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Special Issue

Coping with Climate Change: A Study of Great Lakes Water-Based Recreationists

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Abstract

A multitude of unique year-to-year ecological variations within the Great Lakes basin have been attributed to climate change. These variations include the number and intensity of storms, the volume of water flowing within the watershed, the water quality, the average height of lake levels, and the intensity of waves that strike the coastline (Parry, 2007). Yet, the impact of these changing environmental conditions upon water-based outdoor recreation users remains unclear. While climate change exacerbated environmental conditions are becoming progressively evident to both recreationists and resource managers (NPCA, 2009), few studies have sought to assess the extent to which environmental conditions alter outdoor recreation behaviors. This study examined water-based outdoor recreation visitors' perceptions and coping responses associated with water quality conditions affected by climate change on Lake Erie (n= 284). It used a modified version of the stress-coping model (Lazarus & Folkman, 1984) to examine the relationships between water quality impact, water quality awareness, and coping. Study results indicated that the more visitors identified

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water quality as a negative impact on their overall experience, the more aware they were of water quality conditions. Further, the more aware visitors were of water quality conditions, the more they found the need to employ coping responses.

From a resource management standpoint, a central concept for maintaining high quality outdoor recreation experiences is the identification of visitor resource perceptions and related impacts (Manning, 2011). Study findings confirmed visitors' perceptions of water quality impacts and awareness resulted in the employment of both cognitive and behavioral coping mechanisms that could be accounted for in future management decisions. From a theoretical perspective, this study took the work of Iwasaki and Schneider (2003), Miller and McCool (2003), Schneider and Hammitt (1995), Schuster et al. (2006), and Propst (2008) to the next logical step in the investigation of environmental conditions and coping within recreational settings. It went beyond determining perceptions of environmental conditions and attempted to determine if the impact and awareness of environmental conditions influenced the employment of coping mechanisms. The relationships provided support for advancing the outdoor recreation coping literature by applying coping as a response to environmental conditions.

Keywords

Outdoor Recreation, Great Lakes, Water Quality, Coping, Climate Change

Introduction and Study Background

The occurrence of climate change both worldwide and within the United States has led to pervasive shifts in environmental conditions (IPCC, 2014). In addition to the broad implications of climate change on the planet, various unique regional variations in environmental conditions have also been linked to climate change (IPCC, 2014). The Great Lakes region, specifically Lake Erie, and its associated water-based outdoor recreation (WBOR) activities have become increasingly vulnerable to water quality conditions affected by climate change such as record setting harmful algal blooms and an increased presence of E. coli (Ho & Michalak, 2015; NRDC, 2014). These conditions have become progressively evident to natural resource managers (NPCA, 2009). However, little is known about recreationists' interactions water quality conditions affected by climate change, and how these interactions influence visitor responses and behaviors. The overarching goal of this study was to evaluate perceptions and responses towards water quality conditions among the WBOR visitors who use the Pennsylvania coastal section of Lake Erie.

Environmental Impact and Awareness

While the condition of the natural environment is integral to outdoor recreation activities, only a relatively small number of studies have addressed the topic. This limited body of research focuses almost exclusively on visitors' perceptions of recreation use impacts (e.g., litter, trampling, etc.) (Downing & Clark, 1979; Hammit & McDonald, 1983; Helgath, 1975; Merriam & Smith, 1974). A literature review reveals two distinct schools of thought. Early thinking generally concluded visitors were largely unaware of or oblivious to recreation use impacts and did not perceive them as a concern or problem (Downing & Clark, 1979; Hammit & McDonald, 1983; Helgath, 1975; Merriam & Smith, 1974).

More recent research demonstrates that recreationists are becoming more conscious of recreation use impacts (Farrell et al., 2001; Lynn & Brown, 2003; Manning, 2011; Wyles et al., 2014). Researchers speculate that these increasing perceptions of impacts have led in many instances to a more informed and environmentally aware general public (Gelcich et al., 2014; Manning, 2011; Wyles et al., 2014). The increasing occurrence of environmental impacts may be contributing to growing awareness of issues associated with climate change (Brownlee & Verbos, 2015; Manning, 2011). Yet this limited body of research only considers visitor perceptions' of recreation-induced conditions and does not assess recreationists' perceptions of environmental conditions affected by climate change and their impact on the recreation experience.

Social and Environmental Conditions

The quality of an outdoor recreation experience has been a primary concern for researchers, managers, and recreationists. Encountering undesirable conditions within a recreation setting such as crowding, conflict, or poor environmental conditions can lead to an assortment of negative visitor appraisals toward an entire experience (Manning, 2011; Miller & McCool, 2003; Schuster et al., 2006). To assess the effects of undesirable conditions on the recreation experience, a considerable amount of research has focused on social conditions (e.g., crowding, conflict, and hassles) (Manning & Valliere, 2001; Miller & McCool, 2003; Schneider & Hammitt, 1995; Schuster et al., 2006).

In addition to these social conditions, another lesser studied element that can undermine the overall outdoor recreation experience is the condition of the environment (e.g., water quality). Undesirable conditions, whether social or environmental, have been theorized to cause anxiety or distress for the outdoor recreation visitor, which ultimately can impact a visitor's recreation experience. Yet many studies conclude that when visitors are faced with undesirable conditions (either social or environmental) they maintain their overall experience quality (Downing & Clark, 1979; Hammit & McDonald, 1983; Helgath, 1975; Merriam & Smith, 1974).

The Coping Framework–Cognitive and Behavioral Coping Mechanisms

Research has shown that recreationists often employ cognitive and behavioral coping processes to attain high levels of experience quality despite encountering sub-optimal social situations (Manning, 2011; Manning & Valliere, 2001; Miller & McCool, 2003). Coping is a pervasive concept within the field of social psychology and is generally defined as "constantly changing cognitive and behavioral efforts to manage specific external and internal demands which are appraised as taxing or exceeding the resources of the person" (Lazarus & Folkman, 1984, p. 141). Within the outdoor recreation literature there has been a substantial amount of work that has adopted some form of Lazarus and Folkman's (1984) transactional stress-coping framework.

