Tourists' Climate Perceptions: A survey of preferences and sensitivities in North Carolina's Outer Banks

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Tourism is a major economic driver for North Carolina with $17.1 billion in travel expenditures, $4.2 billion in payroll, and employing 198,900 residents. Despite its fundamental influence on tourism, there is limited understanding of the relationship of climate and weather patterns with day-to-day business operations or long-term economic and environmental sustainability. We present a Climate-Tourism Index to measure and evaluate climate as a resource for tourism businesses in North Carolina. The relative importance of four climate variables is considered, along with differences in the perceptions of local and non-local beachgoers. Cloud cover appears to be more critical to a satisfying experience than temperature. Locals tend to be more sensitive to wind conditions than non-locals, which may be explained by past experiences and a greater appreciation of the local geography.

Keywords: *Climate preferences, Outer Banks tourism, North Carolina*

Introduction

Global climate change is of public concern in the relationship between climate and the tourism industry (IPCC, 2007; UNWTO, 2003). Not only does climate change affect the viability of tourist destinations and activities, but tourism in itself is a contributor to global climate change, owing mainly to emissions from transportation to and energy consumption at tourist destinations (UNWTO, 2003). Climate variability and changing weather patterns over the short term can affect tourism planning efforts, as well as tourists' destination decisions (de Freitas, 2003). These short term effects can be much more detrimental to businesses as they create increasingly changed patterns of tourist demand and impact tourist flow (Martin, 2004). Considering the impact that seasonal climate variability already has on tourism, the projected impacts tied to climate change threatens the longer-term livelihood of many tourism businesses and industries. These effects over the long term will reverberate through businesses and host communities, affecting other industries and sectors that supply these communities and the tourism sector indirectly (UNWTO, 2007).

The primary issue in global climate change with concern to the tourism industry is that of greenhouse gas emissions (GHG). With regards to the tourism sector, the majority of these emissions are generated through traveler's uses of transport services. Tourism also generates a high per capita consumption of water, energy, and waste that requires the industry to take a responsible step toward broader sustainability (UNWTO, 2007). Local communities dependent on tourism are impacted by climate variability and resource consumption both seasonally and annually, challenging stable business activity and the livelihood of permanent residents throughout the year. The sustainability of tourism is often dependent upon maintaining visitor sense of place, a favorable perception of and attachment to a destination. Central to sense of place is place satisfaction, which is affected by a host of social and local conditions that affect the tourist experience. Stedman (2003) argues that research has tended to neglect the role of the physical environment to the construction of place meanings and attachment. Atmospheric conditions play an important yet under-analyzed role in shaping the extent to which people view destinations in positive or negative terms. Weather and climate are not just objective, measurable variables but also cultural constructs that are made important through human interpretation and social action, both inside and outside the context of tourism (Strauss and Orlove 2003).

Tourism is a major economic driver in most state economies yet, despite the fundamental influence that climate has on the tourism industry, there remains a limited understanding of the relationship between tourism industry operations and a changing climate, particularly with respect to longer term sustainability (Nicholls, 2004). Planning for long term adaptation and sustainability requires not just recognizing the likelihood of increased climate and weather variability, but also research to understand tourists' sensitivity to and tolerance of likely changing weather and climate conditions.

North Carolina's tourism industry is particularly vulnerable to changing climatic conditions because of the variety of outdoor tourism sectors represented across the state, including golfing, whitewater rafting, skiing, biking and surfing. Here we focus specifically on North Carolina's Outer Banks. Tourism in the Outer Banks region is extremely sensitive to climate seasonality and variability because outdoor recreation activities are its main driver. In this study beach tourists were surveyed at three locations on the Outer Banks to determine their weather preferences and the extent to which they rely on weather forecasts. The intent was to provide some measure of sensitivity to climate change and extreme conditions. Respondents were also categorized as either local or non-local in order to understand how "local" knowledge shapes perception. The aim was to provide information that could help inform the development of useful weather and climate measures or indices for tourism applications, for both operator and consumer use.

