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A value orientation approach to assess and compare climate change risk perception among trout anglers in Georgia, USA

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ABSTRACT

Trout in Georgia could experience early impacts from climate change as the streams in the region are located at the southernmost edge of their North American home range. This study surveyed trout anglers in Georgia to understand how anglers perceive the potential impact of climate change on trout, and whether and how their perception and response to declines in trout populations vary among anglers of different value orientations. A multivariate cluster analysis based on anglers' beliefs about protection and use of nature and sport fish yielded four segments, and anglers showed a notable variation in risk perception, as well as behavioral intention to reduce fishing trips to their preferred sites. The "Protectionists", followed by "Pluralists", were relatively more aware of risk and likely to reduce trips to affected fishing sites. The "Distanced" were neither strong believers nor deniers, whereas the "Dominionistic" were the least concerned about climate risk and least likely to change their recreation pursuits with forecast declines in trout populations. Results imply that trout anglers are more concerned about the possible impact of climate change in the future than now. In addition, the differences in social and cultural values may serve as barriers among certain angler groups in perceiving the risk of climate change and adapting to changing resources.

MANAGEMENT IMPLICATIONS

- Trout anglers in Georgia are concerned about the impact of climate change but the level of concern and stated responses to hypothetical changes in trout populations vary across value orientation segments.
- While the anglers are relatively insensitive to small declines in trout populations, sharp reductions due to climate change could mean a drop in visitation rates, resulting in reduced statewide sales of trout stamps, and a shift in type and location of recreation pursuits.
- Agencies may see benefit in climate change education programs to remove social and cultural barriers associated with perception of climate change impact on sport fishing.

1. Introduction

Trout fishing is a popular outdoor recreation activity in Georgia and many other parts of the United States. In Georgia, more than 4000 miles of trout suitable streams and rivers, and a few lakes located in 31 counties provide fishing opportunities for more than 100,000 resident and non-resident anglers (Georgia DNR, 2012). North Georgia is home to three species of trout: Brook trout (*Salvelinus fontinalis*), Brown trout (*Salmo trutta*), and Rainbow trout (*Oncorhyncus mykiss*), of which Brook trout is the only native species. However, trout streams in this region are relatively unproductive due to a high proportion of calcium deficit soils (Georgia DNR, 2012). Of the available trout streams, only 2800

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miles are suitable for reproduction, and only 142 miles is a good habitat for native Brook trout. For this reason, the wild trout population alone are not sufficient to meet the demand for trout fishing in Georgia. In response to the demand, the Wildlife Resources Division of the Georgia Department of Natural Resources (Georgia DNR) and the U.S. Fish & Wildlife Service stock roughly a million catchable-sized trout into North Georgia waters annually (Dallmier, 2010).

In the southern region of the Appalachian Mountains, trout are considered highly vulnerable to the risk of climate change[1] (Ahn, de Steiguer, Palmquist, & Holmes, 2000; Clark, Rose, Levine, & Hargrove, 2001). Trout are very sensitive to increases in temperature and decreases in dissolved oxygen levels. Among the three species of trout, Brook trout is the most sensitive to water temperature (Biagi, 1997; TWRA, 2015), and thus is more vulnerable. In general, trout require water that is less than 22 °C, and a dissolved oxygen level above 6 mg/L. Climate change may affect trout habitat by changing the water levels, increasing the water temperature, decreasing the dissolved oxygen levels, and increasing the toxicity of pollutants (Ficke, Myrick, & Hansen, 2007). Considering the sensitivity of trout to stream temperature and quality of habitat, scientists have predicted that trout populations in the region may decline due to changing climate. For example, Brook and Rainbow trout in the southern Appalachians are predicted to lose up to 24% and 16% of their habitat, respectively, if CO_2 emission level is doubled (Clark et al., 2001). Currently, most streams in Georgia remain cold enough to support trout in the winter months, but only certain mountain streams maintain suitable temperatures during the summer months (Georgia DNR, 2005).