The coping framework theorizes that, when faced with a stressful scenario, visitors engage in an appraisal process where they internally assess all possible coping alternatives and identify and implement the optimal coping mechanism in pursuit of a desired outcome (Lazarus & Folkman, 1984). The framework uses a dichotomous coping model consisting of both cognitive and behavioral coping mechanisms. Cognitive coping is a mental process intended to decrease emotional anguish, while behavioral coping refers to an objective, systematic approach that focuses primarily on the setting itself (Lazarus & Folkman, 1984).

Although prior research established a relationship between resource conditions and experience quality, none of these studies used coping to explain this phenomenon. While it can be inferred that cognitive and behavioral coping processes are employed to maintain outdoor recreation experiences in the face of undesirable environmental conditions, few studies have assessed the extent visitors were actually impacted by environmental conditions. Moreover, research has not examined how visitors perceive and cope with a range of environmental conditions. This study addressed these gaps by applying a coping model (Figure 1) to explore the extent to which perceptions of climate change intensified water quality impacts and awareness elicited coping responses on Lake Erie. Based on the literature, the hypothesized model predicts that perceived water quality impact would have a positive relationship on water quality awareness and water quality awareness would have a positive relationship upon both behavioral and cognitive coping responses (Iwasaki & Schneider, 2003; Lazarus & Folkman, 1984; Manning & Valliere, 2001; Miller & McCool, 2003; Schneider & Hammitt, 1995).

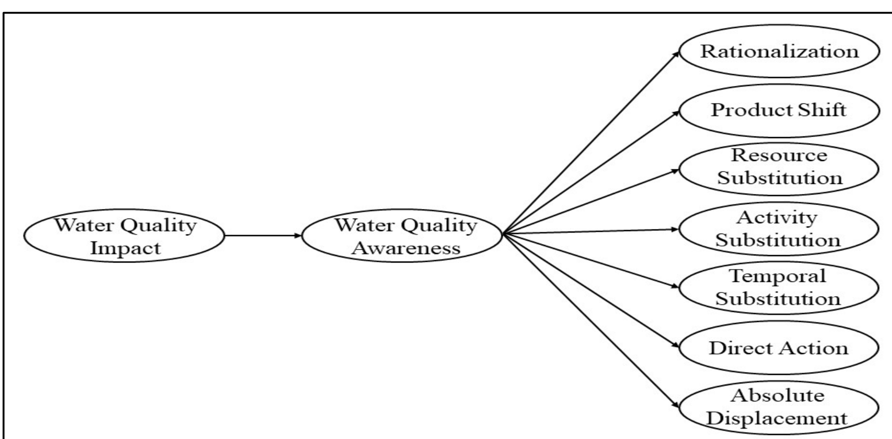


Figure 1. Hypothesized conceptual model.

Methods

Study Area–Lake Erie

Lake Erie is the shallowest and southernmost of the five Great Lakes, and is the fourth largest Great Lake in terms of surface area and the smallest Great Lake in terms of water volume. Due to Lake Erie's southernmost position, it is the warmest and most biologically productive of all of the Great Lakes (McGucken, 2000). During the industrial era of the United States, Lake Erie had been plagued with poor water quality conditions stemming from heavy industrial development, rampant pollution, and a general lack of regulatory oversight (McGucken, 2000). The recent implementation of environmental regulatory policies, such as the U.S. Environmental Protection Agency's (EPA) Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, has begun to help Lake Erie restore its water quality standards. Yet, the increasing presence of climate change factors once again pose significant threats to Lake Erie water quality conditions (NRDC, 2014).

Scientists and managers alike are concerned that water quality issues such as harmful algal blooms and E. coli in Lake Erie are being affected by climate change and could have both short and long term impacts on many of Lake Erie's WBOR visitors. Harmful algal blooms are immense surface algae growths that thrive in aquatic ecosystems (Ho & Michalak, 2015). Escherichia coli (E. coli) is digestive bacteria commonly found in both human and animal fecal matter (NRDC, 2014). While harmful algal blooms and E. coli have existed in Lake Erie for centuries, only recently has their presence been amplified due to the increasing occurrence of climate change (Ho & Michalak, 2015; NRDC, 2014). Both harmful algal blooms and E. coli are toxic to humans and wildlife, alter aquatic food webs, threaten drinking water supplies, and pose significant threats to the recreational use of Lake Erie (Ho & Michalak, 2015; NRDC, 2014).

The state of Pennsylvania manages the smallest portion of Lake Erie, encompassing 76.6 miles of coastline. The Pennsylvania coastline of Lake Erie is home to a multitude of public parks and outdoor recreation facilities. Nearly every one of these recreation facilities serves the primary purpose of providing access to Lake Erie itself. This abundant access includes numerous boat launches, marinas, fishing piers, overlooks, and a large assortment of beaches. The combination of biological and geological diversity, in addition to the abundance of public access points, makes the Pennsylvania coastline of Lake Erie extremely attractive to a wide range of local, regional, and international WBOR visitors. Within the present day Lake Erie region, WBOR and tourism have become an increasingly critical component of the economy, displacing the prominence of manufacturing that once dominated the landscape.

The focal point of this study included all of the public WBOR facilities and affiliated activities located within the Pennsylvania coastline of Lake Erie, proximate to Erie, Pennsylvania. Through conversations with natural resource managers and local stakeholders, the researchers obtained permission to sample all 13 of the publicly accessible coastal parks and protected areas within the Pennsylvania coastline of Lake Erie. A majority of these sites included overlapping WBOR facilities. For example, one of the sites included a boat launch, a beach area, and a fishing area. The centerpiece of these survey sites, Presque Isle State Park, attracts over 4.2 million visitors annually (Mowen et al., 2013). No visitor use statistics were available for the remaining survey sites. Combined, the 13 study sites contained three marinas, seven boat launches, six fishing areas, and five beaches.

Data Collection

On-site face-to-face survey interviews were used to gather data from WBOR visitors throughout the study sites from May 29 to September 27, 2015. To gather a diverse and representative sample, a systematic sampling plan was developed in consultation with natural resource managers and local stakeholders to coincide data collection with peak

WBOR use periods (Vaske, 2008). During the time of data collection, water quality issues persisted within the Pennsylvania section of Lake Erie. For instance, the most severe harmful algal bloom this century achieved maximum biomass in Lake Erie and a total of 108 E. coli related beach advisories and/or restrictions were issued during the time of data collection (Erie County DOH, 2015; Ho & Michalak, 2015).