Climate of the Outer Banks

The Outer Banks of North Carolina are a chain of barrier islands, roughly oriented northeast-southwest and stretching 54 miles. The islands enjoy a mild maritime climate, with cooler summers and warmer winters than mainland North Carolina. Weather observations have been taken almost continuously since 1874 from the village of Buxton, near the Cape Hatteras Lighthouse in the most eastern portion of the islands. The current National Weather Service tower has been making observations since 1957. The location of this station (35°14" N and 75°37" W at an elevation of 10 m), is within the Cape Hatteras National Seashore and is thus protected from the bulk of the development and commercial tourism activity. It is approximately 50 miles to the south of the closest survey site at Nags Head.

The Cape Hatteras station is assumed to represent the general climate of the Outer Banks. We focused on conditions in August, the month of the survey, as compiled in the Comparative Climatic Data publication of the National Climatic Data Center. The Outer Banks experiences the second highest annual temperatures in August (July is highest), with the maximum temperature averaging 84.8 and the minimum averaging 72.3. The average monthly precipitation peaks in August with 6.56 inches, due to convective instability and sea breeze fronts. The average wind speed is higher than the mainland, with August values at 9.5 miles per hour, and a maximum wind speed averaging 60 miles per hour from the North-Northeast. The sun shines 65% of the days in August, and on average 8 days are clear, 10 days are partly cloudy, and 13 days are cloudy. The average afternoon relative humidity is 69%.

An Index Approach

The relationship between weather, climate and tourism has led to a concerted effort by researchers to develop a theoretically sound approach to integrate the effects of climate on tourism, rather than relying on superficial or assumed relationships (de Freitas, 2002). These studies largely focus on quantifying weather and climate effects through an index. The literature shows over 200 indices based at least partially on weather and climate (Matzarakis, 2007).

The most common type is a combined tourism index (Abegg, 1996) which combines meteorological variables with physiological effects or perception. Many of these indices focus on "thermal comfort", derived from a combination of the meteorological conditions of temperature, wind, humidity and radiation (Hamilton, 2007). There are several ways to create thermal comfort indices. One of the earliest, Effective Temperature (Houghton and Yaglou, 1927; Missenard, 1937) based on air temperature and relative humidity and subjects' reports of comfort, has been used by several studies to characterize different locations (e.g. Yan and Oliver, 1996; Makokha 1998). Matzarakis et al. (1999) developed the approach of physiological equivalent temperature (PET) based on human energy balance rather than human perception. Other indices that also use the concept of energy balance include predicted mean vote (PMV, Fanger 1972). More complicated formulations include those proposed by Mieczkowski (1985) which add influences of the amount of sunshine, precipitation, and influence of wind speed on overall comfort in addition to a thermal formulation, and an index proposed by de Freitas et al. (2007) that also adds aesthetic (A) and physical (P) components to the thermal comfort (T), to directly measure the effects of perceived cloud cover (A) and the physical discomfort of wind and rain (P).

Tourism climate research has also been conducted to determine the importance of climate to decision making. A "push-pull" framework, describing the push factors that motivate an individual to travel, and the "pull" factors that draw an individual to destinations has been used in many studies (Hamilton et. al 2005). In a 2002 review of 10 studies, Klenosky did not find origin or destination climate explicitly as a push or pull factor, but did find a warm climate was a pull factor for a selected sector of tourists. In an analysis of the US travel market, Shumacher (1999) found good climate to be an important factor, and Scott and McBoyle (2001) in a study of tourism climate typology showed that annual patterns in TCI correlated with accommodation rates in selected locations. However, in various US locations, Scott and McBoyle contend that the peak demand seasons do not always coincide with a locations peak TCI. The various climate index studies also show a difference in "beach" indices (de Freitas 1999, Gatell et al. 2000) and "urban" indices where site-seeing and shopping are the primary activities (Scott and McBoyle 2001). Most of the climate-tourism relationships and indices in the beach environment have been developed outside the U.S. (e.g. Canada, New Zealand, and Sweden; Scott, Gossling, and de Freitas 2008), thus some new insights could be gained from this study, particularly in regards to the extent to which our sample's perceptions are in agreement with the conventional model of importance and sensitivity of different weather and climate factors to beach tourism. For instance, the American model of vacation (more frequent shorter vacations) is different from the European model, and so expectations and experiences of U.S. tourists may differ from those previously surveyed. The tolerance or sensitivity of tourists to "undesirable" weather conditions may also vary between populations based on their home climate, previous experience, or other factors.

