average, relaxers were more likely to have a "too hot" limit, however the difference between them and other users was not significant.

4.4.1. Discussion

It seems, in general, that the stated importance of weather factors across the four user groups matches up with the observed relationships. Relaxers and rowed boat users appear to have a relatively clear understanding of the weather parameters that make them comfortable, except for humidity. Motor boaters and fishers understated the importance of air temperature and humidity but wind speed and precipitation stated and revealed importance matched up relatively well.

It is important to note that when the results from the two methods do not match up it is not because the user groups are wrong about their own preferences, just that in the regression model it was shown to have a significant effect. The stated importance studies might indicate that motor boaters and fishers do not care as much about the temperature though perhaps do have a preference if, given the choice, they can go out on a nicer day. Perhaps these user groups may be more resilient as warmer temperatures come with climate change.

4.4.2. The Too Hot Threshold

In regards to the question about some uses in RI lagoons having different thresholds for it being "too hot," the interview results seem to partially support the conclusions from the results of the regression model. The results from both models support the conclusion that there may be days that are too hot for people who intend to participate in rowed boat activities. Interview results do not support the same hypothesis for relaxers. Based on the interviews, it would seem that fishers also tend to have an upper limit on air temperature with which they are comfortable, which did

not show up in the regression data. Perhaps fishers may prefer cooler temperatures but comfort is not a strong factor for them as it is for other recreational users.

It is interesting to note that the model for recreational fishing did not fit the data as well as the other user models, suggesting that something other than the controls and the weather factors explain the variance in the amount of fishing observed. This is nicely explained by the open ended interview question about the most important reason for coming to the lagoon. The reason that scored highest in the open-ended responses was fishing. This suggests that the desire to fish, either as a sport or to catch dinner, may be a stronger factor than the psychological drive to take part in the other recreational activities, which tended to be better explained by the control and weather factors in the regression model.

5. Conclusion

5.1 Conclusions

Based on this research, the day-to-day recreational use forecast can be estimated using the day of the week, the month, and weather factors. The data suggest that on warmer days with lower humidity and little to no rain, there will be more relaxers on the coastal lagoons. Rowed boat users are less positively affected than relaxers to air temperatures and are more likely to reach a "too hot" threshold. They are also quite negatively affected by windiness. Motor boaters are less affected by temperature both in the sense of warmer days leading to more users and users reaching a "too hot" threshold. They are negatively affected by windiness, but less so than rowed boat users. Fishers are quite negatively affected by windiness, more so than motor boaters. Air temperature was significant but with a lower coefficient similar to motor boaters and their stated importance for it is significantly lower than other user groups.

Under a climate change scenario of an increase in average summer temperatures between 3°F and 10°F by 2080 (including both low and high emissions scenarios) (Engelhart, Horton, and Kemp 2011), there can be an expected change in recreational use amount, type, and timing on RI's coastal lagoons. While it is possible that with a gradual change in thermal climate, Rhode Islanders will simply adjust to the warmer temperatures, the Nikolopoulou (2001) research suggests that people in warmer climates tend to prefer to feel 'cooler' (1 point lower on the Likert scale than neutral). Based on the regression results, relaxing can be expected to increase about 5% per each degree increase in air temperature, rowed boats can be expected to

increase about 4.5% for each degree increase in air temperature, and motor boats and fishers can be expected to increase about 2.5% and 2.3%, respectively, for each degree increase in air temperature. However, results from the Local Low Temperature variables indicate that relaxing and rowing likely have a "too hot" threshold that has a strong negative effect on those uses. This is supported in the interview data which shows that rowing and fishing users responded that they are significantly more likely to have high temperature thresholds than other users. Motor boat users are less likely than other users to have high temperature thresholds and can reliably be expected to increase in number with higher temperatures. Rowing, relaxing, and fishing seasons may be extended with more warmer days but may also decrease in the peak of the summer with hotter than average days.

Precipitation, humidity and windiness were also factors found to influence these four user groups. Total amount of precipitation in the summer is not expected to change much, but increased intensity of storm events and drought events are likely to affect users. The scenario of fewer but more intense rain days and drier days in between during the summer months may help increase amount of activity for all user groups as they are all negatively affected by precipitation and all but rowed boat users are negatively affected by humidity. It should be noted that many fishing and motor boating interviewees noted that they would go out in light rain or drizzle but not in a heavy downpour or storm event. If climate change increases intensity of rain events, rainy days should see fewer people out on the ponds at all, where now in light rain there will still be people out.

Windiness is difficult to predict with climate change but if fewer storm days leads to fewer windy days, that will also have a positive effect on amount of activity for all user groups except relaxers. If windiness increases with climate change, rowed and motor boat users as well as fishers will experience a decline in activity on the lagoons on those windy days.