The survey was administered via tablet computers using the commercially available off-line data collection application iSurvey. A trained research assistant approached potential respondents, described the purpose of the study, and solicited respondents to participate in the survey, which was read aloud and took between 10 and 15 minutes to complete. If potential respondents indicated they did not partake in a WBOR activity, they were thanked for their time and excluded from the study. For systematic sampling purposes, interviewers contacted every third person or party observed and requested their participation (Vaske, 2008). Only consenting adults (18 years of age or older) were eligible to participate.

The topics within the first portion of the survey included activity preferences, trip visitation patterns, and sociodemographic characteristics. Once this portion of the survey was completed, respondents were given a laminated informational flashcard. This flashcard provided respondents with a brief informational narrative and photograph informing them of the presence of actual water quality conditions within the Pennsylvania coastline of Lake Erie. This description did not identify any potential benefits or drawbacks that water quality conditions could pose upon WBOR visitors. The purpose of this flashcard was to orient the respondent to the environmental condition in an unbiased manner (Brownlee et al., 2015).

After reviewing the flashcard, respondents were asked a series of questions pertaining to water quality conditions and WBOR. These items referred to the awareness, impacts, and coping mechanisms employed when encountering water quality conditions. Recognizing these water quality conditions are a byproduct of climate change and that the topic of climate change has become increasingly contentious, this study did not use the term 'climate change' with regard to measurement as this phrasing and labeling has been shown to bias and alter respondent perceptions (Schuldt, 2016; Schuldt, Enns, & Cavaliere, 2017). Upon completion of the survey, respondents were thanked for their time and asked if they had any other questions. In total, 309 surveys were attempted, yielding 284 completed surveys and a 92% response rate.

Variable Measurement

Perceived impact of water quality. To measure perception of water quality impact, respondents evaluated the extent water quality conditions impacted their overall WBOR experience. This was performed through the use of a single item indicator. The item was created based on previous environmental impact literature and conversations with natural resource managers and other relevant Lake Erie stakeholders (White & Van Riper, 2008) (Table 1). Respondents were asked to indicate the extent to which water quality had impacted their overall WBOR experience using a seven-point Likert scale (1= positively impacted, 7= negatively impacted).

Perceived awareness of water quality. To measure perceptions of water quality awareness, visitors assessed the extent they were aware of specific water quality conditions that potentially affected their WBOR experience. This approach has been previously validated to measure visitors' awareness of environmental conditions that directly affect outdoor recreation activities (Brownlee et al., 2014). Nine items were selected and modified for inclusion in the water quality awareness construct based on conversations with natural resource managers and other relevant Lake Erie stakeholders (Table 1). Respondents were asked to indicate the extent to which they were aware of water quality conditions using a seven-point Likert scale (1= completely disagree, 7= completely agree).

Coping Mechanisms

To assess coping responses, respondents were asked to indicate the extent to which 21 coping items described their response to water quality conditions on Lake Erie (Table 2). Respondents rated these coping items using a seven-point Likert scale (1= does not describe, 7= describes very well). This construct has been previously validated to assess visitors' employment of coping mechanisms (Miller & McCool, 2003; Schneider & Hammitt, 1995). Overall, these coping statements represented the two general or aggregate domains of cognitive and behavioral coping. Within these two domains, seven individual coping sub-domains were represented. The domain of cognitive coping contained the sub-domains: 1) product-shift, and 2) rationalization. The domain of behavioral coping contained the sub-domains: 3) resource substitution, 4) activity substitution, 5) temporal substitution, 6) absolute displacement, and 7) direct action.

Data Analysis and Results

Descriptive statistics were analyzed using SPSS 24.0. Following this, an exploratory factor analysis was run on the coping items. Two-step structural regression modeling was performed in AMOS 24.0 by implementing a confirmatory factor analysis followed by the testing of a structural regression model (Anderson & Gerbing, 1988).

Descriptive Characteristics–Sociodemographic and Trip Visitation Patterns

The survey also collected information on visitors' sociodemographic information and trip visitation patterns. The sample primarily consisted of middle aged (M=50) white (95%) males (71%). The majority of the sample reported household annual incomes of less than $75,000 (60%) and had earned either a four-year college or professional degree (56%). Respondents were asked to indicate which WBOR activity was their primary activity on the day they were sampled. Of the entire sample, boaters represented nearly one-half (47.1%), anglers represented more than one-third (35.2%), and beach visitors (17.6%) represented the smallest proportion of visitors. Respondents were largely repeat (92%) day trip visitors (69%) recreating for an average of 4.5 hours. These experienced and largely localized visitors noted they spent an average of seven days per month, 34 days per year, and 18 total years engaged in their primary WBOR activity and traveled an average of 50.4 miles from their home to the survey site. These sociodemographic and trip visitation statistics closely resembled other similar research in the study area (Mowen et al., 2013).

Descriptive Characteristics–Water Quality Impact and Awareness

To measure perception of water quality impact, respondents were asked to indicate the extent to which water quality had impacted their overall WBOR experience using a seven-point Likert scale (1= positively impacted, 7= negatively impacted). Visitors generally indicated their WBOR activities were slightly negatively impacted by water quality conditions (*M*= 4.3). To measure perceptions of water quality awareness, respondents were asked to assess the extent they were aware of nine individual water quality conditions using a seven-point Likert scale (1= completely disagree, 7= completely agree). Visitors generally reported slight disagreement (*M*= 3.2) with their awareness of water quality conditions with individual mean scores ranging from 4.1 to 2.7 (Table 1). Respondents were most likely to agree they were aware of an increase in the number of harmful algal blooms (*M*= 4.1) and least likely to agree that Lake Erie was experiencing record poor water quality standards (*M*= 2.7).