Methodology and Survey Instrument

Seventy six surveys (Appendix 1) were distributed over a two day period, Saturday and Sunday, August 2nd and 3rd, 2008 on North Carolina's Outer Banks. Three locations on the Outer Banks were used – Kill Devil Hills, Kitty Hawk and Nags Head, with twenty five surveys handed out in each location with the exception of Nags Head with twenty six. Survey participants were chosen at random, approached and asked to participate in a 5-minute survey. The actual conditions were recorded in each location during the survey period using a Skymaster hand-held weather meter (Table 1).

Due to the small sample size, the observations were combined over the three locations. All incomplete records where discarded from the analysis, and tourist preferences for each atmospheric variable were graphed. Also, a table matrix comparing the atmospheric preferences of locals against those of non-locals was added. 'Locals' were chosen on the basis of those who self-identified themselves as spending 0 days on vacation regardless of where on the coast they lived. Each variable had five preference options, temperature preferences for example ranged from 75F to 95F in 5 degree intervals. The increments were chosen to reflect deviations about the climatological conditions (see section 2). Each variable was rated on a scale of 1 (totally disagree) to 5 (totally agree), and the number of responses for each preference were counted and graphed. The data was used to compare locals against non-locals to determine if there were differences in atmospheric preferences for each variable and which variable was most important in the decision to come to the beach.

Incomplete records were kept and in the cases were participant's circled more than one answer for a single variable the highest rating was used. This occurred in only five records, where participants circled an entire column of ratings (e.g. the entire column of '5' values), or circled more than one response for a single preference value (e.g. more than one value per row). If only one of the five preferences was circled for the entire variable then the remaining responses were coded with an 'NA' that was counted in the overall analysis, but left out of the analysis of variable preferences of locals against non-locals.

Results and Discussion

The survey resulted in an n=76 responses, but some responses omitted one or more individual questions, so the number for each question is not constant. However, the amount of missing data in any one case is 8 responses for an n =68 (for relative humidity = 40-60% case).

Comparing the temperature data for all respondents (Figure 2), nearly 70% of respondents rated the climatic mean of 85F a 4 or 5, and only 5% rated this temperature an unacceptable 1 or 2. A majority (>50%) rated all temperatures 75 – 90 to be acceptable (either 4 or 5), and 40% of respondents rated the hottest temperature (95F) either a 4 or 5. The responses for 95F showed the most variation, with over 30% rating 1 or 2, 28% neutral (3), and 40% 4 or 5, followed by the low temperature (75F), rated 1 or 2 by roughly 20% of respondents, neutral by 27% and acceptable by 51%.

Survey respondents' view of cloud cover showed a strong preference for clear to mostly clear conditions (Figure 3). Our results show little to no difference between these two (94% rated acceptable in each case), and that respondents showed a much stronger sensitivity to cloud cover than to temperature (with cloudy and mostly cloudy conditions rated acceptable by only 17% and 16% of respondents, respectively).

Relative Humidity results (Figure 4) showed an expected pattern, with a majority accepting RH values in the 0 – 60% range, and a majority also finding the two highest RH catagories unacceptable. The lowest relative humidities (< 40%) were highly favored, but very rare in August in this part of the state.

Wind velocity results (Figure 5) showed that the mean wind speed of 10 mph (climatological average) was preferred by the highest number of beachgoers (72 % rated 4 or 5), while both calm and windy (20 mph) conditions were rated largely unacceptable (61% and 57% respectively).

These results show that the sample of Outer Banks beach users showed relatively little sensitivity to temperature, which is an important result considering the primacy of thermal comfort in most of the tourism indices. Respondents showed much more sensitivity to the aesthetic/physical factors of wind and cloud cover, suggesting that an index such as Mieczkowski's TCI (1985) or de Freitas' A-P-T index (2007) would be most appropriate for this population.

Locals versus Non-Locals

Locals made up 24% of the survey and consisted of individuals that lived on the Outer Banks, including Roanoke Island, a population area located approximately 2 miles inland. Interestingly, non-locals were primarily from Virginia (31 respondents), as compared to mainland North Carolina (10 respondents). While many of the responses were consistent between these two sub-groups, some differences were noted.