Given that trout in Georgia are maintained more by stocking than natural growth, the initial increase in temperature and associated changes in habitat quality may not create a significant and visible impact. However, beyond a certain threshold, anglers may experience declining catch rates. For example, McMichael and Kaya (1991) found that the percentage of anglers catching no trout increased to 50% or more when water temperature increased to above 19 °C in the lower section of the Madison River in Montana. In put-and-take fisheries, fish growth is not an issue as harvesting quickly follows stocking. However, proportions of harvest and natural mortality of the stocked fish as well as the quality of habitat are fundamental factors to consider in stocking management. A high rate (up to 90%) of natural mortality of stocked trout has been reported in the lower section of the Chattahoochee River in Georgia (Klein, 2003). Thus, a significant increase in temperature and associated change in habitat quality as a result of climate change could make many streams in the lower reaches of North Georgia unsuitable or infeasible for stocking. Reduction in habitat and stockable streams due to changing climate could lead to an increase in the number of anglers per unit area and a decline in trout populations and in catch rates. Such changes may prompt anglers to travel farther in search of suitable fishing sites or fish less frequently. Either case could lead to trip dissatisfaction and/or could induce a gradual decline in trout fishing participation (Responsive Management, 2009).

The general literature on the human dimensions of climate change indicates significant knowledge gaps and misunderstanding about the causes and consequences of climate change among the general public (Heeren, 2012; Leiserowitz, Smith, & Marlon, 2010). Yet, it would be important for managers to know how much anglers themselves perceive the risk of climate change, and whether and how their perceptions vary across the population. Information about anglers' perceptions of risk and potential behavioral responses (e.g., adjustments in recreational pursuits) can be useful in understanding resource management and outreach needs.

By now it is well known that recreation user groups such as anglers differ in their attitudes, behavior, and skills when pursuing their recreation goals (Needham, Vaske, Donnelly, & Manfredo, 2007). Such inherent heterogeneity in the user community could pose additional challenges for planning and implementation of resource management and outreach programs in response to the impacts of climate change. Thus, understanding whether and how knowledge and attitudes vary among different angler groups becomes an important question. While a number of different criteria such as specialization (Chipman & Helfrich, 1988; Fisher, 1997; Hutt & Bettoli, 2007), catch orientation (Kyle, Norman, Jodice, Graefe, & Marsinko, 2007), membership in fishing organizations (Gigliotti & Peyton, 1993), and rural/urban setting (Arlinghaus, Bork, & Fladung, 2008; Hubert & Gipson, 1996) have been used to segment recreationists, little is known about the heterogeneity of recreationists who pursue a specific natural resource such as trout. Moreover, the literature is void about how recreation-resources related value orientations are associated with perception of, and response to, the risk of climate change. This study attempts to fill this knowledge gap by surveying Georgia trout anglers to assess and compare their perception and concern about the risk of climate change on trout and their potential responses to a possible climate change-induced decline in trout populations and catch rates. By doing so, the study investigates whether the perception of risk and potential adjustment in fishing trips vary among value orientation segments of trout anglers. Given the fact that the Appalachian Mountains of Georgia constitute the edge of the natural range of trout, pursuing these research questions in this state seems to be very appropriate.

2. Conceptual background and review of literature

2.1. Theory of cognitive hierarchy

The Cognitive Hierarchy Model of Human Behavior has been a popular theoretical framework for studying attitude, risk perception, and behavioral intention (Fulton, Manfredo, & Lipscomb, 1996; Vaske & Donnelly, 1999). According to this model, values, beliefs, attitudes, and norms are collectively referred to as cognition, the mental processes and dispositions which people use in thinking and understanding situations (Vaske & Manfredo, 2012). Values are commonly defined as one's desirable end state, i.e., modes of conduct, or qualities of life that a person holds dear, such as equality (Rokeach, 1973). Values, albeit in lower order of cognition and few in number, are central in belief, and therefore slow to change. Whereas, attitudes and behaviors, being in higher order of cognition, are high in number, faster to change, and specific to a situation (Fulton et al., 1996; Vaske & Donnelly, 1999). Personal values are hard to change; however, value orientations and other higher order cognitions (e.g., attitude) may be changed as a result of social, psychological, and economic factors (Manfredo, Teel, & Bright, 2003; McFarlane & Boxall, 2000).

Even though the study of values has become common in the human dimensions of wildlife and recreation literature, values account for limited variability within a given culture, and thus are poor measures for the prediction of attitudes, norms, and behaviors (Fulton et al., 1996; Manfredo et al., 2003; Vaske, 2008). Value orientations, on the other hand, are patterns of direction and

[1] Climate change refers to "any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2007, p. 871). Throughout this article we use the term "climate change," as it is a "more scientifically correct term" (Lorenzoni & Pidgeon, 2006, p. 75), except when referring to other studies that have specifically used the term "global warming" in the climate change risk perception literature.