Table 1

Water Quality Impact and Water Quality Awareness

Variable	Item Mean (SD)
Water Quality Impact	
Overall water quality impact	4.3 (1.2)
Water Quality Awareness[a]	
An increase in the number of harmful algal blooms	4.1 (2.0)
A decrease in fish populations	3.4 (1.9)
A decrease in the number of annual fish consumed from Lake Erie	3.3 (1.9)
An increase in the number of beach closures	3.3 (2.1)
An increase in foul smelling water	3.3 (2.1)
Areas within the lake becoming inaccessible due to water quality cond.	2.9 (2.0)
Poor water quality conditions in Lake Erie	2.9 (2.0)
Some marinas closed or unusable due to water quality conditions	2.8 (1.9)
Lake Erie experiencing record poor water quality standards	2.7 (1.9)

Note. Water Quality Impact Scale (1= positively impacted, 7= negatively impacted)
Note. Water Quality Awareness Scale (1= completely disagree, 7= completely agree)
[a]Water Quality Awareness Index Mean (SD) = 3.2 (2.0)

To measure coping, respondents evaluated the extent that 21 coping statements represented their response to water quality conditions using a seven-point Likert-type scale (1= does not describe, 7= describes very well). Visitors generally reported that their employment of cognitive and behavioral coping mechanisms was moderate (Table 2). When comparing overall mean values for the two coping domains, results indicated that in response to water quality conditions, visitors were more likely to employ *cognitive* coping mechanisms (*M*= 3.7) as opposed to *behavioral* coping mechanisms (*M*= 2.7). In the case of the seven individual coping sub-domains, visitors reported they were likely to employ coping responses associated with *rationalization* (*M*= 4.3), *direct action* (*M*= 3.8), *resource substitution* (*M*= 3.5) and *product-shift* (*M*= 3.0). The coping sub-domain that received the lowest mean rating was *absolute displacement* (*M*= 1.7).

Table 2
Coping Mechanisms

Variable	Item Mean *(SD)*	Scale Mean *(SD)*
Cognitive Coping Domain		
Rationalization		
Told yourself that WQC were actually a symptom of some larger problem	4.8 (2.2)	4.3 (1.6)
Told yourself to continue on as if nothing has happened	4.1 (2.2)	
Told yourself that there was nothing you could do about WQC, so you just enjoyed the experience for what it was	3.9 (2.2)	
Product Shift		
Decided that, for the PA section of Lake Erie, WQC were what they should be	4.0 (2.3)	3.0 (1.4)
Realized that the WQC you experienced were really acceptable after all	2.7 (1.8)	
Told yourself it was unreasonable to expect that WQC should have been different within the PA section of Lake Erie.	2.4 (1.7)	
Behavioral Coping Domain		
Direct Action		
Decided to talk to someone who could do something about WQC	4.3 (2.1)	3.8 (1.7)
Talked with other members of your group about WQC	3.6 (2.2)	
Decided to talk with Lake Erie authorities about WQC	3.4 (2.2)	
Resource Substitution		
Decided that you would avoid a certain area of Lake Erie because of WQC	3.7 (2.4)	3.5 (1.9)
Decided you would come back to the PA section of Lake Erie at the same time, but would visit a different area of the lake to avoid WQC	3.4 (2.2)	
Realized that visiting different areas of the PA section of Lake Erie would allow you to avoid WQC	3.3 (2.2)	
Temporal Substitution		
Realized that you could avoid WQC in the future by visiting this area at a different time	2.6 (1.9)	2.3 (1.4)
Decided that, if you visited the PA section of Lake Erie in the future, visiting during a different season would help you avoid WQC	2.4 (1.8)	
Decided that, if you visited the PA section of Lake Erie in the future, visiting during a different time of day would help you avoid WQC	2.1 (1.5)	
Activity Substitution		
Realized that doing some activity other than [*fish/boat/beach*] on Lake Erie would allow you to avoid WQC	2.5 (2.0)	2.2 (1.3)
Planned to do other things besides [*fish/boat/beach*] to avoid WQC	2.4 (1.9)	
Decided [*fish/boat/beach*] is no longer important to you because of WQC	1.7 (1.2)	
Absolute Displacement		
Planned to leave the PA section of Lake Erie because of WQC	1.9 (1.5)	1.7 (0.9)
Decided to never [*fish/boat/beach*] again because of WQC	1.7 (1.2)	
Planned to never visit the PA section of Lake Erie again because of WQC	1.5 (1.0)	

Note. Coping Scale (1= does not describe, 7= describes very well)
Note. WQC = *Water Quality Conditions*

Model Testing

Model testing was performed using maximum likelihood estimations in AMOS Graphics 23. Due to the survey being a face-to-face interview, there were no variables with missing data relevant to the model. Perceived water quality awareness items were measured on a seven-point Likert scale. Respondents were also provided a "does not apply" option. For the purpose of this analysis, "does not apply" was recoded at the mid-point scale value of four, inferring a response of "unaware." This recode was conducted based on item conceptualization in an effort to ultimately retain sample size and power within the analyses. The authors felt this re-code was appropriate based on anecdotal field observations and the nature of the awareness items.

If a respondent stated "does not apply" to awareness regarding a specific water quality item, the authors felt it appropriate that the respondent was generally unaware of that specific issue. The statement with the highest number of "does not apply" responses—with a total of 35 (12.3%)—was, "a decrease in the number of annual fish allowed to be consumed from Lake Erie." When considering this item, it is plausible to see how respondents marking "does not apply" can be grouped with those who selected the mid-point scale value of four, inferring a response of "unaware." In total, 60 (21.1%) respondents answered "does not apply" for at least one option. The authors acknowledge that "does not apply" could have multiple interpretations and this is discussed further as a key study limitation.

Although the coping survey items were theorized to group into specific factors, this instrument has received limited attention and remains in exploratory stages. In the interest of determining how these coping items grouped, the researchers used a similar process as Miller and McCool (2003). First, an exploratory factor analysis was performed, followed by a two-step structural regression analysis (Anderson & Gerbing, 1988).

Exploratory Factor Analysis

Data were first assessed for factorability using Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin Measure (KMO) of sampling adequacy. The Bartlett's Test of Sphericity resulted in a chi-square of 2440.58 (df= 210; p<.001) and the KMO value was .782. Due to the significance of the Bartlett's test and the KMO value being within an acceptable range, data were suitable for further factor analysis (Dziuban & Shirkey, 1974; Kaiser & Rice, 1974). The exploratory factor analysis (EFA) was performed using maximum likelihood extraction method with a direct oblimin rotation (Costello & Osborne, 2005). The oblique rotation method of direct oblimin was selected due to the expected correlation between coping factors. WBOR users were likely to use any number of coping strategies, therefore assuming that coping dimensions were orthogonal to one another was inappropriate (Lazarus & Folkman, 1984; Miller & McCool, 2003).