Regarding zero wind speed, which is uncommon at the Outer Banks, the response of totally disagree (1) was the most popular response among non-locals, and there was a bimodality of responses among locals with 6 selecting totally agree (5) and 8 selecting either (1) or (2). The reason for this is unclear and deserves further study. Another interesting difference was the choice of most preferred weather condition (Figure 6). For locals, all variables were about equal, with a slight preference toward wind speed. However for non-locals, 26 chose cloud cover and 24 selected temperature, while only 12 chose wind speed and 10 selected humidity. Non-locals preferred a variety of temperatures, but 37 respondents agreed that 85° F was an ideal afternoon temperature. This fact, in combination with the preference for clear skies over cloudy skies, suggests that the choice of the favorite variable is informed by a preference for sunbathing. This is also consistent with non-locals disliking zero wind. Finally, there was a difference in the use of weather forecasts for planning an outing at the beach. Non-locals tended to check the weather forecast much more frequently than locals. In fact, 37 out of 58 non-locals either selected 4 or 5 in terms of their frequency to base their day's decisions on the forecasted weather. There are several reasons that could explain this discrepancy. First, locals may believe that they understand the weather of the Outer Banks sufficiently not to require a weather forecast, or they have some past experience not to trust the weather forecast. Second, since locals are not on vacation, they may not construct formal plans, and simply decide to go to the beach based on the current conditions. Non-locals may use the weather forecast to decide upon several tourist options that are either primarily inside (e.g. shopping) or outside (e.g. sunbathing).

Implications for Regional Climate Change

The study results show that preferences were well in line with the mean climate conditions (85F, wind speed 10 mph, etc). However, the recent IPCC report (2007) predicts noticeable regional changes in the climate of this important tourist destination through 2100, with the largest amount (4 – 5F) occurring in the summer time. Additionally, - the number of extreme temperature days and heat waves are expected to increase. While our results showed a reasonable tolerance to temperature, given these projections, an average temperature of 90F would be less desirable than the current, and unacceptability increases for the higher temperatures. If temperatures become considerably hotter, the sensitivity of tourists to temperature may change.

Additionally, regional projections produced by the IPCC show a 5 -10% increase in summer precipitation for the Outer Banks region, with the majority of models predicting an increase. This is largely thought to come from summer thunderstorms (EPA 1998). Given the strong preferences for clear skies and low relative humidity, an environment that produces more summer storms will likely be less desirable to Outer Banks beach tourists.

Conclusions

This research demonstrates that current Climate Tourism Index formulations do not directly address what tourists and locals on the Outer Banks focus their decision-making on. This research also demonstrates the need for further study and a more comprehensive survey to explain the differences in locals versus non-locals, as well as some of the gaps in the existing preliminary data. Given that changing climate conditions on the Outer Banks will affect tourism flows, there needs to be further study into understanding tourists' perceptions of climate change on the Outer Banks as well as addressing the need for region-specific development of weather, climate, and tourism indices.

Table 1. Climate Perception and Reality. Survey asked if the following conditions were ideal for an outing at the beach. Underlined values are closest to the August climatology for Cape Hatteras (NCDC), provided in the last column.

Variable						Climatology
Max daily temperature (F)	75	80	<u>85</u>	90	95	84.8
Cloud cover	<u>Cloudy</u>	Mostly cloudy	Partly cloudy	Mostly sunny	Clear	26% clear 32% var. clouds 42% cloudy
Wind speed (mph)	0	5	<u>10</u>	15	20	9.5
Relative Humidity (%)	0-20	20-40	40-60	<u>60-80</u>	80-100	69

Table 2. Observed Conditions on the Outer Banks.

Saturday (8/2/09) 12:00pm	Nags Head	Between mileposts 16-17
Average Wind Speed:	10.2 mph out of the NW	
Average Temperature:	96.6 F	
Relative Humidity:	47.9	
Weather:	Partly cloudy to cloudy in the evening	
Sunday (8/3/09) 10:30am	Kitty Hawk	Between mileposts 2-3
Average Wind Speed:	2.1 mph out of the SE	
Average Temperature:	89.2 F	
Relative Humidity:	66.7	
Weather:	Mostly Sunny	
Sunday (8/3/09) 2:00pm	Kill Devil Hills	Between mileposts 9-10
Average Wind Speed:	12.6 still out of the E	
Average Temperature:	93.4 F	
Relative Humidity:	63.2	
Weather: Clear	Clear	

Appendix 1. Survey Instrument.