Again, it should be noted that sea level rise, increased storm intensity, and storm surge are expected to increase flooding and coastal erosion in Rhode Island (Rowley et al. 2007), decreasing beach space, accessibility, and water quality and safety. While these climate change factors are not examined in the scope of this weather-related research, they should be kept in mind when considering longer term forecasting of coastal recreation.

This research can be used to help state managers and business owners make some predictions on the amount of traffic in total and across recreational user groups they can expect on a given day. It can also help them predict how the recreational uses might skew one way or another depending on the weather. Similar predictions can be made looking decades into the future with climate change.

5.2. Future Research

Further research should interview people who partake in multiple recreational uses and ask them what factors determine their decisions to choose one use over another. Asking what the main motivators for choosing that activity would also be interesting. Maybe a kayaker on the lagoon for the purpose of exercise is more affected by warmer temperatures than one just there for the scenery.

It would also be interesting to investigate what people do instead of recreating on the lagoons on the days that suggest it is too hot to do so. Perhaps people opt to stay on the barrier beaches where they can enjoy a stronger sea breeze or cooler water temperatures or perhaps people choose to engage in indoor activities. Exploring if this model is effective in other coastal recreational areas in Rhode Island, such as the ocean beaches, would also be a good next step.

Exploring the differences between different types of locals, tourists, and visitors would also be an important next step for this research. Our hypothesis that short-term visitors would be less affected by weather due to the limited time they have access to the lagoons was not supported. Better distinctions between types of tourists, length of stay, should be explored.

5.3. Concluding Remarks

As climate change alters the conditions many expect in the summer time, it is important to know which factors enhance enjoyment and which may be a deal-breaker, and discern how long term trends may change the make-up of the coastal recreation community. It is hoped that this research can be useful for state and local planners working to optimize the health and enjoyment of Rhode Island's natural resources. The coastal lagoons are a complex and beautiful place enjoyed by many Rhode Islanders and visitors who come to enjoy them year after year and they are worthy of our understanding.

APPENDICES

Appendix A: Interview Instrument

LOCATION:

SURVEY CODE:

DATE:

TIME:

Explain that you are working on a URI project to learn more about recreational and commercial activities going on in and around RI's salt ponds. Survey questions will ask the respondent what he/she does in this salt pond and what he/she thinks about this salt pond. Explain that the survey will take about 10 minutes to complete and that the surveys are confidential and you will not ask for their name or any contact information.

A. MAPPING QUESTIONS

I. Have you been on or around a RI salt pond yet TODAY? If no, move onto Sub-section II (below).

- (1) Indicate on the map where you went today in or around the salt pond (use lines for boat routes and circles or other shapes for places you stopped).
- (2) **Outline** the area where you spent the **MOST TIME** today. If you spent a lot of your time at several locations, please select one. (Write "M" inside.)
- (3) **Outline** any areas you tried to avoid today. You can select as many you like. (Write "A" inside and a brief reason for each spot.)

*Now I'm going to ask you some questions about where you went today and where you spent the **MOST TIME**. -GO TO SECTION B-*

II. These questions relate to the **LAST TIME** you were in a RI salt pond or along the edges/shoreline of a RI coastal salt pond.

- (4) Indicate on the map where you went that day in or around the salt pond (use lines for boat routes and circles or other shapes for places you stopped).
- (5) **Outline** the spot where you spent the **MOST TIME** that day. If you spent a lot of your time at several locations, please select one. (Write "LM" inside.)
- (6) **Outline** any areas you tried to avoid that day. You can select as many you like. (Write "LA" inside and a brief reason for each spot.)

*Now I'm going to ask you some questions about where you went that day and where you spent the **MOST TIME**. -GO TO SECTION B-*

D. VISIT CHARACTERISTICS (interviewers may be able to answer some of Section D questions based on mapping exercise)

1. Which salt pond were you at today (or last time at a salt pond)? _____
2. When was the last time you were in a RI salt pond or along the edges/shoreline of a RI coastal salt pond? _____
3. Approximately how many times did you visit RI coastal salt ponds in the last year? _____ times
4. Where did you start from **TODAY** (your home, place of lodging, etc.)
 Village/town/state _____ Zip Code (if known) _____
5. Approximately how far did you travel **TODAY** to get here? _____ miles
6. Approximately how much time did you travel **TODAY** to get here? _____ 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 a salt pond)? _____ hours:mins
8. What are some of the main reasons that you came to the pond today? (circle all that apply, write in others)
 Weather Weekend Day Off Vacation Family/friend visiting

9. Follow up: Please rank the top three in importance (Write a 1, 2, 3 next to reasons) *if less than 3, just rank the 2. If only 1, do not rank*

10. Did you **check the weather forecast** before coming to the pond today? Y / N (circle)

C. PERCEPTIONS OF QUALITY OF EXPERIENCE

Next I'm going to ask you about **SPECIFIC FEATURES** of the place you said you spent the **MOST TIME** today (or the last time at a salt pond). Features are things like water quality or your ability to access the location.