Factor selection was performed using the Kaiser-Guttman rule which uses an eigenvalue cut-off of one and six factors were extracted (Brown, 2015). The total variance explained was 66.8%. The variables loaded on six reasonable theoretical factors, with the two cognitive coping sub-domains largely loading together and behavioral coping items largely remaining within their distinct sub-domains (Table 3). One factor was comprised of two absolute displacement items and one activity substitution item. Upon further investigation, the researchers felt the new factor was logical and it was retained in the analysis.

When examining the factors extracted, four items were removed from further analysis. Two items—"Planned to leave the Pennsylvania section of Lake Erie because of water quality conditions" and "Talked with other members of your group about water quality conditions"—were removed from further analysis due to cross-loadings greater than .32 with other factors (Costello & Osbourne, 2005). One item, "Told yourself that water quality conditions were actually a symptom of some larger problem," was removed due to its weak and illogical loading (.344) on a factor comprised of behavioral direct action items. Finally, one variable, "Decided that, for the Pennsylvania section of Lake Erie, water quality conditions were what they should be" was removed from further analysis due to only loading negatively on one factor at a low level (-.36). Although some items retained had loadings that were relatively low, all were above Tabachnick and Fidell's (2001) recommended cutoff of .32 and loaded on logical factors. As a preliminary test of validity, each factor was analyzed for internal reliability using Cronbach's Alpha. All factors demonstrated acceptable reliability above 0.7 (Vaske, 2008), except for that of direct action (Table 3). This low reliability was addressed during model testing.

Confirmatory Factor Analysis

Following the EFA, all items, except for the four coping items discussed previously, were entered into a confirmatory factor analysis (CFA) (Table 4). Due to the results of the EFA, each factor was treated as its own latent variable. Water quality impact was treated as a single-item latent variable. While this is not traditional in structural equation modeling, it has been shown to be appropriate, with some methodologists even preferring it (Hayduk & Littvay, 2012). The error terms for these types of variables must be fixed in maximum likelihood estimation. Ideally, this error term would be fixed by multiplying the error variance by 1-ρ, where ρ is the reliability estimate of the indicator (Brown, 2015). This reliability would be best derived from scales measuring the same concept in previously published research. In the case of water quality impacts on recreation experiences, such estimates are not readily available. Accordingly, the analysis was run three times with the error fixed at .1, .2, and .3. While there were no large changes in model fit, the higher error values increased the total variance explained. Due to this, the most conservative error rate (.1) was selected. Where necessary, latent variables with two indicators were constrained to be equal at the value of one; this was done to ensure model identification (Kline, 2011).

The initial measurement model did not show an acceptable fit to the data (χ^2:736.12 p<.001; *DF*: 299; χ^2/df=2.46; CFI=0.89; TLI=0.87; RMSEA=0.072; SRMR=.063) (Bentler, 1990; Brown, 2015; Hu & Bentler, 1999). When reviewing modification indices, two items were clearly problematic, as error correlation with a number of items out of construct was suggested which would have resulted in large changes in chi-square. Due to this, one item from the coping domain of resource substitution, "Decided that you would avoid a certain area of Lake Erie because of water quality conditions," was removed, and one awareness item, "Lake Erie experiencing record poor water quality standards," was removed. After removal of these two items, the model demonstrated an acceptable fit to the data (χ^2:536.79 p<.001; *DF*: 250; χ^2/df=2.16; CFI=0.91; TLI=0.89; RMSEA=0.06; SRMR=.06). Although the chi-square was significant, the RMSEA and SRMR were within the acceptable limits suggested by Hu & Bentler (1999) and the CFI was above the minimum threshold suggested by Bentler (1990). Due to the exploratory nature of these indices, the measurement model was accepted.

Table 3

*Exploratory Factor Analysis – Pattern Matrix - Water Quality Coping**

Item	Cognitive	Activity Sub	Resource Sub	Direct Action	Temporal Sub	Absolute Action
Cronbach's Alpha	.83	.85	.79	.58	.75	.70
Realized that the WQC you experienced were really acceptable after all	.78[a]					
Told yourself to continue on as if nothing has happened	.71					
Told yourself that there was nothing you could do about WQC, so you just enjoyed the experience for what it was	.54					
Told yourself it was unreasonable to expect that WQC should have been different within the PA section of Lake Erie.	.52					
Realized that doing some activity other than [fish/boat/beach] on Lake Erie would allow you to avoid WQC		.89				
Planned to do other things besides [fish/boat/beach] to avoid WQC		.83				
Decided that, for the PA section Lake Erie, WQC were what they should be**		-.37				
Realized that visiting different areas of the PA section of Lake Erie would allow you to avoid WQC			.77			
Decided you would come back to the PA section of Lake Erie at the same time, but would visit a different area of the lake to avoid WQC			.68			
Decided that you would avoid a certain area of Lake Erie because of WQC			.65			
Planned to leave the PA section of Lake Erie because of WQC*			.44			.40
Decided to talk with Lake Erie authorities about WQC				.80		
Decided to talk to someone who could do something about WQC				.58		
Talked with other members of your group about WQC**		.49		.55		
Told yourself that WQC were actually a symptom of some larger problem**				.34		
Decided that, if you visited the PA section of Lake Erie in the future, visiting during a different season would help you avoid WQC					-.84	
Realized that you could avoid WQC in the future by visiting this area at a different time					-.62	
Decided that, if you visited the PA section of Lake Erie in the future, visiting during a different time of day would help you avoid WQC					-.395	
Planned to never visit the PA section of Lake Erie again because of WQC						.83
Decided to never [fish/boat/beach] again because of WQC						.63
Decided [fish/boat/beach] is no longer important to you because of WQC						.37

*Maximum likelihood extraction with direct oblimin rotation; 66.7% variance explained; Cut-off Eigen-value=1.00
**Item not included in CFA or included in Cronbach's Alphas
[a]Values are factor loadings from the direct oblimin pattern matrix. Values below 0.30 were suppressed