1. Where do you live (city, state) ______________________________.
2. How many days are you vacationing at the Outer Banks ________________.

3. Do you check the weather forecast before deciding on your day's activities (e.g. outside versus inside)?

Never				Always
1	2	3	4	5

4. I would find the following maximum daily temperature to be ideal for an outing at the beach

	Totally Disagree				Totally Agree
75 °F	1	2	3	4	5
80 °F	1	2	3	4	5
85 °F	1	2	3	4	5
90 °F	1	2	3	4	5
95 °F	1	2	3	4	5

5. I would find the following average cloud cover to be ideal for an outing at the beach

	Totally Disagree				Totally agree
Cloudy	1	2	3	4	5
Mostly cloudy	1	2	3	4	5
Partly cloudy	1	2	3	4	5
Mostly sunny	1	2	3	4	5
Clear	1	2	3	4	5

6. I would find the following average afternoon relative humidity to be ideal for an outing at the beach

	Totally Disagree				Totally agree
<20%	1	2	3	4	5
20-40%	1	2	3	4	5
40-60%	1	2	3	4	5
60-80%	1	2	3	4	5
80-100%	1	2	3	4	5

7. I would find the following average wind speed to be ideal for an outing at the beach

	Totally Disagree				Totally agree
0 mph	1	2	3	4	5
5 mph	1	2	3	4	5
10 mph	1	2	3	4	5
15 mph	1	2	3	4	5
20 mph	1	2	3	4	5

8. Which of the climate variables just discussed have the strongest influence on your decision to come to the beach______________________________.

Figure 2. Temperature Preferences for all Respondents.

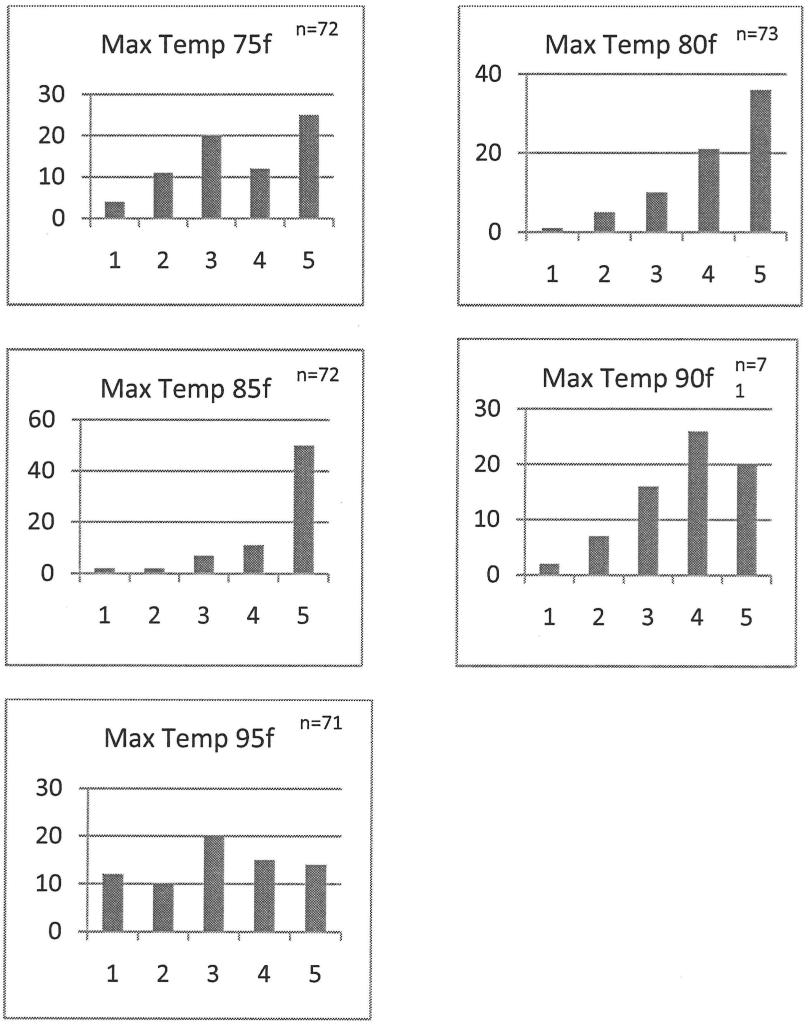


Figure 3. Average Cloud Cover Preferences for all Respondents.