	WOULD YOU SAY THIS FEATURE HAD A POSITIVE, NEGATIVE, OR NO EFFECT ON YOUR EXPERIENCE AT THE PLACE YOU SPENT THE MOST TIME TODAY (OR LAST TIME AT A POND)? WOULD YOU SAY IT AFFECTED YOU (NEGATIVELY/POSITIVELY) A LITTLE OR A LOT?				
SPECIFIC FEATURE	NEGATIVE		NEITHER	POSITIVE	
	A lot	A little		A little	A lot
Your ability to access this place					
Ability to park to access this place					
Ability to catch or harvest fish or shellfish					
Quality of the water at this place					
Amount and types of wildlife at this place					
Amount of noise at this place					
Amount of trash at this place					
Scenery around this place					
Amount of people or boaters at this place					

B. ACTIVITY QUESTIONS (CHECK APPROPRIATE RESPONSES IN TABLE BELOW)								
	WHAT ARE ALL THE ACTIVITIES YOU PARTICIPATED IN IN/AROUND THIS SALT POND TODAY? (OR LAST TIME AT A SALT POND)	WHAT ACTIVITIES DID YOU DO AT THE PLACE YOU SPENT THE MOST TIME? (FROM THE MAP: TODAY OR LAST TIME AT A SALT POND; USE "SAME" IF APPROPRIATE)	WHAT ACTIVITIES WERE OTHERS DOING AT THE PLACE YOU SPENT THE MOST TIME? (WHAT ACTIVITIES DID YOU SEE?)	FOR EACH OF THE ACTIVITIES THAT OTHERS WERE DOING (THAT YOU ENCOUNTERED OR SAW) AT THE PLACE YOU SPENT THE MOST TIME, HOW DID IT AFFECT YOUR EXPERIENCE? (GO DOWN THE LIST OF ACTIVITIES THAT WERE IDENTIFIED IN PREVIOUS COLUMN)				
				DETRACTED		NEITHER	ENHANCED	
				A lot	Little		Little	A lot
Chilling								
Walking/Running								
Cycling								
Swimming								
Dog walking								
Birding								
Kayak								
Sailing	boat size:							
Personal watercraft								
Motor boat	boat size:							
Fishing (Circle all that apply)	Type: Commercial Recreat'n Boat: On boat Not on boat Fish: Shell Fin Other fish	Type: Commercial Recreat'n Boat: On boat Not on boat Fish: Shell Fin Other fish	Type: Commercial Recreat'n Boat: On boat Not on boat Fish: Shell Fin Other fish					
Other:								
Other:								

11. Next I'm going to ask you about some specific weather elements.

How important were these factors in your decision to come to the pond today?

Would you say they are not important, a little important, somewhat important, very important, or extremely important on a scale of 1-5

Specific feature	1 Not Important	2 A little important	3 Somewhat Important	4 Very Important	5 Extremely Important	N/A
Weather forecast (overall)						
Air temperature						
"Feels Like" temp						
Wind speed						
Wind direction						
Relative Humidity						
Chance of Precipitation						
Cloud cover						
Visibility						
UV Index						
Water temperature						
Tide						

12. How warm does it have to be for you to come out and __ (say use here) __ on the pond? _____

13. What temperature would be too warm to __ (say use here) __ on the pond? _____

E. RESPONDENT CHARACTERISTICS

1. Where is your primary home? Town _____
State _____ Zip code _____
2. What is your gender? _____
3. What is your age? _____ years
4. What is the highest level of school that you completed?
☐ Less than high school ☐ Associate's degree
☐ Some high school ☐ Bachelor's degree
☐ Completed high school or GED ☐ Graduate of advanced degree
☐ Some college
5. What is your annual household income **before taxes**?
☐ Less than \$15,000 ☐ \$50,000 to \$74,999
☐ \$15,000 to \$24,999 ☐ \$75,000 to \$99,999
☐ \$25,000 to \$34,999 ☐ \$100,000 to \$149,999
☐ \$35,000 to \$49,999 ☐ \$150,000 or more

THANKS FOR PARTICIPATING IN OUR SURVEY!

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