Table 4

Confirmatory Factor Analysis of Water Quality Coping, Impact, and Awareness

Item	Unstandardized Factor Loadings[ab]	Standard Error	Standardized Factor Loadings
Cognitive Coping			
Realized that the WQC you experienced were really acceptable after all	1.00		.68
Told yourself to continue on as if nothing has happened	1.42	.14	.76
Told yourself that there was nothing you could do about WQC, so you just enjoyed the experience for what it was	1.28	.14	.68
Told yourself it was unreasonable to expect that WQC should have been different within the PA section of Lake Erie.	0.85	.10	.59
Activity Substitution			
Realized that doing some activity other than [fish/boat/beach] on Lake Erie would allow you to avoid WQC	0.91	.09	.78
Planned to do other things besides [fish/boat/beach] to avoid WQC	1.00		.94
Resource Substitution			
Realized that visiting different areas of the PA section of Lake Erie would allow you to avoid WQC	1.02	.09	.82
Decided you would come back to the PA section of Lake Erie at the same time, but would visit a different area of the lake to avoid WQC	1.00		.82
Temporal Substitution			
Decided that, if you visited the PA section of Lake Erie in the future, visiting during a different time of day would help you avoid WQC	1.00		.71
Decided that, if you visited the PA section of Lake Erie in the future, visiting during a different season would help you avoid WQC	1.27	.13	.72
Realized that you could avoid WQC in the future by visiting this area at a different time	1.22	.13	.68
Absolute Actions			
Planned to never visit the PA section of Lake Erie again because of WQC	1.00		.65
Decided to never [fish/boat/beach] again because of WQC	1.33	.16	.74
Decided [fish/boat/beach] is no longer important to you because of WQC	1.63	.15	.63

Table 4 (cont.)

Direct Action*			
Decided to talk with Lake Erie authorities about WQC	1.00		.66
Decided to talk to someone who could do something about WQC	1.00		.63
Water Quality Impact			
Overall water quality impact	1.00		.97
Water Quality Awareness			
Poor water quality in Lake Erie	1.00		.81
An increase in the number of harmful algal blooms	0.65	.07	.54
A decrease in fish populations	0.70	.06	.61
An increase in foul smelling water	0.85	.07	.68
An increase in the number of beach closures	1.02	.06	.83
A decrease in the number of annual fish allowed to be consumed from Lake Erie	0.80	.10	.70
Areas within the lake becoming inaccessible due to WQC	0.91	.09	.78
Some marinas closed or unusable due to WQC	1.06	.06	.92

Note. WQC = *Water Quality Conditions*
Model: χ^2:536.76 p<.001; DF: 249; χ^2/df=2.16; CFI=0.91; TLI=0.89; RMSEA=0.06; SRMR=0.06
[a]Items fixed as a reference item at 1.00 due to constraints required by SPSS Amos
[b]All regression weights significant at p<.001
*Factor not included in final structural model

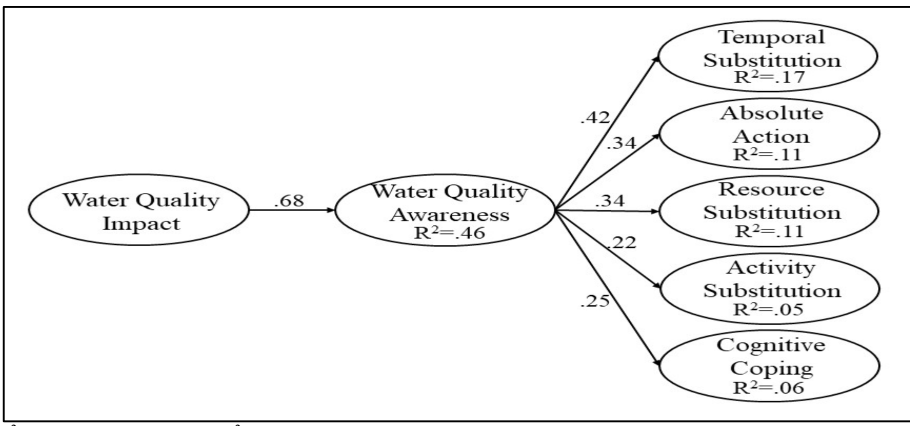
Structural Model

A structural model testing the predicted relationship between water quality impact, water quality awareness, and coping mechanisms was accepted (Figure 2; Table 5). When testing the model, error was allowed to correlate between the six coping factors. Brown (2015) describes two main reasons for correlated error between variables, theoretical rationale and measurement based. When allowing error to correlate between latent variables, the researchers are "reflecting the assumption that the corresponding endogenous variables share at least one common omitted cause" (Kline, 2011, p. 107). Due to the correlated nature of coping (Lazarus & Folkman, 1984; Miller & McCool, 2003), as well as the fact that the model only seeks to explain one reason for the different coping factors, the researchers felt justified in allowing error to correlate.

Additionally, Brown (2015) describes measurement rationale for allowing correlated errors. Due to the similar wording and placement of the items on the same battery and having them all rated with the same scale, correlated error may be expected based on measurement. Finally, if correlated errors are plausible for two variables, then all variables for which this rationale exists should be specified in this manner (Brown, 2015). Due to these reasons, the six dimensions were allowed to correlate before any structural model was tested.

The initial measurement model provided a marginally acceptable fit to the data (χ^2:582.57 *p*<.001; *DF*: 255; χ^2/df=2.28; CFI=0.90; TLI=0.88; RMSEA=0.07; SRMR=.06). The path between water quality awareness and the coping dimension of direct action was not significant. As such, the path, and subsequently the dimension, was removed. After the removal of direct action, the model provided an acceptable fit to the data (χ^2: 481.13 p<.001; *DF*: 215; χ^2/df=2.24; CFI=0.92; TLI=0.90; RMSEA=0.07; SRMR=0.06). Once again the chi-square was significant; however, the RMSEA and SRMR were within the acceptable limits suggested by Hu & Bentler (1999) and the CFI and TLI were above the minimum threshold suggested by Bentler (1990). Using these benchmarks, the model was accepted.