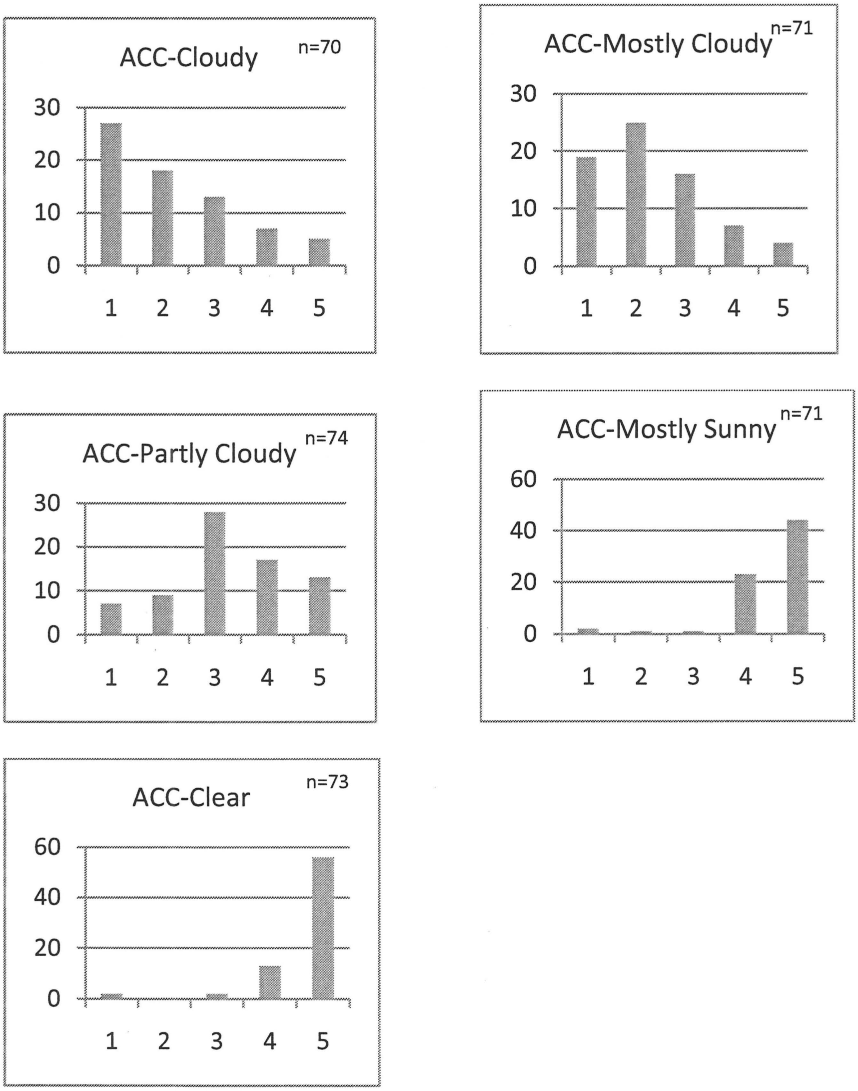


Figure 4. Relative Humidity Preferences for all Respondents.
Tourists' Climate Perceptions