The model showed that water quality impact strongly predicted water quality awareness. This relationship demonstrated that the more visitors identified water quality as a negative impact on their overall experience, the more aware they were of water quality conditions. Further, the more visitors were aware of water quality conditions, the more they employed five of the six coping factors. The awareness of water quality moderately predicted temporal substitution, weakly to moderately predicted resource substitution and absolute actions, and weakly predicted activity substitution and cognitive coping mechanisms.



χ^2:481.13 p<.001; DF: 215; χ^2/df=2.24; CFI=0.92; TLI=0.90; RMSEA=0.07; SRMR=0.06

Figure 2. Structural model.

Table 5
Structural Model

Significant Paths	R^2	Regression Weights	Standard Error	z-values	Standardized Regression Weights
WQ Awareness	.46				
WQ Impact →		.98	.08	11.92***	.68
Resource Substitution	.11				
Awareness →		.38	.08	4.99***	.34
Activity Substitution	.05				
Awareness →		.20	.06	3.13**	.22
Temporal Substitution	.17				
Awareness →		.26	.05	5.71***	.42
Absolute Actions	.11				
Awareness →		.18	.04	4.59***	.34
Cognitive Coping	.06				
Awareness →		.18	.05	3.59***	.25

Model: χ^2:481.13 p<.001; DF: 215; χ^2/df=2.24; CFI=0.92; TLI=0.90; RMSEA=0.07; SRMR=0.06
*p<.05, **p<.005, ***p<.001

Discussion

Water quality conditions such as harmful algal blooms and E. coli have existed within the Lake Erie watershed for centuries, but it was not until recently that the effects of climate change have affected their frequency, scale, and intensity (Ho & Michalak, 2015; NRDC, 2014). Recognizing that these water quality conditions are a byproduct of climate change and that the topic of climate change has become increasingly contentious, this study did not use the term *climate change* with regard to measurement as this phrasing and labeling has been shown to bias and alter respondent perceptions (Schuldt, 2016; Schuldt, Enns, & Cavaliere, 2017). Rather, this study assessed recreationists' perceptions and responses to certain water quality conditions proliferated by climate change. Nevertheless, study findings have potential implications for a range of climate change influenced phenomena.

The coping framework theorizes that when an individual appraises a situation as undesirable, both cognitive and behavioral coping responses are employed to maintain the overall experience (Lazarus & Folkman, 1984). A considerable amount of research has examined coping within the context of undesirable social conditions (Manning, 2011; Manning & Valliere, 2001; Miller & McCool, 2003; Schuster et al., 2006). To our knowledge, no research has attempted to apply the coping framework within the context of undesirable environmental conditions. This study addressed this gap by testing a model to better elucidate environmental-coping relationships amongst WBOR.

From a theoretical perspective, the coping model applied in this study behaved in a similar manner as previous coping models (Iwasaki & Schneider, 2003; Lazarus & Folkman, 1984; Manning & Valliere, 2001; Miller & McCool, 2003). For example, Manning and Valliere (2001) found that recreationists were more likely to employ behavioral as opposed to cognitive coping mechanisms in response to crowding in Acadia National Park. In this study, an examination of the paths between the latent variables revealed patterns generally consistent with the hypothesized relationships based on prior literature. The more visitors identified water quality as a negative impact on their overall experience, the more aware they were of water quality conditions. The more aware visitors were of water quality conditions, the more they reported the need to employ coping responses.

Consistent with the literature, study findings suggest both behavioral and cognitive coping responses are common among recreationists and the employment of coping mechanisms can be related to recreationists' perceptions of both social and environmental changes (Iwasaki & Schneider, 2003; Lazarus & Folkman, 1984; Manning & Valliere, 2001; Miller & McCool, 2003). When accounting for the influence of impact and awareness, results indicated stronger relationships with behavioral as opposed to cognitive coping mechanisms. In this study, higher levels of water quality awareness had the strongest relationship with the behavioral coping mechanisms of temporal substitution, absolute action, and resource substitution and the weakest relationship with cognitive coping and activity substitution. These findings corroborated previous coping research such as Miller and McCool (2003) who found that higher levels of threat perception were more strongly related to behavioral as opposed to cognitive coping responses among recreationists in Glacier National Park.

The literature also suggests that encountering undesirable impacts may influence awareness and may lead visitors to change either their behaviors or their environment

(Anderson & Brown, 1984; Becker, Nieman, & Gates, 1980; Brownlee, Hallo, & Krohn, 2013; Kuentzel & Heberlein, 1992; Miller & McCool, 2003; Pearce et al., 2010; Shelby & Vaske, 1991). In this study, water quality conditions affected by climate change manifested themselves as accelerated forms of relatively familiar and age-old water quality issues on Lake Erie (e.g., E. coli and harmful algal blooms). Lake Erie's history of industrial development, rampant pollution, and general regulatory oversight should also be considered as this history may in fact play a role with regard to coping response. For example, it's possible that older, localized, and experienced Lake Erie water-based recreationists had likely observed and interacted with these water quality conditions in the past. These past encounters may have allowed recreationists to recognize water quality issues as manageable situations they could overcome by employing relatively simple behavioral coping adjustments (e.g., temporal, activity, and resource substitutions). These observations offer support for the notion that a visitor's "judgment concerning what might and can be done" (Lazarus & Folkman, 1984, p. 53) can be related to their perceptions (e.g., impact and awareness) of an undesirable condition.

In summary, this study adapted the coping framework used by Iwasaki and Schneider (2003), Manning and Valliere (2001), Miller and McCool (2003), Propst (2008), and Schuster et al. (2006) through the investigation of environmental conditions and coping within a recreation setting. It went beyond determining perceptions of environmental conditions and attempted to determine if the impact and awareness of environmental conditions influenced the employment of coping mechanisms. While the structural model does not confirm causality between the constructs, the magnitude and significance of the associations provided a means of support for the expected relationships within the overall theoretical model. The relationships found contribute to advancing the outdoor recreation coping literature by applying coping as a response to environmental conditions.