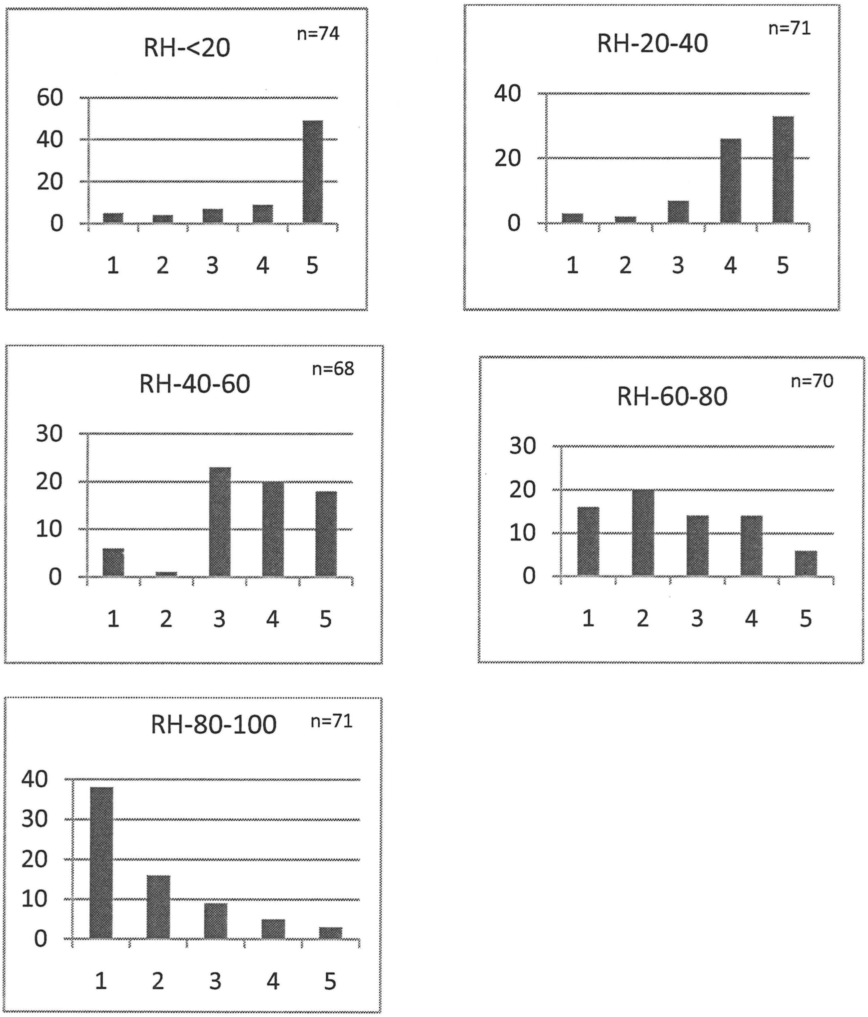


Figure 5. Wind Speed Preferences for all Respondents.

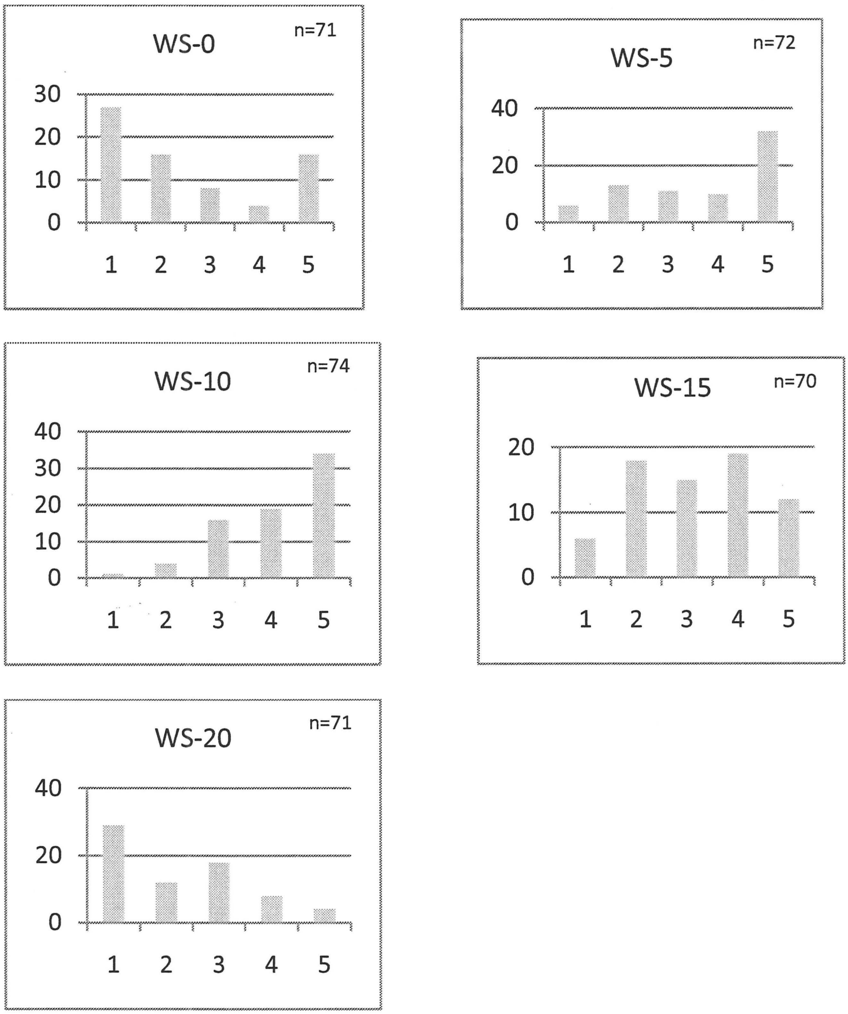
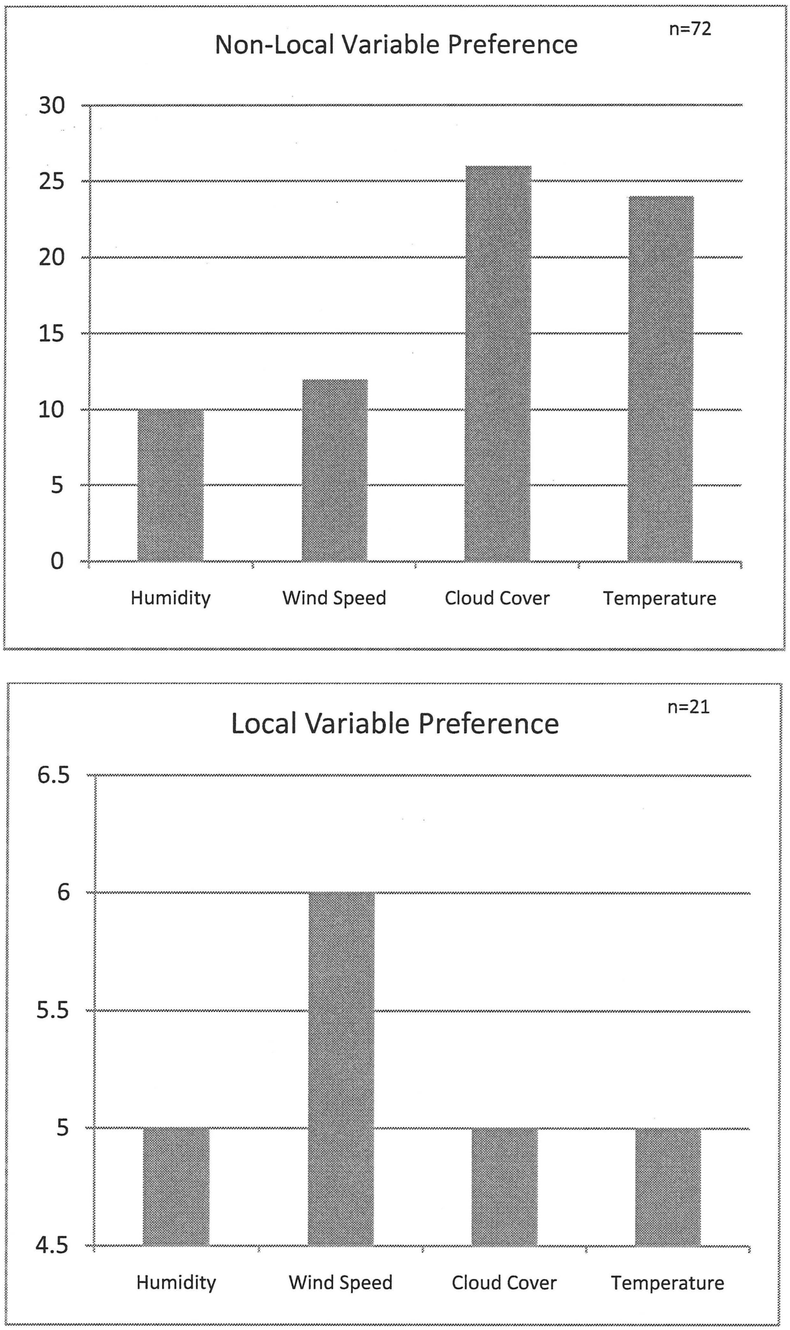


Figure 6. Most Important Climate Variables. Locals versus Non-locals



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