Management Implications

A central concept for maintaining high-quality outdoor recreation experiences is the identification of visitor resource perceptions and related impacts (Manning, 2011). Resource managers often believe that recreationists are not impacted and unaware of environmental conditions (Manning, 2011; Vistad, 2003; Wikle, 1991). Yet in this study, the predominantly older and experienced sample was found to be both impacted and aware of the environmental conditions encountered. Study findings confirmed visitors' perceptions of water quality impacts and awareness resulted in the employment of coping responses. When encountering water quality conditions, the behavioral coping responses of temporal substitution, resource substitution, and absolute action were implemented more often than cognitive and activity substitution coping responses. For resource managers within the Pennsylvania coastline of Lake Erie, these results yield important information about their constituency as well as potential managerial responses.

For example, an understanding of visitors' perceptions and coping responses to environmental conditions can assist resource managers in developing effective strategies to elicit public support, inform policy and planning decisions, and mitigate climate change impacts (Brownlee, 2014; Toth & Hizsnyik, 2008). It is important to recognize that while the scientific community has evidence that water quality conditions are affected by climate change, recreation visitors may not realize or explicitly make this connection. As the topic of climate change continues to be debated and swirled with controversy, its effects on the natural environment continue. Management and scientific efforts to understand climate change impacts should consider using language referencing the outcomes of climate change (e.g., poor water quality), rather than the term 'climate change' as this phrasing and labeling has been shown to bias and alter respondent perceptions (Schuldt, 2016; Schuldt, Enns, & Cavaliere, 2017).

In recognition of Lake Erie's changing environmental conditions, the U.S. Environmental Protection Agency and the Erie County Pennsylvania Department of Health established a two-tiered advisory protocol for public notification of water quality conditions within Pennsylvania's recreational beaches. Based on biweekly water quality sampling, water-based recreation sites can be posted with either recreation advisories or restrictions. Resource managers should consider initiating a targeted communication strategy (e.g., social media, radio advisories, website warnings) directed towards informing key water-based recreation stakeholders (e.g., boaters, anglers, and beach users) of both the advisory status as well as the available temporal and resource substitution options prior to their arrival on site. Recognizing that a significant portion of WBOR visitors are repeat users traveling an average of 50.4 miles to the coastline, resource managers should implement a preemptive communication strategy to directly target WBOR stakeholders and suggest differential timing strategies and alternative resource options to avoid water quality advisories and conditions. Further, Lake Erie managers should increase communication across the multiple resource agencies in the area (e.g., Pennsylvania Fish and Boat Commission, USDA Forest Service, U.S. Fish and Wildlife Service) so that all resource substitution options (e.g., inland lakes, streams, rivers) are known and available to both WBOR visitors as well as the resource managers in those various locales. In an era of dwindling public funding, it is critical to initiate some form of a directed communication strategy to ultimately avoid absolute action and displacement coping responses amongst WBOR visitors and to further strengthen the social and ecological reputation of the resource. Finally, the status of environmental conditions should be constantly observed, monitored, and evaluated within their biophysical context (e.g., harmful algal blooms and E. coli) in an effort to accurately understand the frequency and degree to which recreationists must adapt to environmental conditions.

Limitations

While the focus of the study was to assess WBOR visitors as a whole, there is merit in examining differential effects for specific forms of water-based recreation. The measures used in this study were not activity-specific, making it less appropriate to compare amongst various recreation activity types. Moreover, this study did not have sufficient sample size to examine the various constructs across recreation activity types. Future studies should consider segmenting and analyzing recreationists by activity type. This segmentation could aid in further understanding the effects of water quality impacts and awareness, and the employment of coping mechanisms on individual user segments. Future studies should also consider employing self-administered field surveys as social judgement bias is possible when surveys are read aloud.

In terms of model testing, a number of variables within this data set violated the assumption of univariate normality. When these assumptions are violated, models may show bias. McDonald and Ho (2002) have addressed this issue and stated, "maximum likelihood estimation and its associated statistics seem fairly robust against violations of normality" (p. 70). Due to this, the researchers felt comfortable relying on the robustness of the maximum likelihood method.

Further examination of the construct used to measure perceptions of water quality awareness within this study is needed. While this multi-item indicator has been successful in other environmental perception studies, it was somewhat problematic within this study. Specifically, the use of a "does not apply" option should be reconsidered as its inclusion creates problems for analysis and may not be theoretically necessary. Given the analyses conducted, it was necessary to recode the responses of "does not apply" to the mid-point scale value of four, inferring a response of "unaware." This recode was based on item conceptualization and anecdotal field observations in an effort to ultimately retain sample size and power within a more robust structural equation modeling analysis. The authors acknowledge that "does not apply" could have multiple interpretations in this context and that this recoding process should be viewed as a key study limitation. Future research should consider including other multi-item awareness measures with different unidirectional scaling (e.g., "not at all aware" to "completely aware") as well as individual anchor point labels in addition to this construct in an effort to corroborate study findings.

Finally, while the structural model demonstrated relationships between the latent variables, the absolute values (e.g., averages) of responses were sometimes slightly skewed toward disagreement with the awareness and coping items. Therefore, the actual water quality issues in Lake Erie may not be resulting in a large amount of coping. While the sample in this study appraised the water quality conditions to be slightly negatively impactful, future research within a study setting severely impacted by environmental conditions could serve as an interesting comparison. Application in areas particularly sensitive to the environmental impacts of climate change such as rainforests, prairie regions, and coral reefs could help to identify differences in coping responses within diverse environmental contexts.

Conclusion

This study should interest researchers studying coping in outdoor recreation settings. The vast coping literature notes several measurement variations (Iwasaki & Schneider, 2003; Lazarus & Folkman, 1984; Schnieder & Hammitt, 1995). This study employed an adaptation of Miller and McCool's (2003) coping assessment and specifically measured both cognitive and behavioral constructs commonly associated with outdoor recreation behaviors. Findings indicated that individuals' perception of the physical environment can influence their coping responses. The transactive nature of the coping framework suggests recreationists constantly re-appraise both the environmental conditions encountered as well as the frequency and types of coping responses employed. Likewise, the pervasive presence of climate change suggests the severity of environmental conditions will only continue to increase. Looking towards the future, scholars must longitudinally examine the effects of environmental conditions on outdoor recreation populations. Further and continuous examination of these issues will provide valuable theoretical and practical insights into the important aspects of coping responses within both outdoor recreation settings and climate change contexts.

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